LATIN AMERICAN REGIONAL LEGUME PROGRAM

AND

BRAZILIAN COWPEA PROGRAM

IITA/EMBRAPA/IICA

FINAL REPORT

VOLUME 1 OF 3

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AND

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AND

EMBRAPA/IITA COWPEA PROGRAM

FINAL REPORT 1985

BY

E.A. KUENEMAN AND E.E. WATT

Introduction:

The purpose of this document is to provide, in as much as is possible, a complete summary of activities and results of the 1985 Latin American Regional Program for internal use. A 32 page mid-year report was prepared in July. Some of what was reported then has been included directly in this document. We have also included updated trial results plus travel reports and copies of first drafts of the annual report, highlights, and papers on cowpea and soybean production in Latin America for publication by IITA.

The EMBRAPA/IITA/IICA cowpea program for Brazil was initiated in 1978; Dr. E. Watt was based in Brazil. And since that time 17 varieties have been released in Brazil. Seven varieties were directly from IITA/Nigeria germplasm and 4 other varieties were derived from crosses involving IITA germplasm.

In 1985 the Regional Latin American Program was initiated and Dr. E. Kueneman was based in Brazil as coordinator to develop and distribute appropriate cowpea and soybean germplasm to national programs. Having two scientists based in Brazil has given the program great strength. In addition to running the Brazilian cowpea breeding program (EMBRAPA's cowpea breeder is away for Ph. D. training), Dr. Watt took principal responsibility for the day to day management of the cowpea research of the Regional Program. He also assisted in the international travel responsibilities. Dr. Watt played a key roll in setting up and maintenance of the micro-computer component for data and word processing.

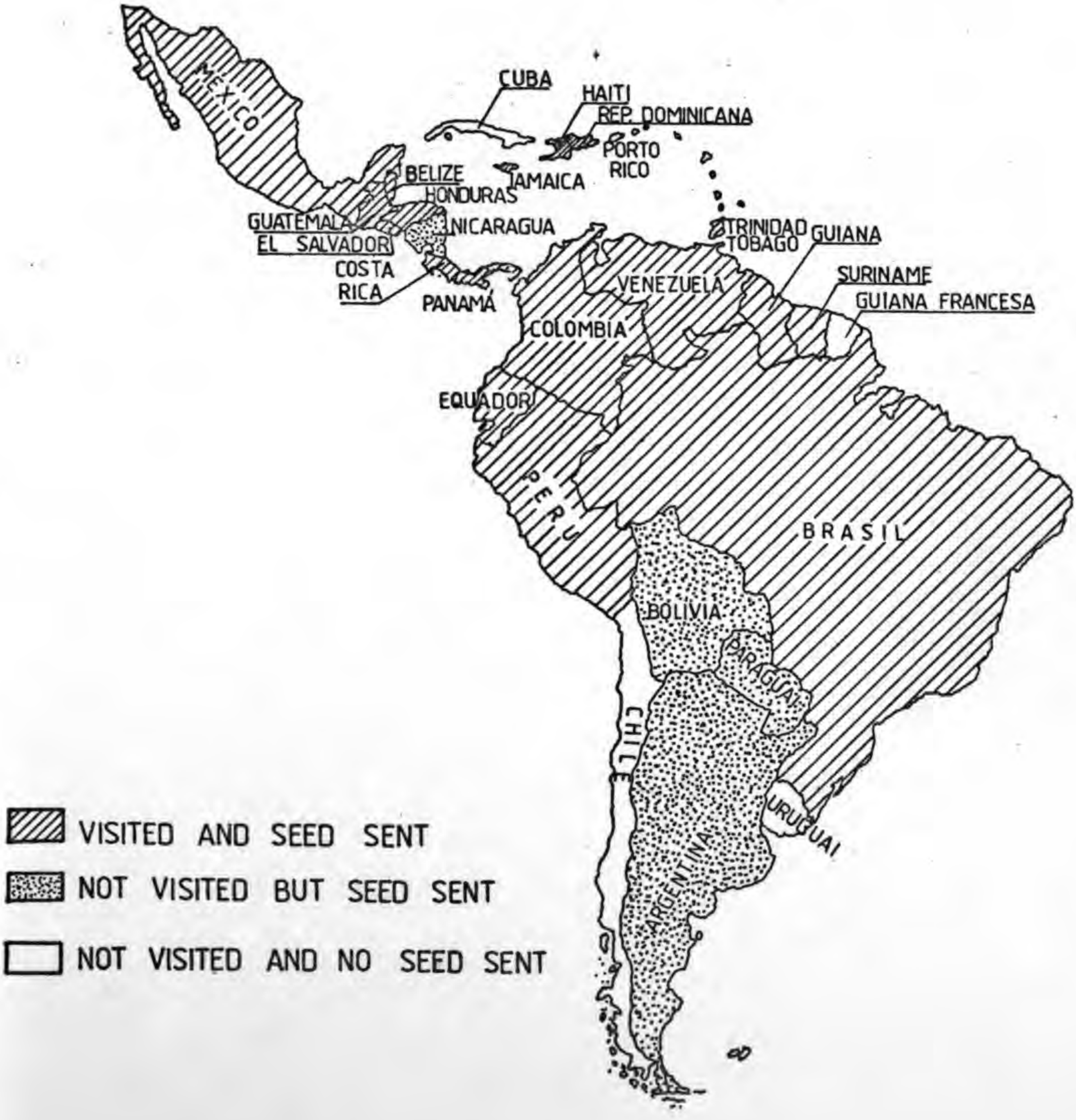
Dr. Kueneman had the overall administration responsibilities of the Regional Program. He organized the first regional cowpea and soybean training course held in April and May. Dr. Kueneman shared cowpea research responsibilities with Dr. Watt and took full responsibility for the soybean testing and breeding program. He also visited several national programs and maintained contact with many programs (Figure 1).

We would be remiss not to emphasize that the quantity of work realized in 1985 would not have been possible without the strong support of EMBRAPA. Research on cowpea was conducted primarily at EMBRAPA's center for rice and beans (CNPAF). CNPAF scientists were helpful in many ways, but particularly in screening IITA germplasm and segregating populations for virus (aphid borne and CSMV) resistance. Soybean evaluation was conducted through the EMBRAPA Soybean Center CNP-Soja at the Goias state research station EMGOPA. Both EMBRAPA and EMGOPA scientists assisted with the Latin American Regional Legume Training Course on cowpeas and soybeans. The Regional Program also received invaluable assistance from the Interamerican Institute for Cooperation in Agriculture (IICA), especially in obtaining visas for international travel.

We feel that 1985 was a very productive first year for the Latin American Regional Program and are confident that the IITA/EMBRAPA program will have substantial impact on cowpea and soybean production. In addition to Brazil, the countries where the greatest impact will likely be obtained are:

Paraguay - cowpea and soybean
Bolivia - cowpea and soybean
Uruguay - soybean
Peru - cowpea and soybean
Ecuador - cowpea and soybean
Colombia - cowpea and soybean
Venezuela - cowpea and soybean
Guiana - cowpea
Surinam - cowpea
Panama - cowpea
Costa Rica - soybean
Nicaragua - cowpea and soybean
El Salvador - soybean
Honduras - soybean
Belice - soybean and cowpea
Guatamala - soybean
Mexico - soybean and cowpea
Trinidad - cowpea
Jamaica - cowpea and soybean
Dom. Republic - cowpea and soybean
Haiti - cowpea
Cuba - cowpea and soybean

FIGURE 1.


MEXICO
CUBA
HAITI
REP. DOMINICANA
PORTO RICO
BELIZE
HONDURAS
JAMAICA
GUATEMALA
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMÁ
TRINIDAD TOBAGO
GUIANA
SURINAME
GUIANA FRANCESA
VENEZUELA
COLOMBIA
EQUADOR
PERU
BRASIL
BOLIVIA
PARAGUAI
CHILE
ARGENTINA
URUGUAI
▨ VISITED AND SEED SENT
▒ NOT VISITED BUT SEED SENT
☐ NOT VISITED AND NO SEED SENT

ANNUAL REPORT 1985

IITA/EMBRAPA REGIONAL LEGUME PROGRAM FOR LATIN AMERICA

E.A. KUENEMAN AND E.E. WATT

IITA/EMBRAPA REGIONAL LEGUME PROGRAM FOR LATIN AMERICA

Brazil is the second largest producer of cowpea behind Nigeria. The crop is primarily grown by small farmers in the humid Amazon Basin and in the semi-arid Northeast where rainfall is erratic. Brazil is also the second largest producer of soybeans behind the U.S.A. In 1978, IITA placed a cowpea breeder with the National Agricultural Research Organization of Brazil (EMBRAPA) to assist in the establishment of a national cowpea research program. The collaborative effort of EMBRAPA and IITA has been very fruitful and 17 cowpea varieties from this program have been released by state organizations in Brazil. In 1985 IITA and EMBRAPA further strengthened their working relationship by initiating a regional legume program for Latin America. Using Brazil as a base, the regional program can take full advantage of the experience and germplasm of both IITA-Nigeria and of Brazil's National Program to assist other countries in Latin America. The major thrust of the regional program focuses on germplasm evaluation, enhancement and distribution. Training is also considered first priority.

Cowpeas have an important role to play in providing vegetable protein to people of Latin America. In lowland tropical ecologies cowpeas have few diseases and insect problems relative to the generally preferred legume, Phaseolus vulgaris. Cowpeas are also better adapted to drought stress and low-fertility soils. However, there are two virus diseases that frequently cause significant yield losses, Cowpea Severe Mosaic Virus (CSMV) and the poty virus complex (PVC). CSMV is specific to the Americas; consequently, germplasm developed in Nigeria is susceptible. Most of the IITA-Nigeria lines are also susceptible to the strains of poty virus found in Latin America. IITA and Brazilian scientists have identified sources of resistance and are incorporating resistance into improved germplasm from IITA to distribute to national programs.

Southern cone countries of Latin America: Brazil, Argentina, Paraguay, Uruguay, and Bolivia are self-sufficient in soybean production. Nineteen countries located in the tropical and sub-tropical regions import substantial quantities of soybeans or soybean products which often causes a drain on scarce foreign exchange. Relatively little research has been conducted on soybeans in the tropics. A major constraint is the rapid loss of vigor of soybean seeds harvested and stored in humid tropical ecologies. In recent years IITA has developed tropical soybean germplasm with superior seed longevity. The Latin American Regional Program is evaluating IITA's germplasm at several diverse sites. Brazilian scientists have recently developed soybean lines for the tropics with disease resistance and superb agronomic characteristics. The regional program is beginning to distribute germplasm to national programs and crosses have been made to combine the superior seed longevity of IITA germplasm with the agronomically superior Brazilian germplasm.

COWPEA RESEARCH

Virus screening: Two hundred and ten cowpea breeding lines from IITA-Nigeria were screened in separate inoculate trials for CSMV and PVC. All lines were susceptible to CSMV. Thirteen lines showed some resistance to PVC and these were re-tested; four of them (IT 82D-784, IT 82D-844, IT 82D-786, AND IT 82D-787) were confirmed to have resistance. IT 82D-716 and IT 82D-812 have shown some field-level resistance to both viruses.

It is important to send virus resistant cowpeas to ecologies where viruses are problematic. In Latin America an ecology may have PVC, CSMV, or both. It is also possible that a new virus may exist. To characterize the virus situation the Regional Program is sending three cowpea differentials: BR 1-Poty (resistant to PVC, susceptible to CSMV); CNC 0434 (resistant to CSMV, susceptible to PVC); and CNCx 252-1E (resistant to both PVC and CSMV). From initial observation it has been determined that in Northern Brazil (states of Acre, Rondonia, and Para), CSMV is the predominate virus. In Amazonas state, viruses are presently of little concern. In Northeastern Brazil both viruses are present. In Ecuador, cowpeas are principally grown in the coastal regions where PVC predominates; CSMV was also observed. In the Amazon Basin of Peru CSMV is the principle virus.

Hybridization in Cowpea

Approximately 100 crosses (simple, double, 3-way, backcrosses) were made to incorporate virus resistance into IITA germplasm. Another 89 crosses were made in the Brazilian National Program (Table 1).

The F2 to F4 populations carrying resistance to CSMV were inoculated and susceptible plants were rogued. Screening for PVC will be initiated in the F3. Most populations are being advanced by single pod descent procedures; pods are only taken from virus resistant plants. In the F5 a few single plant selections are made and the remaining plants are bulk harvested. The single plant selections are re-tested for virus resistance and multiplied for preliminary yield trials. The bulk populations are sent to collaborating scientists within and outside of Brazil for selection in diverse ecologies.

Brazilian/IITA Yield Trials

Regional Trials: Three multi-locational Regional Trials were conducted in 1985 and consisted of lines that had been selected from previous Advanced Trials. Because efforts to incorporate virus resistance are relatively recent, most lines in Regional and Advanced Yield Trials are susceptible to virus.

Regional Trial 1 consisted of 12 colored-seeded entries with sprawling growth habit (Table 2). In Brazil there is a strong preference for large seed. The highest yielding entry, CNCX 166-08G, had a seed weight of 24g/100 seeds which is similar to that of the check 'Serido'. CNCX 105-18E and CNCX 189-05G both showed resistance to poty virus in an inoculated test.

Regional Trial 3 consisted of 12 colored-seeded entries with erect growth habit (Table 3). CNCx 105-22E and CNCx 149-01G were high yielding and had large seed.

Regional Trial 4 consisted of 12 white-seeded entries with erect growth habit (Table 4). Most entries in the trial are resistant to CSMV. The highest yielding entry was CNCx 171-012E.

<u>Advanced Trials</u>: Two multi-locational Advanced Yield Trials were conducted in 1985. Each trial consisted of 25 entries with 4 replications. Entries were selected from 1984 Preliminary Trials.

Advanced Trial 1 consisted of colored-seeded lines with sprawling growth habit (Table 5). Both CNCx 85-6D and CNCx 187-22D-2 were resistant to both poty and CSMV viruses but only the latter had large seed which is generally required in Brazil.

Advanced Trial 3 consisted of colored-seeded entries with erect growth habit (Table 6). The highest yielding line was the check entry BR 1-Poty. CNCx 163-18F is relatively resistant to poty virus and has good seed size. Only the check line CNC 0434 was resistant to CSMV.

<u>Preliminary Yield Trials</u>: Four multi-locational Preliminary Trials were conducted in 1985; each trial had 49 or 36 entries in a lattice design with three replications.

Preliminary Trial 1 consisted of colored-seeded lines with sprawling growth habit (Table 7). Several promising entries are resistant to CSMV. CNCx 252-1E and CNCx 252-9E are resistant to both CSMV and poty virus.

Preliminary Trial 2 consisted of white-seeded lines with sprawling growth (Table 8). The entries in this trial were evaluated for resistance to CSMV; many entries were resistant. Most entries are known to be susceptible to poty virus but this test was not conducted. CNCx 190-3E/P, CNCx 190-6E/P and CNCx 161-17E/P gave the highest mean yields. CNCx 172-1E/P is resistant to CSMV and is large seeded. It only yielded well in Crateus but will be tested further in 1986.

Preliminary Trial 3 consisted of colored-seeded lines with erect growth habit (Table 9). All entries were virus susceptible. CNCx 251-79E and CNCx 251-81E yielded relatively well and had large seed size.

Preliminary Trial 4 consisted of white-seeded lines with erect growth habit (Table 10). CNCx 171-4E/P is resistant to poty virus and has intermediate seed size.

(E.E. Watt, E.A. Kueneman, R. Guazzelli)

SOYBEAN VARIETAL EVALUATION

Agronomic assessment: About 800 IITA soybean lines were sown in single row plots with 200 Brazilian lines near Goiania. Entries were assessed for disease reactions and agronomic characteristics. Based on these preliminary results, 250 lines were sown in northern Goias state at the Rio Formoso Project under short-day conditions (approximately 11 1/2 hours). At the same time, 150 promising lines were multiplied under irrigation near Goiania for entry in multi-location replicated trials in 1986.

Seed longevity analyses: Two trials were conducted to test resistance to field weathering of seed using the IITA incubator weathering procedure (see IITA Annual Report, 1982). Varietal differences were pronounced (Table 11). The experiment will be repeated in 1986.

Seed from the 1000 lines assessed for agronomic characteristics were subjected to IITA's modified accelerated aging test (7 weeks at 70% RH., 40 degrees Centigrade). Some of the most promising lines with good seed longevity are shown in Table 12.

Hybridization in Soybean: Thirty-one single crosses were made involving IITA germplasm having superior seed longevity and/or promiscuous nodulation with Brazilian germplasm having superior agronomic characteristics such as yield potential, disease resistance, lodging resistance, and uniform maturation. An additional 23 three-way and double crosses were made.

INTERNATIONAL GERMPLASM DISTRIBUTION

In addition to the trials sent to national programs by IITA-Nigeria, the IITA/EMBRAPA Latin American Regional Program sent cowpea trials to 12 collaborators outside of Brazil and sent soybean germplasm to 15 collaborators.

(E.A. Kueneman)

TABLE 1.

COWPEA CROSSES MADE IN BRAZIL, 1985

Purpose	Crosses
1) Incorporation of virus resistance into IITA germplasm	100
2) Virus resistance for Brazil	26
3) Virus resistance in bush vegetable pod type	10
4) Virus resistance in yard-long type	03
5) Virus resistance in Venezuelan germplasm	18
6) Fusarium resistance	12
7) Miscellaneous	20
Total:	189

TABLE 2.
BRAZILIAN/IITA REGIONAL TRIAL 1 (SPRAWLING HABIT, COLORED SEED), 1985

	YIELD (KG/HA)							VIRUS		100 SEED
ENTRY	G:GO	A:GO	J:MG	ST:PE	AL:PB	AT:MA	MEAN	POTY	CSMV	WT. (G)
CNCx 105-18E	647	442	905	488	330	313	559	1.0	4.0	16
CNCx 105-12E	527	431	1107	407	380	308	556	3.5	3.5	18
CNCx 158-09G	555	402	908	393	369	327	517	4.5	4.0	19
CNCx 160-10G	638	380	1099	367	360	356	568	4.0	4.0	19
CNCx 189-05G	691	355	508	597	344	272	485	1.5	4.0	18
CNCx 158-01G	596	587	1113	578	372	295	634	4.5	4.0	15
CNCx 166-08G	612	700	1393	501	456	393	720	3.5	3.0	24
CNCx 149-09G	602	516	1240	466	456	319	629	4.5	3.5	20
CNCx 24-015E	828	349	689	255	249	197	464	4.0	4.0	16
CHECKS										
LOCAL CHECK 1	604	593	1121	387	295	221				
LOCAL CHECK 2	573	429	1075	623	378	361				
SERIDO	436	691	1154	394	412	88	553	3.0	4.0	23
MEAN	609	499	1032	455	367	288	574			18
C.V.%	24		12	27	35	39				
LSD (0.05)	210		186	180	184	162				

LOCATIONS: G:GO = GOIANIA, GOIAS; A:GO = ARAGUAINA, GOIAS; J:MG = JANUBA, MINAS GERAIS, ST:PE = SERRA TALHADO, PERNAMBUCO; AL:PB = ALAGOINHA, PARAIBA; AT:MA = ALTO TURE, MARANHAO.

VIRUS SCORES: 1 = HIGHLY RESISTANT, 5 = HIGHLY SUSCEPTIBLE.

TABLE 3.
BRAZILIAN/IITA REGIONAL TRIAL 3 (ERECT HABIT, COLORED SEED), 1985

ENTRY	YIELD (KG/HA) G:GO	A:GO	J:MG	ST:PE	IT:PB	P:MA	MEAN	VIRUS POTY	CSMV	100 SEED WT.(G).
CNCx 105-22E	720	814	1835	916	1958	534	1130	3.5	5.0	19
CNCx 112-01E	573	713	971	1012	1459	524	875	3.5	4.0	15
CNCx 105-8F	790	709	1533	1188	2331	612	1194	3.5	4.0	14
CNCx 177-02G	674	888	1233	641	903	402	790	4.0	4.0	15
CNCx 176-03G	738	731	803	684	1497	591	841	4.0	5.0	17
CNCx 159-03G	486	662	494	394	1918	387	724	4.5	5.0	17
CNCx 149-01G	808	728	1783	1088	1889	477	1129	3.0	4.0	17
CHECKS										
LOCAL CHECK 1	731	797	1194	1097	686	310				
LOCAL CHECK 2	639	722	654	1056	574	542				
BR 1-POTY	857	771	551	822	1725	461	865	2.0	5.0	15
CNC 0434	968	848	849	863	1768	241	923	3.5	1.0	16
40 DIAS	393	433	751	894	2543	384	900	4.5	4.0	14
MEAN	698	735	1054	888	1604	455	906			
C.V. %	17	26	15	32	29	30				
LSD (0.05)	168		226	412	668	198				

LOCATIONS: G:GO = GOIANIA, GOIAS; A:GO = ARAGUAINA, GOIAS; J:MG = JANUBA, MINAS GERAIS; ST:PE = SERRA TALHADA, PERNAMBUCO; IT:PB = ITAPORANGA, PARAIBA; P:MA = PINHEIRO, MANRANHAO.

VIRUS SCORES: 1 = HIGHLY RESISTANT, 5 = HIGHLY SUSCEPTIBLE.

TABLE 4.
BRAZILIAN/IITA REGIONAL TRIAL 4 (ERECT HABIT, WHITE-SEEDED), 1985

	YIELD (HA/KG)								VIRUS		100 SEED
ENTRY	G:GO	A:GO	J:MG	C:PE	M:RN	P:PB	C:CE	MEAN	POTY	CSMV	WT. (G)
CNCx 171-07E	582	968	759	639	743	1055	581	716	3.5	2.0	15
CNCx 171-09E	723	923	1076	947	564	1235	1041	930	3.0	2.0	16
CNCx 171-012E	910	1540	810	1747	993	2055	963	1288	4.0	2.0	16
CNCx 171-03E	734	928	1021	1505	982	2128	884	1169	3.5	1.0	18
CNCx 172-01E	644	968	380	2077	1179	2570	1006	1260	3.5	1.0	17
CNCx 161-01E	859	846	592	1479	1031	1615	994	1060	4.0	1.0	17
CHECKS											
CHECK 1	526	1253	746	1178	1291	1675	381	1007			
CHECK 2	614	1230	564	146	842	1175	550	731			
CHECK 3	148	1439	992	152	782		553	678			
40 DIAS	346	559	484	1765	1127	2113	1025	1059	4.5	4.0	16
CNC 0434	942	1163	506	1848	1216	2145	922	1249	3.5	1.0	16
BR 1-POTY	859	853	965	1811	1278	2155	916	1262	2.5	5.0	17
MEAN	587	1056	741	1275	1002	1811	818	1034	3.6	2.1	16
C.V. %	20	27	13	26	29	28	38				
LSD (0.05)	318	610	137	469	425	743	439				

LOCATIONS: G:GO = GOIANIA, GOIAS; C:PE = CARUARU, PERNAMBUCO; M:RN = MACAIBA, RIO GRANDE DO NORTE; C:CE = CRATEUS, CEARA; P:PB = PATOS, PARAIBA.

VIRUS SCORES: 1 = HIGHLY RESISTANT, 5 = HIGHLY SUSCEPTIBLE.

TABLE 5.
PROMISING LINES FROM BRAZILIAN/IITA ADVANCED TRIAL 1 (SPRAWLING HABIT, COLORED SEED, 1985

ENTRY	YIELD (KG/HA) G:GO	 S:PE	 Q:CE	 P:CE	 P:MA	 MEAN	VIRUS POTY	 CSMV	100 SEED WT. (G)
CNCx 167-43F	849	620	600	734	392	639	4.0	4.0	20
CNCx 153-3F	1136	1425	981	890	270	940	2.0	4.0	15
CNCx 165-7E	1158	1175	816	586	293	806	2.5	4.0	13
CNCx 165-12E	1055	1263	824	623	339	821	3.0	4.0	13
CNCx 85-6D	851	1105	1152	703	239	810	2.0	2.5	11
CNCx 187-22D-2	1041	925	692	462	311	686	2.0	1.0	17
CNCx 167-6F	989	925	1002	800	278	799	4.0	4.0	19
CHECKS									
LOCAL CHECK 1	338	450	501	607	301	-	-	-	-
LOCAL CHECK 2	1024	525	325	466	304	-	-	-	-
CNC 0434	697	605	1213	619	288	684	3.5	1.0	15
BR 1-POTY	837	925	1185	673	284	781	2.0	5.0	14
PITIUBA	421	850	511	509	223	503	4.0	4.0	20
MEAN	855	762	728	625	290	667	3.0	3.0	16
C.V. %	21	30	35	24	30				
LSD (0.05)	256	328	359	213	125				

LOCATIONS: G:GO = GOIANIA, GOIAS; S:PE = SERRA TALHADA, PERNAMBUCO; Q:CE = QUIXADA, CEARA; P:CE = PACAJUS, CEARA; P:MA = PINHEIRO, MARANHAO.

VIRUS SCORES: 1 = HIGHLY RESISTANT, 5 = HIGHLY SUSCEPTIBLE.

TABLE 6.
PROMISING LINES FROM BRAZILIAN/IITA ADVANCED TRIAL 3 (ERECT, COLORED SEED), 1985

ENTRY	YIELD (KG/HA) G:GO	I:PB	P:MA	AT:MA	B:MA	MEAN	VIRUS POTY	CSMV	100 SEED WT. (G)
CNCx 164-9F	535	1030	553	630	320	614	4.0	4.0	17
CNCx 180-3F	683	1130	489	730	336	674	3.5	4.5	15
CNCx 163-18F	544	1447	619	530	295	687	2.5	5.0	18
CNCx 161-5E	1113	1367	491	570	374	783	3.0	4.0	14
CNCx 167-7E	1063	1060	437	693	341	718	4.0	4.0	19
CNCx 164-2F	678	1318	462	891	519	775	4.0	4.0	17
CHECKS									
CHECK 1	706	514	482	810	444				
CHECK 2	522	563	494	566	281				
MANAUS	274	887	432	500	424	503	4.5	5.0	10
40 DIAS	597	1232	586	400	335	630	4.5	5.0	13
CNC 0434	1174	1105	474	518	444	743	3.5	1.0	16
BR 1-POTY	1186	1351	520	645	379	816	2.0	5.0	15
TRIAL MEAN	674	870	493	612	339	598	4.0	4.0	16
C.V. %	23	27	27	43	26				
LSD (0.05)	223	332	186	368	123				

LOCATIONS: G·GO = GOIANIA, GOIAS; I:PB = ITAPORANGA, PARAIBA; P:MA = PINHEIRO, MARANHAO; AT:MA = ALTO TURE, MARANHAO; B:MA = BACABAL, MARANHAO.

VIRUS SCORES: 1= HIGHLY RESISTANT, 5 = HIGHLY SUSCEPTIBLE.

TABLE 7.
PROMISING LINES FROM BRAZILIAN/IITA PRELIMINARY TRIAL 1 (SPRAWLING HABIT, COLORED SEED), 1985

	-------YIELD (KG/HA)--------				---VIRUS----		100 SEED
ENTRY	G:GO	Q:CE	P:MA	MEAN	POTY	CSMV	WT. (G)
CNCx 251-65E	486	235	390	370	4.0	4.0	20
CNCx 252-1E	789	737	546	691	1.0	1.0	14
CNCx 252-3E	714	787	301	601	1.0	3.0	14
CNCx 252-5E	791	817	387	665	4.0	1.0	16
CNCx 252-6E	732	986	403	707	4.0	1.0	16
CNCx 252-9E	860	543	357	587	2.0	1.0	13
CNCx 257-26E	742	980	430	717	3.0	1.0	17
CNCx 279-8E	781	905	366	684	4.0	1.0	15
CNCx 279-9E	744	837	567	716	4.0	1.0	15
CNCx 284-4E	768	750	384	574	3.0	1.0	19
CNCx 284-66E	610	847	503	653	3.0	1.0	12
CHECKS							
SERIDO	331	440	541	437	3.0	4.0	19
CNC 0434	657	720	715	697	3.0	1.0	15
BR 1-POTY	399	731	550	560	2.0	5.0	13
MEAN 49 LINES	547	478	437	485	3.4	2.7	16
C.V. %	17	37	31				
LSD (0.05)	146	280	217				

LOCATIONS: G:GO = GOIANIA, GOIAS; Q:CE = QUIXADA, CEARA; P:MA = PINHEIRO, MARANHAO.

VIRUS SCORES: 1 = HIGHLY RESISTANT, 5 = HIGHLY SUSCEPTIBLE.

TABLE 8.
PROMISING LINES FROM BRAZILIAN/IITA PRELIMINARY YIELD TRIAL 2
(SPRAWLING HABIT, WHITE-SEEDED), 1985

ENTRY	YIELD (KG/HA) G:GO	M:PB	C:CE	MEAN	VIRUS CSMV	100 SEEDS WT. (G)
CNCx 176-4F/CE	471	247	686	468	R	16
CNCx 176-9F/CE	672	267	370	436	R	16
CNCx 284-55F	670	309	310	430	R	15
CNCx 332-10E	684	428	353	488	S	14
CNCx 154-1E/P	483	235	523	414	R	17
CNCx 161-10E/P	583	424	477	495	R	15
CNCx 161-15E/P	570	421	430	474	R	15
CNCx 161-17E/P	684	452	437	524	R	15
CNCx 168-7E/P	718	389	537	548	R	12
CNCx 171-7E/P	576	219	367	387	R	14
CNCx 171-28E/P	758	179	223	387	R	14
CNCx 172-1E/P	378	104	573	352	R	19
CNCx 172-3E/P	421	193	517	377	-	16
CNCx 188-13E/P-1	688	366	297	450	R	16
CNCx 188-17E/P	642	303	173	373	R	13
CNCx 190-1E/P	737	426	413	525	R	13
CNCx 190-2E/P	637	459	456	517	R	13
CNCx 190-3E/P	732	585	400	572	R	12
CNCx 190-6E/P	716	380	547	548	R	15
CHECKS						
CNC 0434	541	296	533	457	R	12
BR 1-POTY	546	268	347	387	S	13
IT 81D-994	240	142	443	275	S	--
IT 81D-991	257	151	477	295	S	--
IT 81D-988	278	104	540	307	S	23
MEAN	523	299	385	402		
C.V. %	21	37	45			
L.S.D. (0.05)	179	180	281			

LOCATIONS: G:GO = GOIANIA, GOIAS, M:PB = MANGABEIRA, PARAIBA;
C:CE = CRATEUS, CEARA.
VIRUS SCORES: R = RESISTANT, S= SUSCEPTIBLE.

TABLE 9.
PROMISING LINES FROM BRAZILIAN/IITA PRELIMINARY COWPEA TRIAL 3 (ERECT HABIT, COLORED SEED), 1985

ENTRY	YIELD (KG/HA) G:GO	 P:MA	 M:PB	 MEAN	VIRUS POTY	 CSMV	100 SEED WT. (G)
L.1413-3 (IPA)	246	527	219	331	-	5.0	20
CNCx 251-3E	413	336	317	355	3.5	4.0	15
CNCx 251-4E	328	578	284	397	3.0	4.0	14
CNCx 251-11E	273	300	272	282	3.5	3.0	16
CNCx 251-36E	300	518	126	315	3.0	4.0	17
CNCx 251-37E	401	363	311	358	4.0	4.0	16
CNCx 251-38E	340	367	195	301	4.0	4.0	16
CNCx 251-40E	412	303	93	269	3.0	3.0	15
CNCx 251-41E	271	304	291	271	3.0	4.0	16
CNCx 251-45E	412	644	172	409	3.0	4.0	17
CNCx 251-60E	335	479	275	363	3.0	4.0	15
CNCx 251-61E	457	554	358	456	3.0	4.0	16
CNCx 251-64E	210	354	70	211	3.0	3.0	16
CNCx 251-79E	436	505	259	400	3.5	3.5	21
CNCx 251-81E	445	566	228	413	4.5	4.0	18
CHECKS							
40 DIAS	108	553	100	254	4.5	4.0	13
CNC 0434	599	536	328	488	3.5	1.0	15
BR 1-POTY	437	326	210	324	1.0	4.0	14
MEAN 49 ENTRIES	278	383	175	278	3.0	4.0	16
C.V. %	30	41	50				
LSD (0.05)	136	229	142				

LOCATIONS: G:GO = GOIANIA, GOIAS; P:MA = PINHEIRO, MARANHAO;
M:PB = MANGABEIRA, PARAIBA.
VIRUS SCORES: 1 = HIGHLY RESISTANT; 5 = HIGHLY SUSCEPTIBLE.

TABLE 10.
PROMISING LINES FROM BRAZILIAN/IITA PRELIMINARY FIELD TRIAL 4 (ERECT HABIT, WHITE-SEEDED), 1985

ENTRY	---YIELD (KG/HA)---- G:GO	C:CE	MEAN	---VIRUS--- POTY	CSMV	100 SEEDS WT. (G)
CNCx 159-15E/P	539	590	565		1.0	11
CNCx 171-4E/P	624	790	707	2.0	1.0	15
CNCx 171-6E/P	552	927	740		1.0	15
CNCx 171-13E/P	449	843	646	5.0	1.0	14
CNCx 171-16E/P	647	590	619	2.0	1.0	14
CNCx 171-23E/P	662	807	735	5.0	1.0	13
CNCx 171-29E/P	738	460	599	3.0	1.0	16
CNCx 171-31E/P	603	600	602	5.0	1.0	15
CNCx 171-32E/P	519	613	566	4.0	1.0	15
CNCx 171-33E/P	704	650	677	4.0	1.0	15
CNCx 172-1E/P	477	740	609		1.0	17
CNCx 172-7E/P	650	627	639	5.0	1.0	15
CNCx 172-8E/P	769	497	633	5.0	1.0	15
CNCx 177-5E/P	564	620	592	5.0	1.0	16
CNCx 177-13-2E/P	472	563	518		1.0	14
CNCx 188-18E/P	638	620	629	3.0	1.0	13
CHECKS						
BR 1-POTY	771	677	724	1.0	5.0	13
CNC 0434	594	670	632	3.5	1.0	15
IT 81D-993	189	667	428	?	5.0	17
IT 81D-1138	230	683	457	?	5.0	22
MEAN 36 LINES	524	620	572	3.7		15
C.V. %	23	27				
LSD (0.05)	195	273				

LOCATIONS: G:GO = GOIANIA, GOIAS; C:CE = CRATEUS, CEARA.
VIRUS SCORES: 1 = HIGHLY RESISTANT, 5 = HIGHLY SUSCEPTIBLE.

TABLE 11.
SOYBEAN LINES RESISTANT TO FIELD WEATHERING, BASED ON INCUBATOR WEATHERING*, BRAZIL

Trial 1 (12 entries)	% emergence
TGx 854-77E	69
TGx 854-60E	64
TGx 252-5E	33
Bossier (check)	08
Trial 2 (21 entries)	
TGx 573-104C	66
TGx 854-42D-1	62
TGx 559-5D	38
Santa Rosa (check)	01

*Pods at yellow stage were picked and placed in an incubator at 30^{o} C and 95% relative humidity for 10 days. Seeds were sown in an emergence test.

TABLE 12.
SEEDLING EMERGENCE BASED ON IITA'S MODIFIED ACCELERATED AGING TEST OF AGRONOMICALLY ATTRACTIVE LINES IN BRAZIL

No.	Line	% Emergence
01.	TGx 856-66E	97
02.	TGx 803-99E	96
03.	TGX 802-125D	94
04.	M 79-4	94
05.	GO 83-21609	93
06.	TGx 863-86D	92
07.	TGx 302A-47E	92
08.	TGx 825-16D	92
09.	TGx 302A-37	91
10.	TGx 825-20E	91
11.	TGx 856-38E	91
12.	SG 33	91
13.	GO 83-27173	91
14.	TGx 251-1C	89
15.	TGx 539-1F	89
16.	TGx 709-8E	89
17.	TGx 802-252D	89
18.	TGx 816-42D	89
19.	IAC-7 (RC 3)	89
20.	TGx 536-02D	89
Checks		
	TGM 737P	96
	Parana	54
	Bossier	52
	Buffalo	05

LSD (0.05) = 12

FOR 1985 HIGHLIGHTS

COWPEA RELEASES IN BRAZIL

BY E.E. WATT, E.A. KUENEMAN, R. GUAZZELLI

Cowpeas are the most important food legume in the north and northeast of Brazil where they are generally grown by small farmers on marginal lands. In 1978, the National Agricultural Research Institute of Brazil (EMBRAPA) initiated with the assistance of IITA a coordinated cowpea program for the country.

Multilocational trials are prepared by EMBRAPA/IITA and sent to scientists in various states of Brazil. After a series of tests, the state programs release the best lines and multiply seed for distribution to farmers.

Since 1981 seventeen varieties have been released (Table 1). Of these, only two varieties, BR 2-Braganca and BR 3-Tracuateua, were not tested in the nationally coordinated trials. Seven varieties (Manaus, EMAPA 821, EMAPA 822, EPACE 1, EPACE 6, CNC 0434, BR 8-Calderao) were directly from IITA germplasm. Four other varieties (BR 1-Poty, BR 4-Rio Branco, BR 6-Serrano, BR 7-Parnahyba) were derived from crosses involving IITA germplasm.

It is not possible at this time to document the area occupied by the new releases. However, EPACE 1 (VITA 7) is grown extensively and there are at least 6000 Ha grown in Ceara State; it is also popular in Piaui and Rio Grande do Norte. EPACE 6 (TVx 1836-13J) has shown promise in intercropping with sugar cane in Ceara State and with cotton in Paraiba. Manaus (4R-0267-01F from IITA) is widely grown in the humid north in the states of Amazonas, Rodonia, Acre, and Roraima. Although CNC 0434 and BR

1-Poty have only been recently released they are already being multiplied extensively in several states because of their resistance to virus diseases.

SUMMARY OF COWPEA VARIETAL RELEASES IN BRAZIL (1981-1986)

NO.	RELEASE	VARIETY	PEDIGREE	SEED TYPE*	100 SEED WT. (G)
01.	1981	MANAUS	4R-0267-01F (IITA)	B/R	09
02.	1982	EMAPA 821	VITA 6 (IITA)	T/S	11
03.	1982	EMAPA 822	VITA 3 (IITA)	R/S	18
04.	1982	IPA 201	SERIDO X ALAGOANO	B/S	25
05.	1982	IPA 202	SERIDO X ALAGOANO	B/S	24
06.	1983	IPA 203	SERIDO X PRINCESS ANN	B/S	25
07.	1983	EPACE 1	VITA 7 (IITA)	T/S	11
08.	1983	EPACE 6	TVx 1836-013J (IITA)	T/S	18
09.	1984	BR 1-POTY	CNCx 27-2E [PITIUBA X TVu 410 (IITA)]	T/S	13
10.	1984	BR 2-BRAGANCA	CATIE-V48	C/S	16
11.	1984	BR 3-TRACUATEUA	CV. QUEBRA CADERIA	WBE/S	25
12.	1984	BR 6-SERRANO	CNCx 24-016E [PITIUBA X TVu 59 (IITA)]	T/S	17
13.	1985	BR 5-CANA VERDE	CNCx 15-7D (PITIUBA X SEMPRE VERDE)	T/S	14
14.	1985	BR 4-RIO BRANCO	CNCx 10-4D [SERIDO X TVu 36 (IITA)]	T/S	15
15.	1985	CNC 0434	F_2 DISEASE SUB-POPL. (IITA)	WBE/S	14
16.	1986	BR 7-PARNAHYBA	CNCx 39-3E [SEMPRE VERDE X TVu 410 (IITA)]	T/S	14
17.	1986	BR 8-CALDERAO	TVx 4678-01D (IITA)	T/S	15

Prepared for IITA Highlights, 1985

E.E. Watt, E.A. Kueneman, G. P. Rios

Virus Resistant Cowpeas for Latin America

Cowpeas have a significant role to play in providing inexpensive vegetable protein to the people of Latin America with consumption reaching 40 Kg per person per year in northeastern Brazil. In the tropical lowland ecology, cowpeas have several advantages over dry bean (Phaseolus vulgaris), which is the preferred legume in many countries. Cowpeas have fewer diseases and insect pests; are more tolerant to drought and waterlogging; and are more tolerant to infertile soils and acid stress than are dry beans. However, there are two types of viruses that cause significant yield losses, Cowpea Severe Mosaic Virus (CSMV) and the poty virus complex. CSMV is specific to the Americas and the races of poty virus appear to be different from those of West Africa. A collaborative effort involving Brazilian and IITA scientists has identified sources of resistance to both kinds of viruses and is incorporating resistance into improved germplasm. CNC 0434, a white-seeded variety released in 1985, carries the gene for immunity to CSMV. It was selected in Brazil from a population sent from IITA, Nigeria. CNC 0434 has now been recommended by several states in Brazil. BR 1-Poty, a tan-seeded variety, carries field-level resistance to the poty virus complex and has also recently (1984) been released in Brazil. IITA's germplasm line TVu 410 was the donor of resistance genes. In 1985 both CNC 0434 and BR 1-Poty were sent by the IITA/EMBRAPA

Latin American Regional Legume Program to about 20 sites outside of Brazil to provide resistant varieties and to determine which viruses exist in different regions.

Now several tan-seeded breeding lines have been developed that combine resistance of both types of virus. One line, CNCx 187-22D-2, was tested in an Advanced Yield Trial in 1985 and demonstrated good yield potential (Table 1). Another promising line with double resistance, CNCx 252-1E, also tan-seeded, performed relatively well in 1985 Preliminary Yield Trials (Table 2). Both of these lines are now being used as parental material in the crossing program. Because in many countries large seeded varieties are preferred, CNCx 187-22D-2 is a particularly useful parent due to its double virus resistance and acceptable seed size.

In 1985 a major thrust of the IITA/EMBRAPA Latin American Regional Legume Program was to incorporate virus resistance into improved germplasm developed at IITA headquarters in Nigeria, with the view to distribute appropriate materials to national programs in Latin America. The new virus resistant lines will be useful as parents and in some cases, as lines for release.

Table 1. Performance of cowpea line CNCx 187-22D-2 with virus resistance in Advanced Trials, 1985.

	Poty Virus*	Severe Mosaic*	Yield (kg/ha) Goiania	Serra Talhada	Seed Weight (g/100 seeds)
CNCx 187-22D-2	2.0	1	1041	925	17
Checks					
Pitiuba (local)	3.0	4	421	850	20
CNC 0434	3.5	1	697	605	14
BR 1-Poty	2.0	5	837	925	13
Trial X (25 entries)	-	-	855	762	-
C.V. (%)	-	-	21	29	-
L.S.D. (0.05)			256	328	-

*Virus scores: 1 = highly resistant,. 5 = very susceptible; scores from inoculated trial.

Table 2: Performance of cowpea line CNCx 252-1E with virus resistance in Preliminary Trials, 1985.

	Poty Virus*	Severe Mosaic*	Yield (kg/ha) Goiania	Yield (kg/ha) Quixada	Seed Weight (g/100 seeds)
CNCx 252-1E	1.0	1	767	737	14
Checks					
Serido (local)	3.0	4	268	440	19
CNC 0434	3.5	1	592	720	14
BR 1-Poty	2.0	5	554	731	13
Trial X (49 entries)	-	-	494	478	-
C.V. (%)	-	-	17	37	-
L.S.D. (0.05)			146	280	-

*Virus scores: 1 = highly resistant, 5 = very susceptible; scores from inoculated trial.

Cowpea Research, Production and Utilization
Edited by S. R. Singh and K. O. Rachie

7

Achievements in Breeding Cowpeas in Latin America

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Cowpeas probably entered Latin America from West Africa during the seventeenth century with Spanish and Portuguese traders. In the tropical lowland ecology of Latin America, cowpeas have several advantages over dry bean (*Phaseolus vulgaris*), which is the preferred legume in many countries. Cowpeas have fewer diseases and insect pests, are more tolerant to drought and waterlogging, and are more tolerant to infertile soils and acid stress, than are dry beans. However, dry beans are better adapted to the ecology at high elevations than are cowpeas; consequently these two legume crops complement each other and only rarely compete within a region.

The largest, drought-prone region in Latin America is northeastern Brazil where cowpeas are frequently sown by farmers' practising shifting cultivation on the marginal lands. These cowpeas are frequently intercropped with maize and perennial cotton. In the extremely dry areas, cowpeas are intercropped with the spineless forage cactus, *Opuntia* spp. The preferred plant type for this dry ecology with erratic rainfall is one with medium duration (80–110 days) and prostrate growth habit; it covers the ground, reducing evaporation and controlling weed growth. Early-maturing, indeterminate varieties are also grown but to a lesser degree. Varieties with determinate growth habit fail when drought occurs during flowering and therefore are not recommended.

In the savanna ecologies with intermediate rainfall (600–1500 mm), cowpeas are frequently grown as a monocrop but occasionally with maize. Examples of this ecology include Bahía and Maranhão states of Brazil, the Llanos of Venezuela and Colombia, and some parts of Honduras and

Nicaragua. Erect, early and medium-maturing varieties are well suited to the savanna areas. Unfortunately, few such varieties have been made available to farmers in Latin America.

In areas of high rainfall, climbing cowpeas are frequently grown but on a small scale because staking costs prohibit large-scale production. Newly developed varieties of both grain and vegetable types that elevate the pods on peduncles can be grown without staking and should increase production. Examples of the high-rainfall areas in Latin America where cowpeas are grown include the Amazon River basin of Brazil and Peru, the coastal regions of Ecuador, Surinam and Guyana; and Trinidad.

The data on production are limited, but estimates are Brazil 600,000 t, Venezuela 10,000 t, Peru 5000 t, Panama 7000 t, El Salvador 6000 t, Haiti 2000 t, and others 30,000 t. Cowpea pods, consumed as a green vegetable, are important in the coastal regions of Ecuador, Guyana and Surinam; in the Amazon Basin of Brazil; and especially in Trinidad. In addition, in most countries, about 10 per cent of the crop is eaten as green immature seeds. In some parts of Brazil and Venezuela cowpea stover is highly valued by dairy farmers as dry-season pasture or hay. Unfortunately, no data are available on production of cowpea as vegetable pods, green seed or forage.

In contrast to consumers in West Africa, Latin Americans prefer smooth-seeded varieties. In Brazil, large, brown and cream-coloured varieties are generally preferred, although in some regions in the states of Rio Grande do Norte, Ceará, Piauí, Maranhão and Pará, white seeds with brown and black eyes are sought. In Venezuela, Peru and Surinam, brown, cream, and white seeds are common, and less emphasis is placed on seed size. In Central American and Caribbean countries, red-seeded varieties are preferred but other seed types including browns, blacks, speckled whites, and creams are also produced.

BREEDING TO OVERCOME PRODUCTION CONSTRAINTS

There are two common types of drought conditions that require different breeding strategies. Where the season is short, but water is available for the first 40 days, early-maturing varieties can escape the drought stress. In Latin America there are two farming systems where early-maturing cowpeas have obvious merit: in relay cropping in a rice- or maize-based system and in systems where cowpeas are sown on riverbanks as water recedes at the end of the rainy season.

Where rainfall is irregular, early maturing cowpea varieties are often not suitable. In Brazil some efforts have been made to select varieties for drought-prone ecologies (Guimarães *et al.*, 1982), and varietal differences have been identified, although the mechanism of tolerance is not clear. Some cowpea lines showing promising levels of resistance include VITA 3, VITA 4 and TVx 1836-015J. Resistance, heritability and breeding methods are under study in Brazil.

Cowpea severe mosaic virus is widespread in the Americas and results in substantial yield losses. Agronomic practices that influence the presence of the beetle vectors can influence the prevalence of the disease, which is often high when maize is the predominant crop. Use of insecticides early in the growing season controls beetle populations and reduces the prevalence of disease. However, the most promising approach to the control of this disease is breeding for resistance. A resistant variety, Laura B, which was developed in Trinidad and released in Jamaica, carries the resistance gene or genes from line 10R3, developed in Puerto Rico (Thompson, 1977). In Brazil, CNC 0434 that carries genes conditioning immunity to severe mosaic virus was identified from an IITA disease subpopulation (Rios *et al.*, 1982). CNC 0434 has white seeds and a high-yield potential and is currently being considered for varietal release in the state of Maranhão, Brazil. CNC 0434 is being used extensively as a parental source of resistance in EMBRAPA's breeding programme. It is also being used to convert IITA's high-yield potential varieties to resistant versions. Another useful source of resistance is Macaibo (Rios *et al.*, 1980). Resistance to severe mosaic virus is genetically recessive; in some crosses one gene appears to control resistance, whereas in other crosses two-gene segregation is observed.

A group of viruses—the potyvirus complex—are primarily found in the dry ecology of northeastern Brazil, and they are all aphid-transmitted and generally seed borne. A useful source of field resistance is found in BR-1/Poty released in Brazil (EMBRAPA, 1984). TVu 410 was the donor source.

Cowpea golden mosaic virus, also found primarily in Brazil, is serious in the transition zone between the wet and dry regions in the north. There are many sources of resistance to this disease including BR-1/Poty and Pitiuba.

Powdery mildew (*Erysiphe* spp.) is frequently present in the state of Bahía in Brazil and has also been observed by one of us (E.A.K.) in Ecuador. There is considerable genetic variability in the disease organism and resistance to it may not be stable. However, some levels of field resistance have been noted in VITA 7 and in Manaus (Rios and Neves, 1982a).

Scab (*Sphaceloma* spp.), a fungal disease attacking stems, leaves and especially pods, occurs frequently in environments where days are hot and nights are cool, such as the high plateaus of northeastern Brazil. Sources of resistance include TVu 1888 and Kalkie.

Cowpea smut caused by *Entyloma vignae* is a sporadic disease in Brazil. VITA 4 offers useful levels of resistance to smut.

The cowpea curculio (*Chalcodermus* spp.) is found from North America to Brazil, boring into and depositing its egg in the seed of 10-day-old pods. The seed quality of infected pods is reduced drastically. Sources of resistance include CR 17-1-13 identified in South Carolina and CNCX 10-2E identified in Brazil.

Leafhopper burn caused by *Empoasca* spp. is common, especially in dry environments. VITA 3 is resistant, and breeders at IITA and Brazil have been able to transfer the resistance into other genetic backgrounds.

Table 1. Cowpea cultivars released in Latin America and the Caribbean

Name	Country	Year	Reference
Arauca, Orinoco	Venezuela	1956	Marcano and Linares, 1956
US 62	Colombia	1957	Anonymous, 1957
IPEAN-V69	Brazil	1970	Araújo, 1983
Bush Sitão	Trinidad	1973	
Tuy	Venezuela	1975	Barrios and Ortega, 1975
Pitiuba	Brazil	1976	Araújo, 1983
Romefa	Panama	1978	Rodriguez *et al.*, 1978
VITA 3	Nicaragua	1979	
Laura B	Jamaica	1981	
Manaus	Brazil	1981	Araújo, 1983
VITA 3, ER-7, TVu 66-2H, TVx 2904-03E	Guyana	1982	Ross (personal communication)
IPA 201, IPA 202	Brazil	1982	Araújo, 1983
EPACE 1, EPACE 6	Brazil	1982	Araújo, 1983
Apure, Unare	Venezuela	1982	Boscan (personal communication)
IPA 203	Brazil	1983	Araújo, 1983
EMAPA-821, EMAPA-822	Brazil	1983	EMBRAPA, 1983
BR-1/Poty	Brazil	1984	Araújo, 1983

RELEASE OF COWPEA VARIETIES

Several countries have released cowpea varieties (Table 1) derived primarily from mass selection of introduced germ plasm and occasionally from local varieties that were not pure lines. A few varieties such as Laura B and BR-1/Poty were developed from crosses made in Latin America.

In collaboration with EMBRAPA in Brazil, IITA is expanding its activity in Latin America and is optimistic that progress will be rapid because of the ties with national programmes. Compared with other crops in Latin America, cowpea has received little research, although it has great potential for production.

Soybean Production and Research in Latin America

Eric A. Kueneman & Luis Camacho

Prepared for Soybean Workshop on
Crop Improvement, Production and Utilization
in the Tropics

Held at International Institute of Tropical Agriculture
September 30 - October 4, 1985

INTRODUCTION

The soybean is an important source of vegetable oil and protein concentrate for most countries in Latin America. Of the 24 countries listed in Table 1, only Brazil, Argentina, and Paraguay, which are all located in the southern cone, export significant amounts of soybeans. Bolivia and Uruguay are self sufficient. Nineteen countries import soybeans. Several of these are exploring possibilities to initiate or expand soybean production to minimize the substantial loss in scarce foreign exchange, which contributes to economic instability.

In this paper we give an overview of soybean production, and applied research in Latin American on a country basis.

SOUTH AMERICA

The greatest quantities of soybean in Latin America are grown by "Southern Cone" countries, Brazil, Argentina, Paraguay, Uruguay and Bolivia (Table 1). Until recently most soybeans were grown in the temperate ecologies of the region, and the technical packages developed in the United States were adopted with relatively few modifications. This transfer of technology resulted in rapid expansion of the crop. It is now clear that with the development of new varieties and appropriate agronomic practices that soybeans can also be grown successfully in several subtropical and tropical ecologies.

BRAZIL

Although Brazil did not begin producing soybeans commercially until the 1940's it is currently the world's second largest producer with more than 16 million tons in 1985. This phenomonal expansion in production resulted in part from the ease in adopting technology developed in the USA to the temperate ecologies of the states of Rio Grande do Sul, Santa Catarina, Parana and Sao Paulo, but also from a number of internal factors such as good prices, dynamic research and extension infrastructure which integrated Federal and State governmental programs and universities with programs of the private sector such as cooperatives, pesticide companies, and seed companies (Emidio Bonato/EMBRAPA, Pers. Comm., 1985). In 1975 the national Soybean Research Center (CNP-Soja) was established within EMBRAPA (Empresa Brasileira de Pesquisa Agropecuaria) not only to conduct research but to stimulate and coordinate efforts made by the State programs. CNP-Soja's efforts are focused primarily on development of varieties and technology to permit the expansion of soybeans into new regions and to reduce production costs. Soybeans are now also being commercially grown in the central states: Mato Grosso do Sul, Mato Grosso, Minas Gerais, Bahia, Goias and the Federal District; a small amount is also grown in southern Maranhao state in northern Brazil. This area of recent

expansion is characterized by a plains "cerrado" ecology with fragil, acid soils low in fertility. Soybean varieties and agronomic practices developed in Brazil for the cerrado have turned what was principally grazing lands into highly productive cropping lands. CNP-Soja has also developed a strong integrated pest management program designed to lower production costs by reducing the number of insecticide sprays to control both leaf-feeding and pod-sucking insects. Brazil has very dynamic varietal development programs with many varieties available for most ecologies. A few of the commonly grown varieties are shown in Table 2. CNP-Soja no longer sees as its primary function the release of new varieties. Breeders at CNP-Soja develop populations advanced primarily by the single pod descent method. Advanced generation populations containing genetic variability are sent to collaborators in other institutions for selection in the appropriate ecologies. Varieties are now released by state institutions and private seed companies.

Principal problems include: 1) production of high quality seed in the humid ecologies; 2) development of farming systems that minimize soil deterioration; and 3) development and application management practices that minimize production costs. While some individuals maintain that assistance from the USA and other countries is responsible for the rapid expansion of soybeans in Brazil, it is abundantly clear that Brazil's own programs have been responsible for the bulk of the development, especially during recent years. Brazil is a world leader in the application of integrated pest management in soybeans and also is a leader in development of management systems that permit crop production on the fragil Cerrados soils. These technologies are being shared with other developing countries directly and through the collaborative IITA/EMBRAPA Latin American Regional Legume Program initiated in 1984.

ARGENTINA

Argentina is Latin America's second largest producer of soybeans and the fourth largest in the world with current production of about six million metric tons. The crop became commercially important in the early 1970's and has expanded exponentially. About 90% of the production is concentrated on the rich soils of the Pampeana region (about 25 to 35 degrees south latitude) involving the states of Santa Fe, Cordoba, Buenos Aires, and Entre Rios. The crop is often sown in November, but more often it is direct-seeded in wheat stubble in December. Yields are among the highest in the world; the mean yield in 1985 was over 2 metric tons per hectare. Production costs are relatively low because little or no fertilizer is required where the crop is currently grown.

The principal varieties in the Pampeana are Hood, Bragg and Ogden. In the northern region Stuart, Bossier and IAS-4 are also sown. In the south, Williams, Culter and SRF-450 are most important. Most varieties are of US origin. The Instituto Nacional de Tecnologia Agropecuaria (INTA) initiated a

hybridization program in 1977. A nacional soybean program was initiated in 1979 to coordinate activities at various experiment stations (Luis-Zelarayan, 1983).

PARAGUAY

Commercial production of soybean began in the 1960's (Antonio Schapovaloff, pers. comm., 1985) and has expanded rapidly. In 1985 approximately 470,000 Ha are under soybean production (Table 1). About 90% of the crop is exported. The rapid expansion is due in part to adoption of technology developed in Brazil and the US, to government supports during the early phases of commercialization, and to the ease of integrating soybeans into a wheat/soybean rotation (Luis Alberto Alvarez, pers. comm., 1985). While the crop is expanding into many regions of the country, the principal departments at present are Alto Parana, Itapua, Canindeya, and Amambay (Antonio Shapovaloff, pers. comm., 1985) all of which are located in the southeast and border either Argentina or Brazil (from 23 to 27 degrees south latitude).

The major efforts in soybean research are carried out at Centro Regional de Investigacion in Itapua state and at the Instituto Agronomico Nacional in Caacupe in the department of Cordillera (Jose Antonio Costa/IICA, pers. comm., 1985). Bragg is the principal variety. Other commercial varieties recommended include Parana, Galaxia, Davis and Bossier which mature in 130 to 150 days. Varieties Santa Rosa, Visoja, Hampton, Hardee and Bienville have maturities of 150 to 170 days; UFV-1 requires more than 180 days (Antonio Schapovaloff, 1985). In addition to adoption of varieties from Brazil and the US, Paraguay is exploiting Brazilian techniques of control of Anticarsia gemmatalis (foliar feeders) with the virus Baculovirus anticarsia. Production of quality seed is a principal problem (Jose Antonio Costa/IICA, 1985) and there is interest in identifying adopted varieties with superior seed longevity.

URUGUAY

Uruguay, located between 30 and 35 degrees S. latitude, is self-sufficient in soybean production. In response to government support prices the area of production increased from 5000 Ha in 1974 to 50,000 Ha in 1979. The economic returns of soybeans have not competed well with that of other crops due to relatively low yields, approximately 1.3 Kg/Ha. Consequently, when the government discontinued supports in 1978 and the area of production decreased to about 20,000 Ha (Mandl, 1983), just satisfying country requirements for oil and meal.

Research is conducted within the Ministry of Agriculture and Research by El Centro de Investigaciones Agricolas (CIAAB). The principle varieties under production are Bragg, Parana and Lee 74 with lesser amounts of Forrest, Dare, Hill, Lancer, Lee 68 and IAS-5.

BOLIVIA

Bolivia produces nearly 70,000 MT of soybeans, up from only 8,500 MT in 1975. Even so, Bolivia is still not self-sufficient in vegetable oil production and imported about 20,000 MT in 1985. Commercial production began in 1970 and expanded in the mid 70's. The principal area of mechanized production is near Santa Cruz de la Sierra. Planting occurs from mid-November until mid-January. In recent years production has extended farther south to the Tarija zone involving smaller scale farmers (Delgadillo, 1983).

The principle varieties now grown commercially are UFV-1, Bossier, and Cristalina. Seed production in the humid area has been problematic and Bolivia still imports some seed from Brazil. Variety trials from INTSOY (USA), from Brazil, and from AVRDC are conducted yearly. In 1981 a breeding program was initiated.

PERU

Peru imports about 90,000 MT of soybeans and soybean products and has only 1000 Ha under production. Commercial production began in the early 1970's and peaked at 6,400 Ha in 1981 with mean yields of 1900 Kg/Ha (Apolitano, 1983). This expansion occurred when there was a government production campaign with technical assistance from INTSOY. Production decreases in the early 1980's reflected low prices for locally grown soybeans. To minimize the loss in scarce foreign exchange the government is again exploring possibilities of stimulating production in the country.

Varieties such as Jupiter, Nacional, Pelicano and Improved Pelican are recommended for the rainfed jungle ecology; Pelicano, Mandarin-S4-ICA, Nacional, Jupiter and Improved Pelican are recommended in the irrigated coastal region.

Marketing policy, seed production, and technology transfer are among the principle constraints limiting expansion of soybeans in Peru.

ECUADOR

Although Ecuador currently grows about 25,000 Ha of soybeans with mean yields of about 1,800 Kg/Ha, Ecuador imports about 50,000 MT of soybean oil. To meet the country's oil demands, Ecuador would need to expand another 134,000 Ha. If production is expanded the country would need to identify a market for the excess in soybean meal (Diaz, 1983). At present soybeans are grown in two ecologies, the central coastal region where rainfall is generally adequate and in the southern coastal region where supplemental irrigation is frequently necessary.

Varietal identification and development is conducted by the Programa de Oleaginosas Agropecuarias belonging to the National Institute of Agriculture Research (INIAP). Three varieties are

under commercial production: 1) INIAP-Jupiter developed by bulking several single plant selections of Jupiter; 2) INIAP 301 which has a maturity similar to Jupiter (130 days) was selected from a cross of Jupiter x F65-170 and; 3) INIAP 302, an earlier maturing variety (115 days) was selected out of Davis. Varieties for Ecuador should have resistance or tolerance to *Cercospora sojina*, *Personospora manshureca* and soybean mosaic virus. Improved seed longevity is also important. In 1983 the seed quality was so poor that it was necessary to import seed of ICA-Tunia from Colombia, which is susceptible to *C. sojina*.

COLOMBIA

Commercial production of soybeans began in 1955 and expanded from 10,000 Ha in 1960 to 78,000 Ha in 1980 in the Cauca Valley (Bastidas, 1983). The crop is grown in two seasons (March to July and September to December and supplemental irrigation is very common. Difficulties in marketing soybean meal resulted in a decrease in price which in turn resulted in a production decrease to 44,000 Ha in 1981; But production has recovered somewhat to 66,000 Ha in 1985. Even so, Colombia imported about 170,000 MT of soybean in 1985, about half of which was soybean oil. In recent years, production has begun to expand outside of the Cauca Valley. The most important new area of production is the Tolima Valley located between Cali and Bogota where soybean is being introduced as a rotation crop with rice. There is also some interest in introducing the crop on the north coast near Turipana as a rotation crop with cotton. In this tropical region, development of varieties with good seed longevity is critical. In the Cauca Valley seed production and storage is not a problem. Seed from the first season is used to plant the second season.

The Instituto Colombiano has a strong varietal development program. ICA-Tunia, released in 1976, occupies about 98% of the planted area. A newly released variety, ICA-N21, developed for the Tolima Valley looks very promising and will likely become important in the future, though it is slightly prone to lodging when grown on the more fertile soils in the Tolima Valley.

In recent years INTSOY and ICA have integrated some components of their breeding programs. This collaborative effort has further strengthened the soybean development in Colombia and insures that improved materials developed in Colombia are made readily available to scientists in other countries.

VENEZUELA

Venezuela, after Mexico, is the second largest importer of soybeans in Latin America; about 900,000 MT of soybeans were imported in 1985. But unlike Mexico, Venezuela has yet to establish significant production in the country. Less than 2000 Ha were sown in 1985. This situation may change in the near

future as elements of the private sector and the government are initiating a collaborative applied research and production program. Trials at the semi-commercial scale have indicated that with adapted varieties such as Jupiter, yields from 1.5 to 2.5 MT/Ha can be achieved in the central "llanos" plains ecology with a latitude of 8 to 12 degrees N (Velasquez, 1983). Should a favorable pricing policy be established relative to costs of imported soybeans, Venezuela could curtail future increases in imported soybeans in the next decade and thereby reduce losses in foreign exchange.

CENTRAL AMERICA

As of yet, no country in Central America is self-sufficient in soybean production. There are several countries in Central America conducting applied research with the view to initiate production campaigns to reduce losses in foreign exchange.

PANAMA

Panamanian scientists have conducted numerous trials of introduced germplasm and a small breeding program selected two varieties, Bayano and Baru, for release. However, governmental policies favor importation, consequently as of yet, there is no commercial production. Panama imported 12,000 tons of soybean meal and 25,000 tons of soybean oil in 1985.

COSTA RICA

Costa Rica imported 16,000 tons of soybeans in 1985, down from 28,000 tons in 1981 (Table 1). Efforts are being made to increase soybean consumption as human food. A production course was conducted recently to expose extension agents to cultural practices. A collaborative project between the government and CARE was initiated in 1980 to promote production. In 1983-84 about 1500 Ha were sown by 45 farmers (Mata and Quiros, 1984). Varieties Jupiter and SIATSA 194 have performed well but the project has encountered some difficulty in producing quality seed of Jupiter.

NICARAGUA

Nicaragua is suffering a substantial shortfall in vegetable oil due to a sharp decrease in cotton seed production resulting from a depressed cotton market. In 1983 Nicaragua imported 36,000 MT of soybeans, 6,000 MT of soybean oil, and 28,000 MT of meal. Due to political and economic stress importation was stopped in 1985 (Table 1). There is interest in initiating soybean production to alleviate the vegetable oil shortage (Amelio Dall 'Agnal, EMBRAPA/FAO consultant to Nicaragua, pers. comm., 1985).

HONDURAS

Honduras imported only 15,000 tons of soybean in 1985. Honduras is an exporter of palm oil. Although Honduras presently has only a few hundred hectares of soybeans, there are reasons to believe that soybean production could expand rapidly. Firstly, there has been a sharp reduction in land sown to cotton, sugar cane and bananas due to depressed markets. Consequently, farmers are interested in identifying new crops that can fit into their cropping system. Secondly, to stimulate production, oil processors and feed mills are offering attractive prices for locally produced soybeans. Thirdly, Honduras has conducted varietal tests throughout the country and has developed recommendations for cultural practices. Three varieties have been locally selected. SIATSA 31 and SIATSA 194 were derived from segregating materials from Mississippi and more recently DARCO-1 was selected from a line provided by AVRDC, 30151-1-1. The program may also release line 7804, which is derived from a cross of SIATSA 194 with Jupiter.

There are two growing seasons. In the center of Honduras near Comayagua soybean is sown in July and harvested in October. In the north, near San Pedro Sula, soybeans are sown in November and harvested in February. Seed from one harvest is used for the next planting. Unfortunately the seed from the north is of questionable quality due to high humidity at harvest time. Varieties with good seed longevity are required.

GUATAMALA

Guatamala imported 43,000 tons of soybeans in 1985, up from 27,000 tons in 1981 (Table 1). This increase is due in part to the decrease in availability of cotton seed resulting from a depressed cotton market. Soybean production in the country is in its infancy. About 4000 Ha were sown in 1984 (Eduardo Menendez-Bolanos, ICTA, pers. comm., 1985). Should government policy change to favor local production, Guatamala could become self-sufficient as there are approximately 640,000 Ha along the Pacific coast with rich volcanic soils that would be highly suitable for soybean production. The country already has several oil extracion plants capable of processing soybeans.

The Instituto de Ciencia y Tecnologia Agricola (ICTA) has conducted varietal tests in several ecological regions. Varieties that have performed well along the coast include: Alamo (to be released as ICTALAM-85), Jupiter, Duocrop, Ecuador-2, and UFV-1. Varieties such as Crawford, Sparks, Lawrence and Braxton have done well in the mid-elevation ecologies. Production of quality seed in the coastal region is somewhat problematic due to field weathering of seed when rains continue into the harvesting period. However, if quality seed is harvested, it can be kept in the cool highlands with little loss of vigor. In recent years stinkbugs have also become a factor in seed production. Guatamala exported small amounts of seed to southern Mexico in 1985.

EL SALVADOR

El Salvador imported 53,000 tons of soybeans in 1985, up from 34,000 tons in 1981 (Table 1). As of yet there is no signficant commercial production, but varietal trials and agronomic experiments have been conducted.

MEXICO

Mexico is the largest importer of soybean in Latin America; about 1.7 million MT of soybeans were imported in 1985 (Table 1). Production increased from about 25,000 Ha in 1965 to about 350,000 in 1975. Production has remained rather static since 1975. The majority of the production comes from the northern states of Sinaloa, Sonora, and Chihuahua. In this region the crop is grown under irrigation. Other states of secondary importance include Chiapas, Tamaulipas and Campeche (Nieto, 1983).

In the northern states Bragg, Davis, and Cajeme are the principal varieties. A substantial amount of seed for the north is grown by US farmers. Mexico has not yet satisfactorily organized its own seed production. In the central region about 60,000 Ha are grown in the state of Tamaulipas. Jupiter, UFV-1, and Santa Rosa are principal varieties. In this region seed is grown in the lowlands and stored on a highland plateau where it is cool and dry. In the south -Chiapas state- Jupiter and UFV-1 are the principal varieties. In this tropical ecology yields are high because of reliable rains, but production of quality seed is problematic. Seed is generally sent by road from Tampico. Guatamala has exported seed to this region. It may be possible to store seed in the highlands at Motocientla, about 200 Km from Tapachula (Dr. J. Nieto, INIA, pers. comm., 1985). This, plus selection of varieties with superior seed longevity, should make quality seed available at a reasonable price in the future.

Leaf feeding insects are a problem throughout most of Mexico and pod-sucking insects are problematic in the south. The most common diseases are frogeye leaf spot and downy mildew; Phomopsis and soybean mosaic virus can also be problems in the south.

CARIBBEAN

No country in the Caribbean produces soybeans commercially. The Jamaican Soya Products Company is in the initial stages of contracting farmers to produce the crop. Several countries are importing significant amounts of soybeans or soybean products. Importation data in 1000 MT for 1985 are: Barbados 11, Cuba 185, Dominican Republic 140, Jamaica 80, Haiti 117, and Trinidad-Tabago 34. It is not likely that these countries will be self-sufficient in soybeans in the near future. Very limited research has been conducted in the region and there is little history of mechanized agriculture. Small scale production could be viable in several countries if local markets were developed. Projects

involving a production campaign coupled to village level processing could assist countries in providing vegetable oil and protein for direct and indirect human consumption. In addition, even the most modest local production could be significant in reducing the loss of scarce foreign exchange.

CONCLUSION

While Brazil and Argentina are major exporters of soybeans, most countries in Latin America import soybeans or soybean products. Development of new varieties for tropical ecologies should make production biologically possible in many more countries. In order for the new technology to take hold, governments need to review their pricing policies to encourage local production. It is unlikely that many countries will become significant exporters, but production campaigns could help a number of countries become less dependent on importation and thereby reduce loss of scarce foreign exchange which in turn will contribute to improved political stability. In certain countries, especially those of Central America and the Caribbean, a production campaign coupled to a soybean utilization program could improve the diet for many poorly nourished individuals.

Table 1. Soybean Production, Imports and Exports from Latin American Countries
(Extracted from USDA Foreign Agric. Serv. Report, June 1985)

Country	Area		Yield		Production		Imports*		Exports*	
	1000-Ha		MT/HA		1000 MT		1000 MT		1000 MT	
Year:	81	85	81	85	81	85	81	85	81	85
Argentina	1740	3150	2.01	2.09	3500	6600	0	0	2865	5750
Barbados	0	0	0	0	0	0	10	11	0	0
Bolivia	27	27	1.48	1.70	40	68	28	21	23	20
Brazil	8501	9500	1.79	1.76	15200	16700	934	150	11276	11900
Chile	1	0	1.00	-	1	0	119	100	0	0
Colombia	44	66	2.02	2.00	89	120	122	170	0	0
Costa Rica	0	0	-	-	0	0	28	16	0	0
Cuba	0	0	-	-	0	0	136	185	0	0
Dominican Rp.	0	0	-	-	0	0	111	140	0	0
Ecuador	21	25	1.76	1.84	37	46	58	50	0	0
El Salvador	0	0	-	-	0	0	34	53	0	0
Guatamala	0	1	-	2.00	0	2	27	43	0	0
Guyana	0	0	-	-	0	0	10	5	0	0
Haiti	0	0	-	-	0	0	42	117	0	0
Honduras	0	0	-	-	0	0	15	15	0	0
Jamaica	0	0	-	-	0	0	64	80	0	0
Mexico	150	350	1.87	1.57	280	550	1545	1705	0	0
Nicaragua	0	0	-	-	0	0	16	0	0	0
Panama	0	0	-	-	0	0	25	52	0	15
Paraguay	400	470	1.50	1.57	600	750	100	0	646	684
Peru	6	1	1.33	2.00	8	2	118	90	0	0
Trinidad	0	0	-	-	0	0	40	34	0	0
Uruguay	35	20	1.27	1.25	45	25	4	2	25	10
Venezuela	0	2	-	1.00	0	2	520	901	0	0

* beans, meal, oil

Table 2. Commonly Grown Varieties in Brazil

Region	Variety	Pedigree	Origin
South	IAS-5	Hill x D52-810	Brazil
(~20 to 30 degrees S. Lat.)	Bragg	Jackson x D49-2491	USA
	Parana	Hill x D52-818	Brazil
	BR-4	Hood x Hill	Brazil
	IAS-4	Hood x Jackson	Brazil
	Davis	D49-2573 x N45-1497	USA
Central	Cristalina	Selection in UFV-1	Brazil
(~15 to 20 degrees S. Lat.)	Doko	Selection in RB-72-1	Brazil
	IAC-7	Selection in RD-72-1	Brazil
	IAC-8	Bragg x E70-51	Brazil
	EMGOPA-301	IAC-4 x Jupiter	Brazil
North	Tropical	Hampton x E70-51	Brazil
(~0 to 15 degrees S. Lat.)	Doko	Selection in RB-72-1	Brazil
	Teresina	UFV-1 x IAC 73-2736-10	Brazil
	Corajas	UFV-1 x IAC 73-2736-10	Brazil
	IAC-8	Bragg x E70-51	Brazil

Source, personal communication, Dr. Romeu Kiihl, EMBRAPA.

MSTAT User News
Michigan State University
East Lansing, Michigan
Summer, 1985

LINEAR REGRESSION FOR EACH CASE IN MSTAT

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In some instances, one may wish to run linear regression across variables within the same case. For example, as a rule, leaf expansion rates are normally linear over time, if very young or very old leaves are avoided. Thus, if one measures leaflet length and width each day over a period of time and calculates leaf area, regression will give the leaf expansion rate.

The following transformations, for use with the CALC subprogram, were written so that up to 20 variables [DIMDZ%(20)] can be used as the dependent variable (y) and time the independent (x) variable. You are prompted by the subroutine for the number of y variables to be used, where to store the results for the slope -W(B), Intercept -W(A), F value -W(F), R2 value (x100 for significance) -W(R2), and the residual mean square or deviations from regression - W(RMS) values. These values can then be used for an analysis of variation of the "b" value to determine, for instance, the effect of drought on leaf expansion rate. One may need to multiply the values stored by a power of 10 to shift decimals for enough significant digits when the analysis is run. It is best to do the multiplications in line 13360 or beyond so that the formulas are not changed To test and permanently save these programs lines, follow the procedure detailed at the end of Section 2.16 (Selection) of the MSTAT User Guide.

```
13336 J=0: K=0: L=0: M=0: P=0: IF MB<>1 THEN GOTO 13350
13337 DIM DZ%(20): INPUT "GIVE NUMBER OF Y VARIABLES TO BE USED ";NC
13338 INPUT "VARIABLE NO. FOR A= ";A
13339 INPUT "VARIABLE NO. FOR B= ";B
13340 INPUT "VARIABLE NO. FOR R SQU= ";R2
12341 INPUT "VARIABLE NO. FOR F VAL= ";F
13342 INPUT "VARIABLE NO. FOR RES. MEAN SQUARE= ";RMS
13343 FOR N=1 TO NC: INPUT "GIVE Y VARIABLE NO. ";DZ%(N): NEXT N
13344 REM
13350 FOR N=1 TO NC: O=DZ%(N): J=J+N: K=K+W(O): L=L+N^2: M=M+W(O)^2
13352 P=P+N*W(O): NEXT N: FUG=P-J*K/NC: TSS=M-K^2/NC: W(B)=FUG/(L-J^2/NC)
13354 W(A)=(K-W(B)*J)/NC: MSR=W(B)*FUG
13356 W(R2)=MSR/TSS*100: W(RMS)=(TSS-MSR)/(NC-2): W(F)=MSR/W(RMS)
13358 PRINT MB,W(A),W(B),W(RMS),W(F)
```

Printed in: MSAT User News - Summer 1985
Michigan State University
East Lansing, Michigan

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Identification of Promiscuous Nodulating Soybean Efficient in N_2 Fixation[1]

E. L. Pulver, E. A. Kueneman, and V. Ranga-Rao[2]

ABSTRACT

Many developing countries lack the facilities to produce and distribute high quality rhizobia inoculants for farmers who are interested in planting soybeans [*Glycine max* (L.) Merr.]. If soybean varieties were available that could nodulate effectively with the ubiquitous, cowpea-type rhizobia, farmers could successfully grow soybeans without inoculation or fertilizer N. When 400 diverse soybean lines were tested at five sites in Nigeria for the ability to nodulate with indigenous rhizobia, only 10 were highly promiscuous, that is, capable of forming an effective symbiosis at all sites. Some entries were rated as compatible with indigenous rhizobia at one or two sites but failed to nodulate profusely at the other locations. Twenty-two isolates from nodules collected from profusely nodulated soybean plants and three other isolates prepared from cowpea nodules, were used to inoculate the 10 most compatible selections from the previous trial and two U.S. varieties, 'Bossier' and TGm 294. 'Malayan', a local Nigerian cultivar, formed an effective symbiosis with 21 of 22 soybean isolates; nodule and shoot weights in each case being greater than or equal to inoculation with Nitragin multistrain inoculant. Other accessions that displayed high degrees of promiscuity were M-381, TGm 120, TGm 119, Indo 180, and Indo 243. Whereas, Bossier formed an effective symbiosis with only one of the isolates, and TGm 294 was compatible with only 2 of the 22 rhizobia isolates. The promiscuously nodulating soybeans identified in the screening trial were also compatible with at least two of the three cowpea isolates, but Bossier and TGm 294 were compatible with none of them. When the scion of Bossier on 'Jupiter' (both of which have high yield potential) was grafted onto the root stocks of 'Orba' or Malayan (Promiscuous nodulators) enough N was fixed to meet the requirements of high yielding genotypes. These results indicate that by genetically incorporating promiscuity into varieties with high yield potential one would not necessarily reduce yield potential.

***Additional index words:* *Rhizobia, Glycine max* (L.) Merr., Microbiology**

DEMAND is increasing in many tropical countries for soybean [*Glycine max* (L.) Merr.] products for animal and human consumption. Improved high-yielding soybean varieties must be inoculated with *Rhizobium japonicum* to realize their yield potential on soils where soybeans have not been previously cultivated (1, 4, 6, 8, 9.), but many tropical countries do not have the facilities or trained personnel to produce high-quality inoculants. Importing packaged inoculants may solve the production problem, but equally serious problems of inoculant storage and distribution will remain.

A practical alternative to the use of inoculants in less developed countries may be the development of soybean varieties capable of forming an effective symbiotic relationship with indigenous rhizobia. Earlier work at the International Institute of Tropical Agriculture (IITA) has shown that some varieties from Nigeria, Tanzania, and Indonesia nodulate without inoculation in soils where the crop has never been cultivated (8). Similar observations have been recorded in Thailand (7) and in the USA (9). Thus, it appears that the ability to form effective symbiotic relationships with cowpea-type rhizobia does exist within the soybean germplasm. Soybean varieties that are compatible with a range of rhizobia are said to be promiscuous.

The objectives of this research were to identify soybean genotypes compatible with indigenous rhizobia in a range of tropical environments and to evaluate the efficiency of the symbiosis under greenhouse and field conditions.

MATERIALS AND METHODS

Screening of Germplasm

Field trials were conducted at five diverse environments in Nigeria, ranging from the high rainfall, acid-soil zone (4°N Lat) to the semiarid Northern Guinea Savannah (11°N Lat) (Table 1). All the soils used were low in N and had no history of soybean cultivation. The land was plowed, fertilized with 300 kg/ha single superphosphate and 100 kg/ha muriate of potash and harrowed.

Four hundred soybean accessions of diverse geographical origin were each planted in a single 4-m row with two replications at all sites. Ten plants were dug from each row at

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[1] Contribution from the International Institute of Tropical Agriculture, P.M.B. 5320, Ibadan, Nigeria. Part of this work was supported by a grant from United Nation Development Programme Project No. 05-0560. Received 2 Apr. 1984.

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Table 1. Climatic conditions and soil properties of testing sites in Nigeria where soybean germplasm was examined for promiscuous nodulation.

Location	Latitude	Mean rainfall	Soil pH (H_2O)	Vegetation zone
		mm/year		
Onne	4°51′	2355	4.3	Tropical rain forest
Yandev	7°23′	1288	5.1	Southern Guinea Savanna (Eastern Nigeria)
Ibadan	7°26′	1215	6.0	Transitional zone (forest-derived savanna)
Mokwa	9°18′	1110	5.6	Southern Guinea Savanna (Western Nigeria)
Funtua	11°38′	1005	5.8	Northern Guinea Savanna

† Soils at Onne are acidic and derived from costal sandy sediments; soils from Yandev and Mokwa are loamy sand and derived from sandstone; soils from Ibadan are sandy loam and derived from basement complex rocks, mainly banded gneiss; soils from Funtua are of loamy texture and are derived from eolian drift.

60 days after planting (DAP) and evaluated for nodule number, nodule size, and plant vigor. Nodule number was rated on a scale of 1 to 3, with 1 = less than 10 nodules/plants, 2 = 10 to 20 nodules, and 3 = more than 20 nodules/plant. Nodule size was also rated on a 1 to 3 scale, with 1 = most nodules having less than 2 mm in diameter, 2 = most nodules 2 to 5 mm diam, and 3 = most nodules greater than 5 mm in diameter. Accessions with high nodule number and mass were further evaluated for "apparent nodule effectiveness" by examining the central bacteroid tissue for leghaemoglobin. Ten nodules from each of these accessions were rated on a 1 to 3 scale, with 1 = at least seven nodules devoid of leghaemoglobin (green center), 2 = even distribution of green and red central tissues, and 3 = bright red central tissue in at least seven nodules. For plant vigor the rating scale was 1 = stunted accessions with yellow leaves, 2 = plants intermediate in vigor with light-green leaves, and 3 = vigorously growing plants with dark green leaves.

Testing of Rhizobial Isolates

Twenty-five strains of indigenous rhizobia were tested for compatibility with 10 soybean hosts selected for broad-spectrum compatibility in the germplasm screening. A multistrain, commercial inoculant, Nitragin®, and a no inoculation treatment were used as controls. Inoculant treatments were also applied to two improved high-yielding varieties developed in the USA ('Bossier' and TGm 294) and responses to inoculation treatments were compared; Bossier is a selection from 'Lee' and TGm 294 is derived from a cross of Lee 68 × Hill and was selected in Mississippi, USA, and reselected in Nigeria. For inoculant production nodules were collected at each testing site from profusely nodulated accessions with dark green leaves. Nodules were placed in screw top vials containing silica gel. Rhizobia isolates were cultured according to standard procedures (10). Cultures were maintained on yeast extract monitol (YEM) plates or slants. Isolates were authenticated as rhizobia using cowpeas as the host plant in Leonard jar assemblies. The 22 isolates were prepared from soybean nodules (four from Onne, three from Ibadan, six from Mokwa, and nine from Funtua), together with three isolates from cowpea collected at Funtua). Prior to inoculation isolates were multiplied to approximately 10^9 cells/mL in YEM broth.

Soil (Alfasol [Oxic Paleustalf, Egbeda Series] derived from banded gneiss) low in N was collected from the field and fertilized with 50 mg of P and K per kg of soil. The soil was air-dried, heat-sterilized for 7 days at 110° C and added to 20 cm greenhouse pots previously washed in 1% sodium hypochlorite. Soybean seeds were surface sterilized by emersion in 0.1% sodium hypochlorite. After rinsing repeatedly in distilled water six seeds were planted in each pot. Pots were watered with distilled water and inoculated with various isolates of *Rhizobium* by adding 20 mL of broth to each pot 7 days after planting. Multiple indentations were made in the soil, and the inoculum was added to each indentation to ensure even distribution. Two replications of each treatment were arranged in a split-plot design with isolates of *Rhizobium* as main plots and varieties as subplots. A 1-m border separated the main plots to reduce contamination. The plants were thinned to two per pot at 10 DAP. The experiment was terminated 40 DAP and the shoots were dried at 80 °C for 72 h. The roots were removed, the nodules collected, washed and dried at 80 °C. Then shoot and nodule dry weights were recorded, and the data subjected to analysis of variance (ANOVA).

Grafting Experiment

Seed of Bossier and 'Jupiter' (two typical nonpromiscuous varieties) and of 'Orba' and 'Malayan' (both promiscuous) were surface sterilized and planted in sterile vermiculite. Grafting was done on 4-day-old seedlings using a technique similar to the "straw-band" procedure (3).

Bossier and Jupiter were used as scions and grafted onto their own root stocks and stocks of Orba and Malayan. Grafted plants were placed in an incubator at 15°C and 70% humidity for 2 days and then maintained at room temperature (20 to 25°C) away from direct sunlight for another 3 days. Survival rate was approximately 90%. Six healthy grafted plants of the same root-shoot treatment were transplanted into metal drums each containing 40 kg of soil. The soil (similar soil classification as described earlier) was collected from a farmer's field where soybeans had never been grown. The soil was fertilized with 50 mg of P/kg of soil, 50 mg of K, 25 mg of S, and 1 mg of B. The experiment consisted of 12 graft combinations grown in uninoculated soil and in soil inoculated with *R. japonicum* (Nitragin Co., Milwaukee, WI). Five replications of each treatment were harvested 50 days after transplanting; then shoot and nodule dry weights and shoot N content determined. Total N was estimated on ground samples as described by Farrari et al. (5). Five replications of each treatment were grown until maturity and seed yield measured.

RESULTS AND DISCUSSION

Screening Germplasm

The purpose of testing in five diverse environments with different native leguminous flora was to identify soybean germplasm that is compatible with a wide range of soil rhizobia. Cowpeas, which are compatible with a wide range of rhizobia, nodulate freely at all the testing sites.

Several accessions had poor stands in some sites and were deleted from the analysis at those sites. The distributions of the visual ratings for nodulation and plant vigor are presented in Table 2. Of the 400 accessions tested only 35, 20, 32, 20, and 36 accessions had many large, effective nodules and vigorous plant growth at Onne, Yandev, Ibadan, Mokwa, and Funtua, respectively.

There was considerable evidence of site-specific nodulation. Of the 35 accessions rated as compatible with rhizobia native to Onne, 17 did not nodulate in any of the other four environments. Four entries formed effective nodule masses at Onne and one other site; three entries nodulated at Onne and two other

Table 2. Distribution of 400 soybean accessions rated for nodule number, nodule size, and plant vigor at five diverse locations in Nigeria.

	Nodule number†			Nodule size‡			Plant vigor§		
Location	1	2	3	1	2	3	1	2	3
	%								
Onne	12	61	28	55	37	8	54	36	10
Yandev	40	45	15	55	40	5	43	50	7
Ibadan	47	45	8	52	40	8	28	60	12
Mokwa	40	52	8	60	35	5	65	30	5
Funtua	41	47	12	51	40	9	55	30	15

† Nodule number: 1 = <10 nodules, 2 = 10–20 nodules, 3 = >20 nodules/plant.

‡ Nodule size: 1 = <2 mm, 2 = 2–5 mm; 3 = >5 mm in diameter.

§ Plant vigor: 1 = yellow and stunted, 2 = light green and intermediate size, 3 = dark green with vigorous growth.

locations; and one accession nodulated at Onne and three other sites. At Yandev, 20 accessions were rated as compatible, but four of them nodulated only at Yandev and one other site. The results at Ibadan were similar: although 32 accessions were classified as compatible, four were specific to the Ibadan site, and 12 nodulated only at Ibadan and one other location. Twenty accessions were selected at Mokwa, but four of them nodulated only at Mokwa and one other site. At Funtua, 36 accessions appeared to be compatible with indigenous rhizobia, but seven nodulated only at Funtua and one other location. In summary, out of 400 accessions screened, only 10 entries were capable of forming effective symbiotic relationships with the soil rhizobia at all five locations. Three of these 10 selections are unimproved cultivars grown in Africa: 'Malayan' from Nigeria, 'Obo' from Central African Republic, and 'Hernon 237' from Tanzania. Four of the entries from Indonesia, Indo 180, Indo 216, Indo 226, and 'Orba', were also rated as compatible at all sites, but more than 70 other accessions collected in Indonesia failed to nodulate consistently. Two other promiscuously nodulating accessions (TGm 119 and TGm 120) were collected in East Africa, but their exact origins are unknown. The remaining accession (M-351) is a progeny of Malayan × 'Clemson Non shattering'. None of the 25 improved cultivars bred and selected in the USA were capable of nodulating well with the indigenous rhizobia at the various testing sites.

Testing of Rhizobia Isolates

The inoculant × host plant interaction, which reflects host-strain specificity, was highly significant ($P<0.01$) for both nodule and shoot dry weights (Table 3). Nodule weight indicates the degree of compatibility between the host and the rhizobial isolate, and shoot dry weight is a measure of the effectiveness of fixing N_2 of the host-isolate combination. Malayan appeared to be the most promiscuous host in the test since it formed more nodule mass than the uninoculated control with all 22 soybean isolates tested and since 21 of these isolates were as effective as Nitragin as shown by shoot growth. TGm 579 (a progeny of Malayan × 'Clemson Non-Shattering') gave similar results; it was compatible with 21 out of 22 soybean isolates, and 16 of these had shoot growth equal to that of Nitragin. In contrast, Bossier and TGm 294 were clearly less compatible with these indigenous isolates than the other accessions. Bossier nodulated with 12 isolates; but only four of these resulted in shoot growth greater than that of the uninoculated control, and only one isolate increased the shoot growth of Bossier as much as did the Nitragin inoculant. Similar results were obtained when TGm 294 was the host. Bossier and TGm 294 nodulated with only one of the three isolates from cowpea nodules, and this symbiosis was ineffective. The promiscuous accessions, however, formed a significant nodule mass with at least two out of the three cowpea isolates (Table 3). Malayan, TGm 120, and Orba grew equally well when inoculated with all three cowpea isolates, as compared to inoculation with Nitragin.

Table 3. Effect of inoculating sterile soil with 22 rhizobial isolates from promiscuous soybean varieties and three isolates from cowpea on nodule mass and shoot growth at 40 days of 10 soybean accessions selected for promiscuity and two nonpromiscuous varieties (Bossier and TGm 294).

	No. of isolates producing nodule or shoot weights greater than the uninoculated control ($P < 0.05$)				No. of isolates producing nodule or shoot weights greater than or equal to inoculation with Nitragin ($P < 0.05$)			
Soybean	Soybean isolates† (n = 22)		Cowpea isolates (n = 3)		Soybean isolates (n = 22)		Cowpea isolates (n = 3)	
Host	Nodule wt.	Shoot wt.	Nodule wt.	Shoot wt.	Nodule wt.	Shoot wt.	Nodule wt.	Shoot wt.
Malayan	22	21	3	3	21	21	3	3
TGm 579	21	19	3	2	17	16	2	2
TGm 120	22	21	3	3	2	19	0	3
TGm 119	21	20	2	2	14	20	2	2
TGm 618	18	15	2	2	4	4	0	1
TGm 725	17	17	3	2	5	16	1	2
TGm 710	15	14	3	3	0	13	2	1
Orba	14	11	3	3	5	11	0	3
TGm 737	15	15	3	2	9	15	1	2
TGm 730	16	7	3	2	1	5	0	2
Bossier	12	4	1	0	0	1	0	0
TGm 294	10	3	1	0	2	2	0	0

† Source of inoculant: three were 22 isolates from soybeans (4 from Onne, 3 from Ibadan, 6 from Mokwa and 9 from Funtua). Three cowpeas isolates were from cowpea varieties, Vita 1, Vita 4, and Vita 5 at Funtua.

It would be presumptuous to assume that the 22 soybean and three cowpea rhizobia tested are representative of the entire indigenous population of *Rhizobium* at the various testing sites. The number of isolates is large enough to provide convincing evidence that soybean genotypes differ in ability to form effective symbiotic relationships with rhizobia indigenous to these tropical soils. The accessions identified as promiscuous during the germplasm screening are clearly more compatible with these rhizobia than are Bossier and TGm 294.

Grafting Experiment

This study was conducted to determine if the promiscuous nodulating character(s) of the low yielding accessions were genetically transferred to the improved cultivars, would the resulting symbiosis provide sufficient N to realize high yield potential? To answer this question, shoots of high yielding varieties, Bossier and Jupiter, were grafted onto root stocks of Malayan and Orba (promiscuous varieties with low yield potential).

Table 4. Shoot dry weight, total N content and nodule dry weight at 50 days after transplanting and seed yield at maturity of inoculated (Nitragin) and uninoculated grafts using Bossier and Jupiter as scions and Orba and Malayan as root stocks.

Graft combination Scion/root	Inoculation treatment	Shoot dry wt.	N content.	Nodule dry wt.	Seed yield
		g/plant	—— mg/plant	——	g/plant
Jupiter/Jupiter	−	12.8 a	386 a	110 a	17.0 a
Jupiter/Jupiter	+	17.5 b	531 b	538 b	22.3 b
Jupiter/Malayan	−	18.6 bc	593 b	486 b	22.8 b
Jupiter/Malayan	+	17.5 b	574 b	477 b	23.7 b
Jupiter/Orba	−	20.2 bc	626 b	728 c	21.4 b
Jupiter/Orba	+	21.3 c	643 b	715 c	22.1 b
Bossier/Bossier	−	8.9 a	259 a	86 a	15.8 a
Bossier/Bossier	+	18.1 d	660 d	622 d	23.7 bc
Bossier/Malayan	−	12.0 b	390 b	310 b	19.9 b
Bossier/Malayan	+	16.0 c	517 c	467 c	23.5 bc
Bossier/Orba	−	18.3 d	617 cd	684 d	24.5 c
Bossier/Orba	+	19.7 d	730 d	647 d	21.0 bc

[*] Means followed by unlike letters with the same scion are significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test.

Results from 12 graft combinations grown in soil containing only indigenous rhizobia or inoculated with *R. japonicum* are presented in Table 4. Bossier scions grafted onto their own root stocks responded to inoculation, as evidenced by an increase of 103% in shoot growth, 632% in nodule weight and 50% in seed yield. When Bossier was grafted onto root stock of Orba and grown in uninoculated soil, the shoot growth, N content, nodule weight, and seed yield were similar to those for Bossier grafted onto Bossier and inoculated. The treatments with Orba root stocks did not respond to inoculation. Grafts of Bossier scions and Malayan root stocks were difficult to perform because of the thick hypocotyl of Bossier and thin stem of Malayan. Vegetative growth of this combination was less than that of the homologous grafts (Bossier grafted onto Bossier), even in inoculated soils, so early growth may have been affected by the grafting. However, seed yield of Bossier grafted onto Malayan roots equaled that of Bossier grafted onto Bossier and inoculated. Grafts of Jupiter scions onto Malayan or Orba root stocks in uninoculated soil produced plants that grew and yielded as well as Jupiter-Jupiter grafts and grown in inoculated soil. It is evident from these studies that the symbiosis between Malayan or Orba and indigenous rhizobia can supply the N needed for agronomically superior plants to realize their full yield potential. Consequently, incorporation of the promiscuous nodulating character into high yielding varieties should result in N_2 fixation adequate for high yields without inoculants or N-fertilizer. In developing countries where cowpea-type rhizobia exist, use of improved promiscuous soybean varieties is likely to result in greater stability in production. If commercial inoculants fail the promiscuous varieties will still grow well.

Heritability studies on the promiscuity character are incomplete, but empirical observations indicate that the character(s) can be transferred genetically. Some national breeding programs have already developed promiscuous nodulating lines, albeit unintentionally. Breeders in Tanzania, who have used 'Hernon 271' as a parent because of its vigorous vegetative growth, have produced at least three lines with the promiscuity of Hernon 271 (2,8), while in a Nigerian program that utilized Malayan as a parent, it was observed that many of the progeny (M-381, M-79, M-90, M-216, and M-98) are highly promiscuous (D. Adedzwa, 1983 personal communication). Several progenies of crosses made in Australia involving the variety 'Gilbert' were found to be promiscuous in Zambia (F. Javaheri, 1981 personal communication).

We have made crosses between some promiscuous accessions identified in the germplasm screening (mainly Hernon 271, TGm 120, and TGm 119) and improved high yielding parents (Jupiter and Bossier). Selections were made in the F_2 generation at Mokwa, based initially upon agronomic characters, then at physiological maturity on nodule mass. When Bossier, which has very limited compatibility with diverse rhizobia, was used as a parent, only 13% of the F_2 progeny were well nodulated. When Jupiter, which is intermediate in promiscuity, was used as a parent, 33% of the F_2 progeny were well nodulated. Selections were made in the F_3 generation at Ibadan, again for agronomic characters and nodulation. Seeds (F_4) from these selection were planted at Mokwa and further selected for favorable agronomic traits and nodule mass. Seeds from the F_4 plants were increased at Ibadan, and F_6 bulk populations (with F_5 heterogenety) were evaluated for yield and nodulation in multilocational yield trials. The vast majority of the entries were highly promiscuous and gave vigorous plant growth even on low-N soil.

It is clear, then, that promiscuously nodulating soybeans with improved agronomic traits can be developed and that this material can be grown without inoculation with *R. japonicum*. Details on the results of breeding for promiscuity, including genetic studies, will be presented in other articles.

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3.0 Objectives:

3.1 To develop high-yielding, disease and insect resistant cowpeas with appropriate seed types adapted to ecologies and farming systems in Latin America. Emphasis will be given to development of germplasm and agronomic practices appropriate to low imput farming systems in stress (drought prone areas, and regions with low fertility soils) ecologies; and to development of technolgy suited to more favorable ecologies.

3.2 To identify and/or develop high-yielding soybean varieties suited to tropical and sub-tropical ecologies of Latin America with emphasis on seed longevity and disease resistance.

3.3 To distribute improved germplasm to collaborators in Latin America.

3.4 To strengthen national programs in cowpea and soybean research and production through training and providing technical assistance appropriate to ecologies.

4.0 Approach to Meeting Objectives

4.1 Cowpeas - There are two principle and complementary sources of technology available to improve cowpea production in Latin America. The IITA-Nigeria program is generating new plant types that hold promise for increasing productivity especially in favorable environmental conditions. The EMBRAPA/IITA-Brazil program has developed improved germplasm with resistance to the local disease, especially virus diseases of Latin America. The majority of germplasm developed to date in Brazil is well suited to the harsh ecologies of N.E. Brazil where rainfall is scarce and erratic and where soils are infertile. There is still scope

for varietal improvement for harsh ecologies and this work will continue. A new thrust of research is being initiated to incorporate resistance to the diseases prevelant in Latin America, expecially virus diseases, into the new IITA plant types with uniform maturity. The initial phase of this research has been to evaluate the performance of new IITA germplasm. In the second phase, crosses are being made to incorporate disease resistance relevant to the Latin American ecologies. Within this activity attention will be given to both seed-type and vegetable-type cowpeas. Consideration will also be given to plant maturity (early, medium, late) and to seed characteristics such as color and size.

In addition to the backcross conversion program to convert IITA lines to resistant versions, populations are being developed by single pod descent until the F5 generation. Disease and insect susceptible plants are eliminated and F6 bulks with wide genetic variability are being sent to collaborators for selection of plants adapted to their ecologies.

4.2 Soybeans

CNP-Soja/EMBRAPA and EMGOPA/GOIAS state (Brazil) are generating high-yielding soybeans for tropical ecologies with resistance to major diseases. IITA/Nigeria has the best source of improved soybeans with good seed longevity and promiscuous nodulation. The majority of the Brazilian germplasm was generated by incorporation of the juvenile gene - which delays flowering - into high-yielding lines adapted to temperate ecologies. The agronomic characteristics of Brazilian germplasm are superb, but seed longevity is often rather poor. The major

thrust of IITA/EMBRAPA/EMGOPA research will be to incorporate improved seed longevity of IITA germplasm into the Brazilian germplasm using screening techniques developed at IITA. IITA germplasm is being evaluated in several ecologies and the best lines are being crossed to Brazilian germplasm. Although promiscuous nodulation is not required in Brazil, this characteristic is relevant for other countries that have not yet developed inoculant industries. Consequently, promiscuous lines from IITA/Nigeria have been multiplied in Brazil and will be evaluated for promiscuous nodulation in diverse ecologies in Brazil. Lines with good nodulation will be distributed to collaborators outside of Brazil for testing and will be used in crosses involving Brazilian germplasm.

5.0 Technology Transfer

The major activities to promote transfer of technology include germplasm distribution, visits to collaborators and formal training. In 1985 a group course was given in Brazil in April and May (see section on training). In addition to group training, future training activities should include research fellowships that would allow Latin American scientists to spend from 1 to 12 months in Brazil working with appropriate IITA and EMBRAPA scientists.

6.0 Research Activities

6.1.1 Cowpeas

Trials distributed to date (within Brazil) are summarized in Table 1.

Table 1. Multilocation trials and bulk populations sent from Goiânia.

Letter number	Date	Location	Bulk	Preliminary				Advanced		Regional		
				P_1	P_2	P_3	P_4	A_1	A_3	R_1	R_3	R_4
162	18/01	EPACE						3	-	-	-	2
163	18/01	EMPARN						1	1	1	2	1
164	18/01	DNOCS, PI						1	1	1	1	1
165	18/01	EMGOPA						-	-	1	1	1
166	18/01	IPA		1		1		1	1	1	1	1
167	18/01	EMEPA						1	1	1	1	1
168	18/01	CPATSA						-	1	-	-	-
169	18/01	EPAMIG						-	-	1	1	1
170	18/01	COTRIJUI						-	-	1	1	-
by hand	18/01	CNPAF		1	1	1	1+1	1	1	1	1	1
299	05/02	EMEPA		-	1	1	-					
300	05/02	EMPARN		1	-	-	1					
301	05/02	DNOCS, PI		-	-	1	1					
302	05/02	EPACE		2	-	-	1					
306	06/02	U. Teresina		1	-	-	-					
311	06/02	EPABA		1	-	1	-	-	1	1	1	-
312	06/02	U. P. Velho		-	-	1	-	-	-	-	-	-
313	06/02	CPATU		-	-	1	1	-	-	-	1	1
314	06/02	EMAPA		-	-	-	-	1	3	-	1	1
318	07/02	U. Manaus		1	-	1	-	1	1	1	1	-
319	07/02	U. Macapá		-	-	1	1	-	1	-	-	1
320	07/02	U. Boa Vist		1	1	1	1	1	1	1	1	1
321	07/02	U. Altamira, BLN		-	-	-	-	-	1	-	1	1

Letter number	Date	Location	Bulk	Preliminary				Advanced		Regional		
				P_1	P_2	P_3	P_4	A_1	A_3	R_1	R_3	R_4
354	13/02	EPACE		-	1	-	-	-	-	-	1	-
358	14/02	P. Velho Agropc.								-	1	-
417	27/02	EPACE								-	1	-
444	04/03	U. Rio Branco	2									
445	04/03	EPEAL	6									
446	04/03	U. Macapá	6									
447	04/03	EMGOPA	1									
448	04/03	IPA	6									
449	04/03	EMPARN	6									
588	20/03	EMEPA	6									
603	24/03	EMAPA	1									
776	24/04	U. Manaus		-	-	-	-	-	-	-	1	-
879	21/05	EPACE EPEE		1	1	1	-	-	-	-	-	-
T O T A L			34	14	5	12	8	11	14	12	20	15

EEW/aso
Ago./85

6.1.2 Trials planted - EMBRAPA/IITA Breeding Project at Goiania.

6.1.2.1 Germplasm: One hundred (100) lines were introduced into Brazil from IITA; 16 from CATIA, Costa Rica; 3 from Venezuela; 2 from Surinam; one from Guyana (BR); and 13 from California. All have been multiplied in the greenhouse and registered with the germplasm bank. Lines were then grown in the field and evaluated to disease reaction (especially for viruses).

6.1.2.2 Crossing: The first crosses were made in the screenhouse by crossing some of the best IITA material in Latin America with lines resistant to CSMV (38 crosses + 15 double crosses, Table 3). F3 seed has been obtained from these crosses and F4 populations planted. The second crossing block was a quarantine isolation block where IITA's best new lines were crossed with virus resistant lines (33 crosses). Later the F1's were intercrossed (32 double and backcrosses in the glasshouse and 34 in the field, see Table 2). One other crossing program has been initiated, a diallel cross with backcrosses to study the number of genes available for immunity to CSMV. The best commercial lines of meter bean from Guiana and Surinam have also been crossed to new lines with resistance to CSMV and Poty virus.

The main crossing block involving lines to incorporate resistance to CSMV, Poty virus, Rust, Cercospora, Mildew and Bruchid resistance with local cultivars has been completed, resulting in 90 crosses.

6.1.2.3 Early generation advance: 177 populations ranging from F2 to F4 have been advanced using a "pod/plant" method while screening for resistance to CSMV. Single plant selections were

Table 2. COWPEA CROSSES

CNCx 544	IT 81D-1228-10	x	CNC 0434
CNCx 545	IT 81D-1228-10	x	CNCx 27-2E
CNCx 546	IT 82D-1228-13	x	CNC 0434
CNCx 547	IT 81D-1228-13	x	CNCx 27-2E
CNCx 548	IT 81D-1228-16	x	CNCx 27-2E
CNCx 549	IT 81D-1228-16	x	CNC 0434
CNCx 550	IT 81D-1205-174	x	CNCx 27-2E
CNCx 551	CNCx 27-2E	x	IT 81D-1228-10
CNCx 552	IT 82D-27	x	CNC 0434
CNCx 553	IT 82D-716	x	CNC 0434
CNCx 554	IT 82D-716	x	CNCx 27-2E
CNCx 555	IT 82D-744	x	CNC 0434
CNCx 556	IT 82D-786	x	CNCx 27-2E
CNCx 557	IT 82D-786	x	CNC 0434
CNCx 558	IT 82D-789	x	CNC 0434
CNCx 559	IT 82D-789	x	CNCx 27-2E
CNCx 560	IT 82D-812	x	CNC 0434
CNCx 561	IT 82D-812	x	CNCx 27-2E
CNCx 562	CNCx 27-2E	x	IT 82D-716
CNCx 563	CNCx 27-2E	x	IT 82D-789
CNCx 564	IT 84D-275-9	x	CNC 0434
CNCx 565	IT 82E-18	x	CNC 0434
CNCx 566	IT 82E-18	x	CNCx 27-2E
CNCx 567	CNCx 27-2E	x	IT 82E-18
CNCx 568	IT 84E-250-7	x	CNC 0434
CNCx 569	IT 84E-250-7	x	CNCx 27-2E
CNCx 570	IT 84E-275-9	x	CNCx 27-2E
CNCx 571	TVx 1948-012F	x	CNC 0434
CNCx 572	TVx 3781-02F	x	CNC 0434
CNCx 573	TVx 3781-02F	x	CNCx 27-2E
CNCx 574	CNCx 27-2E	x	TVx 4659-02E
CNCx 575	CNCx 27-2E	x	TVx 4677-010E
CNCx 576	CNCx 27-2E	x	IT 81D-1228-14
CNCx 577	CNCx 523-1A	x	CNC 0434
CNCx 578	CNCx 535-1A	x	CNCx 520-1A
CNCx 579	TVx 3236-01G	x	CNCx 522-1A
CNCx 580	TVx 3236-01G	x	CNCx 520-1A
CNCx 581	TVx 3236-01G	x	CNCx 535-1A
CNCx 582	CNCx 523-1A	x	CNCx 27-2E
CNCx 583	CNCx 523-1A	x	CNCx 520-1A
CNCx 584	CNCx 520-1A	x	CNCx 523-1A
CNCx 585	CNCx 521-1A	x	CNCx 523-1A
CNCx 586	CNCx 509-1A	x	CNC 0434
CNCx 587	CNCx 590-1A	x	CNC 0434
CNCx 588	CNCx 510-1A	x	IT 82D-789
CNCx 589	CNCx 506-1A	x	CNC 0434
CNCx 590	CNC 0434	x	SERIDO
CNCx 591	CNC 0434	x	BRANQUINHO
CNCx 592	CNCx 27-2E	x	CNC 0434
CNCx 593	CNC 0434	x	CNCx 27-2E
CNCx 594	CNC 0434	x	TVu 612
CNCx 595	TVu 966	x	CNCx 27-2E

CNCx 596	CNCx 27-2E	x	TVu 966
CNCx 597	TVu 612	x	CNC 0434
CNCx 598	TVu 2067	x	TVu 612
CNCx 599	TVu 993	x	CNCx 27-2E
CNCx 600	TVu 993	x	CNC 0434
CNCx 601	TVu 2067	x	TVu 966
CNCx 602	UNARE	x	TVu 612
CNCx 603	UNARE	x	CNCx 187-22D
CNCx 604	UNARE	x	CNCx 252-1E
CNCx 605	CB 5/7977	x	CNCx 252-1E
CNCx 606	CB 5/7977	x	CNCx 187-22D
CNCx 607	CB 5/7977	x	TVu 612
CNCx 608	APURE	x	TVu 612
CNCx 609	APURE	x	CNCx 252-1E
CNCx 610	CB-3	x	CNCx 187-22D
CNCx 611	CB-3	x	TVu 612
CNCx 612	CB-3	x	CNCx 252-1E
CNCx 613	SURINAME	x	CNCx 252-1E
CNCx 614	SURINAME	x	TVu 612
CNCx 615	GUIANA	x	TVu 612

CNCx 616	{TVx 3236-01G x [Vita 7 x (CNC 0434 x Branq.)]} x [TVx 3236-01G x (Vita 7 x CNCx 27-2E)]
CNCx 617	[TVx 3236-01G x (Vita 7 x CNCx 27-2E)] x {TVx 3236-01G x [CNCx 15-7D x (CNC 0434 x Serido)]}
CNCx 618	[(Manaus x TVu 59) x CNC 0434] x (CNCx 27-2E)
CNCx 619	[(Vita 7 x Vita 4) x (Vita 7 x CNC 0434)] x (CNCx 27-2E)
CNCx 620	(IT 82D-789 x CNC 0434) x (CNCx 27-2E x IT 82D-789)
CNCx 621	(IT 82D-789 x CNCx 27-2E) x (IT 82D-789 x CNC 0434)
CNCx 622	(IT 82D-812 x CNC 0434) x (IT 82D-812 x CNCx 27-2E)
CNCx 623	(IT 81D-1228-10 x CNC 0434) x (IT 81D-1228-16 x CNCx 27-2E)
CNCx 624	(IT 81D-1228-10 x CNC 0434) x (IT 81D-1228-10)
CNCx 625	(IT 81D-1228-10 x CNC 0434) x (IT 81D-1228-10 x CNCx 27-2E)
CNCx 626	(IT 81D-1228-10 x CNC 0434) x (CNCx 27-2E x IT 81D-1228-10)
CNCx 627	(IT 81D-1228-16 x CNCx 27-2E) x (IT 81D-1228-16)
CNCx 628	(IT 81D-1228-13 x CNCx 27-2E) x (IT 82D-716 x CNC 0434)
CNCx 629	(IT 82D-716 x CNC 0434) x (IT 82D-716 x CNCx 27-2E)
CNCx 630	(IT 82D-716 x CNCx 27-2E) x (CNCx 187-22D)
CNCx 631	(IT 82E-18 x CNC 0434) x (IT 82E-18)
CNCx 632	(IT 82E-18 x CNC 0434) x (CNCx 27-2E x IT 82E-18)
CNCx 633	(CNCx 27-2E x IT 82E-18) x (IT 82E-18)
CNCx 634	(IT 84E-275-9 x CNCx 27-2E) x (IT 84D-275-9 x CNC 0434)
CNCx 635	(IT 84E-275-9 x CNCx 27-2E) x (IT 84E-275-9)
CNCx 636	(IT 82D-786 x CNC 0434) x (IT 82D-786)
CNCx 637	(IT 82D-786 x CNCx 27-2E) x (IT 82D-786)
CNCx 638	(IT 82D-27 x CNC 0434) x (IT 82E-27)
CNCx 639	(IT 82D-27 x CNC 0434) x (CNCx 27-2E)
CNCx 640	(IT 84D-275-9 x CNC 0434) x (IT 84E-275-9)
CNCx 641	(IT 84D-275-9 x CNC 0434) x (IT 82D-789)
CNCx 642	(TVx 3781-02F x CNC 0434) x (TVx 3781-02F x CNCx 27-2E)
CNCx 643	(CNCx 27-2E x TVx 4677-010E) x (TVx 4677-010E)

CNCx 644 (IT 84E-250-7 x CNC 0434) x (IT 84E-250-7 x CNCx 27-2E)
CNCx 645 (IT 84E-250-7 x CNCx 27-2E) x (IT 84E-250-7)
CNCx 646 (IT 84E-250-7 x CNCx 27-2E) x (IT 84E-250-7 x CNC 0434)

CNCx 647 UCR 204 x TVu 966
CNCx 648 UCR 204 x TVu 966
CNCx 649 UCR 204 x CNCx 252-1E
CNCx 650 UCR 193 x TVu 966
CNCx 651 UCR 193 x CNCx 252-1E
CNCx 652 UCR 194 x CNCx 187-22D-1
CNCx 653 UCR 194 x CNCx 252-1E
CNCx 654 UCR 194 x TVu 966
CNCx 655 UCR 194 x CNCx 252-1E
CNCx 656 UCR 194 x CNCx 252-1E
CNCx 657 CNCx 252-1E x UCR 206A
CNCx 658 CNCx 252-1E x UCR 194
CNCx 659 CNCx 252-1E x UCR 204
CNCx 660 CNCx 252-1E x UCR 204
CNCx 661 UCR C-17 x TVu 966
CNCx 662 CNCx 187-22D-1 x SEMPRE VERDE
CNCx 663 CNCx 187-22D-1 x FEIJAO T-570
CNCx 664 CNCx 252-1E x SEMPRE VERDE
CNCx 665 CNCx 252-1E x TRACUATENA
CNCx 666 CNCx 252-1E x IT 81D-1064
CNCx 667 CNCx 252-1E x SERIDO
CNCX 668 CNCx 252-1E x BICO DE PATO
CNCX 669 CNCx 252-1E x FEIJAO T-570
CNCX 670 TVu 966 x SEMPRE VERDE
CNCX 671 TVu 966 x IT 81D-1064
CNCX 672 TVu 966 x FEIJAO OTELIA
CNCX 673 TVu 966 x APURE
CNCX 674 TVu 966 x TRACUATENA
CNCX 675 TVu 966 x UNARE
CNCx 676 TVu 966 x FEIJAO T-570
CNCX 677 CNCX 36-5E x CNCx 483-?
CNCx 678 CNCx 36-5E x IPA 202 L-076
CNCx 679 CNCx 36-5E x TRACUATENA
CNCx 680 CNCx 36-5E x FEIJAO T-570
CNCx 681 SERIDO x CALIFORNIA BLACKEYE (CB-3)
CNCX 682 SERIDO x CNCx 187-22D-1
CNCx 683 SERIDO x CNCx 252-1E
CNCx 684 CNCx 336-1E x CNCx 252-1E
CNCx 685 CNCx 336-1E x CNCx 187-22D-1
CNCx 686 CNCx 336-1E x IPA 202 L-076
CNCx 687 CNCx 483-1E x UNARE
CNCX 688 CNCx 483-1E x CNCx 187-22D-1
CNCx 689 CNCx 483-1E x FEIJAO T-570
CNCx 690 CNCx 483-1E x IT 81D-1064
CNCx 691 CNCx 483-1E x APURE
CNCX 692 CNCx 483-1E x CNCx 36-5E
CNCx 693 CNCx 333-95E x FEIJAO T-570
CNCx 694 CNCx 333-95E x TVu 966
CNCx 695 CNCx 333-95E x IT 81D-1064
CNCx 696 CNCx 333-95E x UNARE
CNCx 697 CNCx 333-95E x IPA 202 L-076

CNCx 698	CNCx 333-95E	x	CNCx 252-1E
CNCx 699	CNCx 333-77E	x	UNARE
CNCx 700	CNCx 333-77E	x	IT 81D-1064
CNCx 701	CNCx 333-77E	x	CNCx 252-1E
CNCx 702	CNCx 333-77E	x	IPA 202 L-076
CNCx 703	CNCx 333-51E	x	CNCx 252-1E
CNCx 704	CNCx 333-51E	x	UNARE
CNCx 705	CNCx 333-51E	x	IT 81D-1064
CNCx 706	CNCx 333-60E	x	CNCx 252-1E
CNCx 707	CNCx 333-60E	x	UNARE
CNCx 708	CNCx 333-60E	x	IT 81D-1064
CNCx 709	CNCx 333-60E	x	APURE
CNCx 710	CNCx 333-60E	x	CNCx 187-22D-1
CNCx 711	UNARE	x	TRACUATENA
CNCx 712	SEMPRE VERDE	x	CNCx 252-1E
CNCx 713	IPA 202 (L-076)	x	CNCx 161-5E
CNCx 714	IPA 202 (L-076)	x	CNCx 333-95E
CNCx 715	IPA 202 (L-076)	x	TVu 966
CNCx 716	IPA 202)L-076)	x	CNCx 36-5E
CNCx 717	CB-5|BS|7977	x	CNCx 187-22D-1
CNCx 718	CB-5|BS|7977	x	APURE
CNCx 719	CB-5|BS|7977	x	FEIJAO T-570
CNCx 720	CB-5|BS|7977	x	UNARE
CNCx 721	CB-5|BS|7977	x	CNCx 252-1E
CNCx 722	CALIFORNIA BLACKEYE (CB-3)	x	TRACUATENA
CNCx 723	CALIFORNIA BLACKEYE (CB-3)	x	CNCx 333-51E
CNCx 724	CALIFORNIA BLACKEYE (CB-3)	x	BICO DE PATO
CNCx 725	CALIFORNIA BLACKEYE (CB-3)	x	SEMPRE VERDE
CNCx 726	CALIFORNIA BLACKEYE (CB-3)	x	IPA 202 (L-076)
CNCx 727	CALIFORNIA BLACKEYE (CB-3)	x	CNCx 187-22D-1
CNCx 728	CALIFORNIA BLACKEYE (CB-3)	x	FEIJAO T-570
CNCx 729	CNC 0434	x	IT 81D-1064
CNCx 730	BICO DE PATO	x	TVu 966
CNCx 731	CNCx 161-5E	x	CB-5|BS|7977
CNCx 732	CNCx 161-5E	x	VITA 7
CNCx 733	CNCx 161-01E	x	UNARE
CNCx 734	CNCx 161-01E	x	CNCx 187-22D-1
CNCx 735	CNCx 161-01E	x	TRACUATENA
CNCx 736	CNCx 161-01E	x	IT 81D-1064

CNCx 737	(TVx 1948-012F x CNC 0434) x CNCx 252-1E
CNCx 738	(TVx 1948-012F x CNC 0434) x TVx 1948-012F
CNCx 739	(TVx 3781-02F x CNC 0434) x CNCx 187-22D-1
CNCx 740	(TVx 3781-02F x CNC 0434) x TVx 3781-02F
CNCx 741	(IT 81D-1228-13 x CNC 0434) x IT 81D-1228-13
CNCx 742	(IT 82D-789 x CNC 0434) x IT 82D-789
CNCx 743	(IT 81D-1228-10 x CNC 0434) x IT 1228-10
CNCx 744	(IT 81D-1228-10 x CNC 0434) x CNCx 252-1E
CNCx 745	(IT 81D-1228-10 x CNC 0434) x CNCx 187-22D-1
CNCx 746	(IT 84E-275-9 x CNC 0434) x IT 84E-275-9
CNCx 747	(IT 84E-275-9 x CNC 0434) x CNCx 187-22D-1
CNCx 748	[(CNCx 15-7D x VITA 4) x CNC 0434] x CNCx 15-7D
CNCx 749	[(TVx 1836-013J x VITA 4) x CNC 0434] x CNCx 252-1E
CNCx 750	[(TVx 1836-013J x VITA 3) x CNC 0434] x TVx 1836-013J
CNCx 751	[(TVx 1836-013J x VITA 4) x CNC 0434] x CNCx 187-22D-1

CNCx 752	(IT 82E-27 x CNC 0434) x IT 82E-27
CNCx 753	(IT 81D-1228-16 x CNC 0434) x IT 81D-1228-16
CNCx 754	(IT 81D-1228-16 x CNC 0434) x CNCx 187-22D-1
CNCx 755	(IT 82D-716 x CNC 0434) x IT 82D-716
CNCx 756	(IT 82D-812 x CNC 0434) x IT 82D-812
CNCx 757	[(MANAUS x TVu 59) x CNC 0434] x MANAUS
CNCX 758	[(MANAUS x TVu 59) x CNC 0434] x CNCx 252-1E
CNCx 759	[(MANAUS x TVu 59) x CNC 0434] x CNCx 187-22D-1
CNCx 760	{[MANAUS x (CNC 0434 x SERIDO)] x IT 82D-789} x CNCx 187-22D-1
CNCx 761	{[MANAUS x (CNC 0434 x SERIDO)] x IT 82D-789} x IT 82D-789
CNCx 762	(IT 82D-744 x CNC 0434) x IT 82D-744
CNCx 763	(IT 82D-716 x CNC 0434) x CNCx 252-1E
CNCx 764	(IT 82E-18 x CNC 0434) x IT 82E-18
CNCx 765	[(CNCx 15-7D x TVu 59) x CNC 0434] x CNCx 252-1E
CNCx 766	[(CNCx 15-7D x TVu 59) x CNCx 187-22D-1
CNCx 767	(IT 82D-789 x CNC 0434) x IT 82D-789
CNCx 768	[(CNCx 10-4D x TVu 59) x CNC 0434] x CNCx 187-22D-1
CNCx 769	[(CNCx 10-4D x TVu 59) x CNC 0434] x CNCx 252-1E
CNCx 770	(IT 82D-786 x CNC 0434) x IT 82D-786
CNCx 771	{TVx 3236-01G x [VITA 7 x (CNC 0434 x BRANQ.)] x [CNCx 187-22D-1]}

TABLE 3.

COWPEA CROSSES MADE IN BRAZIL, 1985

Purpose		Crosses
1) Incorporation of virus resistance into IITA germplasm		94
2) Double virus resistance for Brazil.		31
3) Virus resistance in bush vegetable pod type		15
4) Virus resistance in yard-long type.		03
5) Virus resistance in Venezuelan germplasm. .		18
6) Fusarium resistance		14
7) Miscellaneous		52
a. Genetic studies	24	
b. Bruchid Resistance	8	
c. Taste (IPA 202)	9	
d. Erect - Virus Resistance	6	
e. Other	5	
	Total:	227

made at Goiania from 44 F5 populations and the remaining plants were bulked for distribution to national and international programs for selection in their specific ecologies.

6.1.2.4 Preliminary trials: There were five preliminary trials planted this year. They are (names, yield and virus scores are in annex):

Prelim. 1. Brown seeded, prostrate plant type -
49 lines, 9 locations (Results 4 locations).

Prelim. 2. White seeded, prostrate plant type -
49 lines, 5 locations (Results 4 locations).

Prelim. 3. Brown seeded, erect plant type -
49 lines, 10 locations (Results 4 locations).

Prelim. 4. White seeded, erect plant type
36 lines, 8 locations (Results 2 locations).

Prelim. 5. Mixed seed types and plant types as this trial
was only planted in Goiania, 80 lines.

Data is summarized in the Appendix, Section 1.

6.1.2.5 Advanced trials: There were two advanced trials planted in Goiania this year, each having 25 lines and 4 replications. Data is summarized in the Appendix, Section 2.

Advanced 1. Brown seeded, prostrate plant type, 11
locations (Results 7 locations).

Advanced 3. Brown seeded, erect plant type, 14
locations (Results 6 locations).

6.1.2.6 Regional trials: There were three Regional trials planted in Goiania, each having 12 lines and 4 replications.

Regional 1. Brown seed, prostrate plant type, 12 locations (Results 6 locations).

Regional 3. Brown seed, erect plant type, 20 locations (Results 6 locations).

Regional 4. White seed, erect plant type, 15 locations (Results 7 locations).

Yields and virus scores are in Appendix, Section 3. Yields at Goiania were quite low due to the heavy attack of diseases and the need to irrigate late in the season. Trials had been planted late for the training course.

6.1.2.7 Disease reaction of IITA-Nigeria germplasm: IITA lines were, in general, quite early and erect. No irrigated or rain forest trials were visited, which are the ecologies in which IITA materials are presently planted. From the virus trials at CNPAF, only a few lines have virus resistance as per the evaluation sent to IITA in May (see Appendix, Section 4). Most of the IITA lines were tested in inoculated trials. Of the 154 lines tested, 15 had a score of 2 for Poty virus (IT 82D-885, 884, 878, 786, 784, 702, 716, 927, 807, 904, IT 82E-25, TVx's 3871-02F, 4304-06C, 5056-07C and 5578-0C). Score of 1 indicates immunity and 5 indicates extreme susceptibility. This represents about 10% of the IITA lines indicating some resistance in the 1st screen to the Poty virus. These lines have been planted in the screenhouse for more accurate testing.

All the 141 lines IITA inoculated with CSMV were susceptible. Two lines, TVx 3236 and VITA 4 initially were

reported to have a virus score of 2 (see May report on IITA lines) but this proved to be a recording error and the resistant rows were actually the resistant check lines.

Incidence of powdery mildew was noted in the yield trials with five IITA lines showing less attack of the fungus. They were: IT 82D-889, VITA 6, IT 81D-988, IT 81D-994 and IT 81D-993.

6.1.3 Upcoming lines and on-farm trials: The Ceara state trial is showing good promise for CNCx 166-08E (from a cross involving TVu 1888, a scab resistant line) and CNCx 163-016G (Serido x TVx 1836-013J).

Piaui state trials are showing promise for TE 570 which ia a large seeded selection from TVx 3777-04E. This line is early, erect and is being sought by farmers for irrigated plantings but it has little resistance to virus.

Goias multiplied VITA 3 for on-farm trials as its seed color is similar to the red beans eaten in the region. IITA lines IT 82D-789, 82D-812, and IT 82D-885 with synchronous podding have been multiplied to assess ease in direct harvest on farmers fields in southern Maranhao state.

6.1.3.1 New releases/recommendations: Cultivar CNC 0434 from the IITA disease sub-population which is immune to CSMV was recommended in Maranhao state (August 2) and Amapa Territory (June 27, 85 release ceremony). Research personnel multiplied 3 ha in Amapa with 800 kg/ha yields and 1 ha in Maranhao with 1000 kg/ha yield.

Cultivar Serrano (CNCx 24-016E using TVu 59 as a parent) was released in late 1984 in the state of Rio Grande do Norte. It

has higher tolerance to viruses and better yield than Serido and Pitiuba, the best local cultivars.

Cultivars Rio Branco (CNCx 10-4D using Serido and TVu 36 as parents) and Cana Verde (CNCx 15-7D using Pitiuba and Sempre Verde as parents) were released 21 February in Rio Branco, Acre. The first line is the higher yielding of the two while the second is more uniform in maturiy. Both are to be planted in a high rainfall region of the Amazon Valley.

CARDI and the Jamaican Ministry of Agriculture released VITA 3 on July 4.

6.1.3.2 Changes in priorities and methods: Identification of virus diseases and screening for resistance has been the first priority in the past. Breeding for resistance to CSMV seems to be under control and a system has been established to transfer resistance into commercial lines. New lines are now available which combine fair seed types in both the brown and white classes with resistance or tolerance to CSMV, scab, and mildew. Breeding for resistance to poty virus has been more difficult because of escapes and lack of immunity. Progeny rows of selected F5 plants are now being inoculated to confirm resistance prior to entry in preliminary trials.

Rust (Uromyces vignae Barcl.) has now been officially identified and registered in Brazil and some priority will need to be given to the study of the extent of damage, spread of the fungus and sources of resistance. From first observations it is widespread and can become epidemic, particulary in irrigated areas. Many of the IITA lines (VITA 7) seem to have resistance

to tolerance while many local lines are highly susceptible (Pendanga, 40 Dias).

Yard long bean is increasing in importance so crosses were made to incorporate virus and scab resistance in this commercial class.

One of the more important changes has been the emphasis on the incorporation of virus and mildew resistance into IITA lines which have performed well in other Latin American countries.

6.2 Soybeans

6.2.1 Trials:

About 800 IITA soybean lines cleared Brazilian plant quarantine and were sown with 200 Brazilian lines from EMBRAPA and EMGOPA in mid-December on the EMGOPA station near Goiania (see Appendix, Section 5). The trial was harvested in May and seeds were tested for longevity using IITA's modified accelerated aging technique. Performance of the best lines are shown in Table 4. About 150 IITA lines that looked adapted were sown in multiplicaton plots in June on the EMGOPA station for entry in preliminary yield trials in collaboration with EMGOPA/EMBRAPA (see Appendix, Section 6). Another 250 lines were sown in June in northern Goias at the Rio Formoso Project near Gurupi to evaluate their adaptation to short-day conditions (11.5 hours) in combination with hot conditions (see Appendix, Section 7).

IITA incubator weathering technique to simulate field weathering of seed was established and several lines were evaluated (see Appendix, Section 8).

TABLE 4.

Seedling emergence based on IITA's modified accelerated aging test of agronomically attractive lines in Brazil

No.	Line	% Emergence
01.	TGx 856-66E	97
02.	TGx 803-99E	96
03.	TGx 802-125D	94
04.	M 79-4	94
05.	GO 83-21609	93
06.	TGx 863-86D	92
07.	TGx 302A-47E	92
08.	TGx 825-16D	92
09.	TGx 302A-37	91
10.	TGx 825-20E	91
11.	TGx 856-38E	91
12.	SG 33	91
13.	GO 83-27173	91
14.	TGx 251-1C	89
15.	TGx 539-1F	89
16.	TGx 709-8E	89
17.	TGx 802-252D	89
18.	TGx 816-42D	89
19.	IAC-7 (RC 3)	89
20.	TGx 536-02D	89
Checks		
	TGM 737P	96
	Parana	54
	Bossier	52
	Buffalo	05

LSD (0.05) = 12

Trials planned for the 1985 main season include: 1) initial evaluation of new germplasm; 2) evaluation of seed quality lines for yield and resistance to seed deterioration at 10 sites in Brazil; 3) evaluation of promiscuity of 25 lines at 6 sites; 4) preliminary yield trials of 150 lines at 2 sites in southern Goias; 5) preliminary yield trials in northern Goias; 6) preliminary trial in southern Maranhao; advance of F2 population of crosses involving IITA and Brazilian parents.

6.2.2 Soybean Crosses: Thirty-one crosses involving IITA germplasm with Brazilian lines were realized. An additional 22 backcrosses and double crosses were made to ensure combinations with resistance to seed deterioration, good agronomic characteristics and resistance to foliar Cercospora (Table 5).

Table 5.

SOYBEAN CROSSING REGISTER

IBX - 01	TGX 711 X PARANAGOIANA
IBX - 02	TGX 711-01D X CRISTALINA
IBX - 03	TGX 814-26D X BR 82-1060
IBX - 04	TGX 814-26D X SAVANA
IBX - 05	TGX 814-26D X TROPICAL
IBX - 06	TGX 814-26D X PARANAGOIANA
IBX - 07	DOKO X TGX 713-09D
IBX - 08	DOKO X TGX 711-01D
IBX - 09	IAC 7 (RC 7) X TGX 711-01D
IBX - 10	IAC 7 (RC 4) X TGX 709-01E
IBX - 11	IAC 7 (RC 4) X TGX 814-26D
IBX - 12	IAC 7 (RC 3) X TGX 713-09D
IBX - 13	PARANAGOIANA X TGX 713-09D
IBX - 14	PARANAGOIANA X TGX 711-01D
IBX - 15	PARANAGOIANA X TGX 802-321D
IBX - 16	TROPICAL X TGX 802-321D
IBX - 17	TROPICAL X TGX 711-01D
IBX - 18	TROPICAL X TGX 713-09D
IBX - 19	TROPICAL X TGX 814-26D
IBX - 20	BR 82-1179 X TGX 713-09D
IBX - 21	BR 82-1179 X TGX 711-01D
IBX - 22	BR 82-1098-4 X TGX 814-26D
IBX - 23	EMGOPA 301 X TGX 814-26D
IBX - 24	EMGOPA 301 X TGX 711-01D
IBX - 25	EMGOPA 301 X TGX 713-09D
IBX - 26	CRISTALINA X TGX 814-26D
IBX - 27	CRISTALINA X TGX 711-01D
IBX - 28	DOKO X TGX 306-036C
IBX - 29	TROPICAL X TGX 854-6D
IBX - 30	TROPICAL X TGX 854-6D
IBX - 31	TROPICAL X TGX 306-036C
IBX - 32	(TGX 814-26D X SAVANA) X CRISTALINA
IBX - 33	(TGX 814-26D X PARANAGOIANA) X CRISTALINA
IBX - 34	(DOKO X TGX 713-09D) X DOKO
IBX - 35	(DOKO X TGX 711-01D) X CRISTALINA
IBX - 36	(IAC 7 - RC 4 X TGX 709-01E) X IAC 7 (RC 4)
IBX - 37	(TROPICAL X TGX 713-09D) X CRISTALINA
IBX - 38	(EMGOPA 301 X TGX 711-01D) X IAC 7 (RC 4)
IBX - 39	DOKO X (TGX 814-26D X SAVANA)
IBX - 40	DOKO X (PARANAGOIANA X TGX 711-01D)
IBX - 41	DOKO X (PARANAGOIANA X TGX 802-321D)
IBX - 42	IAC 7 (RC 7) X (DOKO X TGX 711-01D)
IBX - 43	PARANAGOIANA X (IAC 7 - RC 4 X TGX 814-26D)
IBX - 44	(DOKO X TGX 306-036C) X CRISTALINA
IBX - 45	(DOKO X TGX 306-036C) X IAC 7 (RC 4)
IBX - 46	(DOKO X TGX 306-036C) X IAC 7 (RC 7)
IBX - 47	(DOKO X TGX 306-036C) X (CRISTALINA X TGX 814-26D)
IBX - 48	(TROPICAL X TGX 854-6D) X IAC 7 (RC 7)
IBX - 49	(TROPICAL X TGX 854-6D) X CRISTALINA
IBX - 50	(TROPICAL X TGX 854-6D) X CRISTALINA

IBX - 51	(TROPICAL X TGX 854-6D) X IAC 7 (RC 4)
IBX - 52	(TROPICAL X TGX 854-6D) X IAC 7 (RC 7)
IBX - 53	IAC 7 (RC 7) X (DOKO X TGX 306-036C)
IBX - 54	(TROPICAL X TGX 306-036C) X IAC 7 (RC 3)

7.0 Visitors to Latin American Project.

7.1 Dr. Peter Oyekan, IITA visiting scientist visited Latin American Project for about 10 days in March. Dr. Oyekan visited CNPAF and EMGOPA near Goiania. Kueneman took Dr. Oyekan to southern Goias (near Rio Verde) to see soybean production on the Cerrados and to visit with officers of a large cooperative. His visit to CNP-Soja Londrina was arranged.

7.2 Dr. Luis Camacho, INTSOY soybean breeder, visited for one week in early April. Kueneman took Camacho to EMGOPA and to the soybean production area near Brasilia. Camacho's visit to CNP-Soja was also arranged.

7.3 Dr. Louie Jackai, IITA entomologist, visited the Latin American program for one week in April to assist with the Regional Training Program. Dr. Jackai visited CNPAF, EMGOPA, and CNP-Soja.

7.4 Dr. Jorge Nieto, Soybean Coordinator for southern Mexico, spent 3 days at CNPAF and 2 days at CNP-Soja during late September.

8.0 Germplasm Distributed Outside of Brazil

8.1 Cowpea seed distributed to:

1) Country: Peru
Collaborator: Guillermo Hernandez-Bravo
Date sent: February 1985

Lines sent: POTY, CNCx 0434, 40 DIAS, CNCx 105-8F, 105-22E, 112-01F, 176-03G, 161, 01E, 171, 03E, 171-07E, 171-09E, 171-012E, 172-01E, 161-5E, 163-18F, 164-2F, 164-9F, 167-7E, 167-9E, 167-11F, 167-12F, 167-23E, 167-25E, 167-28F, 167-48F, 167-50F, 167-52F, 168-2F, 180-3F.

2) Country: Argentina
Collaborator: Julio Luna
Date sent: August 1985

Lines sent: Yardlong types: CNCS 8007-20, 8009-12, 8009-24, 8009-25-1, 8010-28-1, 8010-29, 8013-34, 8019-42, 8032-47, 8052-57, TVx 3456-01E, FARV 13.

Grain types: EPACE 6, CNC 0434, VITA 3, VIAT 6, VITA 7, MANAUS, BR 1-POTY, CNCx 24-015E, 24-015E, BR2 TRACUATEDA.

3) Country: Paraguay
Collaborator: Carlos Schultz
Date sent: June 1985

Lines sent: F6 bulk populations, CNCx 251 and CNCx 252, CNCx 252-1E, 187-22D-1, 171-021E, CNCx 0434, BR 1-POTY, CNCx 177-02C.

4) Country: Ecuador
Collaborator: Vincente Bolanos/H. Buestan
Date sent: June 1985

Lines sent: F6 bulk populations, CNCx 251 and CNCx 252, CNCx 252-1E, 187-22D-1, 171-021E, CNCx 0434, BR 1-POTY, CNCx 177-02C.

5) Country: Mexico
Collaborator: Jose Laris Delgado
Date sent: June 1985

Lines sent: F6 bulk populations, CNCx 251 and CNCx 252, CNCx 252-1E, 187-22D-1, 171-021E, CNCx 0434, BR 1-POTY, CNCx 177-02C.

6) Country: Panama
Collaborator: Dr. Gaspar Silver
Date sent: June 1985

Lines sent: F6 bulk populations, CNCx 251 and CNCx 252, CNCx 252-1E, 187-22D-1, 171-021E, CNCx 0434, BR 1-POTY, CNCx 177-02C.

7) Country: Colombia
Collaborator: Gilberto Bastidas
Date sent: June 1985

Lines sent: F6 bulk populations, CNCx 251 and CNCx 252, CNCx 252-1E, 187-22D-1, 171-021E, CNCx 0434, BR 1-POTY, CNCx 177-02C.

8) Country: U.S.A.
Collaborator: Dr. Ken Burr
Date sent: June 1985

Lines sent: CNCx 252-9F, 252-1E, 252-3E, 187-22D-1, 171-021E, 333-95E, 333-77E, 333-51E, 333-60E.

9) Country: Ecuador
Collaborator: Dr. Wes Kline
Date sent: January 1985

Lines sent: BR 1-POTY, CNC 0434, 40 DIAS, CNCx 105-22E, 112-01F, 105-8F, 177-02G, 176-03G, 159-03G, 149-01G, 171-07E, 171-09E, 171-12E, 171-03E, 172-01E, 161-01E, 167-50F, 167-25E, 167-10F, 167-12F, 167-48F, 167-11F, 167-9E, 164-9F, 167-23E, 180-3F, 163-18F, 167-28F, 168-2F, 164-7F, 164-52F, 164-18F, 161-5E, 167-7E, 164-2F.

10) Country: Guyana
Collaborator: Julian Ross
Date sent: April 1985

Lines sent: CNCx 8052-57, 8013-34, 8032-47, 8009-25-1, FARV 13, 8010-29, 8019-42, 8010-28-1, 8007-20, TGx 3456-016E.

8.2 Soybean Seed (list of lines follows) Distributed to:

1) Country: Republic of Benin, West Africa
Collaborator: Dr. Ted Lawson

2) Country: Mexico
Collaborator: Rafael Reza Aleman

3) Country: Zimbabwe
Collaborator: Dr. R. Tattersfield

4) Country: Colombia
Collaborator: Gilberto Bastidas

5) Country: Panama
Collaborator: Dr. Gaspar Silvera

6) Country: Ecuador
Collaborator: Gorky Dias

7) Country: Mexico
Collaborator: Eng. Maldonado

8) Country: Jamaica
Collaborator: Fred Anderson

9) Country: Colombia
Collaborator: Luis Camacho

10) Country: Belice
Collaborator: Dr. Rai

11) Country: Peru
Collaborator: Dr. G. Hernandez-Bravo

12) Country: Phillippines
Collaborator: R.K. Pandey

13) Country: Taiwan
Collaborator: Dr. Shamugusundaram

Germplasm distributed by IITA Latin American Regional Program

Germplasm	Source
Savana	CNPSoja/Brazil
IAC-2	Instituto Agronomico de Campinas-SP/Brazil
IAC-6	Instituto Agronomico de Campinas-SP/Brazil
EMGOPA 303	EMGOPA/Brazil
IAC-12	Instituto Agronomico de Campinas-SP/Brazil
Paranagoiana	CNPSoja-EMGOPA/Brazil
Carajas	CNPSoja/Brazil
Cristalina	Francisco Terasawa/Brazil
EMGOPA 301	EMGOPA/Brazil
IAC-7	Instituto Agronomico de Campinas-SP/Brazil
EMGOPA 302	EMGOPA/Brazil
UFV-1	Universidade Federal de Vicosa-MG/Brazil
Sucopira	CNPSoja/Brazil
Timbira	CNPSoja/Brazil
IAC-11	Instituto Agronomico de Campinas-SP/Brazil
Teresina	CNPSoja/Brazil
Parana	CNPSoja (?)/Brazil
Doko	CNPSoja/Brazil
Numbaira	CNPSoja/Brazil
IAC-8	Instituto Agronomico de Campinas-SP/Brazil
Tropical	CNPSoja/Brazil
Santa Rosa	?/Brazil
Bossier	U.S.A.
BR 83-1578	CNPSoja/Brazil
BR 81-3495	CNPSoja/Brazil
GO 83-29057	EMGOPA/Brazil
BR 81-3195	CNPSoja/Brazil
GO 83-26524	EMGOPA/Brazil
GO 83-18652	EMGOPA/Brazil
GO 83-23588	EMGOPA/Brazil
GO 83-29066	EMGOPA/Brazil
BR 82-1100	CNPSoja/Brazil
BR 82-504	CNPSoja/Brazil
BR 82-1179	CNPSoja/Brazil
GO 83-18779	EMGOPA/Brazil
GO 83-29066	EMGOPA/Brazil
BR 82-1186	CNPSoja/Brazil
IAC-7-RC6	Inst. Agron.de Campinas-SP/CNPSoja/Brazil
BR 83-1121	CNPSoja/Brazil
BR 81-1516	CNPSoja/Brazil
GO 83-16639	EMGOPA/Brazil
GO 83-22791	EMGOPA/Brazil
GO 83-18602	EMGOPA/Brazil
GO 83-25065	EMGOPA/Brazil
GO 83-22763	EMGOPA/Brazil
GO 83-18793	EMGOPA/Brazil
GO 83-22621	EMGOPA/Brazil
IAC-7-RC7	Instituto Agronomico de Campinas-SP/Brazil
GO 83-21590	EMGOPA/Brazil

Germplasm	Source
GO 83-21609	EMGOPA/Brazil
BR 82-516	CNPSoja/Brazil
GO 83-17992	EMGOPA/Brazil
GO 83-18792	EMGOPA/Brazil
GO 83-21581	EMGOPA/Brazil
GO 83-18788	EMGOPA/Brazil
GO 83-21519	EMGOPA/Brazil
GO 83-22748	EMGOPA/Brazil
GO 83-22756	EMGOPA/Brazil
BR 83-5633	CNPSoja/Brazil
GO 83-29068	EMGOPA/Brazil
GO 83-27173	EMGOPA/Brazil
GO 83-20640	EMGOPA/Brazil
GO 83-18749	EMGOPA/Brazil
GO 83-21580	EMGOPA/Brazil
GO 83-17992	EMGOPA/Brazil
GO 83-16629	EMGOPA/Brazil
GO 83-17961	EMGOPA/Brazil
BR 83-11107	CNPSoja/Brazil
GO 83-33033	EMGOPA/Brazil
GO 83-22750	EMGOPA/Brazil
IAC-7-RC10	Instituto Agronomico de Campinas-SP/Brazil
GO 83-2152	EMGOPA/Brazil
GO 83-25639	EMGOPA/Brazil
GO 83-26650	EMGOPA/Brazil
GO 83-25060	EMGOPA/Brazil
GO 83-25058	EMGOPA/Brazil
GO 83-16634	EMGOPA/Brazil
GO 83-22773	EMGOPA/Brazil
GO 83-23756	EMGOPA/Brazil
BR 83-8892	CNPSoja/Brazil
GO 83-17984	EMGOPA/Brazil
GO 83-16641	EMGOPA/Brazil
BR 82-906	CNPSoja/Brazil
GO 83-18766	EMGOPA/Brazil
GO 83-22772	EMGOPA/Brazil
GO 82-495	EMGOPA/Brazil
GO 83-20565	EMGOPA/Brazil
GO 83-23105	EMGOPA/Brazil
BR 83-9218	CNPSoja/Brazil
BR 83-9223	CNPSoja/Brazil
GO 83-22749	EMGOPA/Brazil
GO 83-18789	EMGOPA/Brazil
BR 83-1185	CNPSoja/Brazil
BR 83-9053	CNPSoja/Brazil
GO 83-21582	EMGOPA/Brazil
GO 83-16658	EMGOPA/Brazil
GO 83-21591	EMGOPA/Brazil
BR 83-8901	CNPSoja/Brazil
GO 83-24741	EMGOPA/Brazil
GO 83-17951	EMGOPA/Brazil
GO 83-22774	EMGOPA/Brazil

Germplasm	Source
GO 83-17988	EMGOPA/Brazil
BR 83-11144	CNPSoja/Brazil
GO 83-18014	EMGOPA/Brazil
BR 82-1349	CNPSoja/Brazil
GO 83-24708	EMGOPA/Brazil
GO 83-18791	EMGOPA/Brazil
GO 83-18785	EMGOPA/Brazil
GO 83-17999	EMGOPA/Brazil
GO 83-18757	EMGOPA/Brazil
GO 83-21683	EMGOPA/Brazil
GO 83-18781	EMGOPA/Brazil
GO 83-18015	EMGOPA/Brazil
BR 83-8908	CNPSoja/Brazil
BR 81-1358	CNPSoja/Brazil
GO 83-27048	EMGOPA/Brazil
BR 79-198	CNPSoja/Brazil
BR 82-1102	CNPSoja/Brazil
GO 83-27522	EMGOPA/Brazil
GO 83-21564	EMGOPA/Brazil
BR 82-1098-4	CNPSoja/Brazil
GO 83-18768	EMGOPA/Brazil
GO 83-22782	EMGOPA/Brazil
FT 2	Francisco Terasawa/Brazil
Forrest	U.S.A.
D64-4636	U.S.A.
BR 79-15197	CNPSoja/Brazil
Lo 75-1112	IAPAR/Brazil
PI 181696	Plant Introduction - U.S.A.
D72-9601-1	U.S.A.
BR 6	CNPSoja/Brazil
GO 81-8238	EMGOPA/Brazil
GO 81-11174	EMGOPA/Brazil
GO 81-12049	EMGOPA/Brazil
IPB 78-504	International Plant Breeders, Inc.
GO 81-10050	EMGOPA/Brazil
GO 81-10120	EMGOPA/Brazil
FT 79-3340	Francisco Terasawa/Brazil
GO 81-8182	EMGOPA/Brazil
BR 80-6993	CNPSoja/Brazil
GO 81-8491	EMGOPA/Brazil
GO 81-8115	EMGOPA/Brazil
BR 80-14247	CNPSoja/Brazil
GO 81-12066	EMGOPA
BR 81-3296	CNPSoja/Brazil
IAC-7-RC4	Instituto Agronomico de Campinas-SP/Brazil
IAC-7-RC3	Instituto Agronomico de Campinas-SP/Brazil
IAC 11	Instituto Agronomico de Campinas-SP/Brazil
UFV 80-96	Universidade Federal de Vicosa-MG/Brazil
UFV 80-90	Universidade Federal de Vicosa-MG/Brazil
BR 78-23403	CNPSoja/Brazil
IAC-7-RC7	Instituto Agronomico de Campinas-SP/Brazil
BR 79-32681	CNPSoja/Brazil

Germplasm	Source
FT 79-2007	Francisco Terasawa/Brazil
FT 7--2321	Francisco Terasawa/Brazil
GO 81-11103	EMGOPA/Brazil
FT 79-3912	Francisco Terasawa/Brazil
BR 80-6935	CNPSoja/Brazil
GO 81-11085	EMGOPA/Brazil
FT 79-2528	Francisco Terasawa/Brazil
GO 81-11034	EMGOPA/Brazil
GO 81-11091	EMGOPA/Brazil
GO 81-11015	EMGOPA/Brazil
FT 79-2363	Francisco Terasawa/Brazil
GO 81-11087	EMGOPA/Brazil
GO 81-10056	EMGOPA/Brazil
GO 81-11091	EMGOPA/Brazil
GO 81-8491	EMGOPA/Brazil
GO 81-10050	EMGOPA/Brazil
GO 81-8238	EMGOPA/Brazil
GO 81-11031	EMGOPA/Brazil
GO 81-11087	EMGOPA/Brazil
GO 81-11103	EMGOPA/Brazil
GO 81-11034	EMGOPA/Brazil
GO 81-10056	EMGOPA/Brazil
GO 81-10075	EMGOPA/Brazil
GO 81-11015	EMGOPA/Brazil
GO 81-11075	EMGOPA/Brazil
GO 81-12066	EMGOPA/Brazil
GO 81-11081	EMGOPA/Brazil
GO 81-8239	EMGOPA/Brazil
GO 81-8484	EMGOPA/Brazil
GO 81-11090	EMGOPA/Brazil
GO 81-8115	EMGOPA/Brazil
GO 81-11038	EMGOPA/Brazil
GO 81-8181	EMGOPA/Brazil
GO 81-11174	EMGOPA/Brazil

Germplasm distributed by IITA Latin American Regional Program

Germplasm	Source
TGx 239-6D	IITA
TGx 239-22D	IITA
TGx 309-25E	IITA
TGx 542-2C	IITA
TGx 573-01D	IITA
TGx 713-09D	IITA
TGx 803-28D	IITA
TGx 813-11D	IITA
TGx 813-12D	IITA
TGx 813-25D	IITA
TGx 814-26D	IITA
TGx 814-42D	IITA
TGx 814-49D	IITA

9.0 Training:

The first Latin American Regional Training course on cowpeas and soybeans was conducted at Goiania and Londrina Brazil, April 15 to May 03, 1985. There were 18 participants from 11 countries (see Table 6). Although the course was very successful it was too intense resulting in stress on participants and organizers. The first 2 weeks were filled with lectures and field work at CNPAF plus a trip to EMGOPA Experiment Station and the COMIGO Cooperative near Rio Verde to see soybean research production, oil and meal processing and seed processing.

Table 6.

IITA/EMBRAPA CURSO DE ENTRENIMIENTO SOBRE CAUPI/SOJA 1985

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