Annual Report 1983

Bean Program

Centro Internacional de Agricultura Tropical

BEAN ANNUAL REPORT 1983

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HIGHLIGHTS 1983

Decentralization of the genetic improvement activities continued in 1983 during which 17 700 seed samples were shipped to national programs These were either parental lines often as crossing blocks (4 958 units) early generation new lines (3 813 units) or segregating materials (8 939 units) In Central America where decentralization of genetic improvement is most notable most of the germplasm was shipped as segregating populations or early generation progenies In Africa where an outreach program is being started mostly parental lines were shipped to determine local adaptation among resistance sources to a particular disease and other stresses Local selection in segregating material derived from CIAT s world germplasm bank and its crossing potential considerably increased the travel load of CIAT staff

Decentralization was also strongly expressed in staffing especially in outposted special project staff The Central American project was evaluated and an extension of the project by the Swiss Development Corporation[a] was granted for three more years The outposted agronomist in Peru was replaced by a bean breeder who also acts as co-leader of the national program A breeder was chosen for this position because lack of progress in bean production in Peru is principally due to the lack of disease resistant varieties The agronomist-soil scientist staff member of the CIAT bean program continues his assignment to the National Rice and Bean Centre (CNPAF) in Brazil

An important highlight of the 1983 activities was the stationing of the first CIAT bean scientist in Africa Following the large ISNAR conference in Kigali Rwanda in February 1983 to reorganize Rwandan agricultural research a joint CIAT-SDC mission traveled in Rwanda and Burundi and a project was developed for a collaborative research link between the Great Lake countries (Rwanda Burundi and the Kivu province of Zaire) and CIAT In October the first scientist a plant breeder was stationed in Rubona Rwanda at ISAR the national agricultural research institute to serve the region An agronomist pathologist and anthropologist (the latter a Rockefeller Foundation- funded postdoctoral scientist) will soon join the team in Rubona The project is also expected to serve neighboring countries with similar ecological zones considering that this region has the highest per capita bean consumption in the world and people derive more protein from beans alone than from all animal products combined

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a Appendix I explains the acronyms used in this annual report for collaborating institutions

New varieties continued to be released in 1983 In Brazil three varieties were released two by EMCAPA - BAT 304 as Capixaba Precoce and BAT 179 as Vitoria of which about five and three tons of seed respectively were available at midyear EMPASC released ICA Linea 38 as EMPASC-201-Chapeco In Nicaragua two varieties were released Revolucion 83 (BAT 1215) and Revolucion 79 A (BAT 789) Several countries concentrated on promotion of released varieties and new varieties will be released only if substantial improvement is made over currently released varieties

Studies of farmer adoption of new varieties have started In regions representing about 50% of Costa Rican bean production the variety Talamanca (ICA línea 10103) was grown by 61% of the farmers The second variety released Brunca (BAT 304) was planted by 6% of the farmers Many have already increased planting density of the new varieties compared to that of the traditional varieties In Guatemala ICTA reports that depending on the region 40-60% of the farmers now grow improved varieties and that bean production is increasing while the Bank of Guatemala reports declining imports with no imports made in 1983 The above data will need verification over a period of years before drawing definite conclusions

Highly significant is the support which the CIAT-formed network gives to bean research in the national programs

- An active interchange of germplasm improved lines screening methodologies and agronomic management recommendations takes place among national programs and between CIAT and national programs This was possible following an active training including degree oriented training program at CIAT

- New resistance sources are widely used in local programs (e g for CBB anthracnose ALS) and superior lines identified in one country are rapidly tested in others with similar ecological zones

- A degree of self confidence and competition for research achievements is notable in regional meetings strongly enhancing the network

In addition to backstopping the decentralized network good progress can also be reported from CIAT-based research

- XAN 112 has shown multilocation stable and high levels of CBB resistance New resistance sources identified from an interspecific hybrid developed at the University of California show near immunity to CBB in tropically adapted germplasm

- Significant increases in resistance levels to web blight were obtained in MUS PAI and other lines It is now possible to grow beans economically with a combination of agronomic practices and resistant varieties in web blight areas where beans could not be grown before because of the severity of this disease

- BGMV resistance has been successfully incorporated into other non-black grain types However one or more crossing cycles will be needed before the fully commercial grain type is recovered New resistance sources have also been identified

- In preliminary tests lines resulting from the crossing program with greatly increased seed size were resistant to bruchids indicating that the resistance of small seeded types may be recovered in larger seeds

- BCMV resistance has so far emphasized the I gene only This resistance has now been broadened in experimental lines In a collaborative project IVT (Holland)-INIA (Chile)-CIAT new lines were developed with combined dominant and recessive resistance and all three breeders started projects to develop combinations of dominant with recessive resistance in some of their major grain types Additionally fully commercial red-mottled grain types with the I gene were recovered for the first time

- Extensive testing of anthracnose and ALS resistance sources was sometimes disappointing the sources sometimes succumbed to local races of the pathogen in Mexico or Brazil but others maintained their wide resistance Currently only relevant resistance sources are used

Character recombination activities have progressed well in 1983 Through the decentralized breeding effort in Central America all lines are pre-VEF tested in Central America and the VEF of the Central American grain types is composed following local selection Parallel to the VEF-EP-IBYAN testing scheme a local scheme is operating modified by country called the National Yield Trial (VINAR) which is equivalent to the EP and the Central American Yield Trial (VICAR) which is equivalent to the IBYAN

The Bean Program had an active training and conference schedule during 1983

- Two breeders workshops were held In the workshop for the Caribbean and Central America promising lines were identified for Haiti and Jamaica for the first time In the Dominican Republic superior non-black grain types were also selected Superior black seeded lines were available Noteworthy in the second breeders workshop for South America was the agressive and inventive work on promoting bean consumption in Bolivia and further steps taken to strengthen collaboration between CNPAF and CIAT

- During 1983 eight courses were conducted with CIAT participation one in CIAT with 20 participants and one each in Cuba (with 31 participants) Brazil (26) Costa Rica (28) Dominican Republic (29) Honduras (29) and two in Colombia with 46 participants

- Three additional workshops were held One was organized in collaboration with ICARDA on the potential for field beans in West

Asia and North Africa In this conference participants requested a collaborative research program with CIAT and a project request to donors was formalized for a CIAT bean scientist to be stationed in the ICARDA legume program A second conference was held in CIAT to organize a joint research project between CIAT and East Africa (particularly Uganda and Kenya and with CRSP collaboration) This project was submitted to CDA donor for funding The third workshop was organized to help orient CIAT s efforts in on-farm research Experts from around the world including sister IAR Centers participated and drew up recommendations to CIAT s based upon their experiences and CIAT s specific needs The formation of the Bean program s network of on-farm research will profit from these recommendations

- The Bean Program participated in two other workshops One was conducted in Central America to discuss progress in the control of *Apion* and web blight In Peru the workshop organized by INIPA discussed progress and future plans in bean research associated with the orientation of this special project towards genetic improvement

In 1983 few staff changes took place A physiologist was contracted as visiting scientist to fill this long-standing vacancy and a breeder was added to the CIAT staff in the Great Lakes project

THE PROGRAM

The objective of the Bean Program is to develop in close collaboration with national programs technology that will increase the production and productivity of beans

The principal producer is a small farmer with limited capital and limited access to credit and extension information Bean yields are low and have been trending downwards in many countries The main factors responsible for the low yields are the high disease and insect pressure from which the crop suffers drought low plant density (to avoid disease pressure) and the farmers reluctance to use fertilizers on poor soils due to risk

Therefore the bean team concluded that it should prioritize breeding for more stable higher yielding beans by developing multiple disease and pest resistant varieties with increased tolerance to drought Longer term objectives include tolerance to moderately acid soils and improved genetic ability for symbiotic nitrogen fixation In summary the strategy is that the key to improved bean production is an improved variety around which improved agronomy will be applied The team develops scale neutral technology possibly biased toward small farmers

New bean varieties not only must be superior yielders at the farm level but also must have the proper seed size and seed coat color and they must fit into farmers production systems which often include maize in direct association or relay cropping These requirements often preclude the use of the most disease resistant and highest-yielding genotypes

As the Bean Program must breed for many cropping systems and ecological zones it is evident that a decentralized breeding program is needed which can only be achieved through a concentrated training effort considering that national programs must play an important role in varietal improvement Hence training is the second most important activity after varietal improvement

The Bean Program has three breeders whose responsibilities are divided by production region (which automatically includes a division by color and seed size priority disease complexes and often by cropping system) Therefore while the program breeds for a complex set of requirements as a whole each breeder only concentrates on a subset The three regions and breeding programs are Breeding I- Central America the Caribbean coastal Americas and southern Brazil Breeding II - the Mexican highlands north and northeast Brazil and Argentina and Breeding III - the Andean zone and Africa

Genetic variability for specific traits in beans is generally not expressed at sufficiently high levels to solve production constraints Therefore each breeder not only develops cultivars but also cooperates with particular disciplines to develop maximum levels of character improvements e g for BCMV resistance drought tolerance bacterial blight resistance leafhopper tolerance Ascochyta leafspot resistance ability to fix nitrogen high yield potential architectural traits etc Lines with high levels of specific trait expressions are then used by all breeders for obtaining multiple factor recombinants in the cultivar improvement activities

Once a newly developed line from the improvement program is found superior and uniform in character expression plant and grain type and maturity and is resistant to BCMV it enters the first uniform Evaluation Nursery - the VEF In this nursery approximately 1 000 entries are evaluated for disease and insect resistance and adaptation to the Palmira and Popayan environments Superior entries may enter again into the breeders crossing blocks as parents move to national program nurseries and / or may pass to the second stage of evaluation the Preliminary Yield Evaluation Nursery EP which typically contains about 300 entries Disease resistance is confirmed in this nursery and many other evaluations are made including yield (under high and low input conditions in Palmira and Popayan) N-fixation ability and seed quality evaluation Specific evaluations for some characters are done outside Colombia (that part of the EP nursery with grain types of specific interest to a particular national program is provided upon request)

Approximately 60 of the best lines of the EP advance to the International Bean Yield and Adaptation Nursery (IBYAN) to be evaluated worldwide For each successive nursery seed is produced in special plots under carefully controlled conditions to ensure that the seed is disease free The entries in each of the three nurseries are changed each year on January 1 National programs are encouraged to include their best hybrid lines in this open testing procedure thus providing horizontal transfer of germplasm

However the EP and IBYAN are not the only nurseries shipped internationally Disease or insect resistance nurseries are shipped internationally to identify race complexes of pathogens in target areas as well as donors for wide resistance The crossing blocks are sent to a production zones in the target area to select for specific adaptation in parental material Similarly international nurseries exist for nitrogen fixation (for selection of Rhizobium strains as well as bean lines) and diseases and insects not occurring in Colombia The program increasingly develops segregating populations and early generation progenies for evaluation by interested breeders and outreach programs

From the above philosophy and practice it is clear that the Bean Program strongly emphasizes varietal improvement and considers that improved agronomic practices are best researched at the national program level and should be implemented when a new variety is available Instrumental in this concept are the cropping systems agronomist (on-farm research) and the economist who insure that the breeders are familiar with the systems into which new varieties must fit In addition they adapt methodologies of on farm research so that national programs can develop suitable agronomy around the new varieties in specific regions

After genetic improvement the program has given high priority to training Self-reliance in research at the national level is the eventual goal Furthermore the diversity of cropping systems production constraints and consumer requirements make it impossible for CIAT to attend all concerns The results of training for eventual self-reliance are becoming visible and show an evolution in the program s training strategy For example the EP was exclusively a CIAT nursery now it is now international nursery Decentralized selection from the F_2 generation on is becoming increasingly important CIAT-hosted courses are being replaced by in-country courses An on-farm research network is being developed through an intensive training effort The team expects that through postgraduate training leadership and experience the national programs will develop to such a level that the network becomes a mutually dependent collaborative research program This network has traditionally been limited to Latin America however since stationing the first bean scientist in Africa in 1983 network expansion to this continent has become an important objective

Agro-Ecological Studies on Bean Production Zones

Following initial agroclimatological survey work by CIAT in 1979 80 and 81 efforts have continued to produce the definitive agro-ecological database of beans

Bean team members have produced a draft data form for the collection of microregion cropping system information with which the team is now in a position to test their data acquisition potential using the preliminary microregion map for Central America

An important contribution to microregion delineation has been made in a study of Costa Rica (Scholz 1983) An overlay-correlation technique was used to collate data production zones of the country Data on sown areas were plotted at a scale of 1 500 000 and overlayed for a range of different crops to determine areas of uniform cropping mixes Some results from the study are presented in Table 1 Beans are not the major crop in any of the identified production zones Their importance in each region can be readily determined from the relevant column in Table 1

This technique assumes that the cropping mix for an area may be used as a proxy for the integrated effects of edaphoclimatic and socio economic considerations determining the production pattern The technique is an alternative to that of determining uniform edaphoclimatic cropping zones directly from the soil and climate data It is only feasible where good detailed census data are available in which case it may form a useful adjunct to the physical approach

With the increased interest of the Bean Program in East Africa the agro-ecological studies unit will extend its work to cover this area Presently data accumulation is only in the early stages but map coverage of the region is being increased to cope with future studies as is the CIAT meteorological database A large disk has been added to the database and the African counterpart of SAMMDATA will be loaded in the near future

Table 1 The Agro-ecological production zones of Costa Rica

Microregion production zone and location (province)	Area (km^2)	Elevation (% of total area) 0 500m	500– 1 000m	1 000 1 500m	over 1 500m	Annual crops (harvested areas in km^2) Rice	Beans	Maize	Cassava	Sorghum	Total annuals
Rice-based											
Guanacaste	1569	100	–	–	–	207	10	37	–	8	262
Guanac /Puntarenas	119	100	–	–	–	18	2	3	–	2	25
West Puntarenas	406	100	–	–	–	17	1	11	1	8	38
West Puntarenas	213	100	–	–	–	17	1	5	–	3	26
East-Puntarenas	688	100	–	–	–	111	12	23	–	34	180
	2995		–	–	–	370	26	79	1	55	531
Coffee -based											
Alajuela	619	–	10	70	20	–	5	11	–	–	16
S J /Heredia/Cart	1331	–	10	60	30	–	16	35	–	–	51
East-S Jose	494	–	50	40	10		16	27	–	–	43
East-Puntarenas	212	–	60	40	–	2	8	12	–	–	22
Cartago	79	–	–	–	100	–	2	1	–	–	3
Alajuela	475	–	70	20	10	–	6	5	–	–	11
Cartago	588	5	60	30	5	–	2	6	–	–	8
	3798					2	55	97			199
Cattle-Mixed Annuals											
Guanac /Puntarenas	1850	95	5	–	–	21	50	75	1	5	152
Guanacaste	181	100	–	–	–	3	3	3	–	–	9
Gua /Pun /Ala /S J	1444	100	–	–	–	25	12	19	3	4	63
	625	–	70	30	–	–	10	14	–	–	24
Puntarenas/S Jose	750	100	–	–	–	29	4	7	–	4	44
	481	–	50	30	20	–	16	22	–	–	38
East Puntarenas	375	90	10	–	–	4	5	12	1	–	22
S Jose/Puntarenas	1569	60	40	–	–	45	45	70	–	–	160
NW-Alajuela	338	100	–	–	–	19	21	11	–	–	51
North Alajuela	244	100	–	–	–	7	2	9	–	–	18
Alajuela/Heredia	1281	90	10	–	–	23	8	26	7	1	65
Limon	631	90	10	–	–	1	–	20	1	–	22
Subtotal	9769					177	176	288	13	14	668
Total Prod Zones[a]	24478					649	267	511	22	38	1534
Empty areas	26105					6	–	8			14
Total Costa Rica	50584					655	267	519	22	38	1548
excl I del Coco	50584					655	267	519	22	38	1548

(continu

a Microregion production zone and location data referent to non-bean producing areas have been omitted

SOURCE Modified from Identification and Analysis of Agro-Production Zones by the Overlay-Correlation Method The Case of Costa Rica Scholz CIAT in press

Average monthly rainfall													Soils (distribution in km^2)				
J	F	M	A	M	J	J	A	S	O	N	D	Total	Vertisols	Ultisols	Mollisols	Entisols	Inceptisols
10	5	10	20	240	320	190	180	370	390	110	40	1 885	374	–	63	–	1132
10	15	30	60	290	320	280	330	400	450	120	30	2 335	69	–	–	–	50
70	30	50	150	360	430	440	420	440	650	370	160	3 570	–	125	193	69	19
10	10	15	60	260	360	270	280	350	470	170	50	2 305				19	194
110	90	140	260	470	490	520	540	540	770	490	220	4 640	–	88	475	50	75
													443	213	731	138	1 470
15	10	10	20	260	300	250	270	380	360	120	50	2 045	–	56	–	138	425
30	30	30	70	260	290	210	230	180	330	330	70	2 060	6	–	–	–	1325
40	20	30	110	370	360	290	360	420	530	270	100	2 900	–	194	–	–	300
80	60	90	170	450	390	340	380	400	630	400	160	3 550	–	–	–	–	212
100	60	50	70	270	310	280	220	320	350	230	200	2 460	–	–	–	–	79
10	10	15	50	270	290	200	210	310	350	140	40	1 895	88	–	–	–	387
140	100	90	110	230	270	290	230	230	270	260	260	2 480	–	331	–	–	257
													94	581	–	138	2 985
10	10	15	40	300	320	270	240	390	470	90	25	2 180	125	–	19	63	1643
30	10	20	30	170	370	180	240	340	310	150	90	1 940	12	–	–	–	169
10	10	10	50	250	350	190	230	360	440	120	20	2 040	38	–	50	94	1224
70	30	40	100	240	300	220	240	310	310	160	150	2 170	13	–		181	431
70	30	50	150	360	430	440	420	440	650	370	160	3 570	–	406	94	56	194
40	30	40	80	250	330	240	310	390	450	220	60	2 440	–	–	–	–	481
110	90	140	260	470	490	520	540	540	770	490	220	4 640	–	200	44	81	50
50	40	50	170	380	380	330	410	420	510	310	90	3 140	–	1 144	–	–	420
180	70	60	50	190	300	320	320	330	300	280	210	2 610	–	–	–	–	338
180	70	60	50	190	300	320	320	330	300	280	210	2 610	–	–	–	–	225
300	170	150	100	310	480	540	410	360	450	450	430	4 150	–	119	–	–	1162
280	190	170	210	380	400	440	300	240	350	450	510	3 920	–	268	–	–	363
													188	2 137	207	475	6 700
													870	3 594	1 213	1 446	1 7279
													–	6 150	563	2 194	1 6680
													870	9 744	1 776	3 640	3 3959

BEAN GERMPLASM ACTIVITIES

Germplasm Collection Multiplication and Distribution

1 Germplasm acquisition

Acquisition of new germplasm continued through collaborative efforts with national institutions and the IBPGR collecting missions During 1983 784 new accessions from 13 countries were introduced 86% of these accessions corresponds to *Phaseolus vulgaris* (Table 2)

Status and increase of the Phaseolus germplasm

To date the Genetic Resources Unit has received a total of 33 290 accessions embracing the four cultivated species their wild ancestors and the wild non cultivated species (Table 3) Since the process from introduction to field increase is rather slow and laborious (Bean Program Annual Report 1982) all the germplasm has not been increased Currently 55% of the *P vulgaris* germplasm has been increased and is available for distribution while 30% of the other cultivated species have also been increased The wild non cultivated species are stored only in small quantities

Characterization

A seed type grouping by size and color and more intensive geographical source comparison is underway to quantify the genetic variability of the available germplasm of *P vulgaris*

Preliminary results (Table 4) showed that among the 16 250 less than accessions available of the common bean the small seeded types (less than 25 g/100 seeds) had the highest percentage of germplasm (42%) while the large size (larger than 40 g/100 seeds) is half of that percentage(23%) the medium size represents 35% of this germplasm Of large seeded types the cream (29%) and the white colors (19%) appear predominant The brown-maroon and blacks have the same frequency 4% In the medium size the whites cream yellow and blacks have very similar percentages ranging from 17-20% pinks (4%) are the least represented in this group In small seeded types blacks predominate (42%) followed by whites (18%) and reds (16%) the other colors are represented in rather low percentages

Table 2 Number of new germplasm accession acquired by the CIAT Genetic Resources Unit in 1983

	Phaseolus vulgaris	*Phaseolus* species	Other genera
Argentina	3	-	3
Hungary	301	-	-
United States	-	1	-
Holland	10	1	-
Belgium	-	-	10
Peru	141	9	-
Guadalupe Islands	56	-	-
Chile	15	-	-
Spain[a]	33	-	-
Kenya[a]	1	-	-
Malagasy[a]	88	16	21
Zambia	-	50	-
Honduras	25	-	-
TOTAL	673	77	34

a IBPGR collecting expeditions

Table 3 Status of the *Phaseolus* bean collection held at the CIAT Genetic Resources Unit as of December 1983

Species	No of Accessions	
	Introduced	Increased
P vulgaris	29 552	16 250
P lunatus	2 410	700
P coccineus	1 083	220
P acutifolius	166	166
Wild noncultivated spp (10 species)	84	30
Total *Phaseolus*	33 295	17 366
Other leguminous genera (*Vigna* *Psophocarpus* etc)	452	452

Table 4 Seed type distribution according to seed color and size of the germplasm accessions available of the common bean (*Phaseolus vulgaris*)

Color	Size		
	Small (%)	Medium (%)	Large (%)
White	18 0	18 0	19 0
Cream-beige	9 0	20 0	29 0
Yellow	5 0	19 0	15 0
Brown-maroon	5 0	6 0	4 0
Pink	2 0	4 0	5 0
Red	16 0	10 0	14 0
Purple	3 0	6 0	10 0
Black	42 0	17 0	4 0
Total	100 0	100 0	100 0
Total No of *P vulgaris* accessions	6 825	5 688	3 737
Total %	42	35	23

When seed types were compared with the geographical sources it was found that large seeded types were provided mainly by Europe (28%) non-Andean South America (27%) and North America (22%) For the small types Central America (38%) is the main source followed by North America (30%) The medium size seeds have a wider distribution North America is the main source (33%) but Central America and Europe are both represented with 23% This source distribution reflects the tendency of seed type preferences however a more complete analysis is needed using the true origin of such germplasm

Storage

The *Phaseolus* collection under short term storage (5-8°C) available for distribution has increased to 17 366 accessions of which 94% corresponds to *P vulgaris*

In the long term storage (-6 to -2°C) a special study was done with accessions which had been stored for more than two years to determine if the seed viability i e germination underwent significant change these materials were packed in sealed foil laminated bags at 7% average seed moisture

The results showed a negligible change of germination of less than 1% The light colors (white and cream) presented the biggest change Likewise the big seeded types were more affected than the medium and small seeded However total germination remained above 90% in all accessions leading to the conclusion that storage conditions are adequate to maintain the original germination for at least two years

Seed moisture contents were still in the range of 5% to 8% New procedures are underway to accelerate the number of accessions to be placed under long term storage

Seed distribution service

During 1983 2 696 accessions were distributed to 28 countries Likewise 29 136 accessions were requested by the CIAT Bean Program Total germplasm delivered (Table 5) adds up to 31 832 accessions of which 96% corresponds to *P vulgaris* and the rest to other *Phaseolus* species and few other leguminous genera (*Vigna* *Psophocarpus*) A seed pathology lab is being established to test the seed quality of the materials CIAT distributes This lab will be functional in 1984

Table 5 Total *Phaseolus* bean seed distribution by destination during 1983

Destination	No of countries	No of accessions
Outside CIAT		
North America	2	525
Central America	3	920
Andean South America	5	247
Non-Andean-South America	2	173
Europe	3	151
Africa	5	200
Asia-Oceania	8	480
Subtotal	28	2 696
CIAT Bean Program		29 136
	Total	31 832

GENETIC IMPROVEMENT

Germplasm improvement activities of the Bean Program are based upon the large variability in the germplasm collection stored at CIAT In the evaluation of the germplasm bank useful traits are identified with the potential to solve or reduce the effect of production-limiting factors However in many instances the level of expression of desirable traits in germplasm bank accessions is insufficient to solve particular production constraints e g the level of resistance to bean golden mosaic virus (BGMV) Ascochyta leafspot drought tolerance resistance to storage insects ability to fix atmospheric nitrogen etc For the improvement of commercial varieties combinations of several of these factors are needed Therefore genetic improvement activities of the Bean Program can be divided into two aspects (a) character improvement- the development of maximal expression of a character in a diversity of genotypes by accumulating different genes resistance mechanisms etc and (b) character deployment- the recombination or use of these characters in commercial cultivars according to the needs of the particular production region for which the material is intended

Table 6 lists the specific responsibilities of the three breeders in these two activities the numbers of crosses made during 1983 and the number of coded lines developed

Table 6 Specific responsibilities of the three breeders in the CIAT Bean Program for character improvement and deployment projects in 1983

Research area	Responsible breeding program			No of crosses	No of coded lines
					VEF 84
Character improvement					
Bean common mosaic virus	I			17	-
Bean golden mosaic virus	I			29	59
Rust	I			5	-
Common bacterial blight	I			12	19
Halo blight			III	80	-
Web blight	I			8	2
Anthracnose		II		55	-
Angular leaf spot		II		30	-
Ascochyta leaf spot			III	77	4
Mildew			III		
Bean scab			III		
Empoasca leafhoppers	I			0	21
Apion pod weevil	I			4	-
Storage insects			III	53	-
Bean fly			III	10	-
Mexican bean beetle		II		7	-
Nematodes			III	11	-
Drought		II		-	-
Low temperature			III	59	73
Low P		II		-	
Character improvement					
Maturity		II		-	
N_2 fixation	I			254	12
Architecture		II		111	-
Snap beans			III	112	-
Character deployment					
Black beans	I			134	93
Central America	I			400	28
Caribbean	I			155	152
Coastal Mexico Peru	I			163	90
Other studies	I			37	14
Brazil (non-black)		II		70	19
Mexican highlands		II		162	12
Argentina/W Asia		II		119	7
Andean Zone			III	427	282
Africa			III	226	113
TOTAL				2 817	728

(Number of materials in the VEF 84 - 472)

A Character Improvement

Resistance to Fungal Diseases

The Bean Program continues to emphasize the evaluation of bean germplasm for resistance to the most important bean pathogens This year considerable field evaluation was conducted in several countries in cooperation with the bean scientists of national programs in addition to the routine evaluations in Colombia These evaluations included disease resistance nurseries of advanced lines as well as segregating populations in Argentina Brazil Peru Mexico and Central America This activity permitted simultaneous evaluation of disease resistance local adaptation and other agronomic characters in the target area and facilitated the identification of superior germplasm with multiple disease resistance having commercial grain color Similarly multiple location evaluations enabled the identification of parental sources with broad disease resistance to pathogens exhibiting wide pathogenic variation such as the anthracnose and rust pathogens

The most prevalent fungal diseases studied were anthracnose rust angular leaf spot and web blight Some of the less widespread but locally important fungal diseases studied in 1983 were ascochyta leaf spot in the Andean zone round leaf spot caused by *Chaetoseptoria welmanii* inflicting considerable damage in susceptible cultivars in the highlands of Jalisco Mexico and downy mildew caused by *Phytophthora phaseoli* causing severe damage in some cultivars particularly in Tepatitlan Mexico and in Zaragoza de Palmares Costa Rica

Additional research was conducted on disease resistance mechanisms particularly with the anthracnose and rust pathogens

Anthracnose

Some bean lines with anthracnose resistance in the field and green house in Colombia to a number of isolates from several areas of Latin America were susceptible in field evaluations in the Mexican States of Jalisco Zacatecas and Durango in 1982 Results obtained this year from additional field evaluations in cooperation with Mexican bean scientists show that the pathogenic variation of the anthracnose agent *Colletotrichum lindemuthianum* is very extensive Table 7 shows the reaction of 15 bean lines (some of which have been utilized as anthracnose race differentials) to 15 isolates from four regions of Mexico Two lines PI 165426 and Aguille Vert are susceptible to all the isolates while two others Calima and PI 173022 are resistant to all Both of these lines are susceptible in the field and greenhouse to a number of isolates from Colombia BAT 841 which is resistant in the field in Colombia and Brazil and in the greenhouse to most isolates from these areas is susceptible to a number of isolates from Mexico

Table 7 Seedling reaction of bean lines and varieties to isolates of <u>Colletotrichum lindemuthianum</u> from different areas of Mexico in which S is susceptible and R is resistant

Cultivar	Isolate No and origin															Number of isolates attacking
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	J[a]	J	J	J	J	J	J	J	J	Z	Z	Z	M	M	D	
PI 165426	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	15
Aguille Vert	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	15
Michelite	S	S	S	S	S	S	S	S	S	S	R	S	S	S	S	14
Sanilac	S	S	S	S	R	S	S	S	R	S	S	S	S	S	S	13
PI 165435	S	S	S	S	S	S	S	S	S	S	S	R	R	S	S	13
Black Turtle soup	S	S	S	S	S	S	R	S	R	R	R	S	S	S	S	11
BAT 841	S	S	S	S	R	S	S	S	R	S	S	R	R	R	R	9
BAT 93	S	S	S	S	R	S	S	S	R	S	S	R	R	R	R	9
BAT 44	S	S	S	S	R	S	S	S	R	S	S	R	R	R	R	9
TO	S	S	S	S	R	S	S	S	R	S	S	R	R	R	R	9
Coco a la Creme	R	R	S	R	S	R	S	R	R	S	S	S	S	R	S	8
PI 15041	R	R	S	S	R	R	S	S	S	S	S	R	R	S	R	8
Kaboon	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	1
Calima	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	0
PI 173022	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	0

a Isolate origin J = Jalisco
Z = Zacatecas
M = Mexico
D = Durango

The 15 isolates tested (shown in Table 7) can be placed in eight pathogenicity groups demonstrating the wide variation in the populations of the anthracnose pathogen attacking beans in Mexico and results obtained from similar work conducted by Mexican scientists corroborate the extent of the pathogenic variation of C lindemuthianum in this country

From field observations in which hundreds of entries were tested in Mexico Brazil Argentina Peru and Colombia it is also evident that the pathogenic variation of the anthracnose fungus is broad and differs from one area to another in Latin America For example the lines AB 136 and Mexico 222 are resistant in the greenhouse to the isolates from Argentina Brazil Peru and Colombia but are susceptible to several isolates from Mexico Calima is resistant in the greenhouse to all the isolates tested from Mexico Peru and Argentina and to majority of isolates from Brazil but it is susceptible to most isolates from Colombia The situation is similar for Perry Marrow and Michigan Dark Red Kidney which are susceptible in the field and greenhouse to most isolates from Colombia but are resistant to the majority of isolates from Mexico Argentina Brazil and Peru BAT 841 is resistant in the field in Brazil and in the greenhouse to most isolates from Brazil Argentina and all from Colombia but it is moderately susceptible in the field and in the greenhouse to most isolates from Mexico

This extensive pathogenic variation inherent within the population of the anthracnose fungus as shown in Table 8 makes breeding for stable or durable and possibly broad anthracnose resistance difficult Therefore the Bean Program evaluates germplasm sequentially in the field in several locations and in the greenhouse to eliminate accessions that are susceptible in the target area or resistant to only a limited number of isolates The program attempts to identify accessions with broad resistance From the field evaluations in several locations in the bean growing areas of Mexico during 1982 and 83 a number of anthracnose resistant accessions often with commercial grain color were identified which were also resistant in the greenhouse to Mexican isolates Table 9 shows a selected number of accessions with a resistant reaction in the field and greenhouse in either 1982 or 83 or both and to groups of isolates of anthracnose from the Mexican states of Jalisco Zacatecas Durango and Mexico Table 10 lists a number of bean accessions lines and varieties often with commercial grain color that were not tested in the field but that showed broad resistance when tested sequentially against groups of isolates of C lindemuthianum from bean growing areas of Mexico

Many bean lines in Table 10 that were resistant to anthracnose in the highlands of Mexico were also resistant or intermediate in Brazil Table 11 shows some of these lines resistant in Mexico (Tepatitlan Jalisco) and in Brazil (Irati Parana) In Parana where approximately 700 000 ha of beans are grown annually anthracnose is a major disease in the southern region where black beans are cultivated Several of these resistant lines have also been tested in the greenhouse against

Table 8 Reaction of selected bean genotypes to mixtures of isolates of the anthracnose pathogen Colletotrichum lindemuthianum from Colombia Mexico Brazil and Argentina

Cultivar	Origin of isolate mixtures			
	Colombia	Mexico	Brazil	Argentina
A 374	R	R	R	R
Widusa	R	R	S	S
A 423	R	S	S	S
BAT 44	R	S	R	R
Michelite	S	S	S	S
A 464	S	S	R	R
Calima	S	R	R	R
A 368	S	R	R	R

Table 9 Selected bean accessions lines and varieties with resistant or intermediate anthracnose reaction under field conditions and in the greenhouse to isolates from Mexico

Cultivar	Field[a]		Greenhouse			
	1982	1983	D[c]	7	M	J
A 83	-	R	R	R	R	V
A 177	R	R	R	R	R	R
A 196	R	-	R	R	R	R
A 197	R	R	R	R	R	R
A 262	R	R	R	R	R	V
A 267	-	R	R	R	R	R
A 272	-	R	R	R	V	V
A 279	R	-	R	R	V	R
A 293	-	R	R	R	R	R
A 334	-	R	R	V	R	I
A 336	-	R	R	R	R	R
A 341	-	R	R	R	V	R
A 343	-	R	R	R	R	R
A 360	-	R	R	R	R	R
G 2575	R	-	R	R	R	R
G 11820	R	-	R	V	R	R
G 13811	R	-	R	R	R	R
G 13816	R	-	R	R	R	R
Flor de Abril	R	R	R	R	R	R

a Anthracnose reaction in Tepatitlan Jalisco
b Anthracnose reaction R= resistant no anthracnose symptoms
I= intermediate mild symptoms
V= variable in the greenhouse some plants resistant others have intermediate reaction
c Isolate source D= Francisco I Madero Durango
Z= Caleras Zacatecas
M= Chapingo Mexico
J= Tepatiatlan Jalisco

Table 10 Selected bean accessions lines and varieties with a resistant reaction in the greenhouse when tested sequentially against groups of isolates of <u>Colletotrichum</u> <u>lindemuthianum</u> from the Mexican states of Durango Zacatecas Mexico and Jalisco bean production areas (These accessions were not evaluated in the field in Mexico)

A 193	G 3445	G 8050	BAT 1583
A 252	G 3807	G 8160	BAT 1617
A 253	G 4121	G 11680	Calima
A 280	G 5150	G 13764	Double White
A 342	G 5173	G 13811	Flor de Abril
A 483	G 5971	XAN 43	ICA L 24
A 484	G 6071	XAN 122	Imuna
A 492	G 6436	BAT 1345	Michigan D R K
C 811	G 6474	BAT 1427	Princor
G 959	G 6499	BAT 1428	TU
G 3367	G 7148	BAT 1580	Widusa

Table 11 Bean accessions and lines with resistant or intermediate anthracnose reaction in the field in the state of Jalisco in Tepatitlan Mexico and in the state of Parana in Irati Brazil in 1983

Cultivar	Location		Cultivar	Location	
	Brazil	Mexico		Brazil	Mexico
A 73	1 0	1 5	A 251	1 5	1 0
A 75	1 0	3 0	A 281	1 5	2 5
A 156	1 0	1 0	A 318	1 5	2 5
A 197	1 0	1 0	A 320	1 5	2 5
A 241	1 0	1 0	A 443	1 5	1 0
A 262	1 0	1 0	EMP 110	1 5	1 0
A 319	1 0	2 5	A 83	2 0	1 0
A 320	1 0	2 5	A 267	2 0	1 0
A 321	1 0	3 0	A 270	2 0	1 0
A 322	1 0	2 5	A 280	2 0	1 5
A 329	1 0	1 5	A 282	2 0	1 0
A 360	1 0	1 0	A 285	2 0	1 0
A 442	1 0	3 0	A 286	2 0	2 5
A 444	1 0	1 0	A 287	2 0	1 0
A 150	1 0	1 0	A 288	2 0	1 0
A 248	1 5	1 0	A 318	2 0	2 5
A 250	1 5	1 0	A 322	2 0	2 5

a Anthracnose reaction 1-2 Resistant (immune or very mild symptons) 2 5 - 3 0 = intermediate (mild symptoms) isolates from Brazil and were reportedresistant Additionally some also showed an angular leaf spot resistance reaction in the field in Popayan Colombia and in Anapolis Brazil (Bean Program Annual Report 1982)

Given the extensive pathogenic variation of the anthracnose fungus in many areas where beans are grown much effort is dedicated to the identification of new /or different resistance sources Bean pathology continuously evaluates germplasm bank accessions for their reaction to anthracnose and angular leaf spot first in the field and later sequentially to a number of different isolates in the greenhouse The most anthracnose resistant materials under both field and greenhouse conditions have been grouped in the International Bean Anthracnose Test (IBAT) which also contains anthracnose differential lines As shown in Table 12 many of the bean lines in the IBAT show either resistant or intermediate reaction to all isolates of the anthracnose fungus tested and are resistant in the field in Colombia Some entries were resistant in other countries under field conditions (Table 12) These and other anthracnose resistance sources are used in the crossing block to combine this broad anthracnose resistance with other desirable characters into commercial cultivars

From greenhouse studies it is evident that some accessions show either race specific or broad resistance to all isolates tested Some show the same reaction in the field such as A 262 and A 329 from the IBAT Other accessions may have a different resistance mechanism BAT 527 has an intermediate anthracnose reaction in the greenhouse and in the field in the areas where it has been tested but it yields well Other accessions show another resistance mechanism as with Ecuador 1056 (ICA Llanogrande) which is anthracnose resistant in the field in all areas tested including Peru Ecuador Colombia Mexico and some areas of Africa However it is susceptible in the greenhouse to almost all isolates tested Ecuador 1056 and V 7919 are susceptible to anthracnose in the greenhouse at the seedling stage however as the plants increase in age their susceptible reaction diminishes and the mature plants are resistant (Figure 1) Other lines when inoculated at different growth stages some lines are resistant at all stages while others are susceptible at all stages

Web blight

Much of the work on this disease was conducted in Central America by the national programs particularly in Costa Rica where web blight is endemic Considerable progress has been achieved over the past few years in the control of this disease Although no line is known to be immune some bean lines have been identified as moderately resistant under heavy disease pressure and this level of web blight resistance has been incorporated into several lines Some of the recent crosses for web blight resistance showed higher levels of resistance than their parents when tested in Esparza Costa Rica in 1983 Table 13 shows varieties and lines with the highest levels of web blight tolerance in

Figure 1 Mean anthracnose score of the bean line Ecuador 1056 inoculated at various growth stages with different isolates of *Colletotrichum lindemuthianum* in which the anthracnose reaction was recorded at a scale of 1-5

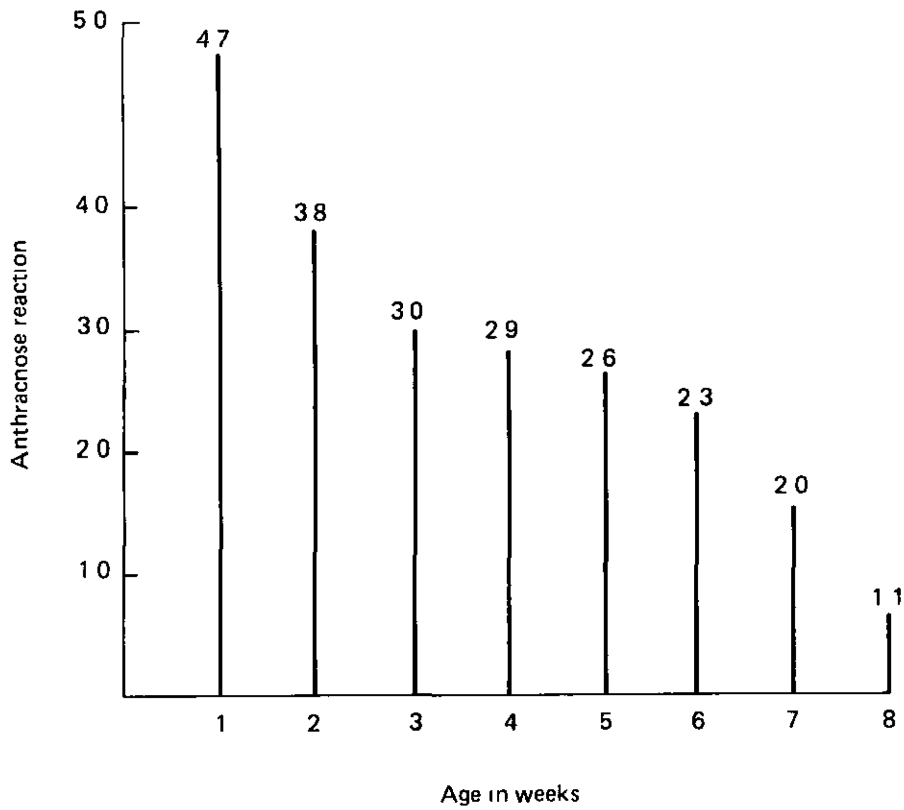

Table 12 Phaseolus vulgaris accessions lines and varieties in the IBAT with a resistant- or intermediate reaction in the greenhouse and in the field to all isolates of Colletotrichum lindemuthianum from different areas of Latin America

Accession	Greenhouse							Field	
	Popayán Colombia	La Selva Colombia	Mixture from Mexico	Mixture from Brazil	Mixture from Guatemala	Mixture from Argentina	Popayan Colombia	Irati Brazil	Tepatitlan Mexico
A 193	R	R	R	R	R	R	R		
A 452	R	R	R	R	R	R	R		
A 475	R	R	R	R	R	R	R		
A 483	R	R	R	R	R	R	R		
K 2	R	R	R	R	R	R	R		
Princor	R	R	R	R	R	R	R		
G 811	R	R	R	R	R	R	R		
G 984	R	R	R	R	R	R	R		
G 2333	R	E	R	R	R	R	R		
G 2338	R	R	R	R	R	R	R		
Evolutie	R	R	R	R	R	R	R		
A 253	R	I	R	R	R	R	R	R	
A 262[a]	R	I	R	R	R	R	R	R	R
A 263	R	I	R	R	R	R	R	R	
A 264	R	I	R	R	R	R	R	R	
A 265	R	R	R	I	R	R	R	R	
A 318	R	I	R	R	R	R	R	R	I
A 329[a]	R	I	R	R	R	R	R	R	R
A 484	R	R	I	R	R	R	R		
G 5653[a]	R	I	R	R	R	R	R		
Kaboon	R	R	I	R	R	R	R		
Imuna	R	R	I	R	R	R	R		
A 463	I	R	I	R	R	R	R		

a Also resistant under field conditions in Mexico

Table 13 Yield in gram/m^2 of the eight most tolerant lines and varieties to webblight in Costa Rica Data MAG UCR Costa Rica

Cultivar	Yield
HT 7716-CB(118)-18-CM-M-M	40 62 a*
HT 7719-CB(112)-15-CM-M-M	35 40 ab
Porillo 70[a]	28 78 abc
HT 1719-CB (112)-5-CM-M-M	27 00 abc
HT 7716-CB(118)17-CM-M-M	21 01 abc
Huasteco (D-145)[b]	18 94 bc
HT 7717-CB(94)-10-CM-M-M	18 79 bc
FB 06466-CM(19B)-1-CM(7B)-M-M	16 72 bc
HT 7719-CB(131)-4-CM-M-M	13 30 c
HT 7694-CB(179)-2-CM-M-M	12 88 c
ICA-PIJAO	0 00

a Tolerant check

b Susceptible check

* Figures followed by the same letter are not significantly different at the 0 05 level of the Duncan test

Table 14 Evaluation of tolerant varieties and lines under different web blight control treatments causing different levels of disease pressure in Esparza Costa Rica Data MAG UCR Costa Rica

Treatment	Variety	Yield (g/plot)
Mulch[a]	HT 7716	104
Mulch	Negro Huasteco 81	90
Benlate[b]	HT 7716	71
Benlate	Negro Huasteco 81	69
Mulch	Porrillo 70	69
Benlate	Porillo sintetico	63
Benlate	Talamanca	57
Mulch	Porrillo Sintetico	48
Benlate	Porrillo 70	46
Mulch	Talamanca	43
Check[c]	HT 7716	22
Check	Negro Huasteco 81	19
Check	Talamanca	17
Check	Porrillo Sintetico	17
Check	Porrillo 70	11
Benlate	ICA-Pijao	6
Mulch	ICA-Pijao	6
Check	ICA-Pijao	0

a Mulch = Rice Husk

b Benlate= Three applications at 20 30 and 40 days after planting

c check = Manual Weed planting control

Table 15 Tolerance of international web-blight nursery entries to web blight in two semesters of testing in Esparza Costa Rica in 1983 Data MAG UCR Costa Rica

Entries	Reaction
Porrillo 70	6 0
S 630 B	5 8
Turrialba 1	6 8
XAN 112	6 5
Porrillo Sintético	6 5
PI 313754 (G-02617)	6 0
Talamanca[b]	6 0
Huetar	6 0
Negro Huasteco 81	5 5
BAT 1225	6 5
BAT 450	5 5
HT 7716-CB (118)-18- CM	4 3
HT 7717-CB (94)-10-CM	5 6
HT 7719-CB (112)-5-CM	4 6
L-81-50	5 5
ICA-Pijao	7 0
Rojo de Seda	8 0
Calima	9 0

a Scale 1-2-3 severity 0-10% = Resistant
4-5-6 severity 11-25% = Tolerant
7-8-9 severity 26-100%= Susceptible

b Tolerant check

Table 16 Integrated control of Web-blight using the moderately tolerant variety Porrillo 70and the susceptible check ICA-Pijao Data MAG UCR Costa Rica

Treatment	Variety	Yield (g/plot)
Round-up + Benlate	Porrillo 70	353
Gramoxone + Benlate	Porrillo 70	339
Gramoxone + Post[a] + Benlate	Porrillo 70	259
Round-up + Post	Porrillo 70	240
Round-up + Post + Benlate	Porrillo 70	239
Check	Porrillo 70	175
Round-up	Porrillo 70	174
Round-up + Post + Benlate	ICA-Pijao	151
Gramoxone + Post	Porrillo 70	139
Gramoxone + Post + Benlate	ICA-Pijao	125
Gramoxone	Porrillo 70	113
Round-up + Benlate	ICA-Pijao	111
Gramoxone + Benlate	ICA-Pijao	109
Round-up + Post	ICA-Pijao	71
Gramoxone	ICA-Pijao	58
Round-up	ICA-Pijao	49
Check	ICA-Pijao	36
Gramoxone + Post	ICA-Pijao	30

a Post = Basagran + Fusilade

Costa Rica The black line HT 7716-CB(118)-18-CM-M-M besides having excellent adaptation and desirable agronomic characteristics showed a higher level of web blight resistance than its resistant parent in a replicated test with three different disease severity levels in Esparza (Table 14) Some of these lines in Table 14 will be included in the VINAR 84

Most web blight resistance studies are conducted in the field using a severity logarithmic scale of nine grades in which 1 is highly resistant and 9 is severely diseased Since the disease is often not evenly distributed in the field the disease reaction grade conferred to a given line is always compared to that of the nearest resistant check which is distributed throughout the field Using this procedure lines like HT 7716 were identified as consistently having higher levels of resistance than Porrillo 70 a variety long recognized as most resistant to web blight

The EP 83 VEF 83 and the Black and Red Seeded Bean Adaptation Nurseries were evaluated in Costa Rica for resistance to web blight Similarly 15 sets of the International Web Blight Nursery (VIM) containing the best resistant materials were evaluated in Costa Rica Mexico Guatemala El Salvador Nicaragua Panama and Colombia From the evaluation of VIM conducted in Esparza Costa Rica the following lines shown in Table 15 had equal or better levels of resistance than the resistant check Talamanca Negro Huasteco 81 Porrillo 70 BAT 450 XAN 112 BAT 1279 and MUS 6

Several segregating populations were also evaluated in Costa Rica and individual plant selection was done During 1984 these individual plant selections will be planted and the effectiveness of this type of selection will be evaluated

Several lines that were identified as resistant in Restrepo Colombia (where the basidiospore type of inoculum is abundant and generally more important than the mycelial and sclerotial inoculum which predominates in Costa Rica) were also resistant in Esparza Costa Rica

Considering that under severe web blight pressure lines have only intermediate levels of resistance other disease management strategies have been evaluated These include the use of mulch created by weeds previously killed by paraquat which serves as a barrier to the sclerotial inoculum that splashes on the plants This practice for use by both small and large farmers was developed in Costa Rica and Panama and is being tested in Central America In one study Table 16 weeds are killed using paraquat before planting A post-emergent herbicide mixture consisting of Prowl and Fusilade was utilized two weeks after planting in addition to three applications of the fungicide benlate at 20 30 and 40 days after emergence at the rate of 500 g/ha The results with the moderately resistant variety Porrillo Sintetico are encouraging opening the possibility of planting bean in the hot humid tropics where web blight is a major limiting factor This integrated control approach will be tested in on-farm trials in several countries where the disease is prevalent

The results from these disease management studies using mulch and fungicides have also greatly improved web blight nursery management The manipulation of disease pressure in the field has resulted in faster and better evaluations

Another agronomic practice which diminishes the inoculum level of web blight is rotation with a non-leguminous crop Low levels of disease pressure have been observed following rotation with maize or fallow in areas where the disease was previously prevalent in Costa Rica and Colombia In these areas high plant density generally is conducive to high levels of disease pressure

Web blight nurseries

All available lines in CNPAF totalling 659 materials were sent to UEPAE Porto Velho and another set of the best lines at Capivara Goiania were sent to Fazenda Itamaraty both for web blight evaluations

The best lines with least symptoms were CNF 137 A 83 A 254 A 266 A 367 A 373 and XAN 117 These lines will be tested in the coming season with the new web blight lines from Central America in the International Web Blight Nursery

At Fazenda Itamaraty 266 lines were planted the experiment showed heavy attack of web blight and only a few lines survived e g BAT 1553 Bat 431 A 365 XAN 137 Pv 99 N and CF 40 Not a single line performed well in both locations (Ouro Preto D Oeste and Itamaraty) indicating lack of adaptation to this hot and humid climate

Ascochyta

A crossing block of 23 sources of *Ascochyta* resistance was distributed and evaluated in relevant regions including the highlands of Guatemala Colombia Ecuador Peru Rwanda and Tanzania Only one of the entries in this nursery GUATE 1076-CM from Guatemala which is *Phaseolus coccineus* subspecies *polyanthus* was highly resistant Interspecific hybrids with this accession are relatively easy to make and resistant progenies have been selected Within *P vulgaris* the most resistant accession found is also from Guatemala GUATE 1213- CM Useful resistance has also been found in the accession G 6040[b] Of advanced lines suitable for the Andean Region VRA 81022 is the most resistant

Although high levels of resistance are still not available the present level of resistance is sufficient for many production areas When approximately 1 500 materials from the VEF 83 were evaluated in Popayan where *Ascochyta* is endemic none had a resistant reaction and the majority were susceptible but some showed an intermediate reaction The entries with an intermediate reaction will be further evaluated

b Appendix II describes the G accessions identified in this report

Ascochyta leaf spot is an important disease under cool high humidity conditions and the disease appears to have become more important in the Andean region in recent years In a trial with selected bean cultivars intercropped with maize in Popayan yield losses of ICA-Llanogrande (a susceptible check) were as high as 74% compared with no loss in GUATE 1213-CM (Table 17) The climbing plant type of Guate 1213-CM favored disease escape since Ascochyta tends to be more severe close to the soil The resistance available however is not due to plant architecture alone as differences in resistance were maintained in a trial comparing un-supported plants with those grown on a trellis Yield losses in susceptible lines were greater in the unsupported plots In a comparison of solo cropping and intercropping with maize no significant differences in disease severity were observed except in highly susceptible lines which suffered more when intercropped

A total of 7 crosses were made for Ascochyta resistance in 1983 of which 59 combined known sources seeking transgressive segregation Selection is carried out in the field in Popayan and at ICA-La Selva

Table 17 Yields of selected bean cultivars which were chemically protected and naturally infected with Ascochyta in Popayan when intercropped with maize

Cultivar	Mean Yield (kg/ha)		
	Protected	Natural infection	Yield difference (%)
ICA Llanogrande (susceptible)	727 c*	190 d	-74
GUATE 1213-CM (resistant)	839 bc	873 a	+4
G 6040	1018 ab	595 bc	-42
V 8010	825 bc	569 bc	-31
V 8017	608 c	409 c	-33
BAT 527	797 bc	540 bc	-32

* Numbers followed by the same letter(s) in the column are not significantly different at (P=0 05)

Rust

One of the principal objectives in working with bean rust is the identification of resistance mechanisms that are stable over time and geographical location Most bean cultivars tested internationally through the International Bean Rust Nursery (IBRN) are resistant in some locations but susceptible in others strongly suggesting race-specific resistance Similarly some cultivars evaluated as resistant in one location are severely attacked by rust at a later planting in the same site From the evaluation of the IBRN 81-82 tested over 10 sites in seven countries accessions and CIAT-bred lines were identified as having resistant or intermediate rust reaction in several locations (Table 18) The reaction of the susceptible check Pinto 650 and of Cuba 168 (a line that is resistant in some locations and susceptible at others) are included for comparison Not included in Table 18 were other entries which had a resistant or intermediate rust reaction in all locations but were susceptible at one Those that were susceptible only in Guatemala were BAT 66 BAT 261 BAT 308 BAT 332 BAT 482 BAT 867 BAT 1057 BAT 1061 BAT 1090 BAT 1127 DOR 62 and Cuilapa 72 Susceptible only in Colombia California Small White Turrialba 1 Turrialba 4 Olathe Pinto BAT 41 and BAT 176 Susceptible only in Brazil BAT 248 Ecuador 299 Mexico 235 and V 3249 Susceptible only in the United States in Maryland Bat 447 and in North Dakota BAT 44 and A 74

Improved methodology for rust inoculations in the greenhouse at the seedling stage was utilized and possible mechanisms of rust resistance were studied such as pustule size latent period and pustule number in pure lines and especially in F_2 populations

Crosses were made in 1983 between the line BAT 308 characterized by the small pustule type of rust reaction without a chlorotic halo and Ex Rico 23 characterized by a very large pustule type surrounded by a large chlorotic halo In the adaxial side of the leaf of BAT 308 the pustule size varied from 150 to 325 microns and about 60/ of the pustules were between 190-250 microns For Ex Rico 23 on the same side pustules varied from 350-586 microns BAT 308 has been evaluated extensively internationally as an entry in the IBRN 79-80 it was evaluated in 22 sites in 10 countries as resistant or intermediate in all locations except one In the IBRN 81-82 BAT 308 was evaluated as resistant or intermediate in nine sites in six countries but had a moderately susceptible reaction in Guatemala

In previous work (Bean Program Annual Report 1982) it was reported that under the field conditions in Palmira Ex Rico 23 and BAT 308 had yield losses of 74 2% and 18 4/ respectively when severely attacked by rust In determining the latent period for these two lines BAT 308 had an average of 10 6 days and Ex Rico 23 of 8 24 days showing that the long latent period was associated with the small pustule type For the F_2 population the average pustule size was 315 microns and the latent period of 9 76 days

The correlation between pustule size and latent period in the F_2 populations was 0 59 These preliminary data suggest that these characters may be manifestations of the same disease resistance mechanism and that selecting for one character such as small lesion size would automatically select for a longer latent period and reduced number of lesions Studies are in progress to further elucidate the nature of these rust resistance mechanisms

Angular leaf spot

During 1983 a large number of bean accessions were evaluated under field conditions in nurseries where the angular leaf spot (ALS) pressure was more than adequate and sometimes very severe on the susceptible checks In Popayan Colombia the VEF 83 nursery consisting of 1 425 entries was evaluated over two semesters

Many of the VEF lines with intermediate or resistant reaction to the disease will be further evaluated in other locations to identify and increase the number of possible ALS resistance sources About 400 F_4 and F_5 bulks were also evaluated for their anthracnose and ALS reaction in Popayan Initially invididual plant selections were progeny tested during the first semester bulk harvested and evaluated again for their ALS reaction in the second semester of 1983

Additionally 345 entries mostly of breeding lines from CIAT but also including varieties from several national programs were also evaluated Many of these lines had been previously evaluated in Colombia and Brazil (Table 19) and are the most likely candidates for the Bean Angular Leaf Spot International Test (BALSIT) a nursery that includes the best ALS resistance sources identified This nursery will be planted in key areas where ALS is an important disease

Similarly approximately 1 500 accessions including lines from the Brazilian National Program from Brazilian state institutions and CIAT-bred lines were evaluated in Capivara Goiania headquarters for the Brazilian National Rice and Bean Research Center (CNPAF) From these evaluations conducted in Capivara it is apparent that a bean accession that is ALS resistant in Popayan may not necessarily be so in Brazil (Table 19) As last year the line BAT 332 had an immune reaction in the nurseries in Popayan but it was highly susceptible in Capivara Other lines with a similar type of reaction include BAT 160 A 352 and A 354 On the other hand some lines such as A 230 A 320 and A 346 had a resistant ALS reaction in Capivara but were susceptible in Popayan Despite the apparent pathogenic variation existing from one area to another several lines had very good levels of ALS resistance both in Brazil and Colombia

Resistance to Bacterial Diseases

Common bacterial blight (CBB)

In the search for new or different resistance sources to common bacterial blight approximately 1 500 accessions from the bean germplasm bank are routinely evaluated twice a year During the first evaluation of 1983 23 accessions were identified as having an intermediate or resistant reaction in Palmira (Table 20) However they were poorly adapted

With the same objective of identifying unique or different CBB resistant lines a number of lines from interspecific crosses between *Phaseolus vulgaris* and *P acutifolius* made under CRSP funding by the University of California Riverside were evaluated for resistance in the field and in the greenhouse Table 21 shows the mean disease rating for two accessions and their reproductive adaptation in terms of pod set evaluation The results are encouraging since lines like XAN 159 and XAN 160 have much higher levels of CBB resistance than the best resistance checks such as XAN 112

Three way crosses are being utilized to combine the unique sources of resistance in well-adapted lines with commercial grain colors It has been particularly difficult to combine lines having brilliant small red red mottled or black opaque grain colors with CBB resistance

Some of CIAT bean lines having CBB resistance have been tested extensively in the field in many locations and in the greenhouse to several isolates of the CBB pathogen Among these XAN 112 (black seeded) has shown good levels of resistance in several locations of Colombia as well as in Mexico Costa Rica Guatemala and the United States This line is early maturing and well adapted in several locations in Central America In addition it has good levels of web blight resistance Other resistant lines include XAN 87 XAN 93 XAN 107 XAN 116 XAN 104 XAN 80 and XAN 131 Lines such as ICA L 24 a type I with thick leaves generally shows good levels of CBB resistance under field conditions However under heavy disease pressure pods sometimes show severe disease symptoms Apparently the foliage has some type of resistance to penetration because when leaves of this or similar lines are wound-inoculated the disease reaction increases considerably Work is underway to elucidate this particular type of reaction and to study a possible genotype x strain interaction between *P vulgaris* and *Xanthomonas campestris* pv *phaseoli* (*X phaseoli*) the CBB pathogen

Halo Plight

Based on screening results in Colombia and elsewhere a set of 17 lines resistant to prevalent isolates of halo blight was prepared as a crossing block and distributed internationally to interested national programs for use as resistance sources The nursery was sent to Colombia Ecuador Peru Rwanda Tanzania Zambia and Mauritiu

Table 18 Selected bean lines from the IBRN 81-82 with resistant or intermediate rust reaction in several locations

Bean Line	A	B	C	D	E	F	G	H	I	J	K
Redlands Green Leaf B	2	2	1	2	2	2	3	2	1	2	2
Redlands Green Leaf C	2	1	1	2	3	3	3	2	1	2	3
Redlands Pioneer	2	2	1	2	2	3	3	2	1	2	3
BAT 48-1C	3	2	1	3	2	3	3	2	1	2	2
BAT 73-1C	3	2	1	3	2	3	2	2	1	2	1
BAT 76	3	2	1	2	2	3	2	2	1	2	2
BAT 93-1C	3	1	1	3	2	2	3	2	3	2	2
BAT 260-2C	3	2	1	3	2	2	3	2	3	2	2
BAT 336-1C	3	1	1	3	2	3	3	2	3	2	1
BAT 337-1C-1C	3	1	1	3	2	3	3	3	1	2	1
BAT 338-1C	3	1	1	3	1	3	2	2	1	2	1
BAT 448-1C	3	2	1	3	2	3	2	2	1	2	1
BAT 520-1C	3	2	1	3	2	2	3	2	1	1	2
BAT 923-1C-1C	2	–	1	3	2	2	3	2	1	2	1
BAT 1210	3	1	1	3	1	3	1	2	1	2	1
BAT 1211	3	2	1	3	2	3	2	2	1	2	2
XAN 41	3	2	1	3	2	3	2	2	1	2	2
A 62	2	1	1	2	2	2	3	2	3	2	1
A 63	3	3	1	1	2	2	2	2	1	2	1
A 155	2	3	1	2	2	2	3	2	3	2	2
A 161	3	3	1	3	2	2	3	3	3	3	2
A 167	3	2	1	1	2	3	3	2	1	2	3
ICA L-24	3	2	1	3	2	2	3	2	3	2	3
G 1089-1C-1C	2	2	1	3	2	2	3	2	1	2	1
G 4829	2	2	1	3	2	2	3	2	1	2	1
Cuva 168 N	2	2	1	2	2	4	3	4	3	5	3
Pinto 650 (Susceptible check)	4	5	5	5	2	5	5	4	4	1	3

a Location A Beltsville Md USA B Saginaw Mich USA C Fargo N D USA D Goiania Brazil E Taichun Taiwan F Chimaltenango Guatemala G Delmas South Africa H Palmira Colombia (Sept 1981) I Tepatitlan Mexico J Palmira Colombia (April 1981)

b Rust reaction 1= immune 2= resistant 3= intermediate 4= susceptible 5= very susceptible

Table 19 Reaction of selected bean lines to the angular leaf spot pathogen (*Isariopsis griseola*) under field conditions in Colombia and Brazil

Entry	Popayan Colombia	Capivara Goiania Brazil	Entry	Popayan Colombia	Capivara Goiania Brazil
A 51	2 0[a]	2 0	BAT 1432	1 5	1 5
A 54	3 0	2 0	BAT 1554	1 5	1 5
A 63	2 5	1 5	BAT 1647	2 0	1 5
A 75	1 5	1 5	Jalo EEP 558	1 0	1 5
A 152	2 0	1 0	Araona	3 0	3 5
A 156	2 0	1 5	Icta Quetzal	3 5	2 0
A 210	2 0	2 0	Icta Jutiapan	3 5	2 5
A 211	2 0	2 0	A 227	4 0	2 5
A 222	1 5	3 0	A 230	4 0	2 0
A 235	2 0	1 5	A 320	4 0	2 5
A 300	1 5	2 0	A 346	4 0	2 0
A 302	2 5	1 5	A 443	4 0	2 5
A 338	1 5	1 5	A 337	2 5	4 0
A 340	2 5	1 5	A 352	2 0	4 5
A 348	1 5	2 5	A 354	2 0	4 0
BAT67	1 5	1 5	BAT 160	2 0	4 0
BAT76	1 5	1 5	BAT 332	1 0	4 5

a Disease scale of 1-5 in which 1 is immune and 5 is severely attacked

Table 20 Bean accessions from the CIAT germplasm bank identified as having intermediate or resistant reaction to CBB in Palmira in 1983

Bean accession	Disease rating	Bean accession	Disease rating
G 14494	2 0[a]	G 02102	3 0
G 10300	2 5	G 02138	3 0
G 10301	2 5	G 02167	3 0
G 13595	2 5	G 11711	3 0
G 13921	2 5	G 12109	3 0
G 03590	3 0	G 12528	3 0
G 04712	3 0	G 13922	3 0
G 06533	3 0	G 00730	3 0
G 10135	3 0	G 01700	3 0
G 10227	3 0	G 01702	3 0
G 02067	3 0	G 01924	3 0
G 02100	3 0		

a Disease rating scale of 1-5 in which 1 = immune and 5 = highly susceptible

Table 21 Evaluation of pod set and reaction to common bacterial blight among recognized sources of resistance and progeny selections from interspecific crosses of *Phaseolus vulgaris* x *P acutifolius*

Entries	CBB		Reproductive adaptation (Pod set)
	No of ratings	Mean rating	
XAN 159 (Interspecific)	5[a]	1 1	4 0
XAN 160 (Interspecific)	5	1 2	4 5
XAN 112	3	2 3	3 0
BAT 93	3	4 0	2 0
New York 67 (Cornell)	3	1 8	5 0
Mita 235-1-1-M (Puerto Rico)	3	2 8	5 0
Great Northern Jules	4	2 7	4 0
Porrillo Sintetico (check)	4	4	1 5

a 1 = immune 5 = severely diseased and the reproductive adaptation was 1= well adapted 5 Non-adapted

Eighty six crosses were made to develop improved resistance and to incorporate resistance into grain types with desirable agronomic characters (Table 6) Of these 48 crosses involved two or more different resistance sources to seek new and improved combinations of resistant genes while 38 crosses involved cultivars or sources of resistance to other diseases especially anthracnose

In Colombia halo blight is important only in the highlands of Narino Red Mexican UI-3 is susceptible indicating the presence of race 2 Field screening for resistance has been undertaken in collaboration with ICA at Obonuco Colombia Susceptible checks were E 1034 (a climber) and Diacol Andino (a bush type) and checks for intermediate resistance were ICA-Llanogrande (a climber) and L 33411 (a bush type) BAT 590 and BAT 1220 have high levels of resistance Lines newly identified for resistance include G 6070 G 10977 G 12753 BAT 740 BAT 1288 EMP 70 and V 7945 E 605 is a promising line for the region with an intermediate field reaction to halo blight

In a trial with 10 cultivars selected to represent a range from susceptible to resistant disease incidence and severity in susceptible cultivars was greater in solo cropping than in intercropping with maize High plant density also increased the level of disease In a comparison between field and greenhouse evaluations some inconsistencies were found especially for the cultivar ICA-Llanogrande (E 1056) which shows good field resistance but is susceptible in the greenhouse This cultivar is also field resistant to anthracnose

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Resistance to Virus Diseases

(BCMV)

BCMV continues to be the most important viral pathogen in the research program The existence of BCMV strains capable of inducing a hypersensitive systemic necrosis (black root) in mosaic-resistant genotypes constitutes a potential threat to improved bean germplasm Another problem has been the incorporation of resistance into certain mosaic-susceptible preferred grain types such as red and yellow (canario) seeded beans

1 Screening for monogenic dominant resistance

Despite the presence of necrosis-inducing strains of BCMV capable of attacking improved genotypes possessing the dominant hypersensitive I gene this type of monogenic resistance has held up for decades in commercial bean plantings throughout Latin America The Bean Program while taking steps to minimize the potential danger of a black root epidemic continues to incorporate the dominant I gene into all of the improved germplasm adapted to the lowland tropics

Table 22 show the source and number of breeding materials screened by the program s sections for their reaction to BCMV in 1983 This year the screening load was approximately 1 000 plants or 100 lines/ work day representing a 38 increase over last year

Table 22 BCMV evaluations conducted in 1983

Source	Number	Section
Germplasm bank accessions	13 135	Virology
Segregating progenies	14 470	Bean breeding I
	6 437	Bean breeding II
	1 422	Bean breeding III
VEF	1 546	Agronomy
National programs	1 500	Bean breeding I
Special projects	850	Microbiology
	96	Pathology
	3 882	Other
Total	43 338	

2 Screening for common mosaic multiple gene resistance

Certain recessive genes such as $bc1^2$ $bc2^2$ and bc^3 protect dominant I gene genotypes against attack by necrosis-inducing strains of BCMV Plants possessing both the I gene and one or more of these recessive genes would behave either as if they were immune or would only develop local pinpoint lesions when manually inoculated with a necrosis-inducing strain

The first multiple gene project was started in Chile initially using the IVT lines 7214 (bc3) and 7233 (I $bc1^2$ $bc2^2$) as donor parental materials to protect black root susceptible Chilean cultivars (Later tropically-adapted hybrids obtained from crosses of IVT and CIAT lines were also used) Table 23 shows the crosses and advanced generations of IVT and Chilean cultivars In addition to the useful results obtained this is an example of a successful cooperative project and effective management of early progenies by a national program The lines are simultaneously selected for their field reaction to bean common and bean yellow mosaic viruses Subsequently a seed sample of the harvested selections is sent to CIAT to be screened for multiple gene BCMV resistance backcrossing and intermating

The Bean Program has also selected other promising donor genotypes with superior agronomic characteristics such as Red Mexican 35 the Great Northern line 31 and an introduction called Don Timoteo to be used in the current crossing projects

However screening for common mosaic multiple gene resistance demands a different methodology Each cross includes at least one mosaic-resistant parent with the dominant I gene and one parent with the recessive genes $bc1^2$ and $bc2^2$ or bc^3 The progeny test is carried out by inoculation with a mixture of the BCMV strains NL3 and NL4 to eliminate plants affected by either mosaic or systemic necrosis Plants showing local pinpoint lesions on the inoculated leaves or behaving as if they were immune (virus-free) are selected for seed increase and further screening until a homozygous local pinpoint lesion or immune line is identified

3 Evaluation of the Phaseolus species in the germplasm bank for their BCMV Reaction

A bean common mosaic screening project was completed this year for accessions of two of the *Phaseolus* spp in the germplasm bank which have passed official quarantine requirements A total of 13 135 accessions of *P vulgaris* and 194 of *P acutifolius* were mechanically inoculated and evaluated for their mosaic or systemic necrosis reaction The results showed that 80 8% of all the *P vulgaris* accessions screened are susceptible to BCMV 14 2% exhibit dominant resistance of the hypersensitive type and 5% are segregating for their reaction to BCMV Surprisingly all of the *P acutifolius* accessions tested were susceptible to BCMV These data have been included in the germplasm descriptors

Table 23 Experimental lines and varieties selected by INIA Chile for common mosaic multiple gene resistance from crosses of IVT lines and Chilean cultivars

Cross	Stage	Grain type by color	size	No of lines
Apolo x IVT 7214	F_5	White	medium	3
IVT 7233 x C Blanco	F_5	Purple		7
T Diana x IVT 7214	F_5	White	medium	3
IVT 7233 x T Diana	F_5	White	medium	2
IVT 7233 x H Dorados	F_5	White	medium	1
T Diana x IVT 7214	F_5	Tortola		2
N Argel x IVT 7214	F_5	Arroz		7
IVT 7214 x Arroz-3	F_5	Arroz		1
N Argel x IVT 7214	F_5	Black		7

4 Selection of Homozygous BCMV resistant lines of red seeded genotype with genetic linkage problems

The rapid progress made in the incorporation of resistance into most of the CIAT-improved genotypes could not achieved initially with certain mosaic susceptible red and red-mottled grain types of commercial importance in Andea Central America and the Caribbean

Studies conducted at C AT demonstrated a genetic linkage between these problem grain types and BCMV susceptibility Isogenic lines from advanced generation segregates in the line BAT 1255 were purified genetically to obtain red mottled ii(BCMV susceptible) and purple mottled II (resistant) versions of BAT 1255 The F_1 plants produced from cro sing the two parents were Ii resistant and produced purple mottled F_2 seed Then the F_2 population was grown under field conditions to maximize seed production F_3 families were classified for grain color and 15 plants/family were inoculated under screenhouse conditions with the necrosis-inducing NL3 strain Results are shown in Table 24 All 94 red mottled F_3 families were 100% ii susceptible Of the purple mottled F_3 families 167 segregated resistant and susceptible plants and in every case the susceptible F_3 plants produced red mottled F_4 seed Ninety-two families were uniformly resistant and produced only purple mottled seed The complete absence of recombinant classes (red mottled resistant or purple mottled susceptible) suggests a very tight genetic linkage Similar studies are being conducted for the Canario grain types

Consequently a continuous screening and individual plant selection process was undertaken that included various red and red-mottled lines egregating for their resistance to BCMV For example Figure 2 shows the selection and screening sequence followed to obtain a soft red seeded (Mexico 80 type) line homozygou resistant to BCMV soon to be released in Central America as Huetar-2

More important however was the selection of four BCMV-resistant red-mottled lines of the Calima grain type (one of the most difficult seed types to improve for this character) A promising red-mottled Pompadour line was also identified this vear as homozygous resistant to BCMV Table 25 presents the characteristics of the lines with dominant BCMV resistance selected to enter the VEF

Considerable progress has also been achieved with Cargamanto a mosaic-susceptible cream mottled grain type of high market value in Colombia The first screening included 29 individual selections derived from three different crosses Of these only five individual selections were made from those obtained from a backcross of Cargamanto with Cornell 49-242 a mosaic and anthracnose resistant line The individual selection/screening process has now been repeated three times and as a result four BCMV resistant lires with Cargamanto grain characteristics have been selected

5 Seed transmission and yield loss induced by different BCMV strains inoculated into genetically diverse bean varieties at various growth stages

Table 24 Observed and expected frequencies in F_3 segregation of ii/I- and red versus purple mottled grain color for BCMV reaction in the greenhouse

Color	Susceptible	Segregating	Resistant	Total Families
Red mottled	94 (22)[a]	0 (44)	0 (22)	94
Purple mottled	0 (66)	167 (132)	92 (66)	259
TOTAL	94	167	92	353

a Observed frequencies appear first followed by expected frequencies in parentheses

Table 25 Mosaic-resistant red-seeded lines with dominant bean common mosaic resistance (CMD) selected for entry in the VEF nursery

Grain type	Line	Destination
Small red	MCD 201	Central America
Small red	MCD 202	Central America
Small red	MCD 203	Central America
Medium red	MCD 221	Central America
Pompadour	MCD 231	Caribbean
Sangretoro	MCD 241	Andean/other
Calima	MCD 251	Colombia/Africa
Calima	MCD 252	Colombia/Africa
Calima	MCD 253	Colombia/Africa
Calima	MCD 254	Colombia/Africa
Calima	MCD 255	Colombia/Africa

Figure 2 **SCREENING METHODOLOGY FOR A SOFT SEEDED LINE HOMOZYGOUS RESISTANT TO BCMV**

Crosses with Mexico 80

↓

46 selections
FB 5682-CM(15) S (30) S (4)

↓

Necrosis test

↓

BCMV NL3

↓

Individual selection
(one plant)

↓

Growth room (20 C)
and seed increase

↓

Necrosis test

↓

Individual selection
Necrosis test

↓

Individual selection
of homozygous R lines

↓

Selection for grain type

↓

Seed increase in the field

↓

Selection of line with best grain type
homozygous Resistant to BCMV

The incidence of seed transmission of BCMV varies according to the infected cultivar and developmental stage when the plant is infected Plants becoming infected past their flowering period will not generally transmit BCMV <u>via</u> the seed The genetics of seed transmission of BCMV however has not been investigated

In 1983 a project was carried out identifying BCMV susceptible varieties which do not seem to transmit the virus <u>via</u> the seed in which different strains of BCMV were inoculated at three different plant developmental stages for a total of 14 cultivars possessing differential recessive resistance to BCMV

6 <u>Screening and genetic problems associated with the incorporation of dominant recessive and multiple resistance to BCMV in Bean germplasm</u>

The incorporation of recessive genes into dominant I gene cultivars seeking multiple resistance to mosaic and necrosis inducing strains has revealed a series of uncommon genotypical reactions possibly induced by the different nature and interaction of the resistance genes involved To study these phenomena two crosses were made between Red Mexican 35 (which possesses the recessive $bc\ 1^2$ $bc\ 2^2$ genes) and two I gene varieties Royal Red (a kidney) and Widusa (a navy bean)

Noteworthy among the preliminary results obtained was the appreciable frequency of plants exhibiting pinpoint local lesions indicating the recombination of recessive and dominant genes such as I and $bc\ 2^2$

7 <u>Serological detection of BCMV strains in infected bean seed and plant tissue</u>

The serological detection of BCMV in infected bean seed cannot be accomplished by the traditional diffusion methods due to the occurrence of non specific reactions The Enzyme-linked Immunosorbent Assay (ELISA) a highly sensitive technique recommended for this purpose was tested using an antiserum prepared to the Florida strain of BCMV This technique not only the detected the virus in seed extracts but also reacted specifically with the Florida strain These results have prompted a similar study to produce highly specific antisera to the most prevalent necrosis inducing strains

In the meantime an antiserum to the most virulent necrotic strain present in Latin America NL3 has been used in conjunction with the technique known as Serological Specific Electron Microscopy (SSEM) (through the recent acquisition of an electron microscope) to detect this strain in infected tissue sample The SSEM test could successfully detect NL3 in less than 10 minutes This seriodiagnostic technique will permit the monitoring of this strain in Latin America and Africa and consequently will help identify high risk areas for deployment of monogenic dominant resistance

Bean Southern Mosaic Virus (BSMV)

Bean southern mosaic is a widely distributed and yet generall unrecognized viral disease in the field One of the main difficulties encountered at CIAT in the study of the epidemiology of this virus has been the symptomless-to-mild reaction observed in most infected bean varieties and the lack of a highly specific antiserum This year however the virus was isolated in pure suspensions and a suitable antiserum was prepared

The antiserum was used to adapt the Enzyme-Linked Immunosorbent Assay (ELISA) test for the detection of BSMV in infected plants and viruliferous beetle vectors For this survey a CIAT field was chosen close to an extensive bean plot with a high population of chrysomelids A total of 66 Diabrotica balteata beetles were captured and processed individually for the ELISA test Simultaneously 56 plant samples were taken at random and also prepared for ELISA The results of these tests showed that 51 5% of the chrysomelids captured were active vectors of BSMV and that 48 2% of the plants assayed were infected by this virus These results demonstrate that BSMV can be an infectious and underestimated pathogen in bean fields

Bean golden mosaic virus (BGMV)

BGMV does not occur in Colombia The research reported here was conducted by the Central American project in Guatemala Since the release of three black seeded BGMV resistant varieties in Guatemala higher levels of BGMV resistance have been sought in black seeds emphasizing the recombination of the existing BGMV resistance with other factors such as earliness resistance to Apion bacterial blight and anthracnose and tolerance to Empoasca low P and to drought Crosses recombining these factors are in various stages of selection But presently advanced lines are being tested which recombine BGMV resistance with earliness and resistance to CBB In the future more emphasis will be placed on drought tolerance

For El Salvador well adapted red seeded lines with good BGMV resistance are now available However these lines have problems with lateness small seeds dark or brownish tones of red and unstable red colors Only in the past two years has the importance of these problems been realized and steps have been taken to redirect the crossing program accordingly Breakthroughs in the improvement of red color should soon lead to better colors in BGMV resistant lines as well

Progress in BGMV resistance in mottled grain types for the Caribbean countries has been slow but has been facilitated by screening parents and progenies in Central America In May 1981 a large number of mottled seeded lines were evaluated and parents for crosses were selected In May 1983 F_2 populations were selected and the F_3 progeny test indicated that high levels of resistance had been attained These families represent progress but they still lack the following characteristics (1) the type I growth habit preferred in the Dominican Republic and (2) proper grain size and preferred grain color It is not yet known if they will be adapted in the Caribbean area The best of these lines will be crossed with commercial types adapted to Caribbean conditions

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Resistance to Insects Pests

Evaluations for plant resistance to Empoasca kraemeri Apion godmani and seed infesting bruchids were continued in 1983

The leafhopper Empoasca kraemeri

The only known index that can be confidently used to evaluate resistance to the leafhopper E kraemeri is yield under leafhopper pressure As noted previously the visual damage scale is not accurate enough to separate close levels of resistance and there is no correlation in percentage yield loss between different plantings Therefore breeding for resistance to E kraemeri is basically yield breeding using the leafhopper as a key factor in the environment Selection is based on early generation yield tests and is conducted in the areas for which the resistant lines are intended

Selections within EMP established at CIAT lines have resulted in improved color seed size and possibly yield over the original EMP lines (Table 26)

In 1983 another 2 000 accessions of the germplasm bank were evaluated for resistance to E kraemeri No high levels of resistance have yet been found and it appears doubtful that they will be discovered

The first yield test at CIAT of materials from the sixth and seventh cycles of recurrent crossing revealed some good lines of red and white seed (Table 27) These materials are being sent to other countries for evaluation

1 Empoasca resistance screening at CNPAF Brazil

The screening for Empoasca resistance at CNPAF Brazil is conducted in the field under natural infestation Materials are tested in three stages and superior lines are used as parents In 1983 700 lines (of which 352 were derived from CIAT) were tested at stage 1 A total of 102 were advanced to stage 2 the best of which are shown in Table 28

The bean pod weevil Apion

The following results were obtained by Central American bean scientists working closely with CIAT based staff through the Central American Project since the bean pod weevil Apion godmani only occurs in Central America where it is the most important pest in farmers fields

Table 26 Yield under protected conditions and yield reduction under a moderate *Empoasca kraemeri* attack of 3-5 nymphs/leaf and heavy attack of 4-8 nymphs/leaf in some EMP lines and selections thereof

		Protected Yield (kg/ha)		Yield loss with *E Kraemeri* (kg/ha)	
Entry	Seed type	Moderate	Heavy	Moderate	Heavy
EMP 86A	Small cream	1518	3192	-12	2101
EMP 86	Small dirty cream	1473	2768	548	1764
EMP 81A	Small cream	1768	3637	664	2130
EMP 81	Small dirty cream	1147	3420	46	2080
EMP 121A	Small opaque black	1514	3128	300	2259
EMP 121D	Small opaque black	1571	2805	552	2102
EMP 121	Very small shiny black	1243	2188	528	1295
EMP 84	Small opaque black	1640	3558	307	2124
BAT 271	Small opaque black	2019	2838	655	1593

Not significantly different at 5% level

Table 27 Yield without Empoasca kraemeri attack and yield reduction under a heavy attack (4-8 nymphs/leaf) in the best lines from part of the 6th and 7th cycles of recurrent crossing

Code	Seed type	Yield without E kraemeri[a] kg/ha	Yield loss with E kraemeri[b] kg/ha
EMP 81 (check)	small cream	1 541	596a
ER 8180-3	small cream	1 955	690a
ER 8227-5	small white	1 716	751a
ER 8191-1	medium small red	2 039	925ab
ER 8227-1	small red	1 977	962ab
BAT 271 (check)	small black	1 727	963ab
ER 8191-24	medium small red	2 205	1 003ab
ER 8236-2	small cream	2 091	1 020ab
ER 8168-2	small white	1 949	1 087ab
BAT 41 (check)	small red	1 893	1 466b

a No significant differences at 57 level

b Means followed by same letter not significantly different at 5% 0 05 level of the Duncan test

In Guatemala *Apion* tends to be a greater problem at the higher elevations but there are also lowland regions (400-1 000 msl) where it is extremely damaging as in Jalpatagua Guatemala as well as in other Central American sites such as Ahuachapan El Salvador and El Barro Honduras The best known resistance sources are poorly adapted at these lower elevations but attempts are being made to recover or develop resistance through genetic improvement of useful genotypes

The main focus has been the International *Apion* Nursery (VIA) for which selections were made for *Apion* resistance from highland materials at the experimental station of ICTA in Chimaltengo Guatemala Several promising lines were identified but the best adapted resistance sources for this region were bush bean lines such as Amarillo 154 and Cuate 209 which will be utilized as parents In August 1983 500 accessions of Mexican origin from the CIAT germplasm bank were planted seeking new resistance sources The EP 82 with Central American or Mexican grain types was screened identifying 32 lines meriting further study

However the main focus has been on the VIA (Table 29) In 1981 the results of VIA confirmed reported sources of resistance identified resistance in new lines and suggested an excellent correlation among results in different lowland testing sites From these results parents were selected for a crossing program in which some crosses combined poorly adapted resistance sources with adapted genotypes to combine sources of intermediate resistance seeking transgressive segregation

In May 1983 these populations were evaluated in 112 families and 23 were selected on the basis of resistance and some transgressive segregates for superior resistance were recovered Apparently some of the selections also have improved adaptation representing a significant advancement Furthermore several lines have nearly commercial grain colors for Central America (opaque black shiny black or shiny red)

In addition to evaluations for resistance studies have also been undertaken to improve the efficiency of data collection The evaluation procedure used by ICTA scientists has been simplified facilitating the evaluation of larger numbers of lines Previously evaluation of a 30 pod sample took 15-20 minutes and now is done in seven minutes Each evaluator is supplied with a sheet of paper divided in squares marked 0 1 2 3 4 and 5 representing the number of damaged seeds/pod The evaluator opens the pods one by one observing the number of damaged seeds and placing each pod in its respective class The only data which are recorded are number of pods in each class and the number of undamaged seed With these data the person responsible for the experiment can calculate the other information of interest (percentage of damaged seed percentage of damaged pods etc)

The feasibility of using a smaller sample size was also studied to use percentage of damaged pods instead of percentage damaged seeds The use of checks in the planting design was evaluated statistically to improve the precision in the estimation of resistance

Table 28 The 20 outstanding lines out of 700 tested for Empoasca resistant by CNPAF scientists Goiania 1983

Identification	Nymphs/leaf	damage* score	Pods/ plant	Yield kg/ha
1 DRO 4679	0 96	2 5	18 8	326
2 DRO 4706	1 70	2 0	14 9	283
3 DRO 4708	1 26	2 0	13 75	283
4 DRO 4704	1 33	2 0	15 4	277
5 A 212	1 70	2 0	13 2	257
6 DRO 4723	1 93	2 3	14 0	253
7 DRO 4707	1 13	2 5	13 2	249
8 PI 208769 X ICA Tui	2 23	2 0	12 4	241
9 PI 298769 X ICA Tui	1 62	2 5	13 5	239
10 DRO 4704	1 40	2 3	11 9	236
11 BAT 1557	1 93	2 5	14 7	231
12 A 211	3 56	2 0	11 8	227
13 Jamapa X Carioca	1 66	2 5	11 3	226
14 Cornell 49242 X Rico 23	1 13	2 3	13 2	224
15 Jamapa X Roxao	1 73	2 5	10 9	224
16 Roxao X Jamapa	1 26	1 5	10 1	223
17 WIS 22 24	2 10	1 8	10 0	220
18 BAT 76	1 63	2 0	11 8	219
19 Jamapa X Carioca	1 73	2 75	11 1	218
20 DRO 4694	1 26	2 5	13 4	217
Susceptible check				
Goiania precoce	2 02	-	-	79
Tolerant check				
Porillo 70	1 67	-	6 0	89

* Damage score average of 3 observations 1= tolerant 5 highly susceptible

Table 29 Damage to selected lines of the International *Apion* Nursery at Monjas Guatemala 1983A

	/ DAMAGE
G 03982	0 0 a*
EMP 87	2 4 a
APN 68	2 6 a
L17-7	2 7 a
APN 64	4 0 a
G 11506	4 3 a
APN 18	4 6 a
ICTA-TAMAZULAPA (check)	19 5 b

* Means followed by same letter not significantly different at 5% level

The aforegoing results were presented in an *Apion* Workshop in Jutiapa Guatemala November 14 - 1ɔ with the attendance of collaborators from Mexico Guatemala El Salvador Honduras Costa Rica Panama and CIAT

Bruchids

First-instar *Acanthoscelides obtectus* larvae that were obligated to penetrate the seed coat of a resistant wild *P vulgaris* (G 12891) and later passed to susceptible Diacol Calima seed suffered no lengthening of their life cycle compared to larvae maintained solely on Diacol Calima However when larvae had penetrated the Diacol Calima seedcoat and were transferred to G 12891 cotyledons they suffered a 12 5 day delay (38%) in development indicating that at least in this accession resistance is located entirely in the cotyledons

Resistance was positively correlated to cooking time and the most resistant wild accessions took four hours to cook compared with the susceptible Calima which required 30 minutes

Progress could be noted in increasing seed size reduced cooking time and maintaining resistance in F_3 progeny of crosses between resistant wild *P vulgaris* accessions and commercial grain types (Table 30)

An age specific life table study was performed for *A obtectus* on Diacol Calima and resistant G 12953 Mortality occurred earlier on G 12953 In the susceptible variety oviposition began at 35 days and at 56 days on the resistant line Egg laying was four times greater in Diacol-Calima as compared to G 12953 (Fig 3)

Bean Fly (*Ophiomyia phaseoli*)

The Bean fly does not occur in Latin America but is possibly the most universal production problem for beans in Africa Collaborative work with Tanzania and in Burundi included screening advanced lines from CIAT for resistance to this pest Of these lines screened A 62 consistently possessed improved resistance at all locations

BAT 93 A 30 and BAT 1252 also have some resistance G 5478 (Tara) showed a high level of resistance and was crossed with the resistant *P coccineus* accession G 35023 as part of the Gembloux project Segregating lines were sent to AVRDC Taiwan and to Burundi for screening At Kisozi Burundi a number of plants were selected for resistance and fertility and their progeny are being selected there Resistance in these materials may be related to the thick woody stem inherited from *P coccineus*

A total of 10 crosses were made at CIAT in 1983 of which nine involved G 5478 crossed with commercial African cultivars (e g Kabanima Jaune du Mosso) These are being advanced in bulk to F_4 before being sent to Africa for selection and evaluation

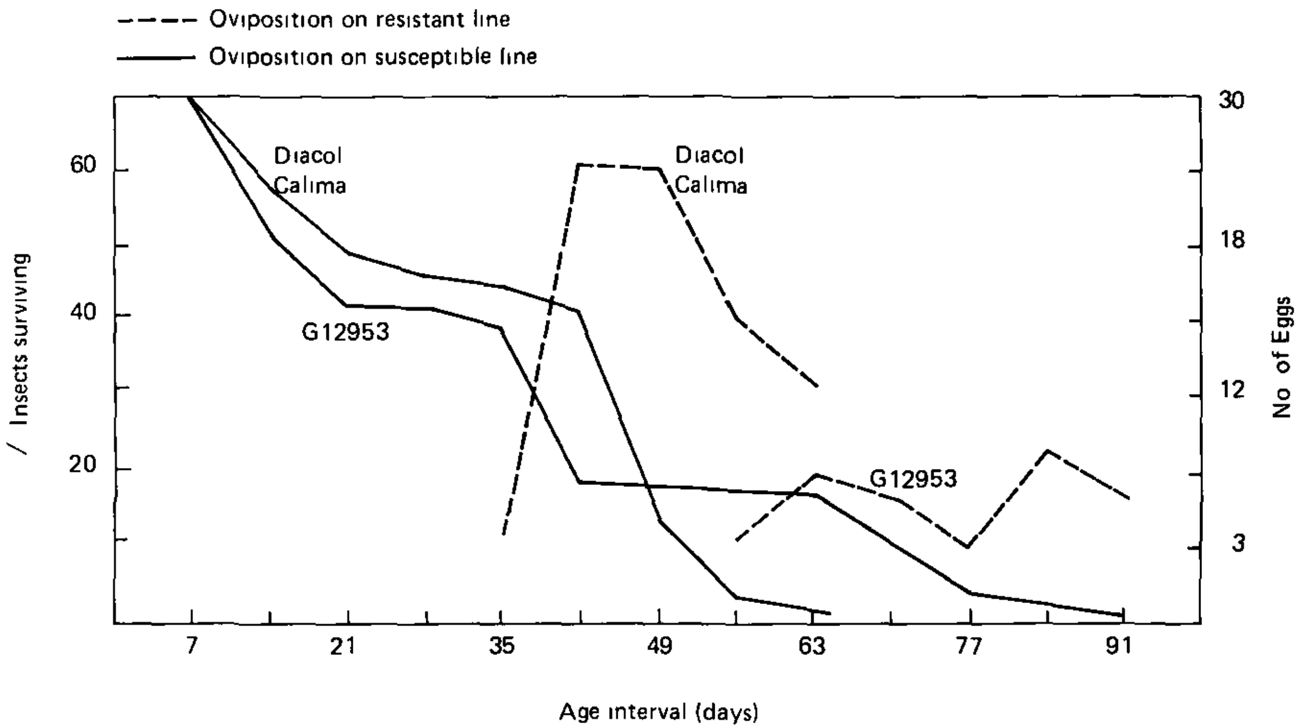

Figure 3 **Age specific life table for *Acanthoscelides obtectus* in a susceptible bean variety Diacol Calima and a resistant wild accession G 12953**

Table 30 Weight/100 seeds cooking time and resistance of seed to bruchids from F_3 plants crosses between resistant wild *Phaseolus vulgaris* accessions and commercial grain types

Cross	100 seed wt (g)	cooking time (min)	No adults emerged[a]	Life cycle of bruchids (days)	Dry wt bruchid adult (mg)	Resistance classification[b]
BAT1235 x G 12952	23	95	179(Z)	46	1 0	I
V7920 x G 12891	15	75	0(A)	--	--	R
G 12722 x G 10019	9	158	72(A)	54	2 0	R
G 1449 x G 12952	14	86	60(A)	51	1 9	R
Calima (check)	45	56	251(Z)	37	1 5	S
Calima (check)	45	56	87(A)	36	2 6	S
G 12952 (check)	8	190	5(A)	63	1 6	R

a (A) = *Acanthocelides obtectus* (Z)= *Zabrotes subfaciatus*
b R = resistant I = intermediate S = susceptible

Table 31 The most drought tolerant lines in stage 1 screening (225 line) January/February dry season and their reaction to <u>Macrophomina</u> <u>phaseoli</u> on a measuring plant loss as an index of tolerance on a scale from 0 (no plants lost) to 10 (100/ lost)

ENTRY	Yield (kg/ha)	Growth habit	Color	M phaseoli[a]
BAT 85[a]	1043	II	Cream	0
BAT 477[a]	1021	III	Cream	0
San Cristobal 83[b]	1014	III	Pink	0
BAT 1298[b]	977	II	Pink	0 8
BAT 1393[b]	913	I	Cream	1 6
A 300	869	II	Cream	0 2
BAT 33[b]	867	II	Cream	0 2
BAT 1617[b]	860	III	Red	0
BAT 1592[b]	773	III	White	0 1
BAT 1400[b]	698	I-II	Cream	0 3
BAT 1375[b]	695	II	Red	0 9
BAT 1449[b]	690	II	Red	0 3
BAT 1572[b]	686	III	Red	0 4
BAT 1532[b]	658	II	Red	0 6
A 381[c]	644	II	Coffee	0
X	202			
SD	234			
C V	116			

a Standard checks
b Line from EP 82

Table 32 Performance of best lines accessions and varieties in stage 2 drought screening (72 lines) for the January/February 1983 season and their reactions to *Macrophomina phaseoli* on a scale from 0 (no plants lost) to 10 (100% lost)

Entry	Stable yield[a] kg/ha	Control yield	Yield under stress	Growth habit	Color	*M phaseoli*[b]
V 8025[b]	1 271	1854	839	IV	Black	0
BAT 85	1 256	2093	707	II	Cream	0
						c
BAT 1289	1 158	2 050	730	III	Red	0
BAT 477	1 156	2 006	592	III	Cream	0
A 55	1 147	1 898	673	II	Black	0
BAT 1210	1 135	1 919	660	II	Cream	0
BAT 332	1 120	1 857	680	II	Cream	0 2
BAT 125	1 072	1 655	544	II	Cream	0
Negro Argel	952	1 869	542	II	Black	0
EMP 84	945	1 737	416	II	Black	0 2
A 54	921	1 509	300	II	Cream	0
A 59[c]	920	1 780	377	II	Coffee	0
						d
V 8017[b]	885	1 921	367	IV	Black	0
BAT 1257	860	1 776	372	III	White	0
BAT 1198[b]	816	1 933	359	III	White	0 3
G 4454	788	1 392	479	II	Black	0 6
XAN 76	782	1 854	354	II	Cream	0
A 195	748	1 270	452	I	Cream	0 6
A 147	730	1 854	354	III	Cream	0 1
G 4523	714	1 392	479	I	Red	0
$\bar{X}$	543	1711	266			
SD	345	323	211			
C V (%)	64	19	79			

a Geometric mean of stress and control yield (in kg/ha)
b New lines
c Cutoff at mean + 2 standard deviations
d Cutoff at mean + 1 standard deviation

Table 33 Performance of best lines in stage 2 drought screening (72 lines) for July/August dry season and their reactions to *Macrophomina* on a scale from 0 (no plants lost) to (100/lost)

Entry	Stable yield[a] kg/ha	Control yield kg/ha	Yield under stress	Growth habit	Color	*M phaseoli*[b]
BAT 85	566	1928	254	II	Cream	1 7
c						
A 54	477	1 723	260	II	Cream	3 2
A 496[b]	462	1 190	302	I	White	0 3
BAT 1393[b]	454	1 684	187	I	Cream	3 3
A 59	432	1 216	238	II	Coffee	2 1
A 487[b]	371	1 069	250	I	Purple	1 0
BAT 1400[b]	315	1 592	155	II	Cream	3 5
BAT 1217	314	1 575	132	II	Red	3 9
d						
BAT 1617[b]	292	1 734	156	I	Red	4 7
BAT 125	264	1 317	115	II	Cream	5 5
G 5059	262	1 493	109	II	Cream	3 6
BAT 1586[b]	255	1 446	80	I	Cream	3 1
A 195	251	1 189	148	I	Cream	1 7
G 4523	251	1 271	137	I	Red	3 0
BAT 1620[b]	244	1 315	135	I	Purple	1 7
$\bar{X}$	93	1 494	46			
SD	205	252	109			
C V (%)	221	17	238			

a Geometric mean of stress and control yield
b New lines
c Cutoff at mean +2 standard deviations
d Cutoff at mean + 1 standard deviation

Nematodes

Field screening for resistance to nematodes has not yet been undertaken in Colombia but with the collaboration of North Carolina State University germplasm has been screened for resistance to Meloidogyne incognita and M javanica

Initially 39 bean cultivars were screened and Alabama 1 (G 3736) P I 313709 (G 2587) P I 165426 (G 5740) Manoa Wonder (G 6278) and Carioca (G 4017) had acceptable levels of resistance to M incognita All cultivars were susceptible to M arenaria Panamito Alabama 1 ICA Pijao and Talamanca were moderately resistant to M javanica

Based on these results a set of 80 advanced lines and four segregating populations were selected from crosses involving these parents and are undergoing further evaluations In addition 11 new crosses were made in 1983 to combine these resistance sources with useful agronomic types

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Tolerance to Drought Stress

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Screening for drought tolerance at Palmira was continued in the January/February and July/August dry periods of 1983 using the two stage system described in the Bean Annual Report 1982 Canopy temperature data were taken but are not presented since they provided no additional information beyond that of the yield data

Of the 225 entries in the stage 1 screening for January/February season the best are presented in Table 31 Among the best five were two pink seeded lines and a type I suggesting that it is possible to escape from the general pattern of cream to black seeded type II's and III s with vastly superior drought tolerance The very high coefficient of variation reflects the fact that 47 of the 225 lines (21%) yielded less than 10 kg/ha These poor yields are attributed primarily to infestation by Macrophomina phaseoli (Ashy Stem Blight) Scoring plant loss as an index of tolerance to M phaseoli indicated probable tolerance or resistance in many lines

Results of stage 2 screening for January/February appear in Table 32 Of the 72 lines accessions and varieties the only new entries of interest were two black seeded type IV s grown without support These

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Results of stage 2 screening for January/February appear in Table 3 Of the 72 lines accessions and varieties the only new entries of interest were two black seeded type IV s grown without support These had been selected from stage 1 screening of the EP 81 Type IV s are grown in areas where drought stress is problematic and the existence of tolerance in a type IV should prove useful in some areas of Mexico Central America and the Andean zone M phaseoli was noted in the trial although the best lines seemed only slightly affected

In stage 1 screening of the EP 82 during July/August M phaseoli reached an unprecedented level causing severe stand reductions Yield data were too variable to warrant analysis but distribution of stand survival under the combined drought and Macrophomina stress are indicated in Figure 7

Similar levels of Macrophomina infestation occurred in stage 2 screening as indicated by scores for plant loss and the very low yields under stress (Table 33) Of the 72 entries the comparatively good performance of many type I s with different seed colors was striking and probably represents a case of disease escape through early maturity BAT 85 and to a lesser extent A 54 and A 59 maintained their outstanding performance observed in previous trials suggesting they combine both drought and Macrophomina tolerance

Although these data represent definite progress in drought screening efforts the rate of advance could be increased if various technical problems are overcome The incidence of Macrophomina has definitely reached levels that make drought tolerance evaluations difficult Consideration was given to the possibility of joint drought-Macrophomina screening but Macrophomina does not appear to be widely enough distributed to justify such an effort Since 1978 all drought trials have been sown in a single field a practice favoring buildup of Macrophomina The obvious first step to reduce Macrophomina pressure is to follow a program of field and crop rotation

In general levels of applied drought stress have increased over subsequent trials This has allowed the program to identify materials with tolerances much greater than originally thought possible but has meant that comparability of results from one trial to another has suffered Nevertheless a comparison of yields of lines common to various trials (Table 34) indicates that there has been some level of consistency particularly among outstanding cream colored lines such as A 54 BAT 85 BAT 125 and G 5059 (Mulatinho) This consistency across seasons may mean that tolerance will be stable over different climatic regimes

Although lines from various EP s and other sources have shown unexpectedly high levels of tolerance simply evaluating existing lines is less efficient than breeding for increased levels of tolerance To evaluate the possibility of using canopy temperature differential as a screening criterion in segregating populations F_4 plants from four crosses were grouped into four categories according to the frequency that individual plants showed low temperature differentials (using canopy of G 5059 to determine the reference temperature) Yields of the F_5 populations under drought stress showed significant differences for yields between temperature categories but overall yield increase was only 12% which is a level too low to justify routine use of this screening system Future studies will look for alternative selection criteria with emphasis on root morphology

Limited or poorly distributed rainfall is a constant threat in many parts of Central America and one of the most difficult limitations of bean production Earliness has frequently been cited as an escape mechanism to avoid drought at the end of the growth cycle so that the Central American project planned a drought experiment which was conducted in Guatemala to determine if earliness was advantagous when drought occurred at the end of the growth cycle

Five genotypes were selected representing a range of maturity ICTA-Tamazulapa (intermediate maturity) CENTA-Izalco and Rabia de Gato (early flowering and early to maturing) Revolucion 79 (intermediate to flower but early maturing and with an extended flowering period) Drought was applied by cutting irrigations at 35 42 49 and 56 days after planting An absolute check received irrigation throughout the growth cycle Almost all available moisture was supplied by irrigation

In percentage yield reduction all varieties lost about 50% when the lowest yielding treatment was compared with the highest for each variety In no treatment did the yield of ICTA-Tamazulapa (the intermediate variety) fall below that of the early varieties In conclusion this experiment did not demonstrate an advantage of early varieties with respect to drought It is possible that the extended vegetative period of later varieties permits better root development which in turn offers a better degree of drought tolerance thus compensating for late maturity

Drought tolerance screening at CNPAF Brazil

Drought screening using on-line source sprinklers was carried out in the dry season at the CNPAF Capivara station Beans were planted in

Table 34 Comparison of stress yields (kg/ha) of selected lines common to at least three drought trials

Entry	Trial				
	8101	8214	8223	8304	Habit
<u>Cream</u>					
A 54	1 917[b]	2 297[a]	407	260[a]	II
BAT 85	2 203[a]	2 321[a]	707[a]	254[a]	II
BAT 125	1 762	2 211[b]	544[b]	115[b]	II
G 5059	2 645[a]	1 754	418[b]	109[b]	II
BAT 477	1 713	2 186[b]	592[a]	59	III
BAT 332	1 990[b]	2 665[a]	680[a]	37	II
BAT 1210	-	2 004[b]	660[a]	29	II
A 147	1 728	1 286	354	26	III
BAC 76	-	1 500	406	14	II
A 170	1 938[b]	1 700	377	9	II
BAT 336	1 962[b]	2 008[b]	186	0	II
A 97	2 172[a]	1 906	340	0	II
<u>Black</u>					
Negro Argel	1 948[b]	1 920	542	46	II
EMP 92	-	1 968	250	45	II
BAT 266	1 858[b]	1 169	301	28	II
A 55	-	1 422	673[a]	15	II
EMP 84	-	1 816	384	11	II
BAT 798	2 179[a]	1 925	233	0	III
ICA-TUI	2 184[a]	1 756	391	0	II
<u>Red</u>					
ICA L-17	1 675	1 541	479[b]	137[b]	I
BAT 258	1 976[b]	1 741	300	32	II
EMP 105	-	2 165[b]	211	26	II
BAT 1289	-	1 559	730[a]	0	III
<u>White</u>					
BAT 1280	-	1 793	265	73	III
BAT 1257	-	1 764	509	71	III
BAT 1282	-	1 230	263	0	III
<u>Yellow</u>					
EMP 110	-	1 809	250	72	II
<u>Coffee</u>					
BAT 805	1 990[a]	1 631	233	6	II
$\overline{X}$ Drought	1 456	1 450	266	45	
X Control	2 608	2 812	1711	1 494	
No lines tested	169	72	72	72	

a Lines yielding in top 10%
b Lines yielding in top 20%

Table 35 The outstanding entries for drought tolerance tested under an One line sprinkler system by CNPAF scientists during the 1981 dry season

Identification	Yields of stress plot kg/ha	Yield of non-stress plot kg/ha	Coeficient of regression
CNF 154	512	2 019	8 27
BAT 117	502	2 206	9 28
BAT 477	443	1 362	5 08
CNF 158	428	1 981	8 52
CNF 152	427	1 854	7 72
CNF 123	399	1 245	4 81
BAT 70	387	1 157	4 33
CNF 151	387	1 765	7 53
CNF 156	375	1 636	6 84
BAT 85	370	1 407	5 54
CNF 155	349	1 241	5 04
CNF 163	335	1 556	6 57
BAT 148	332	1 102	4 32
CNF 149	325	1 161	4 66
BAT 270	319	1 708	7 65
Average experimental yield (84 lines)	241	1 015	

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Tolerance to Acid Soils

It is evident from Tables 36 and 37 that low levels of tolerance to soils with low P level and/or high Al content have been incorporated into lines with different commercial grain types and sizes With the exception of line A 283 which is the Carioca seed type none was equal to or better than the variety which has proved to be tolerant (Carioca) and which is extensively cultivated in Brazil This may be due partially to inconsistency in the screening methodology from one semester to another and due to the fact that the hybrid populations were not evaluated under stress conditions from the start

Part of the evaluation of advanced bean lines corresponding to the final phase (III) testing for tolerance to soil conditions having low P and high concentrations of Al and/or Mn at CIAT-Quilichao is presented in Tables 36 and 37 respectively

The evaluations were done under P stress conditions with applications of 60 kg/ha of P_2O_5 and the equivalent of 2 t/ha of $CaCO_3$ aluminum stress with the equivalent of 1 t/ha of $CaCO_3$ plus 200 kg/ha of P_2O_5 and without stress with the application of the equivalent of 5t/ha of $CaCO_3$ plus 300 kg/ha of P_2O_5 The treatments were distributed in blocks with three replications

Table 36 Average yield in kg/ha of outstanding bean lines under low P soil conditions in CIAT-Quilichao for which Carioca was the tolerant check and ICA Pijao was the susceptible check

Identification	Without stress	Phosphorus stress	Difference (kg)
A 283	2 298	1 121	1 177
A 358	1 993	990	1 003
A 257	1 930	975	955
BAT 1500	2 046	970	1 076
A 336	2 041	954	1 087
A 444	1 961	825	1 136
A 371	2 023	823	1 200
Carioca (G 4017)	2 262	958	1 304
ICA Pijao (G 4525)	1 922	741	1 181

a Tolerant check

b Susceptible check

Table 37 Average yield in kg/ha of outstanding bean lines under high Al and Mg soil conditions in CIAT-Quilichao for which Carioca was the tolerant check and ICA Pijao was the susceptible check

Identification	Without stress	Al stress	Difference (kg)
A 283	2 298	1 254	1 044
BAT 1500	2 046	1 208	838
A 358	1 993	1 050	943
A 254	1 699	934	765
Carioca 80	1 614	924	690
A 288	1 473	898	575
Carioca (G 4017)[a]	2 262	869	1 393
ICA Pijao (G 4525)[b]	1 922	723	1 199

a Tolerant check

b Susceptible check

Table 38 Percent F_1 heterosis above midparent (above diagonal) and above high parent (below diagonal) for yield at two locations Percent heterosis at Palmira is the first number in each column Popayan the second and percent heterosis above mid and high parent is calculated as $(F_1-MP)*100/MP$ and $(F_1-HP)*100/HP$ respectively

Growth habit *	Cultivar	A 132	A 476	BAT 1222	A 359	XAN 122	A 457	A 231	Toche 400	A 375
I	A 132		20 9 28 0	47 7 25 4	76 9** 67 4*	90 2** 74 4	28 3 70 5*	101 8** 68 3*	100 5** 115 5*	132 3** 58 1
I	A 476	-0 6 8 4		25 1 17 1	34 8* 13 2	53 9* 55 9	44 6* 58 3	28 6 85 9**	60 9** 173 5**	84 2** 46 5
I	XAN 122	18 4 12 5	18 4 6 2		43 1 35 1	-11 9 54 4	43 6* 70 9*	111 2** 76 5**	128 9** 141 7*	38 1* 29 9
II	A 359	34 2* 12 9	18 5 -21 9	18 5 -17 8		68 2** 3 7	42 8** 41 0*	44 8** 26 9	22 5 42 9	4 6 6 2
II	XAN 12_	57 9** 60 0	46 2* 20 7	-30 2 18 4	48 0* -28 9		53 4** 69 9*	91 8** 100 7**	46 3* 109 5*	87 1** 83 2**
II	A 457	-5 1 25 1	21 1 24 8	19 4 25 6	37 4** 11 9	38 4* 29 0		29 7* 49 1**	26 1 -13 8	69 3** 39 9
III	A 231	58 9** 7 1	10 9 27 6	102 9** 9 4	41 7** 14 9	66 0** 61 9**	18 8 33 4		83 0** 47 6	4 3 29 1
III	Toche 400	54 9** 81 6	54 7** 146 2**	112 4** 78 0	6 6 -8 3	37 8* 45 5	1 9 -37 8	51 5** 9 2		32 8 74 2*
III	A 375	95 1** 19 2	52 ** 14 2	38 0* -8 3	-0 1 -9 1	55 2** 44 0*	64 7** 23 9	-5 7 16 0	24 9 46 4	

** * Data is presented as percentages however symbols represent significant differences between F_1 and midparent or F_1 and high parent means at 01 and 05 levels respectively

Table 39 Mean squares from a 9x9 diallel analysis of F_1 generation in dry beans grown at two locations in Colombia

	d f	Yield	Yield components: Pods/M^2	Seeds/Pod	Weight/seed
Location	1	789 269 3*	318 102 6*	13 822**	0 0548**
Replication/Loc	2				
Crosses (C)	35				
GCA	8	45 513 4**	49 253 3**	6 864**	0 0755**
SCA	7	9 955 5**	6 641 8	201	0 0018**
C x L	35				
GCA x Location	8	4 882 6	3 209 [illegible]	61	0 0025**
SCA x Location	27	5 651 **	2 652 7*	98	0 0006*
Pooled error	70	2 648 8	1 371 4	0 151	0 0003

*,** Significant at 0 05 and 0 01 levels respectively

Architectural traits

Branches plant	Nodes Branch	Nodes Plant	Nodes Main stem	Main Stem length	Main stem Interno length
84 921*	84 732*	9623 1*	13 242	27454 6**	152 38
2 061**	6 926**	226 5**	42 72**	1312 4**	7 45**
0 994**	4 662**	129 9**	5 44**	332 1**	1 08**
1 306**	4 571**	176 2**	4 07**	299 2*	0 74
0 538	1 164	26 8	2 16**	278 5**	0 71
0 360	1 002	24 84	1 178	133 3	0 44

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Plant Architecture and Yield

To better understand architectural and yield characteristics further studies were conducted in 1983

Three small (Less than 25 g) medium (26 to 40 g) and/or large (greater than 40 g) seeded lines from each of three bush bean types (I II and III) were diallel crossed to obtain a complete set of 72 crosses F_1 and F_2 generations were evaluated in separate consecutive seasons at two locations - Palmira and Popayan in Colombia Significant reciprocal differences between F_1 hybrids were detected for weight/seed and branches/plant All traits studied showed significant F_1 heterosis over the midparent Yield heterosis of the F_1 over the high parent averaged 35 9 % in Palmira and 22 5 / in Popayan and heterosis values tended to increase in crosses between parents of increasingly divergent growth habits (Table 38)

In both the F_1 (Table 39) and F_2 (Table 41) diallel analyses and for all architectural traits in the F_1 analyses general combining ability (GCA) was more important than specific for yield and yield components In both the F_1 and F_2 diallel analysis the same parents A 375 and A 457 were identified as having the largest positive general combining ability effects for both yield and weight/seed Determinate type I parents tended to have positive GCA effects for branches/plant and negative GCA effects for the remaining architectural traits in either one or both locations whereas the opposite was true for the indeterminate lines (types II and III) (Table 40)

Among yield components weight/seed was negatively correlated with Seeds/Pod and Pods/m^2 and no association was observed between Seeds/Pod and Pods/m^2 (Table 42) Yield was positively correlated with pods/m^2 seeds/pod and all architectural traits except branches/plant In contrast weight/seed was negatively correlated with yield number of nodes/branch nodes/plant and nodes on the main stem and positively correlated with main stem internode length and main stem length

The predominance of additive gene action for all traits suggest that selection should be effective in increasing yield and in changing the levels of expression of yield and architectural components Moreover the estimation of GCA identified at least one and often several parents with significant positive values of one or more desirable traits

An implicit objective of this study was the possible identification of architectural traits which might prove useful as indirect selection criteria for the simultaneous improvement of yield and seed size in bush beans All architectural traits except branches/plant had moderate to large positive phenotypic and genotypic correlations with yield *per se* and several could prove useful as indirect selection criteria

However only two architectural traits main stem length and main stem internode length had either zero or positive correlations with both of the desired commercial atributes- yield and weight/seed The implications are that both yield and weight/seed could be increased indirectly by selection for increased main stem and internode length The association between the commercial seed attributes and these architectural traits is consistent with the results of the diallel analyses the two parents identified as having the largest positive GCA effects for both yield and weight/seed A 375 and A 457 also tended to have positive GCA effects for main stem length and main stem internode length and negative or zero GCA effects for the remaining architectural traits in either one or both locations Therefore it could very well be that the underlying cause of why medium and large seeded forms are often outyielded by their small seeded counterparts is that they are characterized by reduced main stem internode length and that only in tall (over 1 5m) climbing beans have equally high yielding genotypes of all seed sizes small medium and large evolved in nature

Direct selection for increased main stem length and main stem internode length may however pose a problem as an excessively viney plant type may result (similar to that of type IV indeterminate climbing beans) which would be poorly adapted to monoculture without artificial support and to mechanical harvesting In addition the prostrate nature of such a plant type in monoculture would aggravate the problem of diseases seed quality etc because of the closed canopy and greater opportunity for pod contact with soil pathogens Thus it appears that some degree of compromise between the desired seed attributes and architectural adaptation to specific cropping systems should be acknowledged The question then facing a breeder who is selecting for adaptation to a specific cropping system is the relative importance of architectural display compared to commercial seed attributes and the relative efficiency of direct *vs* indirect selection criteria

Selection indices could be constructed to simultaneously shift the levels of expression of desirable architectural traits to their optimum value for maximum expression of yield and seed size However their

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Selection indices could be constructed to simultaneously shift the levels of expression of desirable architectural traits to their optimum value for maximum expression of yield and seed size However their effectiveness could not be known at the moment and the time and resources necessary for application of such index in the field may prove prohibitive A simpler alternative to the construction of indices might be to simultaneously select for yield and seed weight within morphologically heterogeneous hybrid populations and limit selection for architectural characteristics only to those necessary for general adaptation to specific cropping systems or environments Since primary selection would be for yield and weight/seed unselected but genetically correlated architectural traits would be expected to gradually move toward optimum values for maximum expression of yield and weight/seed

Table 40 General combining ability (GCA) effects of nine parents of bean varieties used in F_1 diallel analyses in two locations in Palmira (Pal) Colombia and Popayan (Pop)

Parent	Growth habit[a]	Seed size[b]	Yield		Pods/m^2		Seeds/pod		Weight/seed	
			Pal	Pop	Pal	Pop	Pal	Pop	Pal	Pop
A 132	I	S	-24.8	-50.4	11.2	-16.4	-0.23	-0.18	-0.018	-0.039
A 476	I	M	-27.9	-59.9	-13.3	-34.4	-0.26	-0.37	-0.006	0.005
BAT 1224	I	I	-29.4	-36.3	-32.2	-30.8	-0.59	-0.75	0.061	0.093
A 359	II	S	2.1	60.7	19.1	56.2	0.71	0.64	-0.061	-0.082
XAN 122	II	M	-20.8	-26.4	9.4	-4.0	-0.61	-0.6	-0.024	0.045
A 457	II	L	9.0	24.6	-56.3	-31.7	0.44	0.70	0.042	0.028
A 231	III	S	48.0	84.3	94.9	86.6	0.28	0.58	-0.077	-0.088
Toche 400	III	M	-6.9	-35.2	-26.8	-33.2	0.19	-0.11	0.006	0.020
A 375	III	I	29.9	38.3	-6.0	1.7	0.07	0.11	0.018	0.020
Standard error of GCA effect			14.5	11.2	10.4	8.2	0.05	0.13	0.003	0.005
Mean performance of parents			266.6	171.9	214.7	153.7	4.12	3.38	0.327	0.359

a I = determinate II = indeterminate erect and III = indeterminate prostrate

b S = 26 g M = 26 to 40 g and L = 0 4g

(Continued)

Table 40 Continuated

Architectural Traits: Branches/plant Pal	Pop	Nodes/branch Pal	Pop	Nodes/plant Pal	Pop	Nodes on Main Stem Pal	Pop	Main stem Length Pal	Pop	Main stem internode Length Pal	Pop
0 38	0 07	-0 26	-0 78	2 0	-2 2	2 0	-0 5	5 6	-5 8	- 047	-0 68
0 73	-0 12	0 13	-0 79	3 5	-4 4	-0 7	-0 9	-11 0	-12 9	-0 66	-0 92
0 47	0 27	-1 32	-0 21	-6 8	-1 5	-2 0	-1 9	-9 4	-1 2	0 08	0 38
-0 30	-0 21	-0 40	0 71	-3 4	2 4	-0 1	0 7	-2 5	-0 8	-0 03	-0 22
-0 09	-0 30	0 42	0 10	1 2	-2 4	-0 8	-1 5	-1 0	-0 7	0 33	0 39
-0 61	-0 18	-0 01	-0 29	-3 7	-1 9	-0 1	0 2	6 3	8 6	0 57	0 71
-0 28	-0 16	0 70	0 59	4 2	5 3	2 0	2 1	4 5	4 2	0 41	-0 15
-0 03	0 35	1 13	0 26	5 9	2 2	-0 3	-0 4	-0 5	-6 9	0 13	-0 42
-0 26	-0 02	-0 39	0 41	-2 9	2 5	-0 1	1 3	5 8	15 6	0 45	0 92
0 14	0 16	0 26	0 24	1 4	1 0	0 3	0 3	3 3	2 5	0 18	0 16
5 65	3 07	4 90	4 79	37 5	25 8	11 4	10 8	56 7	32 1	4 84	2 89

Table 41 Mean squares and GCA effects from a 9x9 diallel analysis of an F_2 generation of dry beans grown at two locations Palmira (Pal) and Popayan (Pop) in Colombia

Source	d f	Yield		Pods/m^2		Seeds/pod		Weight/seed	
		Pal	Pop	Pal	Pop	Pal	Pop	Pal	Pop
Crosses	35								
GCA	8	8936 9**	28997 0**	2769 3**	18133 26**	2 656**	4 098**	0 0288**	0 0577**
SCA	27	973 0	3362 7	586 5	1643 8	0 258	0 463	0 0014	0 0043
Error	70	485 8	2723 5	285 4	1398 2	0 203	0 458	0 0012	0 00231

Parent	GCA effects g/m^2		No				g	
A 132	-15 6	-56 3	7 5	-26 0	-0 31	-0 29	-0 014	-0 039
A 476	-26 1	-47 5	-2 6	-27 5	-0 44	-0 38	-0 004	0 018
BAT 122	-12 3	0 7	-8 8	-13 9	-0 51	-0 16	0 046	0 045
A359	8 5	48 8	15 7	41 6	0 47	0 74	-0 048	-0 075
XAN 122	-21 2	-28 6	-11 2	-14 4	-0 45	-0 67	0 019	0 051
A 457	34 9	7 5	-17 2	-22 6	0 40	0 34	0 052	0 055
A 231	-2 4	29 7	13 8	48 8	0 36	0 25	-0 057	-0 079
Toche 400	16 1	8 1	-3 6	-6 3	0 32	0 31	0 001	0 002
A 375	18 1	37 5	6 6	20 3	0 14	-0 14	0 005	0 025
Standard error of GCA effect	4 5	10 7	4 5	7 7	0 09	0 14	0 007	0 011
Mean performance of parents	187 2	168 0	146 7	169 7	3 75	3 21	0 308	0 387

** Significant at 0 01 level of the Duncan test

Table 42 Phenotypic (above diagonal) and genotypic (below diagonal) correlations among yield yield components and architectural traits in F_1 progeny from a nine parent diallel of dry beans grown in Colombia for which the correlations are based on F_1 family means over two locations

		Yield Components			Architectural traits					
	Yield	Pods/ m^2	Seeds/ pod	Weight/ seed	Branches/ plant	Nodes/ branch	Nodes/ plant	Nodes on main stem (NMS)	Main stem length (MSL)	Main stem internode length (MSIL)
Yield		77**	57**	- 39*	- 24	56**	54**	55**	67**	43**
Pods/M^2	75		?5	- 67**	08	45**	60**	52**	36**	04
Seed/pod	68	30		- 56**	- 54**	33*	21	62**	4?**	06
Weight/seed	- 48	- 76	- 56		03	- 19	- 34*	- 59**	- 05	41*
Branches/plant	- 56	01	- 87	04		- 42**	02	- 39	- 42**	- 27
Nodes/branch	64	49	44	- 27	- 67		86**	53**	50**	27
Nodes/plant	56	67	26	- 45	- 31	90		60**	44**	09
NMS	66	57	70	- 66	- 78	65	67		63**	- 02
MSI	1 01	47	60	- 07	- 91	68	61	44		75**
MSIL	50	00	04	52	- 49	28	- 20	- 068		

** * Phenotvpic correlations significantlv different at 01 and 05 levels respectively of the Duncan Test

Increased Nitrogen Fixation

A large number of hybrid populations from an extensive array of parents were evaluated in the 1982B and 1983A seasons Unreplicated yield estimates as well as grain type growth habit disease reaction and nitrogen fixation (acetylene reduction) were used to characterize 65 early generation families and several advanced materials The best lines were selected for the VEF 83 nursery and were coded RIZ 19 RIZ 20 RIZ 23 y RIZ 13

During the 1983A growing season 47 early generation families and 28 advanced lines were evaluated in replicated yield trials where grain type plant growth habit maturity vegetative vigor reproductive score yield disease reaction nitrogen fixation (acetylene reduction and nodule dry weight) and root and shoot dry weight were considered Some of the outstanding entries along with the outstanding check varieties are listed in Table 43a With Rhizobium-inoculation marginal phosphorous and reduced chemical protection these entries showed improved performance as compared to the check varieties and to earlier selections They were coded for the 1984 VEF

However recent acetylene reduction estimates of nitrogen fixation have shown very large CV s tending to bias the selection in favor of yield breeding in a multiple-stress environment As a result nitrogen-fixing ability is currently estimated on the basis of combined data from acetylene reduction shoot and nodule dry weights (two replications in Popayan and one in Quilichao) and percentage nitrogen in root and shoot tissues Furthermore a visual scoring system (modified from Rosas 1983) is used to estimate nodulation Thus the breeding and selection management has been modified to include selection for adaptation and bean nitrogen fixation using both field and glasshouse facilities to provide complimentary data

Low pH soils sometimes contain toxic levels of Al and Mn stressing both the host genotype and the Rhizobium strain and resulting in reduced fixation and low yield Further the efficiency of infection depends in part on the compatibility of host and Rhizobium genotypes Considering the vast areas characterized by low pH soils it is important to select bean varieties and Rhizobium strains which prosper under these conditions Thirty-two promising selections from the EP82 nursery and a number of RIZ lines were maintained at pH 5 5 in sand culture and inoculated with a mixture of Rhizobium strains CIAT 632 (non-tolerant) and tolerant CIAT mutant 2545 (from CIAT strain 899) Differences in the tolerance of varieties and the differential survival of Rhizobium strains on bean genotypes are apparent in the results of Table 43b

Table 43a Some outstanding entries among the group of 86 families and advanced lines evaluated for N_2 fixation and general adaption in 1983 A as compared with the best local checks from earlier cycles of selection

		RANKING[1]				
Identification	Color	PSNP[2]	PSRP[3]	PSPA[4]	ACT[5]	PSG[6]
RH 9320-1-4-cm (16B)	Mulatinho	5/29	3/29	9/29	5/29	10/25
RH 9320-1-3-cm (20B)	Mulatinho	7/29	2/29	13/29	3/29	8/29
RH 9305-1-2-cm (20C)	Cream	10/29	5/29	3/29	2/29	7/29
RH 9337-1-m (16C)	Black	2/28	1/28	2/28	7/28	2/28
RH 9281-cm-6-cm (10B)	Black	7/28	6/28	7/28	4/28	1/28
BAT 1493	Red	2/39	5/39	5/39	2/39	14/39
Checks						
RIZ 21	Red mottled	5/39	6/39	6/39	3/39	4/39
BAT 76	Black	14/39	10/39	17/39	15/39	2/39

1 Results are reported as rank order within that particular trial
2 Nodule dry weight
3 Root dry weight
4 Shoot dry weight
5 N_2 ase activity (u moles C_2H_4 per plant per hr)
6 Seed weight

a Figure 4 Recurrent selection and intermating scheme employed by CIAT to increase levels of biological nitrogen fixation in high yielding genotypes

F_3 families progeny-tested in Popayan (conditions identical to F_2) and in Palmira for broad adaptation	Bulk harvest of elite families uniform for plant type grain type and maturity
F_2 field evaluation in Popayan low N_2 marginal P and limited protection inoculated Single plant selections	Replicated yield trials in Popayan (measure nodulation acetylene reduction and yield) plus non-replicated plots in Palmira(adaptation) and Santander (Compare low N and added N to score for adaptation and N_2 fixation)
F_1 Generation advance in Palmira-no selection	Elite lines evaluated in glasshouse to confirm BNF value
	Coding RIZ lines for VFF and as parents

Hybridization and
Introduction of new parents
into crossing program

Table 43 Response of six tolerant and four non-tolerant lines of *P vulgaris* to a mixed infection of acid-tolerant and non-tolerant *Rhizobium* strains at pH 5 5

Identification	Fresh shoot weight (g/plant)	Nodules/ plant	Frequency of recovery (% plant) CIAT 632	CIAT 2545	Dead nodules (% plant)
Acid-tolerant lines					
RIZ 19	5 525	55	62	32	6
RIZ 21	4 010	100	45	45	10
BAT 1470	4 677	102	13	82	5
XAN 112	4 572	65	1	74	25
VRA 81011	7 265	127	21	86	3
VRA 81029	4 144	92	24	75	1
Acid non-tolerant lines					
21536-M-4-1-M(6)	2 953	55	62	16	22
BAT 1432	2 825	41	62	8	30
BAT 1557	2 018	65	21	22	57
RIZ 27	3 000	54	12	2	86

23671

Variability from interspecific Hybridization

The Gembloux project is based on collaboration between CIAT and the Faculty of Agronomy of Gembloux and funded by the Belgian Government (AGCD) Its objectives are the evaluation of *Phaseolus* species and the improvement of the *vulgaris* genome by the utilization of wide crosses with *P coccineus* L its subspecies and *P acutifolius* A Gray

Interspecific hybrids evaluated involved three weedy types and 45 cultivars of *P vulgaris* 33 accessions of *P coccineus* subspecies *coccineus* two accessions of subspecies *formosus* and nine of the subspecies *polyanthus*

Phaseolus coccineus is a species adapted to the cooler climates of the tropical highlands and the temperate zones The hybrids between *P vulgaris* x *P coccineus* were tested in different research stations of the Colombian Andes for resistance to foliar diseases and architectural traits such as a long outriggered raceme and the extrorse stigma

1 *Phaseolus vulgaris L x Phaseolus coccineus L Fr Nursery*

Several F_1 interspecific populations (*P vulgaris* x *P coccineus*) were planted in October 1982 in Popayan for seed multiplication The average yield/plant varied but was relatively low (which is common for F_1 interspecifics) although some crosses with good fertility were identified and the total amount of seed harvested was sufficient for further trials A total of 2 200 seeds from 17 crosses was given to Breeding I for evaluation for BGMV resistance and 750 seeds went to Breeding II for architectural traits

2 *Interspecific complex crosses*

A new crossing scheme was devised by the Faculty of Agronomy in Gembloux to improve the introgression of *P coccineus* genes into the *P vulgaris* genome *P vulgaris* with *P coccineus* crosses have been successful only when *P vulgaris* was used as a female parent (Figure 5) A negative interaction between the *coccineus* genome and the *vulgaris* cytoplasm may exist that rejects *coccineus*-type gamete during meiosis or forms zygotes with low fertility To overcome this new crosses have been made using one of *P coccineus* wild subspecies *formosus* as a bridge between the two species *P coccineus* subspecies *formosus* is used as a female parent crossed with *P vulgaris* Productivity of this hybrid largely surpasses the reciprocal cross The F_1 hybrids were crossed with different *P coccineus* accessions and then with elite *vulgaris* varieties using them as male parents In the presence of a *coccineus* cytoplasm the *coccineus* genome may be able to express itself better and recombine more easily with the *vulgaris* genome

Details of the crosses are listed in Table 44 The hybrid H82/418 (NI 552 x G 00677) x M 7285 x A 133 produced two plants with red *coccineus*-type flowers and its typical extrorse stigma

Figure 4 Recurrent selection and intermating scheme employed by CIAT to increase levels of biological nitrogen fixation in high yielding genotypes

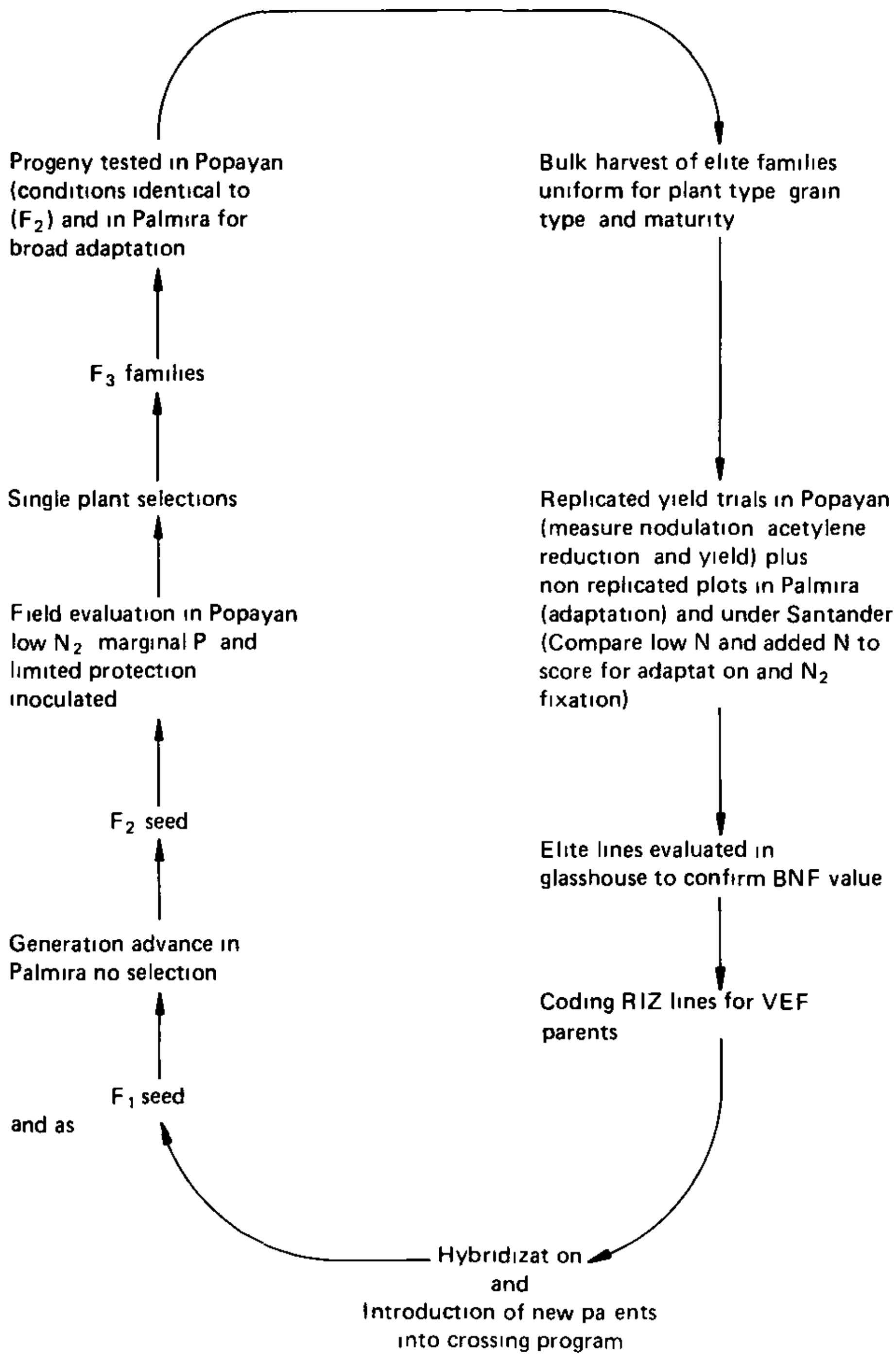

Table 44 Comparison of seed production of complex hybrids ((*P coccineus* subsp *formosus* x *P vulgaris* x *P coccineus* subsp *coccineus*)) x *P vulgaris* by crossing and selfing

Manual Pollination	Spontaneous pollination	Buishand method			White s solution						
Gembloux Code No	Female hybrid Identification	No crosses	No seeds	Male parent	No crosses	No seeds	Male parent	No crosses	No seeds	No crosses	No seeds
H82/380	NI 552 x G 00677 x M 7689A x Turrialba 1	7	0	0	3	0	0	6	4	7	4
H82/383	N I552 x G 00677 x M 7689A x D 145	0	0	0	5	0	0	4	2	5	0
H82/384-1	NI 552 x G 00677 x MI 689A x D 145	6	1	Guate 1076CM	8	0	0	8	13	12	12
H82/384-2	NI 552 x G 00677 x M 7689A x D 145	7	1	D 145	13	0	0	40	15	24	3
H82/384-3	NI 552 x G 00677 x M 7689A x D 145	4	1	Guate 1076CM	2	2	Calima Guatemala	0 1076 CM	0	0	0
H82/418-1	NI 552 x G 00677 x M 7689A x A 133	13	0	0	12	0	0	15	6	12	0
H82/418-2	NI 552 x G 00677 x M 7689A x A 133	11	0	0	16	0	0	5	6	2	0
Total seeds				3			2			46	19
Total crosses	Successful	3			2			27		19	
	Unsuccessful	45			57			41		43	
Number of crosses		48			59			78		62	

Table 45 List of complex crosses that set seed during the drought period in Popayan from June to September in 1983

Generation	Identification of crosses[a]	Identification	Project	Characteristics
F_2	FxVxCxV	NI 552xG 00677xG 35325xA 133	BGM	Vigorous early and fertile strongly Resembles *P vulgaris*
F_3	FxVxCxVxV	NI 552xG 00677xM 7285xD 145xD 145	BGMV	Climber hybrid type vigorous and healthy
F_3	FxVxCxV	NI 552xG 00677xM 7689AxTurrialba 1	BGMV	Bush type late
F_3	FxVxCxVxV	NI 552xG 00677xM 7285xD 145xD 145	BGMV	Bush type healthy late
F_1	FxVxCxVxVxVxV	NI 552xG 00677xM 7285xD 145xD 145XDOR 303xDOR 60	BGMV	Climber healthy

[a] F= *Phaseolus coccineus* subsp *formosus*
C= *P coccineus* subsp *coccineus*
V= *P vulgaris*

All other hybrids showed flowers with different shades of pink and purple and a vulgaris introse stigma

The cross pollination gave a lower percentage of success than self pollination Crossing was successful only with two hybrids by using the Buishand method and applying White s solution to the stigma before pollinating

Manual pollination wounded the stigma and provoked flower shedding but it augmented the average number of seeds/pod which overwhelmingly compensated for the higher number of pods harvested from spontaneously-pollinated flowers

The success of the back cross to the P vulgaris parent did not depend on whether the vulgaris or polyanthus parent has been previously included in the female hybrid parent genome

The progenies of the plants grown in the growth chamber were planted in Popayan in April 1983 Severe drought conditions started during flowering in June and continued until October severely affecting pod set Only 25% of the populations set seed (see Table 45)

Plants that produced seeds presented characteristics similar to P vulgaris The hybrids with red coccineus flowers were vigorous but did not produce any seed

3 Backcrosses of P vulgaris x P coccineus x P vulgaris in Popayan

F_2 and F_3 backcrosses were planted in April 83 in Popayan for seed multiplication and evaluation These plants fared better than the complex crosses during the drought probably because of the high levels of vulgaris introgression Plants with long coccineus racemes were harvested as well as plants with resistance to rust and Oidium

Ninety percent of the crosses produced seed The best lines were (G 04459 x G 35022) x Guate 1240 (a vigorous climber with disease resistance yield associated with long racemes) (G 04459 x G 35022) x Riñon (a late bush type with disease resistance) and ((G 04459 x G 035022)) x Rinon x Rinon (a bush type with good yield)

4 Selection of interspecific hybrids for coccineus type racemes in F_4

An important objective of the Gembloux project is the incorporation of the long outriggered coccineus raceme with more than eight flower nodes Twenty individual plants from nine different crosses (Table 46) presenting this character were selected in F_3 nurseries and their progenies were planted in Popayan All the progenies tested produced at least one plant with the desired trait Ecuador 229 x Piloy and Mortino x X7 had the highest percentage of *coccineus* racemes Ecuador 299 x Piloy was consistently the best cross of the nine progenies tested followed by Mortino x X7 Those lines were more fertile under the severe drought conditions These progenies were the most vigorous and also most resistant to *Ascochyta* rust powdery mildew gray leaf spot and BCMV

All of the progenies produced plants with the desired raceme and differed from each other for other architectural and resistance traits This implies that the long raceme can be selected in a range of crosses that exhibit different agronomic traits

5 *Miscellaneous F_3 and F_4 Interspecific nurseries*

Interspecifics (*P vulgaris* x *P coccineus*) combining parents from Africa Latin America and Europe were sown in Popayan in October 82 for single plant selection Table 47 gives the identification of the parents and the characters for which the hybrids were selected

The most fertile plants came from a cross between a *P vulgaris* variety Colorado found in Zaire and Rwanda and a *polyanthus* from Venezuela Several F_3 and F_4 hybrids with long racemes were fertile such as Coco White from Zaire crossed with NI2 a *coccineus* accession from Turkey Resistance to *Ascochyta* powdery mildew rust and anthracnose was also observed

Table 46 Selection of *coccineus* type racemes in *Phaseolus vulgaris* x *P coccineus* in the F_4 generation

Cross	% of plants with *coccineus* raceme	Average resistance score	Average vigor score
G 5066 x Piloy	29	2 2	3 4
Bat450 x Piloy	21	2 5	3 6
BAT 788 x Guate 909	20	3 0	3 4
Mortino x X7	43	2 1	2 6
Rinon x Piloy	26	2 7	3 2
Ecuador 299 x Piloy	50	2 5	3 3
San Martin x Piloy	10	2 4	3 2
Mortino x 88-1	14	2 4	3 5
Guate 1008 x Piloy	6	2 5	3 0

Table 47 Selection criteria for single plant selections in the F_3 and F_4 interspecific (*Phaseolus vulgaris* x *P coccineus*) populations

Female parent		Male Parent						
Code No	Source	Code	Source	Subspecies	Generation	Selected character	No plants selected	No seed harvested
NEP 2 G 04459 NI 565	CRA	NI 132 G 35315	RMN	*Coccineus*	F_3	Resistance Long racemes	2 11	11 339
Colorado NI 11	ZRE RWD	G 35317 NI 373	VNZ	*Polyanthus*	F_3	Resistance Long racemes	5 4	499 838
Colorado NI 11 G 07457	ZRE RWD	NI 2 PI 1766/72	TKY	*Coccineus*	F_3	White seeds	4	248
G 2211 PI 311824 NI 555	GTA	G 04835(G35160) NI 579	MEX	*Coccineus*	F_3	Resistance Long racemes + precocity	2 1	179 137
Linea 17 G 4523 NI 572	CLB	NI 2 PI 176672	RWD	*Coccineus*	F_3	Long racemes Long racemes+ extro se stigma	1 1	24 3
NI 141	Adelaide Bot gardens	NI 229 G 35174	ZRE	*Coccineus*	F_4	Long racemes + resistance	2	194
						Long racemes + extrorse stigma	6	44
						Resistance	1	45
Coco White	ZRE	NI2	TKY	*Coccineus*	F_4	Resistance Long racemes+ resistance	2 2	283 76
						Long racemes	2	197
						Long racemes + extrorse stigma + architecture	1	14
NEP 2 G 04459 NI 565	CRA	NI 132 G 35315	RMN	*Coccineus*	F_4	Extrorse stigma + resistance	3	28
G 06388 NI 573 var arborigeneus	BZL	NI 2 PI 176672	TKY	*Coccineus*	F_4	Long racemes	2	21
						Extrorse stigma + resistance	8	98

6 Comparison of single plant selections in three highland locations

The interspecific nurseries of the Gembloux project were sown in three stations in the Colombian highlands Popayan Rio Negro and Pasto Each nursery contained between 30 and 40 different crosses in two different generations depending upon the seed availability A comparison was made between the three locations for single plant selections in the F_2 and F_3

In the F_2 populations the percentage of plants selected was the same in Popayán and Rio Negro and was lower in Pasto (Table 48) The average plant yield was 40/ less in Popayan and 70/ less in Pasto than in Rio Negro Also a wider range in character combinations was found in Rio Negro Twenty-six different character combinations were selected in Rio Negro 12 in Pasto and 13 in Popayan

A high level of natural cross pollination assured high fertility levels in Rio Negro (with an average of 100 seeds/selected plant on an extrorse stigma)

In Rio Negro Cargamanto X 88-1 produced a series of healthy plants combining different characters such as long racemes with more than eight nodes high fertility precocity or the red flower with resistance and/or precocity Both in Popayan and in Rio Negro Riñon x 29 BK provided numerous plants with long racemes associated with resistance or architectural features

In Pasto Rinon x 99-1 and Ecuador 299 x Piloy were the most productive crosses and associated resistance with yield and precocity

Many plants exhibited racemes with numerous nodes (up to twenty) but produced only a few pods partly because of competition Only plants showing high fertility on long racemes were selected In Rio Negro and Popayan BAT 788 x Guate 909 Cargamanto x 88-1 and Riñon x 29 BK combined the long raceme with general resistance to pests and diseases Pasto x C 35122 and Guate 1008 x Guate 909 showed the same combinations of characters in Pasto and Popayan In Rio Negro San Martín x Guate 1259 presented the most interesting combination of the extrorse stigma with long racemes seed type yield resistance to diseases and architectural traits whereas Ecuador 299 x Piloy exhibited the same characteristics in Pasto

For F_3 populations the best results were obtained in Rio Negro Plants grew more vigorously and were more fertile exhibiting more coccineus characters than in Popayan In Pasto seven different character associations that did not appear in other stations were found especially in the progenies of San Martin x Piloy

The populations best adapted to Pasto and Rio Negro were Mortino x X7 Mortino x 88-1 Ecuador 51 x 88-1 and Ecuador 51 x 46-1 (Table 49)

Table 48 Comparison of seed production in Popayan Rio Negro and Pasto in a F_2 population

Location	No seeds sown	/ plants selected	Total seed	Average no of seeds/selected plant
Popayan	579	7	3 224	94
Rio Negro	910	7	9 882	163
Pasto	807	5 5	2 207	49

Table 47 Selections and seed produced in the F_3 in Rio Negro and Pasto

Parent	No of seeds sown	% plants selected	Number of seeds/ selected plant
Rio Negro			
Mortino x X7	788	12	150
Mortino x 88-1	300	7	143
Ecuador 51 x 88-1	230	10	181
Ecuador 51 x 46-1	40	6	203
Pasto			
Mortino x X7	601	72 12/	88
Mortino x 88-1	180	9/	91
Ecuador 51 x 88-1	.90	11	131
Ecuador 51 x 46-1	40	7 5	84 3

These crosses had the highest yield/selected plant and presented the highest diversity of characters 62 character combinations in Rio Negro of which 22 involved red flowers and 17 the extrorse stigma In Pasto 57 combinations were found nine with red flowers and 11 with the extrorse stigma An example of the many character associations found in a single F_3 population from a cross between Mortino and X7 in Rio Negro is given in Table 50

Discussion When the first interspecific F_2 population was evaluated in Popayan at the beginning of 1982 it was suspected that the sterility of the plants with red flowers or an extrorse stigma was principally genetic Intensive manual pollinization did not improve the situation over two semesters However in Rio Negro these plant types were very fertile and no hand pollination was needed In this location both the activity of intensive pollinators mainly bumblebees and honeydew bees and the favorable climatic conditions explained not only the fertility of the plants with red flowers or with extrorse stigma but also the vigor and exceptional fertility of the other hybrids some of which carried very heavy pod loads

A comparison of the outcome of the selections in the F_2 in Popayan and Rio Negro shows that the character combination spectrum is much narrower in the first location and reduces the advantage of further selection in a favorable spot such as Rio Negro Moreover the sterility of some character combinations in Popayan cannot be explained from a purely genetic point of view Environmental factors should be held responsible

In Pasto the range of combinations is quite narrow but offers combinations not found in the other locations as well as pressure from pathogens such as halo blight and rust

7 Interspecific crosses Phaseolus vulgaris x Phaseolus acutifolius

P acutifolius is a species reported to have high level of drought tolerance resistance to CBB rust Empoasca and BGMV but has a sterility problem in the F_1 The faculty of Agronomy in Gembloux has overcome the sterility problem of the F_1 by doubling the number of chromosomes with colchicine Two crosses (G 40005 x Mortino and G 40034 x Pico de Oro) were requested for multiplication and observation at CIAT

For most characters the tetraploids resemble a vulgaris plant although differing from the original vulgaris parent They are determinate type III climbers Flowering starts 32 days after planting like the acutifolius but continues for approximately 40 days The tetraploids are immune to CBB and most of them are highly resistant to rust Three generations were multiplied in the greenhouse and in the fields with good pod set Currently a return to the diloid state is sought

Table 50 Character combinations selected in a F_3 population of Mortino x X7 (figures represent no of plants) in Rio Negro Colombia for which a = coccineus red flower b = resistance to foliar diseases at Rio Negro (Ascochyta-anthracnoses-rust-powdery mildew-grey leafspot) c = extrorse stigma d = yield precocity e = Long racemes g = Architecture

	Character combinations															
	a	b	ab	c	ac	d	e	de	f	af	g	fg	dgdf	abef	efg	total
Resistance	4	16		6	1	9	1		5	3	1	1				47
Stigma			2	1			2	1	3	2		3				14
Red flower				6					2			1			1	10
Raceme			1		4	1	2	1	4		1					14
Precocity					1					2			1			4
Architecture						1			1					1		3
Total	4	16	3	13	6	11	5	2	15	7	2	5	1	1	1	92

International Collaboration

Bean fly (Ophiomyia phaseoli) nursery

A series of interspecific crosses between Phaseolus vulgaris and P coccineus were sent together with their coccineus parents to AVRDC in Taiwan for screening for bean fly resistance (Table 51)

G 35023 G 35075 (two P coccineus varieties used as parents in the interspecific crosses) G 05478 and a local P vulgaris cultivar were planted at four locations in central and southern Taiwan to test stability of bean fly resistance

Interspecific crosses (F_2 F_3 and F_4 generations) were planted at one location and each plant decapitated at the growing point after unifoliate leaves were completely open but before the first trifoliate leaves started to emerge

This decapitation resulted in the emergence of two or three side shoots at the unifoliate leaf auxillary buds At the time of the bean fly evaluation one of these branches was cut and bean fly infestation recorded by counting the number of larvae and pupae feeding inside Visible damage (tunneling in the stem) was also scored In all locations G 35023 and G 35075 were highly resistant In two locations the bean fly population pressure was so high that most plants of G 05478 and the local cultivar died whereas the resistant entries survived

Most of the interspecifics were tolerant to the bean fly and several entries did not show signs of infestation All F_2 F_3 and F_4 were segregating populations Single plant selections were made in each cross except for those resulting from in BAT 450 x G 35075 which were susceptible

The plants were harvested and the seeds sent back to the Gembloux project at CIAT for multiplication Of the 2 340 seeds sent only 270 were viable These were desinfected pregerminated in petri dishes checked for sanitation and then planted in the screenhouse in Palmira

Bean fly does not occur in Latin America so the strategy is to first multiply the F_1 in Popayan the F_2 in Palmira and the seed will be sent to AVRDC in Taiwan and other collaborating countries

Other international collaboration

Collaborative work on BGMV resistance screening has started this year with INIA-CIAGOC in Mexico and CNPAF-EMBRAPA in Brazil Seeds have also been sent to the USDA in Washington for screening and resistance to roots rots

Table 51 Crosses in which resistance to Bean fly has been detected in F_2 and F_3 or F_4 AURD Taiwan

Pasto X G 35122	X28-3-66 cafe x G 35023
Ecuador 299 x G 35122	BAT 450 k G 35075
(Morelos 662 x Ragally) x (Coryo x NI 289)	BAT 788 x G 35023
BAT 450 X G 35075	BAT 450 x 46-1
50609N-283 x G 35023	BAT 450 x G 35075
(60/s Pop x Nep 2) x G 35023	
BAT 93 x G 35023	

Table 52 Dispatches of bean breeding materials to the Andean Zone in 1983

	Crossing blocks		Segregating materials (F_4 bulks)		Advanced lines (VEF)	
	1983		1983		1983	
	A	B	A	B	A	B
Colombia						
La Selva	-	352	-	38	-	57
Obonuco	-	224	-	167	-	54
Ecuador						
Santa Catalina	-	240	-	185	-	118
Cuenca	467	404	-	337	-	82
Peru						
Cajabamba	-	218	-	176	-	136
Cuzco	467	208	-	203	-	158

Table 53 Yield in kg/ha of red mottled IBYAN lines in Africa

Lines	Burundi: Kisozi	Burundi: Mosso	Rwanda: Rubona	Rwanda: Karama	Zaire: Rwerere	Zaire: Mucungu
L 22	629	1 392	1 299	1 563	2 608	1 083
L 23	662	1 368	1 212	1 358	2 993	912
L 24	396	1 392	1 132	1 076	2 783	1 101
BAT 1230	537	1 481	1 193	1 462	2 219	041
BAT 1296	1049	1 304	1 153	1 544	2 569	617
BAT 1297	613	1 732	1 427	1 639	2 177	1 062
Best local control and yield	Dore de Kirundo	Karama 1/2	Tostado	Bataaf	Tostado	Nyagosi
	1 290	1 832	1 177	1 635	3 045	1 192
LSD	259	425	353	462	416	355

	South Africa: Delmas 27506	Togo: Sotouboua 27519	Mauritius: Beau Bassin 27507	Tanzania: Morogoro 27504	Zimbabwe: Chiredzi 27505	Gwebi 27511
L 2	1857	156	1037	1501*	2082	2206*
L 23	2038	0	993	824	2068	2135
L 24	1872	286	903	854	2069	1771*
BAT 1230	1616	660	980	868	2168	2292*
BAT 1297	1853	1589	1212	1043	1981	2406
Best local control and yield	Bonus	Bassar	Local red	Selian	Natal Sugar	Canadian Wonder
	2460	625	885	976	2177	1087
LSD	335	587	152	Wonder		

Table 54 Yield in kg/ha of red mottled IBYAN lines in Africa

	Location and Yield					
	Zambia		Tanzania	Swaziland		Mean
Lines	Chipata	Misanfu	Uyole	Big Bend	Malkerns	
A 179	311	83	1 769	527	1 015	741
L 24	439	167	2 117	622	776	824
XAN 43	392	177	1 972	1 816	875	1 046
Bat 1253	892*	330	2 680	1 162	751	1 163
Bat 1254	825*	206	2 856	994	862	1 149
Bat 1276	368	133	1 730	756	489	695
Best local control	Misamfu Speckled Sugar	Misamfu Speckled Sugar	Kabanima	Speckled Sugar	White Canning	
Yield of	469	318	3065	1 195	1 011	1 212
LSD	280	179	445	512	296	

Table 55 Yield in kg/ha of small white lines in the IBYAN in Africa

	Location and Yield		
	Ethiopia		South Africa
	Debrezeit	Addis Ababa	Delmos
BAT 38	1 744	333	2 210
BAT 482	1 935	496	-
BAT 1061	2 168	369	2 296
BAT 1198	2 240	258	2 585
BAT 1257	1 869	289	2 378
BAT 1280	1 797	183	2 200
BAT 1281	2 112	374	-
EX RICO 23	1 792	129	2 448
78-0374	1 912	176	2 237
Best local control	Mexico 142	Mexico 142	Nep 2
and yield	1651	206	2 985
LSD	451	241	360

Table 56 Bean breeding materials dispatched to Africa in 1983

Locations	Crossing blocks		Segregating materials		Advanced lines	
	1983A	1983B	1983A	1983B	1983A	1983B
Ethiopia	60	198	-	-	-	-
Rwanda						
Rubona	467	454	-	186	-	150
Rwerere	-	-	-	37	97	150
Burundi						
Mosso	-	15	-	-	399	30
Kisozi	-	54	-	-	-	-
L Imbo	-	15	-	-	-	-
Kenya	-	65	-	-	-	-
Tanzania						
Lyamungu	467	-	-	-	-	-
Morogoro	-	-	-	-	100	-
Uyole	-	133	-	142	268	105
Malawi	-	-	-	-	131	185
Zambia						
Chipata	467	-	-	-	131	-
Lucheche	-	141	-	-	-	185
Zimbawe						
Harare	-	-	-	-	131	185
Chiredzi	-	-	-	-	-	185
Swaziland	-	64	-	-	-	35

Table 57 Numbers of crosses in the field in 1983 B season made for African conditions and listed according to the project or country of origin of female or recurrent parent

Project	Generation F1	F2	F3	Total
	No of crosses			
Halo Blight	42	10	28	80
Ascochyta	28	20	29	77
Bean Fly	10	-	-	10
Bruchids	9	17	27	53
Snap Beans	92	3	17	112
Country of Origin				
Burundi	8	-	-	8
Kerya	17	9	5	31
Malawi	21	2	21	44
Zimbabwe	6	-	-	6
Rwanda	16	-	1	17
Tanzania	69	8	8	85
Uganda	19	-	-	19
Zambia	14	-	2	16

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CHARACTER DEPLOYMENT

Central America Coastal Mexico Peru the Caribbean and Black Seeded Types

With respect to small seeded red and black grain types for Central America the transition from a Colombian-based selection and testing program to a regionally-managed activity was initiated in 1981-82 The change was completed in May 1983 when national program and CIAT scientists met in a breeders workshop to discuss results and determine a stable format for the Pre-VEF Adaptation Nurseries (Figure 6) Several important results are already apparent and imply some adjustments

- Since the second season in Central America is the most important for bean production it was decided to plant the adaptation nurseries in August-September

- Honduras is planting the nursery in the maize-bean relay system and data from that nursery suggests that the genotype x relay cropping system interactions were more location specific than expected

- Red and black seeded check varieties selected from the same type of nursery the preceding year are performing well and will be difficult to beat

- National program scientists are acquiring the ability to select among the many candidates those which are most useful locally

- Local interest is much greater in the VEF and EP trials which are now selected within the region

- Overall quality of the VEF has improved now that entries are selected on the basis of regional restraints and from a broad array of genotypes

- Great benefits have been derived from local scientists evaluating grain quality in the early generations

- The use of a fixed check a floating scale (for disease or adaptation) is most appropriate to make comparative subjective ratings

- More resources from the Palmira-based program are now dedicated to preparation and shipment of the nurseries and travel time to assist in their evaluation

- For the national programs increased commitments in testing and selection must be balanced against promotion and technology package refinement of earlier promising lines

- Cuba s varietal improvement requirements are also well served by the Central American Adaptation Nursery

With respect to red and red mottled grain types for Caribbean countries results from the Adaptation Nursery 82 planted in the Caribbean identified superior lines which were coded and included in the VEF 83 Different types of data and different limiting factors were encountered in each location A workshop of Caribbean bean researchers was also held in CIAT in May to better define interest and preferences for an Adaptation Nursery similar to that already initiated in Central America As a result the Adaptation Nursery for 83-84 of Caribbean grain types was distributed to 10 locations in seven countries

Genetic linkage problems complicating the recombination of dominant I-gene resistance to BCMV with soft red and red mottled grain types have been largely overcome by the use of unconventional small Pompadour lines as parents for Central American and Caribbean red and red-mottled crosses

In spite of the large diversity from site to site and variance in planting dates in 1982 trials a select group of lines was coded and advanced to the VEF 83 A small group of these which showed especially wide adaptation was multiplied for more extensive testing in Haiti The Dominican Republic and Jamaica are also testing those materials which were most promising in 1982 A larger array of grain colors with BCMV resistance are now available

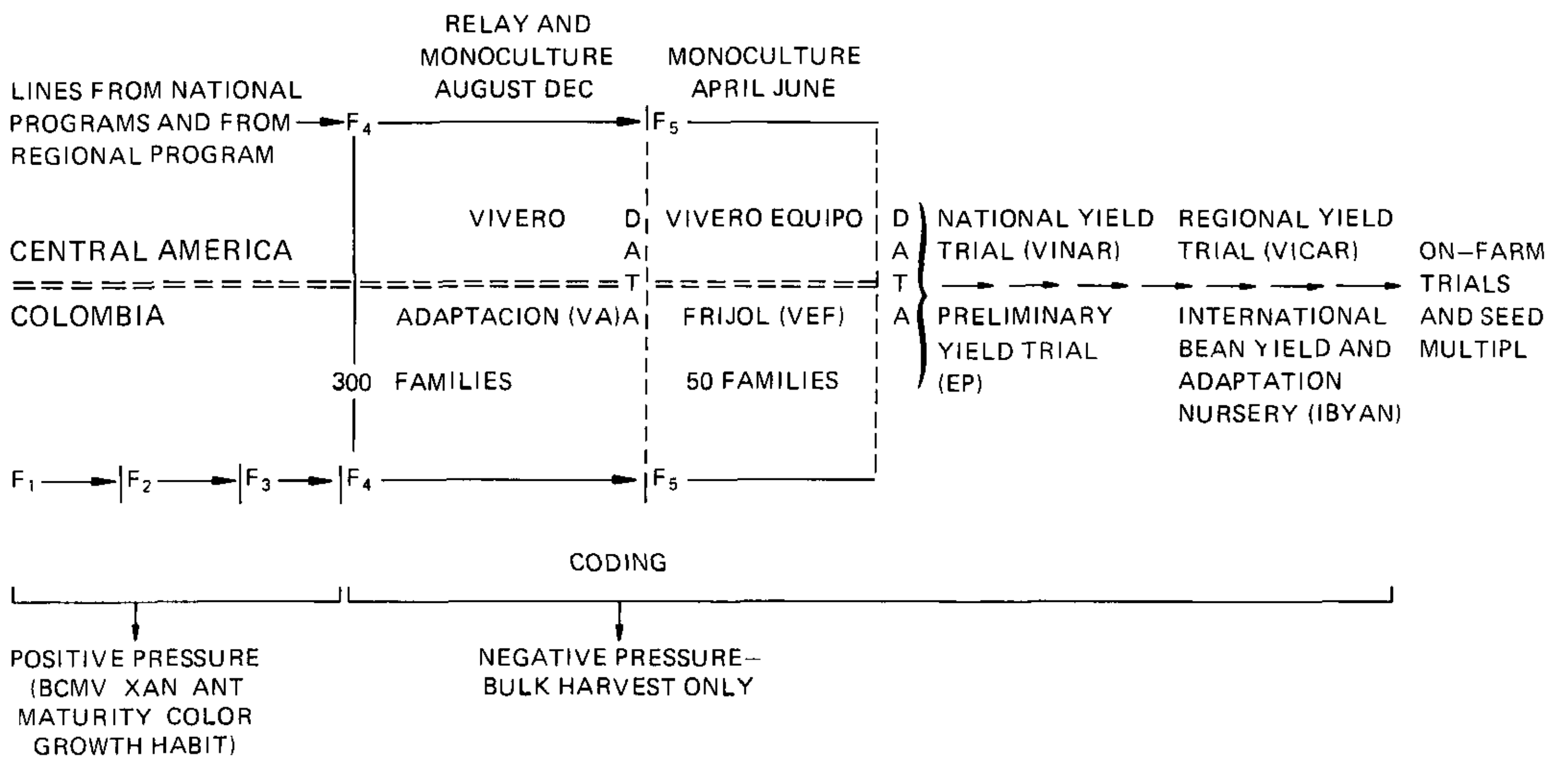
With respect to the Bayos and Canarios for the Pacific coasts of Peru and Mexico there are serious limitations to the genetic improvement of these grain types due to the linkage of I gene BCMV resistance to darker (and unacceptable) grain colors as was explained in the Bean Program Annual Report 1982 Significant advances were made in 1983 largely as a result of the excellent BCMV field testing program developed in Chincha Peru At this location a large number of plants carrying dominant and/or recessive resistance was selected These selections are currently being progeny tested in Peru

A Pre-VEF Adaptation Nursery was established in late 1983 (despite the relatively poor grain characteristics in most families) to identify parents of interest to the two national programs both of which are capable of generating hybrid populations Because of the importance of local adaptation in the selection of progenies for Peru and Mexico the Pre-VEF Adaptation Nursery is particularly valuable

An exciting development in 1983 was the discovery of I gene progenies with a true Canario color originating from crosses of nonconventional red mottled selections with their Canario and Azufrado counterparts These lines are being backcrossed and intermated to increase grain size as rapidly as possible

With respect to genetic improvement of materials for Chile crosses and backcrosses were made in an attempt to combine dominant resistance to BCMV recessive protection against necrosis-inducing strains and resistance to mild and virulent strains of BYMV into important grain types especially medium-sized white seeded ones CIAT s role is to facilitate parental stocks to generate some of the necessary hybrids and to confirm the BCMV resistance reaction of selections used as parents of crosses and backcrosses Some progenies are nearing varietal status and Chilean expertise in BCMV screening has identified sources of recessive-gene BCMV resistance which is also useful to African bean breeders

Figure 5 Scheme for the Adaptation Nursery of early generation progenies in Central America and its integration with the established VEF ⟶ EP ⟶ IBYAN sequence and VINAR ⟶ VICAR counterpart



Non-black Beans for Brazil Mexico Argentina Western Asia and North Africa

Brazil

Considering the availability of many lines which have been inadequately tested in Brazil over previous years CNPAF and CIAT worked jointly hard again in 1983 in Brazil While severe drought for the fifth consecutive year in the northeastern states of Bahia Pernambuco Alagoas and others severely hindered thorough evaluation and utilization of Mulatinho lines predominantly grown there substantial progress has been made in germplasm distribution and evaluation in the rest of the bean production zones All bean germplasm from CIAT channeled through CNPAF Goiania and its subsequent testings through their CAM (Campo de Avaluacao Multidisciplinar) at key sites and in the FPR (Ensayo Preliminar de Rendimiento) all over Brazil has started this year In addition to CNPAF farm at Capivara Goias the CAM was grown at Irati Parana in a joint collaborative project of IAPAR in Parana CNPA and CIAT The site at Irati was excellent for anthranose rust and CBB testing in the wet season (September-December) and in dry season (January-May) for angular leaf spot A third site (which is badly needed) for CAM is being sought by CNPAF in the north eastern states very likely in Pernambuco or Bahia An agronomist pathologist and breeders from CIAT joined scientists from CNPAF and state institutions in the evaluation and selection of material in the CAM and FPR in states of Goias Minas Gerais Parana Espiritu Santo Rio de Janeiro Santa Catarina etc

In state trials in Goias line A 295 of the Jalinho grain type has been doing well over the last two years Similarly in Minas Gerais line BAT 160 and BAT 332 (both Mulatinho grain types) are in the final stages of testing In both of these states basic seed of these lines is being multiplied by their respective institutions for possible varietal recommendations and formal releases in the near future However in the northeastern state of Pernambuco where in 1982 lines A 301 and A 303 significantly outyielded local checks severe drought has hindered further evaluations

It is estimated that in Brazil over 80/ of bean production area is planted to improved varieties released within last 20 years Essentially al of them are small seeded bush bean varieties of types II and III with stable and high yield performance These current varieties (Carioca Arcana IPA I IPA 74-19 Rico 23 Rio Tibagi Rio Iguacu Catu Costa Rica Cuba 168 N etc) apart from carrying resistance to BCMV and some tolerance to moderately acid soils generally exhibit a susceptible reaction to such problem diseases as anthracnose CBP and angular leaf spot rust BGMV etc In Brazil CBB and angular leaf spot are different from those occurring elewhere in Latin America and ary from one part to another within the country It was also noted that in Brazil races of anthracnose and angular leaf spot are more serious and widely spread than previously thought In northern Parana and the triangle of Minas

Gerais farmer have stopped growing beans particularly in the second semester January-May dry season due to heavy losses caused by BGMV

While production of an adequate quantity of quality seed is a major bottleneck all over Brazil successful adoption of any new variety will also depend on the overall yield superiority level of resistance to multiple factors minimizing yield losses and cost of production and increasing stability of performance Brazilian farmers are reluctant to adopt new varieties solely on the basis of attractive grain types and seasonal yield advantages often conditioned by resistance to specific problems

With over 600 lines still waiting to be included in the FPR of 84-85 new experimental lines of beans from CIAT could not be utilized by CNPAF until February 1985 so that CIAT s germplasm improvement strategy was re-examined As a result breeding activities for Brazilian grain types were moved from CIAT Palmira to CIAT-Quilichao due to the similarity of the soil with that of bean production zones in most of Brazil and higher natural CBB pressure there Additionally discussions were held with CNPAF to work out a joint breeding program in which from parental selection and determination of hybrid combinations through to the final selection and coding of lines will be decided upon jointly by both CNPAF and CIAT breeders In execution of the project and handling of segregating populations strong points of both institutions advantages of their growing environments etc and complementarity in their research activities will be sought

Mexican Highlands

As in 1982 an adaptation nursery including standard check varieties comprising 500 lines 30 segregating populations and over 100 resistance sources to different production problems were sent to INIA One set each was grown at the INIA research stations of CIAB-CAEJAL Tepatitlan CIANOC-CAEPAB Aguas Calientes and CIANOC-CAE VAG Victoria An agronomist breeder a pathologist from CIAT and a scientist from INIA participated in the evaluation of these materials In an independant study CIAT and INIA pathologists determined that over 15 pathogen types of the fungus *Colletotrichum lindemuthianum* causing anthracnose were present in one field alone at CIAB-CAEJAL Tepatitlan during the 1982 growing season Some of these overpowered the resistance of lines BAT 44 and BAT 841 previously considered resistant to all races of anthracnose from Latin America and other parts of the world At all three sites exceptionally good performance of lines bred for Brazil was striking This was probably due to their advanced improved state better tolerance to low soil phosphorus and combination of resistance for principal diseases occurring there The performance of lines such as A 410 A 439 to A 445 A 321 A 322 etc derived from the cross Carioca x G 2618 merits special mention Carioca is a widely grown variety from Brazil and carries a moderately high level of tolerance to acid soils G 2618 is a germplasm bank accession of the Bayo grain type originating from highlands of Mexico

Although there is great similarity of grain color and in some cases growth habit between varieties grown in Brazil and those occurring in the Mexican highlands the former are smaller (22 vs 35g/100 seeds)

Therefore it is doubtful if any one line of Brazilian grain type would be used directly for commercial production in the Mexican highlands Most of the Brazilian lines are being used as parents in crosses seeking recovery of their performance and production of medium-sized seeds with appropriate colors for the Mexican highlands This is expected to be a gradual process since only one crop cycle/year is produced there

Abundant moisture and favorable growing conditions in the Mexican highlands completely changed the general performance and yielding ability of the criollo varieties extensively grown there Most were vigorous with long guides and heavy pod loads (estimated yield about 3 000 kg/ha) and generally free from diseases and insect pests It appeared that though diseases like anthracnose angular leaf spot CBB halo blight etc could be endemic due to scarse and erratic rainfall the were seldom epidemic Also performance of stability and minimum yield of 500 kg/ha/year was more important than breeding for high yield potential Greater emphasis should therefore be given to breeding for early varieties with high tolerance to drought and to low soil P along with desirable resistances to diseases and insect pests

Adaptation of Mexican climbing bean varieties e g Garbancillo Zarco Cejita Rosa de Castilla Conejo Frijola and Cacahuate Criollo under Colombian conditions and vice-versa poses a more serious breeding problem than incorporation of resistance to specific diseases and insect pests As a result INIA and CIAT bean researcher agreed to screen and select in the early generation hybrid populations (F_2 to F_4) in the Mexican highlands Most of the crosses will be made at CIAT based on the performance of parents both in Mexico and Colombia and taking into account other desirable traits such as resistance to diseases and insect pests Subsequent generations will be advanced at CIAT where three or four crops/year are often obtained and prescreened for seed size and color resistance to BCMV CBB and low P etc However combining the I gene resistance to BCMV in the Flor de Mayo and Garbancillo type seems to be problematic Therefore increasing emphasis will be given to the incorporation of resistance conditioned by recessive genes e g bc_3

Argentina Western Asia and North Africa

Argentina is the third largest dry bean producing country in Latin America and a major part of the production is of large white Alubia types After the first fact-finding trip to Argentina in 1981 CIAT bean team member realized the severity and multiplicity of widespread bean production problems e g BCMV CBB BCLMV anthracnose and angular leaf spot and genetic improvement of Alubia beans was seriously undertaken at CIAT Since then collaborative projects for germplasm development and evaluation have been functioning well with EFAOC Tucuman and with two INTA stations at Cerrillos Salta and Famalla Tucuman Nearly all bean scientists working at these institutions and elsewhere in Argentina have received training at CIAT

Within the past three years primary emphasis has been given to germplasm evaluation at key sites in the four most important bean producing provinces of northwestern Argentina namely Tucuman Salta Santiago de Estero and Jujuy to identify parental lines including sources of resistance for production limiting factors and for hybridization In addition segregating hybrid populations and early generation families (F_3 to F_5) have been supplied each year to these three institutions Presently EEAOC-Tucuman INTA-Salta and INTA-Famalla each have an active program for improvement of Alubia beans Scientists at each of these institutions have gradually begun their own hybridization program from germplasm mostly supplied by CIAT

In 1983 an adaptation nursery of 526 families in F_4-F_5 generations and sources of resistance were sent for evaluation at key sites in each of four states One pathologist and a breeder from CIAT joined Argentinian bean scientists in evaluations of those nurseries High levels of much needed resistance for BCLMV CBB anthracnose and angular leaf spot were observed in many families (Prior testing of all materials for BCMV was done at CIAT) Promising families at each location were marked for individual plant selections at harvest EEAOC and INTA-Famalla grew about each 200 selections in heated plastic houses during the winter and further multiplied their seed in the following spring Thus sufficient seed of a large number of lines should be available for yield trials in 1984

In the meantime similar evaluation and selection was carried out at CIAT-Palmira for CBB angular leaf spot BCMV and anthracnose - the latter two under controlled conditions in the greenhouse A breeder from EEAOC (who spent four months at CIAT) participated in evaluation and selection of these materials the best of these (about 250) will be included in an adaptation nursery for multilocation testing in Argentina and Colombia in 1984

Although it is easy to combine resistance to principal diseases in a short time it has been difficult to obtain lines with large (50 g/100 seed) white shiny alubia grain types and desirable resistances for most factors often had to be transferred from small seeded parents of other grain types

It is hoped that most materials bred for Argentina will serve equally well for Western Asia and the North African countries whose bean type requirements are similar However resistance to specific problems not common in Argentina e g BYMV halo blight bean fly etc have to be incorporated additionally as desired During the workshop at ICARDA in May preliminary contacts for germplasm exchange initiation of collaborative projects were made with participants from many countries of the region A bean breeder from Egypt spent three months at CIAT and took with him selected germplasm It is hoped that this activity will gradually increase in the future with Turkey Iran Spain Yemen Arab Republic Sudan Pakistan Greece etc

In black beans improved lines have been introduced through IBYAN and subsequently evaluated extensively Seed multiplication and adoption by farmers has been rapid in Argentina where in less than four years after their introduction into the country the line DOR 41 BAT 76 PAT 448 and BAT 304 will occupy over 30 000 ha in 1984 Each o these new varieties have at leas a 50/ yield advantage over the local variety Negro Comun

Andean Zone and Eastern Africa

Genetic improvemen for the Andean zone

Cultivar improvement for the Andean Zone involves collaborative projects with the national programs of Colombia Ecuador and Peru and is concentrated in two locations in each country From North to South these are La Selva Obonuco (ICA Colombia) Santa Catalina Cuenca (INIAP Ecuador) Cajabamba Cuzco (INIPA Peru) Breeders from each of these countries met at CIAT for a workshop in December 1983 to discuss advances achieved review breeding methodology and to evaluate field nurseries in Colombia

In addition to IBYAN trials breeding nurseries were distributed to all locations consisting of crossing blocks segregating generations and advanced lines (VEF) Nurseries were prepared individually for each location according to local needs (Table 52) In addition a large number of crosses were made in CIAT from cultivars from each country and improved germplasm In many cases these crosses were specifically requested by a national program A bulk breeding procedure including mass selection for grain type allows these crosses to be rapidly advanced to the F_4 generation distributed to the relevant programs as segregating populations for local selection Advanced lines emerging out of local selections are entered into the VEF nursery which is made available on a regional basis allowing free interchange of improved materials and evaluation over a wider ecological range

Colombia

In addition to the internationally distributed nurseries shown in Table 52 a collaborative breeding program with ICA is underway at La Selva and Obonuco involving all generations of selection As a result of the collaborative project in La Selva ICA-Llanogrande was released in 1982 Approximately one ton of breeder seed of this cultivar was produced in La Selva in 1983 and all certified seed (approximately four tons) was sold by ICA In on-farm trials conducted in the region the climbing bean line La Selva which was selected from a cross made by ICA of Mexico 235 x Bola Roja continues to be promising as it is resistant to anthracnose tolerant of low soil fertility and has a grain type similar to Cargamanto the local cultivar Breeder seed of this line and three other promising advanced lines is being produced in 1983 An early climbing bean line with the Cargamanto grain type V-6785-325-M-M (now recoded as ZAV 83102) shows promising results in the coffee region (1 500-2 000 msl) but is unstable in on-farm trials in Antioquia above 2 000 msl It is the result of a cross between a Colombian cultivar CUN-96 crossed with AB 136 a source of resistance to most races of anthracnose Another early line with the Liborino grain type V-5783-38-M-M (recoded as ZAV 83101) is the result of a cross between

Cargamanto and Guanajuato 22 from Mexico (as a source of anthracnose resistance) and is also highly promising for the coffee region A total of 426 pre-VEF lines were tested in La Selva in 1983 to select advanced lines for 1984 All new materials are field resistant to anthracnose and selection pressure is now being given to increasing the level of Ascochyta resistance in materials with commercial acceptability

At Obonuco work was also concentrated on climbing types which are predominantly intercropped with maize Beans selected at Obonuco are for the high altitude Andes above 2 500 masl The germplasm selection E 605 was selected from the Ecuadorian collection It has a grain type virtually indistinguishable from Mortino but is somewhat earlier and significantly higher yielding (46/) according to results of on-farm trials in the Ipiales district It has intermediate resistance to anthracnose In addition promising results on farms have been achieved with the breeding lines ICA 32980-m (4) -ma-mb-1-41 recoded as TIB 25-41 and 32980-m(4)-ma-mb-1-44

Approximately 500 kg of breeder seed of E 605 and ICA-Llanogrande was produced in Obonuco in 1983 ICA-Llanogrande is not suitable for altitudes above 2 500 masl unless planted at relatively high density (8 plants/m^2) and with an early cultivar of maize (e g Cundinamarca 431) according to the results of an intercropping trial with 10 cultivars of beans and three of maize E 605 on the other hand responds to a taller later maize cultivar (e g MB-521) of the sort more typically grown in the region

Breeder seed (approximately 100 kg) of promising bush bean lines L-33462 and L-33411 was produced at Obonuco in 1983 In addition to the materials shown in Table 52 selection is underway with 132 pre-VEF lines at Obonuco in a preliminary yield trial and in observations nurseries off-station

Ecuador

A total of 77 crosses were made with Ecuadorian cultivars in 1983 Typical climbing bean cultivars include Bolon Rojo and Bolon Bayo bush bean cultivars include Cargabello and Shaya a semi-climber Climbing beans are intercropped with maize and bush types are normally sole cropped

From the evaluation of the crossing block in 1983A a number of crosses were requested and made in Popayan and Obonuco Selected parents included F 4 E 521 E 605 E 1253 VRB 81057 From previous shipments of climbing bean segregating materials local selections from V-5797 V-6800 and I-20902 significantly outyielded the checks and are now being tested in seven locations A selection from Ecuadorian germplasm (E 1056 ICA-Llanogrande in Colombia) is also being considered for varietal release in Ecuador This line would replace Shaya over which it has a yield advantage of 130/ in experiment station trials Justification for the varietal release includes the need for a higher yielding bean companion to the earlier maize cultivars now being planted and with resistance to anthracnose Approximately 751 kg of breeder seed of E 1056 were produced in 1983

The most promising bush bean lines have been ICA-Guali (known locally as E 101) E 1486 and Linea 24 but a yield trial of advanced lines from the VEF 83 revealed some new promising lines PVAD-1426 PVAD-1427 PVAD-142 and A 36 which are being evaluated in four locations

Peru

A total of 132 crosses were made with Peruvian cultivars from the Andes The principal cultivar in the northern department of Cajamarca is Blanco Caballero a climber intercropped with maize while in the southern department of Cuzco Amarillo gigante is the principal climbing cultivar and Red Kidney and Panamito are the principal bush bean cultivars

As a result of collaborative work in Cajabamba a new climbing cultivar Gloriabamba (CIAT accession G 2829) was selected and named in 1982 Other promising lines include G 3366 G 5653 (Ecuador 299) and E 1056 All are resistant to anthracnose but improved resistance to *Ascochyta* is needed Of 150 F_4 segregating materials originating from crosses made in CIAT some promising climbing bean lines with improved resistance to *Ascochyta* and anthracnose have been selected in Cajabamba These include the following Ancash 143 x E 1056 Compuesto 11 x G 2641 and Ancash 143 x G 2641

In Cuzco halo blight replaces *Ascochyta* in importance after anthracnose Promising climbing bean lines include Puebla 444 (G 3410) and Gloriabamba Bush beans however are more important and the best of these types include ICA Palmar and Red Kloud both with intermediate resistance to anthracnose and halo blight Other promising lines include Ancash 66 (G 4727) ICA Tundama Nariño 20 (G 12666) and BAT 1222 Of the Panamitos BAT 338 BAT 482 and BAT 1061 are promising

Eastern Africa

Collaborative work in Africa began in 1976 with the shipment of IBYAN trials to an increasing number of locations Of the small red bush beans BAT 41 (released as Revolucion 79 in Nicaragua) and A 21 have been consistently superior to local controls in Rwanda Zaire Uganda and Tanzania With the red mottled types there has been less consistency in their results but BAT 1296 and BAT 1297 have been superior to the control in several locations (Table 53) In Table 54 results from the series of red mottled types do not indicate any consistent superiority although BAT 1253 and BAT 1254 look promising in Chipata Zambia and XAN 43 in Big Bend Swaziland Of the small whites BAT 1061 and BAT 1198 are the best in Ethiopia and South Africa (Table 55) In Zimbabwe and Swaziland good results have been obtained with cream coloured lines BAT 561 A 79 A 67 and XAN 66

Despatches of breeding materials to Africa increased greatly in 1983 (Table 56) Many programs have requested crossing blocks for evaluation under local conditions and to provide sources of resistance to specific factors A few segregating materials have been sent to Rwanda where the first CIAT outreach scientist in Africa is stationed and to Tanzania as a result of training visits to CIAT of Tanzanian scientists in collaboration with the Title XII project Considerable numbers of advanced lines from the VEF 83 nursery have been selected according to the needs of each location

The number of hybrids made in CIAT are shown in Table 57 They are listed according to projects or the country of origin of the female or recurrent parent A number of these crosses were specificaly requested by collaborating countries They will be advanced to F_4 and shipped as bulk populations to interested programs

In many parts of Africa the necrotic strains of BCMV limit the usefulness of materials only carrying the dominant I gene for resistance An active program of hybridization to incorporate other sources of resistance is underway Sources of bc-2^2 gene such as Red Mexican UI 35 and Great Northern 31 and of the bc-3 gene such as Don Timoteo are being extensively used The possibility of other mechanisms of resistance is being investigated in the field in Rwanda

Bean fly is possibly the most important problem and sources of improved resistance already identified in Africa and Taiwan are being crossed with African cultivars for testing in the collaborative CRSP project Title XII in Tanzania

Angular leaf spot also occurs very widely in Africa and useful resistance has been identified in A 240 and A 152

Halo blight is important in some areas and Montcalm and Mecosta have shown good resistance and useful adaptation in Lyamungu Tanzania

Climbing beans are important mainly in Rwanda and Burundi where V 79116 and G 6977 have been identified as superior at Rubona Rwanda and Ecuador 299 Ecuador 131 and E 1056 at Kisozi Burundi

Dıacol Calima has been released ın Burundı and large quantitıes of certıfıed seed are avaılable It ıs still uncertaın how this varıety wıll behave if mıxed with local land races New advanced lines from the VEF 83 were evaluated at the Mosso experiment statıon and a number of them of the Calıma type look promisıng Some of these (e g PVAD-1312 PVAD-1362) are type II s and may compete better ın mixtures than Dıacol Calıma

Snap Beans

A total of 112 crosses were made at CIAT in 1983 many of which involved crosses of green bean cultivars with improved dry bean lines The objective of these crosses was to incorporate improved disease resistance from dry beans into green beans the majority of which are highly susceptible to rust and other pathogens In addition many segregating populations of bush types were received from Washington State University This collaboration has advanced selection of tropically adapted bush green beans with improved resistance to rust powdery mildew and CBB The highest quality pods tend to be associated with disease susceptibility but some advanced lines now in F_6 show promising combinations of pod quality disease resistance and yield (Table 58) The parents of the most promising lines include Olivade Tendergreen Tempo and Beautiful Emphasis has been given to the round podded stringless type but new crosses have included the flat podded type and some of the lower quality pod types may be suitable in some areas for dual purpose green bean and dry seed production

Progress in climbing types has also resulted in F_6 lines combining satisfactory pod quality with improved disease resistance and yield (Table 59) The principal green bean parents used have been Pole Blue Lake (G 8992) and a Mexican accession P I 263596 (G 1040) Both are round podded stringless types Of the flat podded types White Stokboon (G 10053) has been one of the best parents Of the dry bean donors of resistance and yield the best have been V 7920 and VRB 81047 In most crosses with these pod quality has suffered but will be recovered with further intercrossing

The first green bean nurseries including segregating materials were sent to Egypt Chile and Argentina in 1983

Table 58 Evaluations of promising selections of bush green beans on a 1-5 scale for all characters where 1 0 is excellent

Generation	Code	Selection	Growth habit	Rust	Powdery mildew	Pod quality	Yield efficiency
F_5	QC-23	-11	I	2 0	2 0	1 0	2 5
F_5	QC-95	-17-15	I	1 0	2 0	1 0	3 0
F_5	QC-95	-17-12	I	1 5	2 5	1 0	3 0
F_6	QC-2579	-12	I	1 0	2 0	1 0	2 0
F_6	QC-2579	-110	I	1 0	2 0	1 0	2 0
F_6	QC-2579	-116	I	2 0	2 0	1 0	2 0

Table 59 Promising selections of climbing green beans Evaluations for all characters on a 1-5 scale where 1 0 is excellent

Generation	Code	Selection	Growth habit	Rust	Pod quality	Yield efficiency
F_6	QC-9110	-19	IVA	2 5	1 0	2 0
F_6	QC-9101	-16	IVA	3 0	1 0	2 5
F_6	QC-9101	-111	IVA	3 0	1 0	2 5
F_6	QC-9102	-11	IVA	3 0	1 0	2 5
F_6	QC-9110	-16	IVA	3 0	1 0	2 5
F_6	QC-9111	-14	IVA	3 0	1 0	2 5

EVALUATION IN UNIFORM NURSERIES

As mentioned in the Bean Program Annual Report 1982 the three phase system for evaluation and distribution of experimental lines was extended Each of the three phases VEF EP and IBYAN now runs a full year

The genetic material tested in the three nurseries was as follows 1 385 entries in the VEF 83 304 entries in the EP 82 and 140 entries in the IBYAN 83

VEF the 1 385 entries of the VEF 83 were distributed in 12 groups/ (Table 60)

Table 60 Distribution of the 1385 entries of the 1983 VEF

Group no	Growth habit	Group identification	No of entries
10	Bush	Black seeded small	115
20	Bush	Red seeded small	196
25	Bush	Red mottled med/large	448
30	Bush	White small mottled	59
35	Bush	White large mottled	35
40	Bush	South and North Pacific Coast	14
45	Bush	Mexican highlands	132
50	Bush	Brazil	148
60	Climbing	Black warm climates	19
70	Climbing	Red warm climates	45
80	Climbing	Light colors warm climates	112
85	Climbing	Light colors cool climates	62

The red mottled group seems larger but this group includes materials for the Caribbean Andean highlands and East Africa The numbers reflect well the need for specific types in the areas where beans are grown Table 61 shows the number and proportion of bean entries within each basic group showing different growth habits

With respect to maturity variability was less than expected In most of the groups the majority of materials reached physiological maturity between 73 and 78 days No materials were found maturing at less than 70 or more than 83 days (Table 62)

Yield data for the VEF were calculated as if they were taken from plots of 5 0 m^2 and 10 0 m^2 in the first and second semester respectively although data were recorded from plots of 4 8 and 7 6 m^2 Only clean sound grain was used for these calculations These provisions were taken to compensate for yield estimates based on small

Table 61 Number and proportion of bean entries in the VEF 83 within each basic group according to seed type adaptation and growth habit

Group Code and Description	Growth habit			
	I	II	III	IV
10 -black	-	107 (93%)	8	-
20-red small	-	163 (83%)	33	-
25-red mottled large/med	294 (66%)	143	11	-
30-white small	11	38 (64%)	10	-
35-white large	26 (74%)	4	5	-
40-S & N Pacific Coast	3	10 (71%)	1	-
45-Mexican highlands	18	25	89 (67%)	-
50-Brazil	4	73 (49%)	71	-
60-Black warm climates	-	-		19 (100%)
70-Red warm climates	-	-	-	45 (100%)
80-light color warm climates	-	-	-	112(100%)
85-Light color cool climates	-	-	-	62 (100%)

Table 62 Number of bean entires in the VFF 83 within each maturity and seed type grouping

Maturity (days)	Black 10	Small red 20	Red mottled 25	Small white 30	Large white 35	Mexican highland 45	Brazil 50
70	0	0	2	0	0	0	1
71	0	1	9	0	3	0	8
72	3	1	15	0	11	3	5
73	1	2	23	1	28	8	12
74	2	2	20	8	25	10	12
75	3	6	14	18	14	13	22
6	27	15	9	23	17	15	16
77	19	22	3	23	0	13	12
80	4	9	1	1	1	4	2
81	12	6	1	3	0	5	3
82	1	1	0	0	0	2	0
83	0	0	0	0	0	2	0

Table 63 Mean yield in kg/ha of the five outstanding materials within each group of the VEF 83A in Palmira

Code	Description	Yield of best check	Experimental Line	Yield of line	over best check
10	Black bush small	3 984	NAG 15	4 919	23 5
			NAG 54	4 663	17 0
			NAG 11	4 550	14 2
			NAG 42	4 532	13 8
			XAN 147	4 472	12 2
20	Red bush small	2 618	RAB 3	4 980	90 2
			RAB 93	4 524	72 8
			RAB 13	4 498	71 8
			RAB 77	4 289	63 8
			RAB 59	4 257	62 6
25	Red mottled bush medium large	3 923	PVAD 1425	4 136	5 4
			PVAD 1430	3 912	0 0
			PVAD 566	3 807	-0 3
			PVAD 773	3 751	-0 4
			PAI 26	3 665	-0 7
30	White bush small	3 022	PAN 12	3 586	18 7
			BAT 1716	3 520	16 5
			PAN 29	3 428	13 4
			PAN 10	3 419	13 1
			BAT 1721	3 280	8 5
35	White bush large	2 120	PVAR 1502	2 763	30 3
			PVAR 1485	2 722	28 4
			PVAR 1459	2 713	28 0
			PVAR 1492	2 627	23 9
			PVAR 1477	2 586	22 0
40	Bush South & North Pacific Coasts	2 404	APN 74	3 699	53 9
			997 CH-73	3 552	47 8
			DOR 307	3 495	45 4
			BAT 1764	3 374	40 3
			BAT 1765	3 107	29 2
45	Bush Mexican highland	3 787	PVMX 1583	4 540	19 9
			PVMX 1795	4 429	17 0
			PVMX 1605	4 344	14 7
			PVMX 1568	4 281	13 0
			PVMX 1531	4 217	11 4

Table 63- Continued

50 Bush Brazil	3 688	PVBZ 1798	4 922	33 5
		PVBZ 1899	4 782	29 7
		PVBZ 1706	4 595	24 6
		PVBZ 1726	4 556	23 5
		PVBZ 1782	4 553	23 4
60 Black warm climate	2 513	V8379	3 545	41 1
		V8371	3 489	38 8
		V8370	3 260	29 7
		V8374	3 255	29 5
		V8375	3 201	27 4
70 Red climbing warm climate	3 579	ACV 8365	4 619	29 1
		ACV 8370	4 343	21 4
		ACV 8310	3 931	9 8
		ACV 8368	3 811	6 5
		ACV 8320	3 702	3 4
80 Light colors climbing warm climates	3 127	ZAV 8362	4 686	49 9
		ZAV 8360	4 374	39 8
		ZAV 8301	4 220	35 0
		ZAV 8368	4 060	29 8
		ZAV 8354	4 014	28 4

Table 66 Average yield (kg/ha) of different seed color groups of bush beans of the EP 82 (results of trials in 1983 A from Palmira and Popayan

Group no	PALMIRA Without chemical protection	PALMIRA With chemical protection	Difference in yields for Palmira	POPAYAN Without chemical protection	POPAYAN With chemical protection	Difference in yields for Popayan
10	1258 6a*	1865 8[a]	607 2	1341 1[a]	3790 9[a]	2449 8
50	1151 6[ab]	1716 5[ab]	564 9	1350 2[a]	3634 5[a]	2284 3
20	1050 7[abc]	1719 1[ab]	668 4	1165 3[a]	3313 7[abc]	2148 4
30	1011 5[abc]	1847 2[a]	835 7	886 2[ab]	3372 8[ab]	2486 6
40	968 7[bc]	1655 2[b]	686 5	1416 1[a]	3592 5[a]	2176 4
20	865 0[c]	1215 9[d]	350 9	584 7[b]	1985 2[d]	1400 5
40	847 6[c]	1448 5[c]	600 9	887 7[ab]	2849 1[c]	1961 4
30	557 4[d]	1010 9[e]	453 5	854 5[ab]	2945 4[bc]	2090 9
Average	963 9	1559 9		1060 7	3185 5	
C V (/)	18 1	12 8		31 2	18 0	

* Means followed by the same letter are not significantly different according to the Duncan test at P = 0 05

Table 64 Average yield (kg/ha) of different color groups of bush beans in the EP 82 (results of trials in 1982 A) in Palmira and Popayan

	Palmira	Popayan		
Croup No	Without chemical protection	Without chemical protection	With Chemical protection	Difference in yields for Popayan
35	521[bc]*	222[b]	1489[a]	1267
10	765[ab]	699[a]	1266[a]	567
30	680[abc]	472[b]	1209[a]	737
50	811[a]	779[a]	1143[a]	364
45	620[abc]	731[a]	1014[ab]	283
20	630[abc]	444[b]	969[ab]	525
40	496[c]	416[b]	941[ab]	525
25	462[c]	430[b]	740[b]	310
Average	635	623	1080	
C V	33 8	39 4	39 4	

* Means followed by the same letter were not significantly different at p = 0 05

Table 65 Average yield (kg/ha) of bush bean seed color groups in the EP 82 (results of-trials in 1982B) in Palmira and Popayan

Group No	PALMIRA		Difference of yields in Palmira	POPAYAN		Difference of yields in Popayan
	Without chemical protection	With chemical protection		Without chemical protection	With chemical chemical	
30	2362 7^{a*}	2571 4^{a}	208 7	1495 4^{b}	2361 1^{a}	865 7
10	2150 4^{ab}	2842 2^{a}	691 8	1453 0^{bc}	2108 2^{abc}	655 2
50	2105 6^{b}	2684 4^{a}	578 8	1615 8^{a}	2221 1^{ab}	605 3
20	2074 9^{b}	2615 1^{a}	540 2	1333 3^{bcd}	1902 6^{abc}	569 3
45	1718 3^{c}	2535 6^{a}	817 3	1927 9^{a}	2627 9^{a}	700 0
25	1656 8^{c}	2198 0^{b}	541 2	949 6de	1333 0^{cd}	383 4
40	1647 6^{c}	2140 6^{b}	493 0	1079 1^{cde}	1506 9^{bcd}	427 8
35	1279 4^{d}	1741 2^{c}	461 8	744 9^{e}	983 6^{d}	238 7
Average	1874 5	2426 0	1324 8	1880 6		
C V (/)	15 3	14 2	29 6	26 9		

* Means followed by the same letter were not significantly different according to the Duncan test at P = 0 05

Table 67 Black-seeded bush bean lines of the EP 82 with above average yields (kg/ha) with and without chemical protection in trials conducted during four semesters in 1982-83 in Palmira and Popayan

	PALMIRA			POPAYAN		
	Chemical Protection			Chemical Protection		
Line	Without	Difference with	Protection	Without	With	Difference
82 A						
XAN 527(C)	819			1636	1737	101
XAN 93	828			1078	1703	625
A 237	741			946	1687	741
$\bar{x}$ Group	765			699	1266	567
n =	31			31		
82 B						
BAT 1470	2429	2990	561			
BAT 1481	2959	3530	571			
XAN 109	2450	3264	814			
G 7249	2465	2917	452			
XAN 108	2516	3269	753			
A 210				922	2132	1210
A 214				983	2349	1366
A 231				1410	2133	723
$\bar{x}$ Group	2129	2817	688	712	2124	1412
n =	31			31		
83 A						
BAT 1554	1443	1912	469	1546	4187	2641
BAT 1647	1788	2116	328	1612	4059	2447
$\bar{x}$ Group	1259	1866	607	1341	3791	2450
n =	20			22		

Table 68 Lines of red seeded bush beans in the FP 82 with above average yields (kg/ha) in trials with and without chemical protection conducted over four semesters in 1982-83 in Palmira and Popayan

	Palmira Chemical protection			Palmira Chemical protection		
Line	Without	With	Difference	Without	With	Difference
82 A						
XAN 90	715	-	-	886	1886	1000
BAT 1670	683	-	-	502	1801	1299
BAT 1654	695	-	-	697	1649	952
BAT 1493	690	-	-	718	1614	896
BAT 1570	804	-	-	524	1166	642
BAT 1577	857	-	-	938	1126	188
BAT 1572	708	-	-	543	969	426
$\bar{x}$ Group	630	-	-	444	969	525
n=	34			34		
82 B						
BAT 1449	2402	2961	559	936	2323	1387
BAT 1532	2243	-	-	624	2333	1709
XAN 90	2518	2982	464	953	3343	2390
$\bar{x}$ Group	2107	2621	514	591	1903	1312
n	34			34		
83 A						
BAT 1514	1344	2126	782	1330	4038	2708
BAT 1670	1368	1772	404	1810	3642	1832
$\bar{x}$ Group	1051	1719	668	1165	3314	2149
n=	18			25		

Table 69 Large red seeded bush bean lines in the EP 82 with above average yield (kg/ha) in trials with and without chemical protection conducted over four semesters in 1982-83 in Palmira and Popayan

	PALMIRA			POPAYAN		
	Chemical protection			Chemical protection		
Line	Without	With	Difference	Without	With	Difference
82 A						
A 488	-	-	-	593	1744	1151
Ancash 66	683	-	-	1242	1641	399
A 482	542	-	-	738	890	152
$\bar{x}$ Group	462	-	-	430	740	310
n =	53			53		
82 B						
BAT 1260	1895	2403	508	650	-	-
BAT 1582	2047	2428	381	874	-	-
BAT 1387	1889	2179	290	760	-	-
BAT 1385	1779	2221	442	564	1815	1251
BAT 1579	1998	-	-	555	1794	1239
$\bar{x}$ Group	1648	2141	493	481	1312	831
n=	53			53		
83 A						
A 485	937	-	-	1024	3250	2226
BAT 1579	911	1750	839	1031	2703	1672
$\bar{x}$ Group	865	1216	351	566	1952	1386
n =	31			23		

Table 70 Small white seeded bush beans of the FP 82 with above average yields (kg/ha) in trials with and without chemical protection conducted over four semesters in 1982-83 in Palmira and Popayan

	PALMIRA			POPAYAN		
	Chemical protection			Chemical protection		
Line	Without	With	Difference	Without	With	Difference
82 A						
XAN 125	788	-	-	813	1700	887
BAT 1419	839	-	-	542	1351	809
$\bar{x}$ Group	680			472	1209	737
n=	11			11		
82 B						
XAN 125	3026	3222	196	647	2612	1965
BAT 1259	2621	-	-	636	2663	2027
$\bar{x}$ Group	2432	2644	212	516	2418	1902
n=	11					
83 A						
XAN 125	1284	2317	103	915	4732	3817
BAT 1453	1116	-	-	1366	-	-
$\bar{x}$ Group	1012	1847	835	886	3373	2487
n=	8			8		

Table 71 Large white seeded bush beans in the EP 82 with above average yields (in kg/ha) in trials with and without chemical protection conducted over four semesters in 1982-83 in Palmira and Popayan

	PALMIRA			POPAYAN		
	Chemical protection			Chemical protection		
Line	Without	With	Difference	Without	With	Difference
82 A						
A 493	561	-	-	470	1335	865
$\bar{x}$ group	493			222	867	645
n=	13			13		
82 B						
A 492	1302	-	-	626	-	-
A 493	1523	1930	407	727	2227	1500
$\bar{x}$ group	1297	1857	560	424	910	486
n=	13			13		
83 A						
A 493	636	1492	856	1004	3685	2861
$\bar{x}$ group	557	1011	454	855	2946	2091
n=	7			7		

Table 72 Bush bean lines of the FP 82 with above average yields (in kg/ha) in trials with and without chemical protection conducted over four semesters in 1982-83 in Palmira and Popayan

	PALMIRA			POPAYAN		
	Chemical protection			Chemical protection		
Line	Without	With	Difference	Without	With	Difference
82 A						
BAT 1417	794	-	-	775	138	612
FMP 106	828	-	-	1029	1330	301
BAT 1544	621	-	-	826	13 5	499
x̄ Group	486	-	-	416	941	525
n =	23	-	-	23		
82 B						
BAT 1373	1705	2293	588	624	-	-
BAT 1456	1781	-	-	849	2363	1514
BAT 1425	1835	2802	967	1218	2250	1032
BAT 1463	1871	2794	9?3	838	?145	1307
BAT 1544	2167	2714	547	112	733	1611
EMP 106	2397	2834	437	862	2499	1037
x̄ Group	1660	2196	536	592	1574	982
n =	23			23		
83 A						
BAT 1463	984	1579	595	1176	3187	2011
XAN 128	1237	2232	995	1037	3808	2771
EMP 83	977	1956	979	978	3161	2183
FMP 106	1057	1794	737	1862	3954	2092
x̄ Group	848	1449	601 x group	888	2849	1961
n =	15			10		

Table 73 Bush bean lines for the highlands of Mexico from the EP 82 with above average yields (Kg/ha) in trials with and without chemical protection conducted over four semesters in 1982-83 in Palmira and Popayan

	PALMIRA			POPAYAN		
	Chemical Protection			Chemical Protection		
Line	Without	With	Difference	Without	With	Difference
82 A						
A 445	686	-	-	1574	1786	212
A 414	677	-	-	866	1614	748
A 410	758	-	-	819	1121	302
x̄ Grupo	620	-	-	731	1014	283
n =	18			18		
82 B						
A 410	2013	2871	858	2202	2903	701
A 407	2030	2867	837	1380	-	-
A 411	1990	2995	1005	1482	2634	1152
A 439	1964	3204	1240	1663	2933	1270
A 442	1925	2737	812	1838	3022	1184
A 445	2209	3158	949	2017	3065	1048
A 429	1943	2713	770	1363	2733	1370
x̄ Grupo	1734	2524	790	1244	2577	1333
n =	18					
83 A						
A 439	1021	1806	785	1734	-	-
A 445	1034	1717	683	1952	-	-
A 429	1380	1978	598	1675	-	-
x̄ Grupo	969	1655	686	1416	3592	2176
n =	11					

Table 74 Bush bean lines with cream colored seeds from the EP 82 with above average yield (kg/ha) in trials with and without chemical protection conducted over four semesters in 1982 and 83 in Palmira and Popayan

	Palmira			Popayan		
	Chemical protection			Chemical Protection		
Line	Without	With	Difference	Without	With	Difference
82 A						
A 321	936	-		1147	2198	1051
A 375	952	-		1382	2189	807
A 242	847	-		1053	1500	447
A 358	1019	-		910	1380	470
A 315	1009	-		1023	1330	307
A 176(C)	878	-		1048	1284	236
A 297	945	-		823	1236	413
$\bar{x}$ Group	811			779	1143	364
n=	56			56		
82 B						
A 242	2412	2994	582	1101	2503	1402
A 271	2511	2992	481	1244	2452	1208
Carioca 80	2489	2768	279	1438	2556	1118
A 339	2434	3017	583	1148	2795	1647
$\bar{x}$ Group	2107	2687	580	1003	2214	1211
n=	56			56		
83 A						
A 250	1335	2174	839	1622	4420	2798
Carioca 80	1541	1838	297	1448	-	-
		2076	680			
BAT 1601	1361	1835	474	1808	4513	2705
A 322	1218	1823	605	2161	3870	1709
BAT 1458	1268	1851	583	1469	3834	2365
$\bar{x}$ Group	1152	1716	556	1350	3635	2285
n=	44			44		

single plots Table 63 shows the outstanding materials in each group in the trial grown in CIAT-Palmira during the first semester of 1983 Yields seem high because they were calculated from small plots but performance above the best check was clear in all groups except in the red mottled

The main diseases evaluated in the VEF 83 were rust and CBB in Palmira and anthracnose angular leaf spot and Ascochyta in Popayan A high number of entries were resistant to either rust anthracnose angular leaf spot but few were resistant to anthracnose and Ascochyta

EP Preliminary Yield Trial

As was previously mentioned the Bean Program changed its germplasm evaluation scheme of the EP and VEF nurseries extending the evaluation period from six months to one year for each nursery For that reason the EP 82 was evaluated from January 1982 to December 1983 over four semesters in Palmira and three in Popayan Partial results were presented in the Bean Program Annual Report

A total of 304 entries were included in the EP 82 nursery When evaluations were repeated in 1983 approximately 150 lines were evaluated eliminating obviously inferior material

The entries were separated into 14 groups according to seed size seed color bush bean (8 groups) and climbing bean (6) growth habits The experiments were done at CIAT-Palmira and Popayan under high input (with chemical protection) and low-input (without chemical protection) conditions with the exception of first semester of 1982 EP 82A which was only done in Palmira under low input conditions

During the second semester of 1983 bush bean advanced lines were included having the highest yields in the FP from 1979 to 1982 These trials were done in both the CIAT-Palmira and Popayan stations with high and low inputs A total of 175 entries were included for Palmira and 154 for Popayan separated into eight groups of bush lines

In the first semester of 198? the medium and large white seeded group outyielded the other groups under protected conditions in Popayan This was partially due to the low number of entries evaluated in this group The yields of the groups of small black seeded entries and small white and cream-colored seeded entries were statistically equivalent to the higher-yielding group in both locations under chemically protected conditions Without protection the yield statistics changed completely for blacks and whites In general the yields were low partially due to the heavy rains and floods in Palmira and Popayan (Table 64)

During the semester 1982B (Table 65) the small whites the small blacks and the small cream colored-seeds outyielded the other groups in Palmira under non-protected conditions However under protected conditions the performance of all these groups was similar with the exception of the large and medium reds the large and medium-sized light-colored beans and the large and medium whites in Popayan The highest yielding group was the medium and large pintos under both protected and non-protected conditions The yields were relatively low but were higher than the previous semester mainly due to improved climatic conditions

In the semester 1983A in Palmira the EP 82 showed improved yield of small blacks under protected and non-protected conditions (Table 66) For Popayan the medium and large pintos had higher yields followed by the small blacks under non-protected conditions With chemical protection the highest yielders were the small blacks followed by the medium and large pintos In Palmira the yields of the different groups were affected by the heavy attack of CBB due to high temperature and humidity conditions Nevertheless the yields were relatively high under both protected and non-protected conditions despite the climatological environment This was partially due to better agronomic management related especially to crop rotation with wheat organic fertilization with chicken manure and minimum tillage

Within the EP 82 in the semester 83A 57 materials were selected for outstanding yield in Popayan and 73 in Palmira In general the beans' performance in the different groups was not consistent over the semesters evaluated nor between locations or under protected and non-protected conditions

The outstanding materials in each of the eight groups of bush varieties are presented in Tables 67-74 The criteria for selection of these lines was above-average yield under protected and non-protected conditions in Palmira and Popayan Additionally the entries showed broad adaptation over semesters 82A 82B and 83A Only selected lines common to both locations were included in the tables although selection was done independently for each location

From the EP 82 semester 82A of 42 materials selected for their performance in Popavan 28 presented above-average yields in Palmira

It should be noted that the climatic conditions for the semester 83B through November were characterized by little rainfall in both environments and as a result disease pressure was not as heavy

IBYAN - Only the 1983 results of the Colombian sites and a brief summary of the 1982 trials conducted worldwide are presented (a separate report of IBYAN trials is published every year with a complete analysis of the international yield trials) Table 75 shows the characteristics number of entries and distribution pattern of the 83 IBYAN in 277 trials distributed mainly throughout Latin America and Africa

Bush bean trials at Colombian sites Trials were planted in CIAT-Palmira and Popayan in two semesters Trials at Palmira were conducted without chemical control for diseases whereas in Popayan a trial without chemical protection and protected one were conducted

Black beans Results for semester A are shown in Table 76 Two lines A 227 and BAT 1481 were among the best yielders in Palmira and Popayan contrasting testing sites in Colombia Performance was consistent under both protected and non-protected conditions ICTA Tamazulapa was also another material that showed good yield at both sites

Small red and red mottled beans These lines were tested at Palmira only during the first semester of 1983 Experimental lines clearly outperformed the local check BAT 1532 and BAT 1654 were the best materials in the small red group outyielding A 21-a very consistent performer through the years in the red-mottled group the best materials were BAT 1297 and A 463 (Table 77)

White beans New materials did not show a clear advantage over Ex Rico 23 and line 78-0374 well known materials from previous trials BAT 1592 was the best material at Palmira the sole testing site (Table 78)

Beans for the Mexican highlands Table 78 shows the results at Palmira of the experimental lines developed for the Mexican highlands Although conditions at this site do not reflect the stresses to which these material would be subjected nevertheless at least four materials were as good as Carioca a very good yardstick for measuring progress in these bean types

Brazilian beans The beans of the Brazilian grain types were grown in three trials where the Mulatinhos Cariocas Rosinhas Chumbinhos and Enxofres were tested separately in three trials

Table 79 shows the results obtained with the cream-seeded types (Mulatinho) tested at Palmira and Popayan A 321 and BAT 1601 showed good performance at both places with and without chemical control of diseases A 321 was outstanding even without the use of fungicides The Brazilian commercial variety IPA 74-19 could not compete with most of the materials tested under these conditions

In the cream striped (Carioca) group the results were very similar (Table 80) the outstanding lines in one place were the same in the other place A 206 A 267 A 268 and A 445 performed well in Palmira and Popayan whether chemical disease control was applied or not

Table 75 Characteristics composition number of entries and distribution of the IBYAN 83

Code	Grain characteristics	Growth habit	No of entries	Locations: South America	Central America	Caribbean	North Africa	East Africa	Southern Africa	West Africa	Northern Africa	Asia	Others	Total
10	black small	bush	16	25	22	4		1	1					53
20	red small	bush	16	8	38	7		1	1				1	56
25	red mottled large	bush	10	6	2	7		15	4	6		2		42
30	white small	bush	10	8	4	3		5	2		1	1	1	25
45	Mexican types	bush	20	4			2	12	3	1			1	23
50	Brazilian types													
	Mulatinho		16											
	Carioca		16	34		1		2	4	2	1	4	2	50
	Rosinha		16											
70	red warm	Climbing												
	climate		10	2	6			4						12
75	red cool	Climbing												
	climate		18	2			2	9	1			1	1	16
				89	72	22	4	48	16	9	3	8	6	277
		TOTAL		178	144	44	8	97	32	18	5	16	12	
	% of TOTAL				67 5				27 4			2 9	2 2	

Table 76 Average yield in kg/ha of the black seeded materials tested in the IBYAN 83 at CIAT-Palmira and Popayan during semester A

PALMIRA		POPAYAN			
Without protection		With protection		Without protection	
Line	Yield	Line	Yield	Line	Yield
BAT 1481	2 263a*	BAT 1432	3 460a	A 227	3 212 a
BAT 1554	2 15 ab	A 227	3 377a	XAN 112	2 777 b
A 227	2 129abc	Jamapa	3 289ab	A 213	2 534 bc
BAT 271(LC)[1]	2 110abc	BAT 1481	3 251ab	XAN 93	2 521 bc
ICTA	1 992abc	XAN 93	3 169abc	BAT 527(LC)[1]	2 468 bcd
Brunca	1 976abc	BAT 527(LC)[1]	3 139abc	Tamazulapa	2 425 bcd
Mean (n= 16)	1 840		3 111		2 301
CV (%)	9 3		8 3		10 7

1 LC = Local Check

* Figures followed by the same letter were not significantly different at the 0 05 level according to the Duncan test

Table 77 Average yield in kg/ha of the red materials tested in the IBYAN 83 at CIAT Palmir semester A

	Small reds		Red Mottled	
Rank	Experimental lines	Yield	Experimental lines	Yield
1	BAT 1532	2 223a*	BAT 129	2 562a
2	BAT 1654	2 111ab	A 463	2 449ab
3	BAT 1561	2 101b	ICA 21148	2 053cd
4	BAT 1577	2 075b	Calima	2 053cd
5	A 21	2 024b	A 463	2 032cd
	A 21		BAT 1336	1 927d
	Zamorano	1361c	Linea 24	1 882d
			A 469	1 816d
			BAT 1387	1 802d
			Linea 23 (LC)	1 423d
16 Local check	Zamorano 21 361c			

Mean 1 859 Mean 2 021
n= 16 n= 10
CV (%) 14 1 CV (%) 7 9

* Figures followed by the same letter were not statistically different at the 0 05 of the Ducan test

1 LC= Local check

Table 78 Average yield in kg/ha of white seeded materials and those developed for the Mexican highlands tested in the IBYAN 83 at CIAT Palmira semester A

White seed			Materials for Mexico		
Rank	Identification	Yield	Rank	Identification	Yield
Experimental lines					
1	BAT 1592	1 847a*	1	A 442	2 046a
2	Ex Rico 23	1 763ab	2	A 114	1 923ab
3	78-0374	1 650abc	3	A 410	1 876ab
4	XAN 125	1 640abc	4	A 429	1 866ab
5	BAT 1453	1 449abc	5	Carioca	1 860ab
Local checks					
7	BAT 1469	1 353abcd	13	G 2858	1 653bcde
12	BAT 1061	1 054d	17	A 67	1 430cde
Mean		1 423			1 672
n=		12		20	
CV(/)		19 5		11 6	

* Figures followed by the same letter were not significantly different at the 0 05 level of the Duncan test

Brazilian materials A450 Carioca and Carioca 80 showed good performance particularly Carioca

Table 81 shows the results with the pink dark tan and yellow materials A 381 and BAT 1670 showed the widest adaptation and were among the best materials in both sites Palmira and Popayan Aroana 80 the Brazilian check performed well at Palmira only

IBYAN 82 CIAT distributed 223 bush trials Materials were divided in groups as mentioned in the Bean Program Annual Report 1982

Table 82 shows the mean yields of the different types of bush bean trials across locations EMP 84 was the outstanding material among the blacks Corocibi in the small red group A 336 among the cream-seeded (Mulatinho) materials and A 176 in the group which included an assorted number of other Brazilian grain types All the red mottled lines tested have similar performances

Table 83 shows the comparison between the best experimental line and the best check in each of the groups of materials tested The best local check was in most uses outperformed by the best experimental line

Table 79 Average yield in kg/ha of the Mulatinho materials tested in the IBYAN 83 at CIAT Palmira and Popayan in semester A

Palmira			Popayan					
With protection			With protection			Without protection		
Rank	Identification	Yield	Rank	Identification	Yield	Rank	Identification	Yield
Experimental lines								
1	A 321	2 208a*	1	A 321	3 639a	1	A 321	3 145a
2	A 301	2 128ab	2	A 292	3 349ab	2	A 292	2 697ab
3	A 354	1 989abc	3	BAT 1601	3 309ab	4	A 315	2 563ab
4	A 343	1 956abc	4	A 343	3 259ab	5	BAT 1601	2 527ab
6	BAT 1601	1 866 bc	5	A 305	2 508ab			
Checks								
5	BAT 561	1 920bc	7	A 140	3 200ab	3	A 140	2 689ab
11	A 140	1 775c	8	BAT 561	3 132abc	8	BAT 561	2 473ab
13	IPA 74-19	1 741cd	10	IPA 74-19	3 079abc	14	IPA 74-19	2 122b
Mean (n=16)		1 804			3 012			2 415
CV (%)		8 2			19 0			17 2

* Figures followed by the same letter were not significantly different at the 0 05 level of the Duncan test

Table 80 Average yield in kg/ha of the Carioca materials tested in the IBYAN 83 at CIAT Palmira and Popayan in semester A

Palmira			Popayan					
With protection			With protection			Without Protection		
Rank	Identification	Yield	Rank	Identification	Yield	Rank	Identification	Yield
Experimental lines								
1	A 83	2 222a*	2	A 445	3 675a	1	A 286	3 480
2	A 286	2 050ab	3	A 442	3 675a	2	A 445	3 384
5	A 267	2 001ab	4	A 267	3 650ab	4	A 26	3 196
6	A 268	1 995ab	6	A 286	3 625ab	5	A 268	3 000
7	A 445	1 943ab	7	A 268	3 99ab	6	A 282	990
Brazilian materials								
3	Carioca	2 008ab	1	Ay o	3 715a	3	Carioca	3 77
4	Ayso	2 006ab	5	Carioca	3 627ab	9	Carioca 80	2 784
11	Carioca 80	1 829bc	8	Carioca 80	3 468ab	11	A so	2 565
Local check								
12	A 248	1 666cd	11	A 248	3 423ab	12	A 48	2 539
Mean (n=16)		1 878			3 483			2 794
CV (%)		8 6			7 3			13 1

* Figures followed by the same letter were not significantly different at the 0 05 level of the Duncan test

Table 81 Average yield (kg/ha) of the (pink) Rosinha (dark tan) Chumbinho and (yellow) Enxofre seeded materials tested in the IBYAN 83 at CIAT-Palmira and Popavan 1983 semester A

Palmira				Popayan						
With protection				With protection			Without protection			
Rank	Identification	Yield		Rank	Identification	Yield	Rank	Identification	Yield	
1	BAT 1297	2 191	a*	1	BAT 1670	3 463a	1	A 176	2 888	a
2	A 38	2 183	a	2	A 176	3 243a	2	A 373	2 815	ab
3	BAT 1375	2 012	ab	3	A 364	3 219a	3	A 381	2 663	abc
5	BAT 1670	1 867	abcd	4	A 373	3 188a	4	BAT 1670	2 480	abcd
6	A 29	1 785	abcde	5	A 381	3 097a	5	A 364	2 357	abcd
Checks										
4	Aroana 80	1 950	abc	12	Aroana 80	2 673a	9	Rosinha G-2	1 959	de g
14	Rosinha G-2	1 277	efg	13	Rosinha G-2	2 663a	13	Aroana 80	1 648	efg
Mean (n= 16)		1 659				2 942			2 112	
CV (%)		17 2				17 2			15 4	

* Figures followed by the same letter were not statistically different at the 5% level of the Duncan test

Table 82 Average yields of the bush breeding lines accessions and varieties tested in the IBYAN 82 across locations

Experimental Lines	Yield	Experimental Lines	Yield	Experimental Lines	Yield
Black seeded lines		Red mottled lines		Other Brazilian grain-types	
(based on data from 31 sites)		(based on data from 14 sites)		(based on data of 11 sites)	
EMP 84	1886a	BAT 1253	1118a	A 176	2224a
XAN 78	1824ab	BAT 1276	1060a	A 79	2142ab
EMP 60	1802ab	BAT 1147	1054a	A 140	2118abc
Jamapa	1767abc	BAT 1254	1052a	A 107	2092abc
BAT 304	1738abc	Linea 24	1017a	XAN 66	2084abc
A 231	1736abc	XAN 43	976a	A 86	2074abc
Porrillo Sintetico	1728abc	BAT 1272	961a	A 73	1953abc
BAT 58	1721abc	A 179	895a	A 89	1950abc
A 211	1710abc	Mean	1017	A 148	1938abc
XAN 40	1673bc	C V (%)	21 4	A 113	1903abc
DOR 62	1648bc			A 154	1879abc
AZ235	1595c	Mulatinho lines		XAN 68	1873abc
Mean	1736	(based on data from 5 sites)		A 147	1842bc
C V (%)	19 0	A 336	2825a	A 59	1840bc
		BAT 85	2738ab	A 156	1838bc
Small red-seeded lines		A 140	2632abc	A 162	1837bc
(based on data from 14 sites)		EMP 86	2607abcd	A 152	1831bc
		BAT 477	2574abcd	A 163	1787bc
Corobici	1740a	A 148	2543abcde	EMP 86	1766c
XAN 36	1733a	A 147	2483abcde	Mean	1947
Copan	1653ab	AETE 3	2468abcde	C V (%)	16 1
Chorotega	1629ab	G 7148	2399abcde		
BAT 1215	1547ab	IPA 74-19	2380abcde		
BAT 1192	1502bc	XAN 68	2335abcdef		
BAT 1217	1346c	CATU	2289bcdef		
Mean	1593	A 163	2217cdef		
C V (%)	15 3	G 5059	2215cdef		
		G 5054	2118def		
		A 156	2055ef		
		A 162	2047ef		
		A 154	1850f		
		Mean	2375		
		C V (%)	16 9		

Table 83 Performance of outstanding lines relative to the best local checks IBYAN 82

Location: City	Location: Country	Local variety	Yield in kg/ha	Yield of local variety compared with the best experimental line: Greater than %	Yield of local variety compared with the best experimental line: Less than %
Black seeds					
Palmira	Colombia	BAT 271	2702	9 9	
Popayan	Colombia	BAt 527	2629	20 2	
La Molina	Peru	Costa Rica I-8	1716	10 7	
Cotaxtla Veracruz	Mexico	Negro Veracruz	1295	35 6	
S Ixcuintla	Mexico	Negro Nayarit	3720		4 9
Chillan	Chile	Negro Orfeo	3265		14 9
Popayan	Colombia	ICA Pijao	3069		19 8
Popayan	Colombia	ICA Pijao	2836		20 9
Graneros	Chile	Negro Argel	2542		38 1
Trancas	Argentina	DOR 41	2486		7 0
Chillan	Chile	Negro Argel	2459		21 9
Graneros	Chile	ICA Pijao x Gratiot	2200		6 8
Chillan	Chile	Negro Argel	2176		24 5
Saman Mocho	Venezuela	Tacarigua	2119		18 5
La Cocha	Argentina	DOR 41	2118		14 8
Alajuela	Costa Rica	Testigo Local 2	2110		15 4
Cerrillos	Argentina	ICTA Quetzal	2083		11 4
Las Lajitas	Argentina	ICTA Quetzal	2021		55 7
Popayan	Colombia	BAT 527	1877		15 4
Alajuela	Costa Rica	ICA Pijao	1626		26 9
Turmero	Venezuela	Coche	1522		5 8
San Andres	Salvador	S-184-N	1464		34 0
Arist del Valle	Argentina	BAT 832	1437		16 4
Palmira	Colombia	BAT 271	1318		10 6
Maracay	Venezuela	Coche	1181		47 8
Alquizar	Cuba	CC-25-9	1098		26 0
Altamira	Mexico	Linea 1374	1078		24 8
Danli	Honduras	Jamapa Jamastran	858		69 9
Rosario de la Frontera	Argentina	ICTA Quetzal	762		65 6
Villaflores	Mexico	Negro Chiapas	671		60 4
Pt -au-Prince	Haiti	Testigo Local 1	667		30 0

Table 83 continued

Location				Yield of local variety compared with the best experimental line	
City	Country	Local variety	Yield in kg/ha	Greater than	Less than /
Small red seeds					
Popayan	Colombia	A 21	4 006	13 0	
Palmira	Colombia	A 21	2 170	4 4	
Popayan	Colombia	A 21	2 075	8 5	
Alajuela	Costa Rica	Huetar	1 668	7 9	
Palmira	Colombia	A 21	1 592	15 0	
Popayan	Colombia	A 21	2 660		16 8
Alajuela	Costa Rica	Local check 2	2 431		7 4
Popayan	Colombia	A 21	2 100		13 2
La Cocha	Argentina	DOR 41	1 944		0 4
Alquizar	Cuba	CC-25-9	1 530		27 0
Kingston	Jamaica	Miss Kelly	1 371		9 2
San Andres	Salvador	Rojo de Seda	1 333		9 7
San Francisco del Valle	Honduras	Criolla	1 083		14 9
Danli	Honduras	Salama	1 050		23 8
San Andres	Salvador	Arbolito Retinto			15 2
Large red seeds					
Uyole	Tanzania	Kabanima	3 065	6 8	
Big Bend Exp Station	Swaziland	Teebus	2 138	42 9	
Popayan	Colombia	A 182	2 028	25 9	
St Catherine	Jamaica	Miss Kelly	1 878	0 4	
Popayan	Colombia	A 182	1 864	10 4	
Alquizar	Cuba	Hatuey	1 464	4 6	
Popayan	Colombia	A 182	706	18 5	
Santander	Colombia	ICA Palmar	425	44 1	
Moshi	Tanzania	Kiburu	2 977		2 0
Mollepata	Peru	Red Kloud	2 597		8 4
Popayan	Colombia	A 182	2 209		12 4
Palmira	Colombia	Linea 23	1 855		4 8
Quillabamba	Peru	Linea 17	1 458		21 4
Palmira	Colombia	A 190	1 059		20 2
Caisan	Panama	Rosado	1 055		47 0
Malkerns	Swaziland	White Canning	1 011		0 5
Chipata	Zambia	Misamfu Speckled Sugar	489		82 4
Pt au Prince	Haiti	Local check 1	433		13 5
Misamfu	Zambia	1	318		3 8

Table 83 continued

Location				Yield of local variety compared with the best experimental lines	
City	Country	Local variety	Yield in kg/ha	Greater than	Less than/
Small white seed					
Graneros	Chile	ExRico 23 x NEP	4 375		14 3
Palmira	Colombia	BAT 1061	2 024		19 3
Graneros	Chile	Arroz Tuscola	1 160		141 9
Mulatinho seed					
Graneros	Chile	Amanda x Tortolas	4 271		16 3
Graneros	Chile	Negro Argel	2 839		40 4
Palmira	Colombia	A 286	2 396		0 3
Palmira	Colombia	A 286	1 856		1 6
Alquizar	Cuba	Bonita II	1 380		52 3
Carioca seed					
Palmira	Colombia	A 286	2 629	7 6	
Palmira	Colombia	A 286	1 910	6 5	
Moshi Kilimanjaro	Tanzania	Testigo Local 2	2 919		12 7
Graneros	Chile	Negro Argel	2 682		18 0
Cream colored seed					
Popayan	Colombia	A 286	3 857		9 5
Santiago Ixcuintla	Mexico	Azufrado Regional	3 154		25 2
Popayan	Colombia	A 286	3 129		6 3
Popayan	Colombia	A 286	2 541		19 7
Popayan	Colombia	A 286	2 534		5 2
Chapeco	Brazil	Carioca	1 803		44 7
Arist del Valle	Argentina	Iapar Rai 54	1 792		10 0
Big Beng Exp Station	Swaziland	Speckled Sugar bean	1 353		77 2
Tainan	Mexico	Agrarista	1 021		5 4
Malkerns	Swaziland	Speckled Sugar bean	690		158 6

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EVALUATION AND IMPROVEMENT OF AGRONOMIC PRACTICES

On-Farm Research

Bean Program on-farm research continues with three principal objectives (a) the feedback of information to breeding programs on the performance of new technologies especially varieties in farmers existing cropping systems (b) the adaptation of methodologies for on-farm research to cropping systems which include beans and (c) the training of national program scientists in these methodologies

A fourth objective is expected to gradually increase in importance namely the support of national program scientists in a network (initially in Latin America) conducting on-farm research in areas where beans are an important crop

Since October 1982 surveys have been conducted (see Economics section) and 102 trials (Table 84) in the four work areas in Colombia (for description of methodology see the Bean Program Annual Report 1982 On-Farm Research Table 1) A further 86 trials were planted in the work zones in 1983 between August and November based on results from the previous year s trials Also the Ford Foundation approved a special project for pilot training and network establishment activities for on-farm research in areas where bean cropping systems are important

In December 1983 a one week workshop was held to which five specialists in on-farm research were invited as consultants Their detailed recommendations and general support of present on-farm research activities will provide the basis for further evaluation of Bean Program activities

General feedback to breeding programs

Results from several types of trials in different zones and seasons permitted the estimation of the relative importance of different changes in cultural practices to increase yield (Tables 85 and 86) Often more than one type of trial contributed information about the same production factor Surprisingly few interactions between factors were detected in factorial trials designed for this purpose making the effects in Tables 85 and 86 approximately additive In the two highland climbing bean/maize systems (direct association in southern Nariño relay in Eastern Antioquia) improved foliar disease control and increased density were relatively more important than extra fertilizer application or seed treatment while in the main (B) cropping season in the bush bean areas of Central Narino (monoculture) and Northern Narino (row intercropped with maize) fertilizer application produced a greater agronomic effect The economic rates of return on investment for these different production factors are described in the economics section of this report Although the importance of production factors in the areas chosen for on-farm work in Colombia cannot necessarily be expected to be representative of that in bean growing areas throughout CIAT s mandate area the importance of soil fertility and drought in two of the four zones has had considerable influence on the evolving perception of Bean Program priorities in stress breeding

Bush bean yields in the first semester (A) in central and northern Narino were low principally due to the effects of drought and perhaps to the interaction of drought with low soil fertility No manipulable production factor changed this situation

Feedback to breeding programs from southern Narino

Two highly promising climbing bean lines were identified in the 1982/83 season Ecuador 605 a germplasm accession with the desirable seed size and color as well as type (IVb) which is almost identical to Mortino the most common local variety (7_/ of area planted) was identified on the ICA Obonuco station and in two farm trials in 1981/82 as having acceptable yield and considerable anthracnose tolerance In 1982/83 it outyielded Mortino by a mean of 243 kg/ha in four variety trials (Table 87) and five exploratory trials (Table 88) matured one month earlier and was attractive to farmers

In the exploratory trials Ecuador 605 outyielded Mortino at all technology levels and had a greater response to increased bean density than Mortino (achieved by changing the maize spacing within the row without changing the maize population density) (Table 88) In general increased bean yield depressed maize yields in the direct association system but the increase in bean density/change in maize spacing increased the yields of both (Table 85 and 88)

Taking into account these results Mortino and Ecuador 605 were planted in 1983B at three different technology levels (1) the farmer s (2) benomyl added to disease control and (3) benomyl + maize spacing changed/bean density in 14 verification trials throughout the zone in what is expected to confirm the utility of new technologies combined with Ecuador 605

One of the limits to crop production in Southern Narino identified by local researchers was the extreme length of the maize + bean cycle (9 to 11 months depending on the altitude) In an effort to shorten this a search wa made in 1982/83 for an early but strong stalked maize variety to accompany the recently-released early less aggressive bean variety ICA Llanogrande These were tested at different maize and bean densities The highest bean yield and highest net income or the system as a whole was obtained with four maize seeds and eight bean seeds/m^2 whenever Llanogrande was present Cundinamarca 431 a maize germplasm accession recommended by ICA for this experiment (also a parent of the hybrid H556) was the maize population which gave the highest bean yield while maintaining an acceptable maize yield and provided the highest income (Table 89) Even when averaged over all the densities tested including those less favorable it yielded only 180 kg/ha less than the local maize and permitted 325 kg/ha more bean yield (Table 85) In addition it matured two months earlier than the local maize

However Llanogrande was rather poorly adapted on farms of southern Narino (Table 85 and 87) despite its good performance on the ICA Obonuc station which serves the area

To continue trials on the intensification of the cropping system in 1983/84 an earlier but better adapted variety was needed Fortunately this was identified in the 1982/83 variety trial as the new line

32980-[m(4)-ma-mb]-1-41 which resulted from a cross originally made by ICA followed by selection in the collaborative CIAT-ICA program at Obonuco This was the most promising of five lines tested on farm for the first time and the highest yielding of all the climbing bean entries in the bean variety trial despite its early maturity (Table 85) It also had anthracnose tolerance and a seed type somewhat similar to the local variety Cargamanto Rayado In 1983/84 32980-1-41 was therefore planted with Cundinamarca 431 at a number of different maize and bean populations

The two lines Ecuador 605 and 32980-1-41 represent two different strategies to improve the varietal component of the southern Narino cropping system Ecuador 605 represents a conservative approach with little change involved for the farmer or intermediary in plant habit or seed type but with additional disease resistance and earliness 32980-1-41 represents a greater change in seed type and plant habit Additionally if it is grown with an earlier maize variety there is the possibility of fitting in another crop at the end of the growing season It could apparently also be grown with the local maize Anthracnose incidence was low in 1982/83 but as both lines have some resistance to this disease greater superiority over the susceptible local variety Mortiño might be expected in a year of high disease incidence

Few farmers grow bush beans in southern Narino but ICA is offering an alternative bean production system to farmers Results from two bush bean lines tested (Table 85) suggest that such a radical change might be justified although contrary to the usual experience and desirability of working within farmers present cultivation systems

Although the superior lines were all identified at the Obonuco experimental station the low correlation of performance between the station and the farms (Table 90) for the whole group tested indicates that it would be unadvisable to bring initially from station to farms a smaller group than the 11 climbing beans (plus three local checks) tested in 1982B In fact it may be advisable to screen larger number of materials at an earlier stage This process has been initiated in southern Narino in 1983B with the planting for on-farm evaluation of 120 parental materials from the Andean region crossing block for cool climate climbing beans It the future advanced lines will be screened on farm and possibly segregating generations as well

There was also poor correlation between bean performance on different farms Since the two bush bean lines tested were among the highest yielding on all but one farm their inclusion in the analysis increased the correlation coefficients (Table 88)

Another example of active feedback in on-farm research is provided by fertilizer application methods for climbing bean systems which are planted with a dibble stick It was found in the surveys during 1982 that a majority of farmers applied 100 kg/ha of 13-26-6 as chemical fertilizer and that some applied it below the seed as is normally

Table 84 Locations and number of trials planted on farms in Colombia in 1982B and 83

Type of trial	Eastern Antioquia 1982B	Southern Narino 1982B	Central Nariño 1982B	Northern Narino 1982B	Eastern Antioquia 1983A	Central Narino 1983A	Northern Narino 1983A
<u>Variety trials</u>							
Bean varieties							
Maize varieties	5[a]	4[a]	2	2	2	3	4
<u>Exploratory trials</u>							
FVFD Exploratory[b]	-	6[a]	2	3	-	6	6
IETV Exploratory[c]	-	-	2	2	-	5	6
Exploratory intensification trial (earlier maize and beans + high densities)	-	4[a]	-	-	-	-	-
<u>Trials for determination of economic levels</u>							
Variety x cultural practices	12	-	-	-	4	-	-
Fertilizer (N P K Mg Zn B)	-	4	1	1	-	-	-
Seed and soil treatment	-	2[a]	-	-	-	-	-
Leaf miner control	-	2	-	-	-	-	-
<u>Verification trials</u>	3[a]	2[a]	-	-	3	-	-
Total	20	24	9	10	9	14[d]	16[d]

a Copy of trial planted on nearby experimental station for comparison
b Foliar disease control x variety x chemical fertilizer x bean density (2^4 factorial trial)
c Foliar insect control x foliar disease control x seed treatment x varieyt (2^4 factorial trial)
d Two small trials per farm

Table 85 Yield increase of bush and climbing beans in kg/ha in monoculture and in association with maize as a response to changes in varietal and cultural practices and their interactions in which D= density E= disease control F= fertilizer and V= variety Positive (+) or negative (-) interactions are indicated where pertinent

	Southern Narino		Central Narino		Northern Narino	
	Beans	Maize	Beans B	Beans A	Beans B	Beans A
Changes in bean practices						
Improved foliar disease control	313	-166	235	54	186	21
Foliar insect control	--	--	107	0	169[e]	55
Seed treatment with fungicide	0[a]	--	316	11	53	-14
Soil treatment with insecticide	0	--	31		124	
Chemical fertilization with extra 39N-34P-15K	119[b]	33[b]	494	74	315	90
Minor element application	200[b]	0	70	--	0	--
Minor element applied	(Mg)		(Zn)			
Density increase in beans	245[g]	334[g]	108	97	20	67
Change in bean variety						
Change from farmers variety to principal new line tested	243	-156	213	30	-56	2
Change from farmers variety to most promising new line	490	-317	461	307	601	112
Farmers variety used	Mortino		Limoneno		Limoneno	Nima
Principal new line	Ecuador 605		Ancash 66		BAT 1235	
Most promising new line(s)	32980-1-41		Argentino		ICA L-23 BAT 1297	Argentino
Change to new maize variety	325	180	--	--	0 (+564)[f]	--
Maize variety	Cundinamarca 431		--	--	MB311[f]	--
Farmers yield	401	1997	978[c]	386[c]	537 (+800)[f]	252 (+300)[f]
Farmers harvested plant population/m^2	1 7	2 3	14 6	14 6[d]	7 2	6 0[d]
Interactions detected	DV+** DE+**	Absent	Absent	VF-	Absent	Absent

a Result seems low conflicts with observations of importance in the zone
b Estimate made assuming that correct application at ridging would avoid stand loss caused by application at planting time
c Obtained by farmers using Argentino Limoneno yielded much less but commanded a higher price
d Estimate
e Result seems high in comparison to field observations of insect importance
f Estimated change in maize yield
g Maize spacing changed to increase bean density
* Significant at 5% level
** Significant at 5-10% level

Table 86 Bush and climbing bean yield increase in kg/ha in monoculture and in association with maize as a response to varietal and cultural practices in farm trials in Antioquia in two more highly developed towns- El Carmen (E) and Marinilla (M) and one less developed town San Vicente (S) from 1978-83A

Season	1983A	1982B	1981B	1980B	1979B	1978B	Mean	1982B
Town	E	E&M	E	E	E	E	E&M	S
No of farms	4-9[a]	8	14	15	15	11	--	2 4[b]
<u>Fertilization change</u>								
Foliar disease control changed from maneb to benomyl/maneb	--	111	625[c]	569[c]	--	--	402	18
Apply carboxin + carbofuran or aldrin	95	--	--	--	-202[d]	--	-53	--
200 kg/ha additional 13-26-6	16	--	--	--	--	--	16	--
<u>Rhizobium</u> inoculation in place of N	--	--	-278	--	-195	-475	-316	--
<u>Increased bean population</u>								
Stakes as additional support	--	--	--	681	478[e]	569	576	--
More beans/maize hill	36	--	467	174	--	--	226	--
Maize spacing changed	--	103	--	--	--	--	103	439
	--	-188M	--	--	--	--	-188M	179M
<u>Bean population changed (m^2)</u>								
Projected from	2 0	2 35	2 35	2 35	2 35	2 35	--	1 65
to	5 0	4 7	4 7	7 0	7 0	7 0	--	3 3
Harvested from	2 8	2 0	--			1 8	--	1 2
to	3 9	2 7	--			5 2	--	2 5
<u>Bean variety change</u>								
Cargamanto to Llanogrande	110	219	259	201	--	--	197	-189
Cargamanto to La Selva 1	13	119	--	--	--	--	64	277
Cargamanto to Viboral	--	-11	36	-204	-142	--	-80	-51
<u>Maize variety change</u>								
Montana to ICA V-402	--	141M	--	--	--	--	141M	659M
Farmers yield								
Beans	1 086	902	1 013	957	1 192	1 000	1 025	600
Maize	2 500[f]	1 704	--	--	--	--	2 000[f]	1 955

a 9 farms for variety data 6 for seed treatment data 4 for other data
b 2 farms for bean data 4 for maize data
c Estimated from difference between yields of farmers who use and do not use benomyl
d Carbofuran alone
e Includes effect of seed treatment with fungicide Further population increase from 7 0 - 9 5/m^2 causes a yield reduction of 56 kg/ha
f Estimate

Table 87 Selected results from a bean variety trial in southern Nariño 1982B (mean of four farms) with 16 entries in which climbing bean density was planted at four plants/m^2 and 2 8 plants/m^2 harvested and bush bean density planted at 25 plants/m^2 and 5 9 plants/m^2 harvested

	Length of bean cycle in months	Bean yield kg/ha	Maize yield kg/ha	Seed color	Seed weight (mg)
32980-1-41	7 5	956	1745	Cream/black	700
Ecuador 605	8 5	707	1920	Purple/cream	620
Mortiño (check)	9 5	466	2062	Purple/cream	750
Llanogrande	7 5	293	1747	Cream/purple	530
TIB 33411 (bush bean)	6 0	1470[a]	0	Red/cream	480
TIB 33341 (bush bean)	6 0	1231[a]	0	Red	520
LSD (5%)		365	765		

a Severe foliar disease incidence above 2 700msl approximately

Table 88 Yield costs and benefits of new technologies with Mortino and Ecuador 605 (from an exploratory trial for disease control x variety x fertilizer x density with a mean of five farms in southern Narino 1982B)

	Farmers technology		Increased bean density		Better foliar disease control		Increased bean density + disease control	
	Beans	Maize	Beans	Maize	Beans	Maize	Beans	Maize
Yield (kg/ha)								
Mortino	435	1 832	550	2 094	658	1 462	890	2 049
Ecuador 605	592	1 617	818	1 874	847	1 509	1 253	1 736
Increase due to change of variety	157	-215	268	-220	189	47	363	-313
Variable costs ($Col/ha)[a]	8 253		11 276		10 835		13 858	
With Mortino	38 129		45 896		39 348		59 233	
With Ecuador 605	41 693		54 845		49 602		71 061	

	Beans	Maize
LSD (5%) for yield (kg/ha) with same disease control	159	441
LSD (5%) for yield (kg/ha) with different disease control	168	513

a Fixed costs $Col 10 831/ha

Table 89 Selected results (mean of three farms) from an exploratory intensification trial with a total of 16 treatments in southern Narino 1982B

Maize variety	Bean variety	Density/m^2		Yield in kg/ha		Variable costs[a] ($Col/ha)	Net income ($Col/ha)
		Maize	Beans	Maize	Beans		
Local	Llanogrande[c]	4	8	2706	582	6 901	46 969
Cacahuacintle[c]	Llanogrande[c]	4	8	2597	637	5 979	48 021
Cundinamarca 431[c]	Llanogrande[c]	4	8	2847	861	5 979	62 080[b]
H556[d]	Llanogrande[c]	4	8	3371	477	5 979	56 554
Local	Mortino (check)	4	2	2147	545	2 159	43 872[b]

a Fixed costs = $22 759 Col/ha

b Economically efficient treatments

c Two months earlier than local

d One month earlier than local

recommended by agronomists Therefore the fertilizer used in different types of trials was applied in the same way There was considerable drought at planting which led to what was apparently fertilizer burn in those plots which had been more heavily fertilized Two trials were planted in 1983B to investigate this problem The results of plant establishment (Table 91) in one of the trials not only show the danger of applying high doses of fertilizer below the seed but confirm the validity of the practice of applying fertilizer above the seed (a practice whose advisability was initially doubted by agronomists) The use of a DAP/Huila rock phosphate mixture produced similar serious problems with stand loss despite mixing with the soil possibly due to the urea and potassium chloride added to make the nutrient content of the mixture equivalent to the compound formula

Feedback to breeding programs from central Nariño

In the monoculture bush bean system in Central Narino the second semester was confirmed as productive and amenable to new technological inputs (Table 85) whereas the first semester appeared highly marginal with drought being the principal limiting factor

In 1982B the local variety Limoneno with a preferred seed type similar to Calima was chosen as the principal farmers check for the trials The Peruvian germplasm accession Ancash 66 identified a promising on CIAT and ICA stations outyielded Limonero in all but two of the seven farms where they were tested together Its response to applied inputs was equal to that obtained in Limoneno but at a higher yield level Although its seed color (cream/purple turning red when cooked) is slightly less preferential than that of Limoneno (red/cream) this was compensated by its greater yielding ability illustrated by the data presented in Table 92 (These data relate to a particular design of trial If the mean responses to Ancash 66 and fertilizer derived from different trials and presented in Table 85 are used the returns are slightly different)

Ancash 66 is normally classified as a type IIIb on experimental station trials and is usually tested with climbing beans In farm trials it proved to be highly variable in its growth habit expression Under low fertility conditions Ancash 66 behaved as a compact type II with no apparent guide and a high harvest index Under more fertile conditions it showed type IIIa habit with branches borne well above the ground and slight guide development while under high fertility it formed a dense mat with some branches trailing on the ground and profuse intertwined guides above These changes are illustrated by the data in Table 93 where the change in plant size is not accompanied by a correspondingly large increase in yield These observations of habit variability on farms have helped the program to evolve concepts of growth habit x environment interactions

Although Ancash 66 outyielded Limoneno it was beaten in the regional variety trials by the local variety Argentino which has been increasingly adopted by farmers in central Nariño since it first appeared in 1977 Although it suffers up to a 40% price discount because of its less desirable seed color and size (purple small-medium seeds) Argentino has found acceptance with farmers because of its high stress resistance Table 94 provides a summary of the relative performance of Argentino Ancash 66 and Limoneno in the first and second semesters at different altitudes in central and northern Narino The superiority of Argentino over Limoneno decreased below 1 700 msl although Argentino is apparently adapted down to 1 000 msl Ancash 66 is apparently not adapted below 1 400 msl and was generally outyielded by Argentino with the exception surprisingly of northern Narino in 1982A

The stability and wide adaptation range of Argentino have led to its adoption as the farmers check in the 1983B trials in central Narino More importantly it has been placed as a check in international EP trials and used more intensively than before as a parent for crosses in the breeding program for the Andean region and eastern Africa

Feedback to breeding programs from northern Nariño

In the second semester in El Tambo northern Narino lines such as ICA L-23 will be ICA L-24 and Diacol Nima which do not have high levels of disease resistance generally outyielded lines from the CIAT Bean Program having more disease resistance genes In the first semester ICA L-23 the highest yielding and apparently most stable line in 1982B was among the lowest yielding lines (Table 95) However in 1983B it is expected that ICA L-23 is the most promising line for the second semester planting the more important season

The line originally selected as a representative of improved varieties with disease resistance BAT 1235 showed no yield advantage over the farmers checks Limoneno for 1982B and Nima for 1983A (Table 85) Chemical fertilization followed by disease and insect control were the factors which caused the largest yield response in 1982B and have entered verification trials in 1983B

However fertilizer application did not provide an adequate return on investment in the set of three exploratory trials (Table 96) although the effect was larger in a preliminary fertilizer trial The fertilizer rate applied in verification trials has therefore been reduced to 200 kg/ha and a fertilizer trial is being conducted on more farms in 1983B

In northern Narino parental lines F_4 bulks and advanced lines are being preliminarily evaluated on farm in 1983B to aid CIAT breeders in a search for material with medium or large red seeds better adapted to these conditions

Feedback to breeding programs from Eastern Antioquia

In 1982B trials were conducted in two more developed towns- El Carmen and Marinilla which were previously studied in ICA-CIAT on-farm work and in one less developed town-San Vicente where ICA-CIAT work on beans started in 1982A The results for these two areas are presented separately in Table 86 In addition the effects of changes in varietal and cultural practices evaluated since 1978 in El Carmen are included (see CIAT Bean Program Annual Reports 1979-1981)

In 1982 the researchers planted both maize and beans in the trials in the relay system used in this area Instead of planting beans in relay with farmers maize plantings this was an attempt to test the benefits of changing the maize within-row spacing without changing the maize density in order to increase the bean density It also provided the opportunity to test the maize variety ICA V-402 in certain treatments The effect of the change in maize spacing on beans was too small to be economically beneficial in El Carmen and Marinilla and also produced a yield loss in maize In San Vicente however where maize and bean densities are lower due to wider inter-row and inter-plant spacing the effect of the change was positive on both maize and beans (Table 86)

The effect of changing the foliar disease control from maneb (four times) to benomyl + maneb (twice) was small in both zones probably because Ascochyta which is not controlled by benomyl seems to have replaced anthracnose as the main disease of the area In addition many farmers now use benomyl in mixtures with other chemicals and the change must now be considered as having been incorporated into farmers practices

The yield advantage of ICA Llanogrande over Cargama to in El Carmen and Marinilla (219 kg/ha) was similar to that in the previous two years (Table 86) Surprisingly it showed no more response to density than Cargamanto and no more response to improved disease control (Ascochyta was the main disease) It seems unlikely that ICA Llanogrande would be readily adopted by farmers in these areas in view of its small yield advantage and price discount although in other areas of Colombia its yield advantage is expected to be greater

The line ICA La Selva 1 identified as promising on farms in 1982A and confirmed in 1982B was more successful since it has a seed type almost identical to Cargamanto and equally appreciated by farmers Its relatively small yield advantage (119 kg/ha) might be sufficient to facilitate adoption by some farmers More important ICA La Selva 1 is more stable than either Cargamanto or Llanogrande This was particularly evident for the poor soils and low plant densities of San Vicente where La Selva 1 outyielded Cargamanto but Llanogrande yielded poorly The trends shown in Figure 1 tend to confirm that lines classified as of type IVb on station (Cargamanto and La Selva) are more stable than those of type IVa (Llanogrande and V6785-325) The trials included in this stability analysis were conducted when anthracnose incidence was low hence the responses measured are principally to soil fertility La Selva 1 is particularly stable These results have led to an increase in the emphasis given to type IVb in CIAT climbing bean breeding although emphasis is still given to type IVa due to the reduced danger of maize lodging

In 1983 the planting time of the trials in El Carmen was advanced to March to synchronize planting again with farmers who have been trying to obtain a better bean price at harvest Trial planting dates for beans in Marinilla and San Vicente were maintained in August and September There was little disease incidence and excellent plant development in El Carmen in 1983A so none of the agronomic practices applied (seed treatment additional chemical fertilizer increased density) had a significant effect on yield for any of the varieties tested (Table 86) The benefit obtained from La Selva 1 and Llanogrande as disease resistant varieties was also small However since La Selva 1 yielded as well as Cargamanto in a season with little disease and commands the same price it is to be expected that it would outyield Cargamanto agronomically and economically in a year with greater anthracnose incidence

In eastern Antioquia the lack of correlation between farm and station results in variety trials and between one farm and another has been similar to that discovered in southern Narino (Table 90) It is suspected that soil phosphorus levels may be the reason for this divergence Variety trials are therefore being conducted in 1983B at two fertility levels and on a larger number of farms than in 1982

Methodology adaptation

The basic methodology within which different strategies are being tested has already been described (CIAT Bean Program Annual Report On-Farm Research 1982) It has been modified slightly to specify more clearly the stages involved in characterization of the farmer s situation (Figure 2) The methodology provides a framework both in survey activities and in trial activities of the stages and different functions involved in on-farm research Increasing emphasis is being given to the design and testing of strategies when time or resources are limited

The types of trials designed and the stages commenced simultaneously (Table 82) were conceived with the likely strategy of a national On-farm research program in mind rather than to provide specific feedback to the CIAT Bean Program The results reported above illustrate however that within specific zones both objectives can be achieved by the same set of trials

In all three zones of Narino the utility was demonstrated of simultaneously commencing variety trials exploratory trials (in which the variety is a component) and a few determination trials (which may specifically use the most promising variety) This is particularly true when some information is already available on promising varieties If none is available it may be best to first conduct variety trials for one season Even in northern Narino where the initial choice of variety proved incorrect much information was gained by a multiple-stage approach in the first year

The advisability of commencing with verification trials from the first year depends principally on the urgency with which a first approximation of a recommendation i needed The experience in southern Narino with this type of trial in the first year was not positive since the variety chosen (ICA Llanogrande) proved non-adapted to farms in that area

When little is known about a cropping season in a specific area or risk is high it may be preferable to commence with only variety and exploratory trials as in central and northern Nariño in 1983A

The performance of groups of varieties tested in variety trials has generally been more variable between farms in a particular zone than originally expected This led in 1983B to an increase in the number of variety trials planted/season in each zone typically up to four in the heterogeneous conditions of the Colombian work zones

Factorial exploratory trials may be designed with more than one replication/farm only one/farm or even with one incomplete block/ farm The first two approaches have been tested by the CIAT Bean Program and the second appears preferible at present since with the same resources the mean response to production factors can be obtained on a more representative sample of farms in a zone

One of the most critical stages on-farm research and the most difficult to conceptualize and teach is the study of the limiting factors identified in the reconnaissance and survey then identification of those which provide the best opportunities for socioeconomically viable solutions through research and the corresponding technological components These must then be incorporated in one or more trials in the different agronomic research stages An example of this process is shown in Table 85 for southern Nariño in which the number of research opportunities and technological components available was unusually high

Training and Network Construction

As mentioned in the introduction a pilot project for training and network establishment for on-farm research in bean cropping systems in Latin America was prepared by CIAT staff and approved by the Ford Foundation Training activities will follow more than one model The first intensive CIAT-based course will be given for seven weeks from March to May 1984 following the multidisciplinary phase of bean postgraduate training Regionally or nationally based on-farm research courses in more than one phase will carry out the steps in on farm research in a specific area

As a preparation for both types of courses two CIAT staff members attended as observers one phase of a similar course given by CIMMYT in Honduras Discussions on regional training in on-farm research in Central America with CATIE are also in progress It is hoped that from both contacts mutually complementary or collaborative training activities will develop

Table 87 Number of trials planted on farms in Colombia in 1982B and 1983A

Type of trial	Eastern Antioquia 1982B	Southern Narino 1982B	Central Narino 1982B	Northern Narino 1982B	Eastern Antioquia 1983A	Central Narino 1983A	Northern Narino 1983A
	LOCATION						
Variety trials							
Bean varieties	5[a]	4[a]	2	2	2	3	4
Maize varieties	-	-	-	1	-	-	-
Exploratory trials							
FVFD Exploratory[b]	-	6[a]	2	3	-	6	6
IETV Exploratory[c]	-	-	2	2	-	5	6
Exploratory intensification trial (earlier maize and beans + high densities)	-	4[a]	-	-	-	-	-
Trials for determination of economic levels							
Variety x cultural practices	12	-	-	-	4	-	-
Fertilizer (N P K Mg Zn B)	-	4	1	1	-	-	-
Seed and soil treatment	-	2[a]	2	1	-	-	-
Leafminer control	-	2	-	-	-	-	-
Verification trials	3[a]	2[a]	-	-	3	-	-
TOTAL	20	24	9	10	9	14[d]	16[d]

[a] Copy of trial planted on nearby experimental station for comparison
[b] Foliar disease control x variety x chemical fertilizer x bean density (2^4 factorial trial)
[c] Foliar insect control x foliar disease control x seed treatment x variety (2^4 factorial trial)
[d] Small on farm trials

Table 90 Correlations between yields on four farms of southern Narino and the ICA Obonuco experimental station in 1982B

Yields evaluated	Between individual farms		Between individual farms and experimental station		Range mean of farms and experimental station[a]
	Range[a]	No significant[b]	Range[a]	No significant[c]	
14 climbing beans	0 02 to 0 37	0	-0 10 to 0 51	0	0 34
14 climbing beans+ 2 bush beans	0 22 to 0 90***	1	0 31 to 0 95***	2	0 86***
Local maize with 14 climbing beans	-0 19 to 0 46*	1	-0 49* to 0 37	-1	-0 10

a Values of Pearson correlation coefficient and level of significance

b At 5/ level total of six comparisons

c At 5/ level total of four comparisons

Table 91 Effect of fertilizer application method on plant establishment in the maize/climbing bean system in southern Narino in 1983B

Application	Establishment / Beans	Maize
Unfertilized (to be fertilized at ridging)	74	46
Hole at side (500 kg/ha 13-26-6)	70	45
Above seed (500 kg/ha 13-26-6)	45	29
Below seed (500 kg/ha 13-26-6)	17	15
Below seed (DAP/urea/KCl/rock phosphate)	4	9

Table 92 Economic returns on new variety and fertilizer use in central Nariño in 1982B (mean of two farms in a disease control variety fertilizer density exploratory trial)

	Limoneno		Ancash 66	
	No Fertilizer	300 kg/ha 13-26-6	No Fertilizer	300 kg/ha 13-26-6
Yield (kg/ha)	342	920	692	1209
Gross revenue ($Col/ha)	15 390	41 400	31 140	54 405
Total costs	15 860	23 546	15 860	23 546
Net income	-470	17 854	15 280	30 859

Table 93 Effect of fertility changes on plant height and yield of Ancash 66 in a fertilizer trial on one farm in central Narino in 1982B

Application kg/ha	Plant height (cm)	Yield in kg/ha
Mean of P levels		
0 N	44 9 c*	1414 b
46 N	52 1 b	1675 a
92 N	68 2 a	1745 a
Mean of N levels		
0 P	49 7 b	1537 a
40 P	56 8 a	1597 a
80 P	58 8 a	1725 a

*Means in the same column followed by the same letter are not significantly different (P = 0 05) according to Duncan s multiple range test within N & P levels

Table 94 Yield comparison in kg/ha of Argentino and Ancash 66 with Limoneño across zones and seasons

	In Monoculture in Central Narino				Intercropped with maize in Northern Narino		
	1982B		1983A		1982A	1982B	1982B
	Monoculture				Row intercrop with maize		
Altitude (msl)	1 800-2 300msl		1 800-2 300msl		1 400-1 500msl	1 320msl	1 050msl
No of farms	4	7	3	14	3	1	1
Varieties							
Argentino	1 270	ne	386	ne	738	907	434
Ancash 66	ne[a]	1 197	244	353	949	272	0
Limoneno	809	985	79	323	687	707	298
Varietal superiority							
Argentino over Limoneno	461	-	307	-	51	200	136
Ancash 66 over Limoneno	-	212	165	30	262	-435	-298
Argentino over Ancash 66	249[b]		142[c]	277[b]	-211[c]	635[c]	434[c]

a ne = not evaluated
b Calculated difference
c Real difference in same trial(s)

Table 95 Contrasting performance of bean lines in first and second semesters in El Tambo northern Narino Yield in kg/ha

Season	1982B	1982B	1982A	1983A
No of farms	1	1	3	4
Altitude	1 320masl	1 050masl	1 400-1 510masl	1 320-1 420masl
ICA Line 23	1 120	1 087	548	173
ICA Line 24	1 098	659	677	269
BAT 1235	900	306	956	286
BAT 1297	1 165	806	875	399
Argentino	907	434	738	398
Nima (check)	1 155	590	631	286
LSD (5/)	242	224	156	88

Table 96 Response of Limoneno and BAT 1235 to fertilization and disease control Data from a disease control variety fertilization density exploratory trial in el Tambo northern Narino 1982B Mean of three farms at 1 280-1 400 masl)

Variety	Disease control	Fertilizer (kg/ha 13-26-6)	Bean yield[a] (kg/ha)	Variable costs ($Col/ha)	Net Income ($Col/ha)
Limoneno	Without	0	686	5 280	23 528[c]
		300	992	13 116	28 238
	With[b]	0	945	8 775	30 652[c]
		300	1 132	16 611	30 483
BAT 1235	Without	0	526	1 723	10 952[c]
		300	790	9 559	9 135
	With[b]	0	721	5 218	11 903
		300	983	13 054	10 040

a Estimated maize yield 916 kg/ha Farmer managed bean yield 697 kg/ha LSD (5/) bean yield 256 kg/ha

b Benomyl (0 5 kg/ha) + maneb (1 0 kg/ha) twice

c Economically efficient treatments

Table 97 Correlations between bean yields in different sites seasons and systems in Antioquia 1982

	Experimental Station		Farm		
	1982B La Selva Relay	1982B La Selva Monoculture	1982B Marinilla Relay	1982B S Vicente Relay	1982A Marinilla Monoculture
Experimental Station					
1982A La Selva Relay					
1982B La Selva Monoculture	0 40 NS[a] (21)				
Farms					
1982B Marinilla Relay	0 19 NS (19)	0 03 NS (19)			
1982B S Vicente Relay	0 00 NS (23)	0 46* (23)	0 03 NS (20)		
1982A Marinilla Monoculture	0 41 NS (23)	0 34 NS (23)	0 09 NS (20)	0 34 NS (24)	
1982A El Carmen Monoculture	0 36 NS (21)	0 42 NS (21)	0 07 NS (18)	0 53* (22)	0 57** (22)

a Values are those of the Pearson correlation coefficient r
The number of varieties appears in parentheses

Table 98 Design of trials for southern Narino in 1982B

Limiting factors	Technological components	Type of trial and number planted						
		Bean variety	EVFD exploratory	Exploratory intensification	Fertilizer	Seed treatment	Leaf miner	Verification
		4	6	4	4	2	2	2
Foliar and pod diseases root rots	Resistant variety (same growth cycle)	T[a]	T	-	General	-	-	-
Foliar and pod diseases root rots low bean density	Resistent variety (early and less vigorous)	T	-	T	-	-	-	T
Maize + bean cycle too long	Early maize + early less vigorous bean variety	-	-	T	-	-	-	-
	Bush bean in monoculture	T	-	-	-	-	-	-
Foliar and pod diseases	Cut and mulch weeds to reduce splash	-	-	Additional Traits	-	-	-	-
Farmers chemical disease	Add benomyl to present control	-	T	General	General	General	General	General
Farmers fertilizer doses may be incorrect or incorrectly balanced	More chemical fertilizer	-	T	General	T	-	-	T
	Change N/P ratio	-	-	-	T	-	-	-
	Add secondary or minor elements	-	-	-	T	-	-	-
Root rots	Chemical fungicides and insecticides	General	-	General	General	T	General (fung only)	T
Leaf miner	Soil and foliar insecticides	----------General---------- (in Emergency only)					T	T

a T= farmers check

Economics Production Research

Production research in bean economics is focused on three principal activities (1) identification of constraints characterization of production systems (2) technology evaluation and (3) adoption and impact studies

Identification of Constraints

Results of initial characterization surveys in Narino and in eastern Antioquia Colombia were presented in the CIAT Bean Program Annual Review Report 1982 In 1983 basic economic data on costs of production for beans and alternative crops were collected in three regions of Narino

In the climbing bean/maize system in southern Narino use of both agrochemicals and labor is quite high (Tables 99 and 100) In contrast labor inputs are much lower in the bush bean systems though agrochemical use is frequent in the bush bean monoculture system but low in the bush bean and maize intercrop Returns on land and capital calculated from the current cost structure provides a basis for evaluating the acceptability of new technologies

Technology Evaluation

Both returns on land and capital are economic criteria in farmers evaluation of new technologies Marginal net returns per hectare and marginal rates of return are calculated to present the profitability of new technologies (Tables 101 and 102) compared to current technologies (Table 100) Returns on total costs (Table 100) reflect of the situation of relatively larger more commercial farmers while the returns on cash costs are more indicative of the situation of smaller farmers who make extensive use of family labor For smaller farmers returns on capital are generally higher than for large farmers and quite high returns to capital appear to be necessary to make new technologies economically attractive to small farmers for whom capital is a scarce resource

Several changes in variety and cultural practices were tested in on-farm trials in Colombia (see On-Farm Research section of this report for detailed agronomic discussion) The germplasm bank accession E 605 performed well in on-farm trials in southern Narino Colombia (Table 101) This line has a grain type that is highly commercial but due to its somewhat smaller seed size is likely to sell at a slight discount compared to the farmer s current variety Mortino Nevertheless E 605 appeared profitable in 1983 trials

More profitable than the new variety are improved disease control practices supplementing farmer s traditional use of dithane with benomyl (Table 98) Increased density of bean planting also appears to be profitable although the management implications of a changed planting arrangement remain to be assessed A linear programming model of a small farm in southern Narino has been constructed to assess the impact of new bean technology on the whole farm system The model indicated that area planted to beans would stay constant with the new technology (variety + disease control + increased density) while whole farm net income would rise 10 6/

In on-farm trials in Central Narino in the fall of 1983 the germplasm bank accession Ancash 66 which has a grain type likely to be commercially acceptable in Colombia both outyielded and was more profitable than the local farmer check variety (Table 102) Use of fertilizers foliar disease control and insect control (all practiced in some form by most farmers in the area) (Table 99) were also prof table The combination of soaking seed in benomyl and the incorporation of aldrin in the soil a practice not utilized by local farmers was also profitable This year s trial results suggest that several elements for an attractive new technology may be available for this zone The performance of the line Ancash 66 is being verified in the 1984 trials but studies of the commercial acceptability of this grain type are needed Optimal fertilizer dosages for the region remain to be determined and the performance of the seed and soil treatment is also being retested

Trials from the spring planting suggest that fertilizer foliar disease control and increased density are not profitable in this drier season although the new line maintains its superior performance compared to the local variety

In the high stress environment of northern Narino several changes in cultural practices led to increases in yields and profits/ha but in general relatively low rates of return on capital were attained (Table 103) In the fall fertilizer application at planting raised yields but capital requirements were high for fertilizer increasing total costs about 39/ while the marginal return on investment in fertilizer was low compared to current returns to capital in beans (Table 96 and 103) Of course lower fertilizer dosages might prove to be more attractive Insect control was the most profitable alternative tested achieving both the highest returns per hectare as well as the greatest return on capital with the smallest investment Foliar disease control may also be economically viable earning a 118 2/ on capital while requiring a 19/ increase in total investment (Table 103) Despite some slight yield increases that were achieved in the spring planting most changes in practices led to economic losses in this season

Adoption Studies

In recent years many new bean varieties have been released to farmers which were developed in collaborative research between CIAT and national programs In 1983 a survey of 195 bean farmers was undertaken in a joint project between the University of Costa Rica and CIAT to assess the adoption process of new bean varieties in Perez Zeledon Costa Rica an area that directly accounts for 15/ of the national bean production and is broadly representative of the Brunca region which contributes 42/ of national bean production

The survey found that in the wet season 60 5/ of farmers sampled were growing the variety Talamanca and 5 6/ were growing Brunca (both varieties developed in collaboration between CIAT and Costa Rica) (Table 104) These varieties together accounted for 49/ of the area sown in beans Farmers also reported higher yields with these new varieties than those obtained with the most common traditional variety in the zone Jamapa (Table 104)

Of farmers growing Talamanca 11/ reported some incidence of disease while 7% noted that it was more difficult to thresh No other problems were reported with any significant frequency and 96/ of farmers growing Talamanca intended to continue to do so The only major change observed in cultural practices so far associated with Talamanca is that 37/ of farmers planted at a higher density than other varieties This may be due both to its more erect architecture than most local varieties and its improved disease resistance Relative acceptance of Talamanca appears to be somewhat lower in the dry season than the wet season (Table 104 and 105)

Marketing and Consumption

Since grain characteristics such as size color brilliance and shape are often important determinants of consumer acceptability and the price of beans considerable attention is devoted to assessing consumer preferences to guide program scientists in the selection of new commercially acceptable materials

One approach has been to study current patterns of bean consumption Surveys have been conducted of 187 households in Cali and 260 households in Medellin Colombia to test the utility of this technique In both cities per capita consumption of dry red beans was found to be relatively constant across income strata although in all income groups consumption was higher in Medellin than in Cali (Table 106) However in both cities there was a clear difference in consumption of bean varieties with highly preferred large reds accounting for 92/ of bean consumption in the high income strata in Medellin compared to 52% among the lowest income group Similarly in Cali large reds accounted for 52% of bean consumption in the high income group and only 21% of consumption in the lowest income group

Hence there is clearly a market for less preferred bean types among the poor as long as these are cheaper In urban Colombia there does exist a market for less preferred small red beans that might be casually rejected as too small to be commercial However these small beans will sell at a substantial price discount and they may also face a relatively narrow market For example the Colombian data show little tendency for households to increase bean consumption but a strong trend to shift from less preferred to more preferred bean varieties as resources permit

While the poor do not eat significantly less beans than the well-to-do in Cali and Medellin they do eat beans more frequently in smaller quantities/serving (Table 107) This is achieved in part because the poor in urban Colombia prepare beans mixed with plantain to stretch them out

Aggregating across income classes the total market share for different bean varieties can be calculated In Cali bean consumption is quite varied with five varieties each holding more than 12/ of the market and the single most important variety occupying a market share of only 25 9/ (Table 108) By contrast in Medellin preferences are more rigid with a single highly preferred high price variety accounting for 65% of total consumption Thus even within a country great regional variation exists in bean preferences and their rigidity

To better understand consumer attitudes towards beans a subsample of low income housewives were interviewed in depth in both Cali and Medellin In Cali 80% of housewives reported that they enter the store with no fixed intention to buy any particular bean variety They purchase what is available and are fairly flexible in that they do not search for a particular bean Larger beans are indeed preferred but low income housewives buy small beans both because they are cheaper and because they absorb more water making them more filling Preparation methods give housewives control over several characteristics so that a bean improvement effort directed at the Cali market need not take these factors into account

Most Cali housewives prefer a thick broth but since 93% cook beans with plantain broth thickness as a bean characteristic is not a critical factor Similarly light red beans are less preferred than darker red beans but most housewives (68%) use food coloring to achieve desired broth color Similarly cooking time is not an important consideration in purchasing beans since 94% of surveyed households use pressure cookers to prepare them The highly preferred Cargamanto bean for example is widely known to require more cooking time than others

While general knowledge of consumer bean preferences can offer broad guidance in the selection of new materials more specific information on the direct economic value of particular traits can be useful in assessing new lines For example in Colombia small beans are known to be less preferred than large but to evaluate a new variety for example in on-farm trials it is useful to be able to assign a price for a bean of a particular size or color To address this information need a sample of 31 bean merchants in Colombia were asked to provide price estimates for a number of varieties some commercial other experimental The average of merchant estimates for the price of commercial varieties (which were not identified as such in the interview) were extremely accurate differing from prevailing market prices by less than 2%

By this means price estimates of several promising new lines for Colombia were obtained (Table 109) and these estimated prices are being used to assess the economic profitability of new varieties

These results from studies of consumer preferences in Colombia alone cannot serve as a overall guide to incorporating grain quality factors into selection of new materials for all of Latin America and Africa Rather they illustrate how simple low cost methodologies can be used by national programs to assess their needs with respect to grain quality factors and to estimate the economic value of promising lines in yield trials

Table 99 Input use as a percentage in three bean production systems in Narino Colombia 1983

Input use in /	Southern Narino Climbing beans/ maize	Central Narino Bush bean monoculture	Northern Narino Bush bean/ maize
Chemical fertilizer	52	85	22
Fungicides	89	69	11
Insecticides	100	85	11
Seed treatment	7	0	0
Credit	7	62	17

Table 100 Average costs and returns in three bean production systems in Narino Colombia 1983

Costs and returns	Climbing beans/ maize	Bush bean monoculture	Bush bean maize intercrop
Labor (days/ha)	113 4	54 3	69 0
Cost of agrochemicals ($/ha)	5 482	3 369	0
Other costs ($/ha)	3 100	4 250	3 983
Total costs ($/ha)	27 377	17 514	24 008
Cash costs ($/ha)	14 557	9 369	10 850
Value of bean output ($/ha)	31 680	37 500	24 000
Value of maize output ($/ha)	22 440	0	16 830
Net return on total cost ($/ha)	26 743	19 986	16 822
Net return on total costs (/)	97 7	114 1	70 1
Net return on cash costs ($/ha)	39 563	28 131	29 980
Net return on cash costs (/)	271 8	300 0	276 3

Table 101 Economic Analysis of changes in varietal and cultural practices tested in on-farm trials southern Nariño Colombia 1983

Change	Marginal Cost ($/ha)	Net marginal return ($/ha)	Marginal rate of return (%)
Variety -F 605	0	8 962	-
lertilizer	7 180	-658	-
Foliar Disease Control	2 582	9 643	373 5
Increased Density	3 023	15 593	515 8

Table 102 Economic Analysis of changes in varietal and cultural practices tested in on-farm trials Central Narino Colombia 1982-83 Fall (B) and spring (A) plantings

Change in fall (B)	Marginal cost ($/ha)	Net Marginal return ($/ha)	Marginal rate of return (%)
Variety-Ancash 66	0	5 310	-
Fertilizer	7 686	14 544	189 2
Foliar disease control	3 383	7 232	213 7
Foliar insect control	1 315	3 500	266 1
Seed and soil treatment	6 482	20 428	315 1
Density increase	7 040	-2 180	-
Change in spring (A)			
Variety-Ancash 66	0	1 350	-
Fertilizer	7 686	-4 356	-
Foliar disease control	3 343	- 913	-
Density increase	7 040	-2 675	-

Table 103 Economic analysis of changes in varietal and cultural practices tested in on-farm Trials in northern Narino Colombia 1982-83 fall B and spring A plantings

Change in Fall (B)	Marginal cost ($/ha)	Net marginal return ($/ha)	Marginal rate of return (%)
Fertilizer	7 836	2 578	32 9
Foliar Disease Control	3 495	4 131	118 2
Foliar Insect Control	1 790	5 139	287 1
Soil Treatment	3 150	1 319	41 8
Seed and Soil Treatment	5 525	2 593	46 9
Density Increase	7 320	-6 500	-

Change in Spring (A)	Marginal Cost ($/ha)	Net marginal return ($/ha)	Marginal rate of return (%)
Fertilizer	7 836	-4 146	-
Foliar Disease Control	3 495	-2 634	-
Foliar Insect Control	1 790	4 665	26 0
Density Increase	7 320	-4 573	-

Table 104 Bean varieties and farmers yields in the wet season 1983 in Perez Zeledon Costa Rica

Variety	No farmers planting (%)	Area planted (%)	Yield (kg/ha)
Talamanca	60 5	46 9	1 052
Brunca	5 6	2 1	1 146
Jamapa	19 5	27 5	944
Turrialba 4	3 1	1 4	861
Porrillo Sintetico	3 6	1 7	1 197
Mexico 80	10 3	4 2	780
Mexico 27	2 6	1 4	624
Canero	6 7	3 6	718
Chimbolo Rojo	11 3	3 6	625
Chimbolo Negro	3 6	1 4	709
Others	13 8	6 2	642

Source University of Costa Rica/CIAT survey data

Table 105 Bean varieties and farmers yields in the dry season at Perez Zeledon Costa Rica 1982

Variety	No farmers planting (%)	Area planted (%)	Yield (kg/ha)
Talamanca	34 [illegible]	23 4	633
Brunca	2 7	1 4	719
Jamapa	28 2	20 9	556
Turrialba 4	4 0	1 9	544
Porrillo Sintetico	4 0	2 4	754
Mexico 80	12 1	8 6	623
Mexico 27	2 0	2 2	1 039
Cañero	3 4	3 0	609
Chimbolo Rojo	21 5	13 4	477
Chimbolo Negro	14 1	8 0	415
Sierra	11 4	6 0	508
Others	13 4	8 8	384

Source University of Costa Rica/CIAT survey data

Table 106 Dry bean consumption by income and grain type in Cali (1982) and Medellin (1983) Colombia

Income	Cali			Medellin		
	Total[a]	Large reds	Small reds	Total[a]	Large reds	Small reds
High income	6 3	3 2	3 0	11 5	10 6	0 9
Middle high	6 5	3 0	3 2	14 6	11 4	2 9
Middle low	7 8	2 2	5 4	12 6	8 2	4 4
Low income	6 5	1 4	4 7	12 9	6 7	6 2

a Excludes immature green beans and white beans

Table 107 Frequency of dry bean consumption by income in Cali (1982) and Medellin (1983) Colombia

	Cali		Medellin	
	Serving /week	Average portion (g/capita/serving)	Servings/week	Average portion (g/capita/serving)
High income	2 2	55	2 7	82
Middle high	2 6	48	3 8	74
Middle low	2 9	52	4 3	56
Low income	3 2	39	5 0	50

Table 108 Market share of bean varieties in Cali (in 1982) and Medellin (1983) Colombia

Variety	Cali market share (%)	Medellin market share (%)	Grain type
Cargamanto	4 8	65 4	Large cream red mottled
Mortino	12 7	-	Large red mottled
Radical	5 7	1 8	Red
Rojo americano	13 6	0 6	Small red
Calima	25 9	12 3	Medium red mottled
Blanquillo	16 7	3 6	White
Caraota	2 5	-	Black
Verde	17 2	10 7	Immature green
Others	0 9	5 6	

Table 109 Prices of new bean varieties estimated by bean merchants in Cali Colombia December 1983

Commercial Varieties	Price (Col $/½ kg)
Calima	49 2
Mortiño	61 3
New varieties	
BAT 1297	36 0
ICA 23	48 1
Llanogrande	45 0
La Selva 1	50 0
E 605	57 5

Biology and Control of Insect Pests

Survey on importance of invertebrate bean pests in Latin America

A questionaire on the importance of invertebrate pests of beans in Latin America was prepared and given to participants of the Bean research and training course visitors and others involved in bean research A summary of the results of 28 participants from 10 countries is presented in Table 110 On a regional basis the pests most often mentioned in Colombia as severe were soil pests and leaf-feeding beetles In Mexico the severe pests were whitefly (as a vector of BBMV) and leafhoppers (Empoasca) In Central America and Cuba slugs white flies Heliothis pod borers and leaf-feeding beetles were most often noted as severe In the southern part of South America Empoasca was most often considered a severe pest Seed infesting bruchids were mentioned as important pests throughout Latin America

Many participants wrote that pesticides were often applied with no apparent need Some important local pests that were unknown to the Bean Program were also mentioned

Effect of the insecticide carbaryl on pod set There was concern that the use of the insecticide carbaryl during flowering of beans might reduce pod set in much the same way that the chemical is used to thin apples A study of the application of 1 and 1 5 kg AI/ha of carbaryl in a wettable powder formulation twice during flowering had no effect on pod set or yield (Table 111)

Biology of a stinkbug and damage to beans In areas such as Brazil and Costa Rica stink bugs have been noted as pests of bean pods The damage stink bugs cause to crops is often underestimated For example the economic threshold of stinkbugs on soybeans has been calculated to be about two late instar nymphs or adults/ meter of row

Stink bugs infesting beans at CIAT-Palmira include Thyanta perditor (F) Piezodorus guildinii (Westwood) Euschistus crenator (F) Leptoglossus sp Megalotomus rufipes (Westwood) and Acrosternum marginatu (Palisot de Beauvois) Of these the latter is known to be important in Central America

The biology of A marginatum at 24 C is summarized in Table 112 The life cycle is relatively long compared to the growing season of bush beans at Palmira It is doubtful that stinkbugs could build up to high population levels in one crop season An average of 96 8 eggs were laid/female

Late instar nymphs and adults of A marginatum were used to infest ICA-Linea 24 bean plants in cages in the field The cages covered 3 m (5 meter row) of beans and were infested at the rates of 5 10 and 20 bugs/cage Bugs were replaced as necessary to maintain the infestation levels throughout the podding stage There were three replicates/ treatment and the entire trial was repeated three times

Each stink-bug/meter row caused about a 40 kg/ha loss (Figure 1) At a price of 42 Colombian pesos/kilo (about US $0 50) an economic threshold for stinkbugs on this variety would be about one late instar or adult/meter of row (0 6 m)

Biology of Heliothis virescens on beans Species of Heliothis have been noted as important pests of beans in Central America and Africa The duration of the life cycle of H virescens from egg to adult at 4 C in CIAT was 27 3 days 3 1 for the egg 19 1 for the larva (five instars) and 5 1 on beans for the pupa Under field conditions two-thirds of the eggs of H virescens were found on the foliage and equal numbers on the upper and lower leaf surfaces Young leaves were preferred The rest of the eggs were found on fruiting structures Beans were less preferred than cotton or soybeans for oviposition in the greenhouse

H virescens at Palmira was resistant to monocrotophos (Azodrin) (Table 113) The addition of a small amount of piperonyl butoxide to permethrin made that synthetic pyrethroid more toxic to H virescens

Effect of bean maize association on insects A study was conducted on the effect of planting maize associated with beans on insect pests In this study the effect of relay beans planted in relay at maize maturity was compared with monoculture beans monoculture maize and beans plus maize planted together on the same date Two treatments involved the mature maize in relay with the leaves stripped off the maize stem or with the dry leaves left on

Population levels of the leafhopper Empoasca kraemeri nymphs/leaf on beans relayed with maize stems possessing leaves were 20% of those on monocultured beans at 39 days after planting There were no significant differences between the other treatments (Table 114)

There were no significant differences in populations levels of the leaf-feeding beetle Diabrotica balteata on beans between treatments Heavy damage caused by D balteata larvae to maize was not different between monocultured and associated maize

Table 110 Results of a questionaire on the importance of invertebrate bean pests in Latin America

Pest	Number of responses			
	Damage Level			Use of control chemical
	Severe	Moderate	Occasional	
Empoasca	10	12	5	16
Whiteflies	9	7	1	10
Aphids	1	6	13	8
Mites	1	6	10	2
Leaf beetles	9	16	1	18
Mexican bean beetle	1	1	4	2
Defoliators-worms	0	5	8	5
Soil pests	7	5	10	8
Slugs	5	2	5	6
Heliothis	3	2	9	6
Apion	2	0	2	2
Other pod borers	0	4	5	3
Stink bugs	3	1	8	3
Bruchids	12	7	3	6

Table 111 Effect of insecticides applied during flowering when no noticeable in ect problem was present on the number of newly set pods/bean plant and yield

(kg/ha) Treatment		Number of newly set pods/ 10 plants Days after planting 36	 41	 56	Yield (kg/ha)
Carbaryl WP	1 5 kg AI/ha	5 5*	18 1	3 7	1 590
Carbaryl WP	1 0 kg AI/ha	2 7	16 9	3 2	1 532
Monocrotophos	1 0 kg AI/ha	4 9	17 1	3 4	1 748
Water	-	3 2	18 0	3 9	1 542
Check (Untreated)		4 2	16 5	4 3	1 374

* No significant differences at 5/ level

Table 112   Biology of *Acrosternum marginatus* on beans in Palmira at 24 C

Life Stage	Duration (Days)
Egg	6 8
Instar 1	4 5
Instar 2	6 5
Instar 3	6 3
Instar 4	6 0
Instar 5	12 0
Total to adult	42 1
Adult female duration	43 2

Table 113 LC_{50} and LC_{90} values for monocrotophos and permethrin with and without piperonyl butoxide to *H virescens* third instar larvae

Treatment	LC_{50}	LC_{90}
Monocrotophos	86	851
Monocrotophos + piperonyl butoxide	63	20 558
Permethrin	7 9	54
Permethrin + piperonyl butoxide	3 8	14

Table No 114 Effect of bean maize association on population levels of *Empoasca kraemeri* nymphs

TREATMENT	No of nymphs/10 leaves at days after planting[a]		
	29	39	54
BAT 1235 alone	7 5 b	5 2 b	30 0
BAT 1235 + Suwan uno 1 maize	2 5 ab	5 2 b	31 0
BAT 1235 in relay with stripped maize stalks	4 0 b	4 0 b	41 5
BAT 1235 in relay with maize plants	0 2 a	1 0 a	40 5
VRB 81069 with pole and wire support	7 7 b	6 7 b	34 0
VRB 81069 + Suan uno 1 maize	6 7 b	7 2 b	26 0
VRB 81069 in relay with stripped maize	3 2 ab	6 5 b	42 8
VRB 81069 in relay with maize plants	1 2 a	1 0 a	33 0

[a] Means followed by same letter are not significantly different at 5/ level of the Duncan Test

23677

Hybrid Dwarfism

Over a dozen additional cases of F_1 hybrid dwarfism were encountered in crosses made at CIAT during 1983 Further studies were undertaken to demonstrate that differences in seed size of the parental lines giving F_1 hybrid dwarfism were a critical factor and that one parent always had small (25g/100 seeds) and the other either medium (26 - 40g/100 seed) or large (40g/100) seeds (Table 115) Hybrids within small or among medium and/or large seeded types were always normal A relationship was established between selected parents studied at CIAT and those reported by other researchers showing similar phenomenon (Tables 116 117) It was therefore concluded that this apparent incompatibility between the two groups of germplasm was controlled by two complementary dominant genes Dl_1 and Dl_2 reported earlier by Shii et al (1980 1981) Small seeded bean lines carrying gene Dl_1 originated from Brazil Colombia Guatemala and Mexico medium or large seeded lines carried gene Dl_2 were from Bolivia Brazil Chile Colombia Turkey the United States and West Germany These two genes have probably played an important role in the evolution of bean forms of different seed sizes by serving as a genetic barrier or isolating mechanism thus limiting free genetic recombination between the two germplasm groups Some lines which are non-carriers of dominant alleles with genotype dl_1 dl_1 dl_2 dl_2 of small e g ICA Pijao A 30 G 3807 etc medium e g G 2858 G 2618 and large e g Calima were also identified to be utilized as bridges for transferring or recombining desirables genes from two or more incompatible parents

Table 115 Growth of the F_1 hybrids involving common testers of small-seeded and large seeded types for which N= normal growth and development and D= dwarfs or retarded growth and development

Males	Females	
	BAT 332 (small)	ICA L-23 (medium)
Small seed		
BAT 332	-	D
BAT 1061	N	D
G 4017	N	D
G 7148	N	D
Medium and large seed		
G 153	D	N
G 159	D	N
G 568	D	N
G 623	D	N
G 688	D	N
G 910	D	N
G 5066	D	N
G 5129	D	N
G 7613	D	N
G 7633	D	N
G 7635	D	N
G 7160	D	N
ICA L-23	D	-

Table 116 Growth of the F_1 hybrids of selected bean accessions from a CIAT and those hybrids reported by other workers giving crippled sub- or developmental abnormality for which N= normal growth and development
D= dwarfs or retarded growth and development

Females	Males						
	Small seeded				Large		
seeded	BAT 332	BAT 1061	G 4017	G 7148	G 623	G 5066	G 7633
G 623 (Large)[a]	D	D	D	D	-	N	N
G 4017 (Small)[a]	N	N	-	N	D	D	D
G 4489 (Small)[b]	N	N	N	N	D	D	D
G 3804 (Medium)[b]	D	D	D	D	N	N	N
Maestro (Medium)[c]	D	D	D	D	N	N	N
PI 165435 (Small)[c]	N	N	N	N	D	D	D

[a] Selected lines from the CIAT study

[b] Studied and reported by Shii et al 1980 Journal of Heredity 71 219-222

[c] Studied and reported by York and Dickson 1975 Annual Report Bean Improve Cooperative (New York) 18 88-89

Table 117 Growth of the F_1 hybrids from diallel crosses among bean accessions reportedly showing dwarfism by different workers in which N= Normal growth and development and D= dwarfs or retarded growth and development

	Males					
Females	BAT 332	L-23	G 4489	G 3804	Maestro	PI 165435
BAT 332	-	D	N	D	D	N
L-23		-	D	N	N	D
G 4489			-	D	D	N
G 3804				-	N	D
Maestro					-	D
PI 165435						-

23678 Ingles

SCIENTIFIC TRAINING AND NETWORK ACTIVITIES

Central America and Caribbean

The objective of the Swiss Development Cooperation (SDC) financed project is to generate and transfer improved technology and train personnel of the national programs for bean research and production The logistics of locating a scientist in Costa Rica and two scientists in Guatemala respectively are provided through agreements between CIAT and the Interamerican Institute for Agricultural Cooperation (IICA) and the Instituto de Ciencia y Tecnologia Agricola de Guatemala (ICTA) The project was reviewed in August 1983 by representatives of the SDC and an extension was approved for three more years

Highlights

During 1983 farm-level testing of newly released varieties was emphasized in Honduras Costa Rica and Guatemala and for the first time on-farm trials were set up in the Dominican Republic A more practical integrated control for web-blight was developed which made bean production by either small or large farmers feasible in areas where the disease is epiphytotic Resistance to BGMV has been increased in black materials and have been combined with other desirable characteristics such as earliness and resistance to Apion and CBB Increased BGMV tolerance was achieved in red as well as in mottled grain types Efficiency for evaluation of Apion resistance was improved so larger number of lines can be evaluated The establishment of the adaptation nursery of red black and red mottled grain types considerably strengthens the Central American network and of its individual national bean programs

In order to help national programs transfer new varieties and technologies to farmers in-country courses were conducted in Cuba Costa Rica the Dominican Republic and Honduras emphasizing on-farm trials In Costa Rica and the Dominican Republic the courses were organized in collaboration with FAO and had participants from Mexico Guatemala El Salvador Honduras Nicaragua Panama The Dominican Republic Costa Rica and Haiti A field workshop was held in Guatemala and Costa Rica involving twenty participants financed by FAO and CIAT In the workshop participants evaluated the Apion and the web-blight nurseries and discussed improvements in methodology to further raise tolerance and develop a more practical integrated control for web blight

National programs emphasized production of larger volumes of breeding and foundation seed Workshops were held for varietal description in collaboration with the Seed Unit in Guatemala and Costa Rica

Research Activities

Adaptation nursery Initially CIAT distributed germplasm through the IBYAN as finished advanced lines The number of lines which could be distributed in the IBYAN was small and the probability of recovering an adapted acceptable variety was likewise reduced Consequently lines in early stages of testing in CIAT's program have been distributed to collaborators in national programs but not until 1982 was a uniform nursery organized to distribute a large number of lines in an adaptation nursery for multi-site testing in Central America The purpose of this nursery is to rapidly and efficiently sift a greater quantity of breeding lines in the target area itself to identify the best adapted lines

Adaptation Nurseries with 84 black seeded lines each were planted in Guatemala El Salvador Costa Rica and Honduras In each site a single replication was planted with the sites serving as replications A local check variety was planted every 5-10 rows and the yield of the best materials was adjusted as a percentage of the nearest checks This planting design offers great promise in overcoming the effects of variation in the field thereby permiting early generation yield estimates When data from the various sites were compiled some lines outyielded the checks in all sites The superior lines were selected for testing for resistance to BGMV Apion and web blight the three priority biological restraints in Central America

Feedback The Central American program has increased feedback to CIAT over the past year Fxamples are the importance of earliness the need to understand the relationship between earliness and yield potential the use of land races in the crossing program (particularly to introduce resistance to BCMV) more emphasis on drought and low phosphorus tolerance and a special project to improve cooking quality in the cultivar Rojo 70 for El Salvador

The Adaptation Nursery (discussed previously) is also an important feedback mechanism identifying the best adapted materials

The system of crossing codes developed by the CIAT based breeders greatly facilitates requests for crosses for Central America A broader use of computer facilities should improve the transfer of data to and from Central America

Technology Transfer

From CIAT to national programs CIAT staff researchers continuously made training and other visits to project countries and sent germplasm to fit consumer preferences Visiting the different countries was needed either to help in the selection of new germplasm participating in field workshops establishment of on-farm trials or participating in country courses or training regional personnel in specific problems During the year IBYAN sets were distributed in Central America and in the Caribbean according to the color and size preferences of each collaborating country

Sets of the climbing bean nursery VIRAF were distributed and planted in Central America In addition specific nurseries were distributed for BGMV web blight angular leaf spot Ascochyta anthracnose rust CBB and Apion as well as for tolerance to low phosphorus and heat Finally eight sets of the EP were distributed and planted in the region to screen for regionally important production constraints such as BGMV web blight Ascochyta rust Apion and heat

The national programs now manage and select germplasm from early generations making it possible to plant the Adaptation Nursery and to start selecting progenies for local adaptation as well for resistance to regionally important pests and diseases in larger numbers in the F_3 F_4 F_5 thus accelerating the process of producing superior varieties for the region

Among national programs The project assisted the Costa Rican Guatemalan and Hondurean programs in the planning assembly and distribution of the local yield nurseries VINAR

The VICAR (Vivero Centroamericano de Rendimiento) was extended to the Caribbean A total of 60 sets were distributed 29 red seeded and 31 black seeded nurseries to Nicaragua Honduras Costa Rica El Salvador Guatemala Mexico and Cuba The best black entries were Talamanca Negro Huasteco 81 ICTA-Tamazulapa ICTA-Quetzal Porrillo Sintetico Tazumal and Brunca (Table 118) Composites formed of some of these varieties were stable in yield although not superior The line XAN-112 tolerant to CBB and as early as Brunca performed well in most of the locations in 1983B The ICTA line Jutiapa 81-26 also did well

In the red VICAR Huetar and BAT-789 were superior in most locations in Costa Rica Honduras and Nicaragua (Table 118)

The Instituto de Nutricion de Centro America y Panama (INCAP) and beginning this year the Centro de Investigación de Tecnologia de Alimentos (CITA) of the University of Costa Rica continued the analysis of protein content amino acid composition cooking time etc of the materials included in the VICAR The preliminary results indicated that all of the newly released varieties have good physical and chemical composition

Agronomy - on farm trials

Costa Rica In collaboration with the Consejo Nacional de Produccion (CNP) 24 on-farm trials (12 red seeded and 12 black seeded trials) were established in which three-production factors were studied In each trial four new varieties were studied in comparison with the local variety and fertilization on two levels one according to a soil analysis and the other the level utilized by the farmer Weed control was studied in two levels-use of herbicides vs the farmer s manual weed control The results so far indicate that the new varieties are highly superior to the farmers variety Brunca yielded between 40-80/ more and Huetar between 50-100/ not only in the improved technology package but also under farmer practices (Table 119 120 and 121)

Honduras In Santa Rosa de Copan different types of on-farm trials were established including varieties and fertilization as variables The improved varieties Acacias 4 and Huetar yielded better than the local variety

Dominican Republic For the first time on-farm trials were set up with improved lines for comparison with the local varieties Pompadour Chica, Rose Beta and Constanza. The lines included were BAT 1412, DOR 198, DOR 211 and DOR 214. The trials will be harvested in February 1984.

Guatemala Six on-farm trials for the integrated control of web blight among the small and large farmers of the Pacific Coast were established in collaboration with students of the University of San Carlos and ICTA. The results are outstanding and it is expected that the farmers will increase bean acreage in 1984.

Seed multiplication The agronomist in Guatemala has increased seed for the VIM and VICAR nurseries as well as for the national and on-farm trial in each country.

Varietal release In 1983 Nicaragua released the lines BAT-789 as Revolucion 79A and BAT 1217 as Revolucion 83. In Cuba BAT 93 and BAT 518 are in multiplication.

Varietal adoption Studies by the socio-economic program of ICTA have shown a significant adoption by the farmers of the improved varieties Suchitan (ICA-Pijao), ICTA-Tamazulapa, ICTA-Quetzal and San Martin. They estimated that 40% of the total area is planted with these varieties. A study in collaboration with the Department of Agricultural Economics of the University of Costa Rica and CIAT in the region of San Isidro de El General showed that the new variety Talamanca was adopted by 5 % of the farmers. In Nicaragua about 60% of the area has been planted with the improved varieties and in Cuba about 90% of the total area planted in beans by the state sector.

Training Efforts were directed to strengthen the bean research network in the region. Fourteen scientists were trained at CIAT headquarters and nine in Central America. These candidates came from Costa Rica, El Salvador, Honduras, Nicaragua, Guatemala, Mexico, Cuba, Dominican Republic, Haiti and Panama. Training in bean production mainly directed to technology transfer and on-farm research was emphasized. In-country courses were organized in Cuba, Costa Rica, Dominican Republic, and Honduras. The courses in Costa Rica and Dominican Republic were regional and partially financed by FAO. About 120 technicians were trained. Project personnel as well as CIAT-based personnel participated actively in these courses.

Two MS candidates finished postgraduate studies at Vicosa, Brazil and returned to their countries Guatemala and Costa Rica. One scientist from El Salvador went to Chapingo, Mexico to begin postgraduate studies at the MS level.

Field workshop on Apion and web blight research A field workshop on Apion was held in Guatemala with participants from all the Central countries. The main objective was to discuss the progress made in the development of mass screening techniques, evaluation scales and problems encountered. Another objective was to standarize evaluation criteria and the formation of a collaborative network in the region.

Most of the participants and others from countries where Apion is not a pest met in Costa Rica to study progress made in web blight control This progress was measured in terms of varietal improvement for resistance to the pathogen chemical control and cultural practices as well as for the standardization of the evaluation scale

All the participants were active in the field discussions and agreed upon the establishment of an effective network for reliable evaluation of materials for Apion and web blight In-service training in these two regional problems for all the countries in the region was also proposed

Other Activities During 1983 the project was reviewed by a team of four scientists selected by the SDC including the project coordinator They visited the national programs and farmers in Cuba Guatemala and Costa Rica In a day long-workshop the leaders of the national programs of the region were able to assess progress in bean research and the raising of the national productivity in the countries where newly released varieties have been adopted by farmers

All three members of the Central American project who participated in the meeting of the PCCMCA held in Panama City April 4-9 helped in the organization of the grain legume session and in the presentation of the work carried out in the region

Future Plans The project will continue to evaluate early generation tailor-made bean materials to improve and correct the weakness of the newly released varieties The project will emphasize development of earlier maturing materials tolerance to drought Apion and web blight

To increase the communication among the national programs in the region and to transfer more easily the technology generated by the national programs the project will organize field workshops and a meeting of the leaders in the region to increase horizontal transfer and cooperation among national programs

The addition of economic evaluations in the project will permit the study of adoption of newly released varieties and their contribution to the increase in productivity in the countries This input will also increase the activity of the agronomist in the on-farm research needed in the different countries

Table 118 Yield (hg/ha) of Central-American Yield nurseries (VICAR 1983) in Costa Rica Claudio Baudrit Expt Sta

BLACK VICAR		RED VICAR	
1/4 D-145 + 3/4 composite	1 680 a	Revolucion 81	2 200 a
ICTA-Quetzal	1 630 ab	Revolucion 79	2 110 a
Brunca	1 610 abc	Huetar	2 070 a
1/2 D-145 + 1/2 composite	1 590 abc	DOR 164	2 050 ab
3/4 D-145 + 1/4 composite	1 580 abc	Mexico 80	1 950 abc
ICTA Tamazulapa	1 570 abc	CENTA Izalco	1 880 abc
Porrillo sintetico	1 550 abc	BAT 789	1 840 bcd
CENTA Tazumal	1 540 abc	Acacias 4	1 770 cde
Composite	1 540 abc	Coribici	1 680 de
ICTA-81-64	1 540 abc	Rojo de seda	1 570 e
ICA-Pijao	1 480 abc	Honduras 46	1 560 e
Negro Huasteco 81 (D-145)	1 450 abc	Chorotega	1 550 c
Talamanca	1 440 abc		
ICTA Jutiapan	1 340 bcd	C V = 6 71%	
Turrialba 1	1 310 cd		
Pavamor (Check)	1 110 d		

C V = 10 3 %

COMPOSITE 1/4 Icta - Quetzal
1/4 Talamanca
1/4 Centa Tazumal
1/4 Porrillo Sintetico

Table 119 Yield of improved varieties in farm trials under improved technology packages and farmer s practices in two locations in of San Isidro de El General in Costa Rica

Variety	Treatment	YIELD (k/ha) Location 1	Location 2		Yield over check 7	Yield over farmer /
ICA-Pijao	Recommended fert [a] + herbicide	1 245	1 440	1 342	110	270
	farmer fert + herbicide	660	920	790	24	118
	Recommended fert + hand weeding	800	980	890	40	145
	Farmer fert + hand weeding (check)	600	673	636	-	75
	Aveg $\overline{X}$	826	1003	915	38	
Talamanca	Fert recommended+herbicide	1 022	1 300	1 161	86	220
	Fert farmer+herbicide	533	913	723	16	99
	Fert recommended + hand weeding	666	1 300	983	58	171
	Fert farmer + hand weeding (check)	400	847	623	-	72
	Aveg $\overline{X}$	655	1 090	872	32	-
Porrillo Sintetico	Fert recommended+herbicide	1 200	1 400	1 300	59	258
	Fert farmer + herbicide	666	953	809	-	123
	Fert recommended + hand weeding	1 200	760	980	20	170
	Fert farmer + hand weeding (check)	1 000	633	816	-	125
	Aveg $\overline{X}$	1 016	936	976	47	-
Brunca	Fert recommended+herbicide	1 466	1 633	1 549	31	327
	Fert farmer + herbicide	557	1040	798	-33	120
	Fert recommended + hand weeding	1 133	1 720	1 426	20	293
	Fert farmer + hand weeding (check)	1 200	1 173	1 186	-	227
	Aveg $\overline{X}$	1 089	1 391	1 240	87	
Farmer s practices	Fert recommended+herbicide	800	1106	953	162	
	Fert farmer+herbicide	600	847	723	99	
	Fert recommended + hand weeding	666	553	610	68	
	Fert farmer + hand weeding (check)	400	327	363	-	
	Avg $\overline{X}$	616	708	662		

a Fertilization according to soil analysis (recommended) or according to farmers practice

Table 120 Yield in kg/ha of improved black bean varieties in the VINAR in three regions of Costa Rica The number in parenthesis gives the number of trials/region

	Location			
VARIETY	Alajuela	Perez Zeledon	Upala	Average
Porrillo Sint	1 966(10)	1 517(12)	1 814(6)	1 766(28)
Talamanca	1 839(8)	1 473(10)	1 797(4)	1 703(22)
ICA Pijao	1 960(8)	1 173(10)	1 807(4)	1 647(22)
Brunca	1 917(6)	1 185(7)	1 606(3)	1 569(16)
Jamapa	1 663(8)	1 235(8)	1 813(5)	1 570(21)
Mexico 27	1 450(4)	1 208(5)	2 063(3)	1 574(1)
San Fernando	1 175(3)	1 142(8)	1 541(4)	1 286(15)
Average	1 710	1 276	1 777	1 588

Table 121 Yield in kg/ha of improved red beans in the VINAR summary of three regions in Costa Rica The number in parenthesis gives the number of trials/region

	Location			
Variety	Alajuela	Perez Zeledon	Upala	Average
Huetar	2 007(3)[1]	1 228(4)	1 350(2)	1 528(9)
Corobici	2 019(3)	784(3)	1 399(2)	1 401(8)
R 79	1 848(3)	1 197(4)	1 388(2)	1 478(9)
Chorotega	1 871(3)	1 229(4)	1 323(2)	1 474(9)
R 81	1 807(3)	681(3)	1 557(1)	1 348(7)
Mexico 80	1 466(3)	1 074(4)	1 202(2)	1 247(9)
Average	1 836	1 032	1 370	1 413

Brazil

Germplasm flow to Brazil

All CIAT advanced breeding lines must enter Brazil through CENARGEN the EMBRAPA Center for genetic resources Post quarantine is conducted in CNPAF in a multiple disciplinary evaluation field (Campo de Avaliacao Multidisciplinario = CAM) and the CENARGEN scientists participate in evaluation of entries The CAM is harvested and two sets are sent to CAM in southern Brazil (in the Experimental Station of IAPAR in Irati) mainly for anthrachnose screening and the CAM sent to the northeast (the site to be defined) with main emphasis on drought screening The evaluations of the CAM 1983 are available in CNPAF

Only selected entries from CAM at CNPAF receive a GF number (Germplasm Feijao)and are distributed to
1 Scientists from various disciplines within CNPAF for further testing
2 Germplasm Bank for storage
3 Seed multiplication under high and low P at CNPAF to obtain information on the performance under P stress The best entries are then advanced to the EPR (Ensaio Preliminar de Rendimento = Preliminary yields trials) the first stage of the National Bean Evaluation and Recommendation Network (NBERN)

National Bean Evaluation and Recommendation Network (NBERN)

The committee responsible for the NBERN divided the Brazilian bean production into three areas according to seed colors and production problems The data for Region III in Table 122 include Phaseolus and Vigna beans

The NBERN working scheme is adapted to the existing testing scheme of the state research institutions The FPR is conducted for two years without discarding the poor performers or substituting these for new lines

A significant increase in participation in the EPR was observed in 1983 Sixty five EPR will be distributed in 1983/84 to at least 13 states in Brazil In 1983/1984 the red EPR be distributed to eight state research institutes

The results of the black EPR of 1982/83 have been distributed to all participants Copies are available at CNPAF The 10 outstanding lines of the combined analysis are given in Table 123

Testing of advanced breeding lines prior to NBERN

Many lines entered Brazil in the past through the IBYAN and these are being tested according to state evaluation schemes Some lines have been released as new varieties This year Empresas Catarinense de Pesquisa Agropecuaria (FMPASC) released ICA I 38 as CHAPFCO and Empresa Capixaba de Pesquisas Agropecuria (FMCAPA) released BAT 304 and BAT 179 which were called Capixaba precoce and Vitoria respectively Several other materials are in advanced testing FMGOPA conducts trials in five locations Combined analysis of the first year showed outstanding lines as compared to the standard varieties (Rio Tibaji for black and Carioca and IPA 74-19 for cream seed types) Table 124

In 1982 and 83 more than 400 advanced breeding lines entered Brazil each year through CENARGEN and have been evaluated in CAM in CNPAF and CAM of southern Brazil The selected lines will participate in the EPR 84/85

Besides these advanced breeding lines some materials entered Bra 1 as potential parental sources e g for anthracnose BGMV angular leaf spot CBB web blight etc for CNPAF scientists in collaboration with the state research institution and according to regional needs A total of 12 nurseries was sent from 1982-83

In the future these specific nurseries will be sent to specific locations

Anthracnose	IAPAR - Irati ENCAPA-Venda Nova / ES
Angular leaf spot	CNPAF - Goiania IPA - Caruaru
CBB	PESAGRO - Campos IAPAR - Londrina
Bean golden mosaic virus	CNPAF - Rio Verde EPAMIG- Uberaba IAPAR-Londrina
Web blight	UEPAE- Porto Velho- Ouro Preto D Oest UEPAE- Dourados- Ponta Pora
Empoasca	CNPAF - Goiania
Fusarium	EPEAL - Maceio

Partial results of some of these nurseries are

EMPASC introduction nurseries 1982/83 Two sets of introduction nurseries (40 black and 30 colored lines) were conducted during the wet season 1982/83 at CHAPECO experimental station The promising lines were A 266 309 288 338 249 326 and 334 and BAT 52 for colored seeds and A 210 211 227 BAT 108 148 1470 1647 1552 and RIZ 11 for black lines respectively These will be advanced to the preliminary yield trials

Adaptation nurseries in the northeast in EPAGE The main limiting factor in this region is water stress The nursery at Tiangua received only 70 mm and at Ubijara 287 mm during the growth cycle The 10 outstanding lines at Ubijara and Tiangua are shown in Table 121 Some lines (A 351 A 339 A 340 A 160 and A 353) were tolerant to *Empoasca* These lines were also free from *Gargaphia* sp attack Other experiments sent to the northeast of Brazil were not planted because of lack of rainfall

Introduction nursery of black advanced breeding lines at PESAGRO Seventy-eight black advanced breeding lines were planted at PESAGRO experiment station at Campos Out of these nine were advanced to the preliminary yield trials (Table 122)

Future Research Direction

To obtain a larger number of lines adapted to Brazilian conditions the following strategies are suggested

- Start a joint breeding project between CNPAF and CIAT
- Introduce early generation breeding lines from CIAT These introductions will decrease when the joint breeding project becomes effective
- Screen lines for low soil P tolerance during seed multiplication
- Conduct root studies and develop nondestructive screening methods for low P tolerance

Table 122 Bean production data from NBERN in Brazil in 1982

	State	Area (ha)	Production (ton)	/ Cowpea	Average yield (kg/ha)
Region I	Rio Grande do Sul	213 451	146 763	0	688
	Santa Catarina	373 000	321 040	0	861
	Parana	879 990	666 800	0	758
	Espiritu Santo	110 013	55 555	0	505
	Rio de Janeiro	25 787	17 021	0	660
		1 602 241	1 207 179	0	660
Region II	Goiania	232 005	95 696	0	412
	Mato Grosso	99 150	47 4[illegible]9	0	479
	Mato Grosso do Sul	50 230	24 319	0	484
	Minas Gerais	743 755	335 833		452
	Sao Paulo	574 945	396 600		683
		1 700 085	895 947		
Region III	Bahia	689 699	224 527	10	326
	Pernambuco	270 804	92 358	54	341
	Alagoas	150 236	49 576	10	330
	Sergipe	86 257	43 215	5	501
	Paraiba	207 509	28 002	2	135
	Rio grande do Norte	120 876	19 130	95	158
	Ceara	595 190	167 279	98	281
		2 120 571	624 087		

* Levantamento Sistematico de Producao Agricola (IBGF) 1982

** CNPAF estimate in 1980

Table 1_3 The 10 outstanding black seeded lines in EPR 83

Identification	Country of origin	Average yield (kg/ha)
1 ICTA Quetzal	Guatemala	1 945
2 ICA Pijao	Colombia	1 877
3 PV 99 N	Costa Rica	1 858
4 EMP 84	CIAT	1 817
5 RAI 78	IAPAR	1 806
6 CNF 178	CNPAF	1 782
7 Preto 132	CNPAF	1 779
8 BAT 431	CIAT	1 766
9 A 222	CIAT	1 698
10 A 237	CIAT	1 696
Checks		
Rio Tibaji	IAPAR	1 544
Carioca	IAC	1 681

Table 124 Summary of yield of ten outstanding lines in four locations in state yield trials by FMGOPA in Goias 1982/83

Identification	Seed color	Yield (kg/ha)
1 A 295	Cream	956
2 Carioca	carioca	894
3 CNF 178	black	893
4 AYSO	pink	973
5 IPA 74-19	cream	848
6 IPA 1	cream	843
7 Aroana	tan	838
8 A 248	carioca	833
9 Rio Tibaji	black	828
10 ICA Col 10301	black	826
Avg 20 lines		817
CV (%)		28 1

Table 125 Yield of the ten outstandıng lınes tested ın northeast Brazıl at Ubijara andTiangua ın 1983

Entry	Yıeld (kg/ha) at Ubajara	Entry	Yield (kg/ha) at Tıanga
A 338	620	CATU	106
A 292	568	A 160	98
A 318	560	BAT 85	94
AETE 1/37	559	A 352	92
A 331	538	A 353	88
A 339	526	A 357	88
A 330	518	A 344	87
A 344	499	A 340	87
AETE 3	477	EMP 115	78
A 176	474	A 161	78
Checks			
IPA 74-19	464	IPA 7419	84
IPA 1	357	IPA 1	55
G 5059	388	G 5059	26
CV (%)	29 2	CV (/)	47 5

Table 126 Yield of outstanding black lines from the introduction nursery 1982/83 in PESAGRO Campos

Identification	Yield (kg/ha)
1 EMP 84	604
2 EMP 60	2 125
3 ICTA Quetzal	2 083
4 A 272	2 104
5 BAT 1647	2 000
6 XAN 78	1 958
7 BAT 304	1 917
8 BAT 76	1 792
9 BAT 434	1 646
Checks	
G 4495	2 167
Toruna	1 938
G 2005	1 729

PERU

The CIAT regional project for research and agricultural extension on beans in Peru (financed by the World Bank) has been functioning for the past six months This project is the subsequent phase to the Swiss Project with the change of emphasis toward crop improvement The project has a plant breeder who also acts as co-leader within the National Grain Legume Program (PNLG) of the Instituto Nacional de Investigacion y Promocion Agropecuaria (INIPA) in Peru To date the Co-Leader s activities have been to support the regional grain legume programs in the 15 research and agricultural development centers (CIPA) giving priority to those programs on beans Of all the edible legumes beans have the greatest economic importance for Peru whose area harvested in 1979 was 63 000 hectares with a production of 61 000 tons of dry beans green beans (physiologically mature not dried grain) and snap beans in total

General Work-Related Activities

Overview and organization

During the first working semester high priority was given to familiarization with the tasks at hand to facilitate integration of work done by researchers and that of agricultural extensionists To this end meetings for evaluation and planning were held with the work groups (of researchers and extension specialists in grain legumes) in each of the 11 CIPA s - events which notably served to develop a better plan of operation for the PNLG in 1984

Organization and coordination of the Conference on the Evaluation of Research and Agricultural Extension Work on Beans in Peru

This meeting was held on September 19 - 21 1983 in Chiclayo Peru with the support of the former Swiss Project on beans and scientific personnel of the CIAT Bean Program The principle objective of the meeting was to evaluate the results and progress of the Bean Program over the last few years As a result of this meeting concrete recommendations were made for each of the three principle bean production regions of Peru (the coast the highlands and the rain forest areas) One of the main observations was that since 1977 there has been a gradual reduction not only in the cultivated area but also the production of this legume has gradually diminished This situation became more critical in 1982-83 due to the heavy rains in the northern part of the country and the severe drought in the highlands and the southern coast which adversely affected crop production

Organization and coordination of the II Annual Conference of the National Grain Legume Program of INIPA in Peru"

The conference was held from October 11-15 1983 on the ICA Experimental Station of CIPA VI on the central - southern coast The principle objectives were to analyze the results obtained from the agricultural campaign of 1982-83 on research and development in common beans broad beans cowpeas lima beans (Phaseolus lunatus) soybeans and chickpeas At the same time projects and subprojects were drafted on research and agricultural extension for 1984 with their corresponding budgets Carrying out the special recommendations of this conference an emergency plan was developed for the increase and production of basic bean seed to reduce the possible shortfall in 1984 In addition a special effort was made on experimental stations and on farmers fields to stimulate the consumption of beans and other edible legumes in Peru

Principle results and research advances in Peru

Coastal region

BCMV is the principle pathological problem affecting beans in Peru Field evaluation of experimental lines was done on the North Coast on the Vista Florida Lambayeque Experimental Station and on the Central Coast on the Chincha-Ica Experimental Station Table 126 shows lines which were outstanding in their resistance to the virus and in adaptation and also shows the outstanding lines for adaptation and yield of the 354 experimental lines tested on the Vista Florida-Lambayeque Experimental Station

Within the reserach done by the Universidad Nacional Agraria La Molina in summer plantings (December-January) when the temperatures are higher on the Central Coast of Peru the following lines had the highest yields Puebla 304 G 0154A and Pinto 4I 114 (Table 127)

The highlands of Peru

In this promising region where nearly 28 000 hectares of dry beans are cultivated three yield experiments were conducted with the experimental lines and varieties on the Cajabamba Experimental Station in Cajamarca As observed in Table 128 the experimental variety Cloriabamba (G2829) which is being promoted in the region had the highest yield together with lines G 2333 Puebla 444 and G 858

However studies in this highland region are being intensified to identify new lines of beans with resistance to Anthracnose and Ascochyta leaf spot - the two diseases which drastically reduce yield Table 129 shows the lines with the best adaptation and tolerance to the two diseases in the evaluation of 417 experimental lines conducted in Cajamarca

Several yield trials were conducted with experimental lines in the central highlands of Peru in the Huanta province The results in Table 130 show that the best lines were BAT 482 and BAT 1296

White and red bush bean lines were also evaluated in two different sites in the bean producing zones of the department of Cuzco in the central highlands The line ICA L-24 had the highest yield together with four other red-seeded lines (Table 131) Line 24 was also outstanding in other experiments in the zone Similarly the white-seeded line Ex Rico 23 was outstanding in the zone for its high yield and wide range of adaptation

Rain forest of Peru

In this region research and agricultural extension activities on the common bean have been minimal since most studies concentrate on other grain legumes such as cowpeas soybeans and peanuts Not withstanding in the Tulumayo Experimental Station in the Department of Huanuco two experiments were done with bean lines (Table 132) In one of the experiments the CIAT line (I-276) was the best and in the other the best was Guatemala (-14)

Training Results

The training activities in 1983 supported by CIAT included training of a biologist from CIPA II in Lambayeque Peru who did her masters thesis in bean pathology At the same time an agronomist the leader of the PNLG of INIPA and a researcher with CIPA XIV-Cuzco participated in the Workshop on Genetic Improvement of Beans for the Andean zone and Brazil in December 1983

The implementation of an ambitious program of training and professional advancement is required for scientific personnel of the PNLG of INIPA in Peru since to date only five scientists working in beans have MS degrees and there are no scientists with a doctorate

Table N 126 Experimental bean lines outstanding for resistance to Bean Common Mosaic Virus and adaptation to two zones of the Peruvian Coast in 1982-83

North Coast LAMBAYEQUE		Central Coast ICA
BCMV NURSERY	Nursery with 354 Entries	BCMV and adaptation NURSERY
BAT 83	BAT 1591	BAT 76
BAT 281	FB 8815-9-1-4-F_4	BAT 883
BAT 389	BAN 15	BAT 1444
BAT 1061	BAN 19	BAT 1719
BAT 1198	BAT 1061 x CIAT 1230	BAT 1724
BAT 1282	A48 (BAT 47 x BAT 1155)	BAT 1725
A-118	FB 7525-6-5-CM(7B)-CM(5B)-CM(41-B)	BAT 1743
A-140		BAT 1744
A-147		EMP 112
EMP-86		A-48
G-4459		A-491

Table 127 Experimental bean lines outstanding for yield in summer plantings at the La Molina Experimental Station UNALM in 1982-83

Experimental lines	Grain color	Yield in (t/ha)
UNA 8325 (P 504)	yellow	2 0
UNA 8321 (G0154A)	yellow	1 1
UNA 8318 (P 703)	mottled cream	1 0

Table 128 Experimental lines and varieties of climbing beans outstanding for yield in three experiments on the Cajabamba Experimental Substation in Cajamarca Peru in 1982-83

Outstanding lines	Average yield (t/ha)
G 2333	1 1
Gloriabamba	1 0
Puebla 444	1 0
G 858	1 0
Blanco Caballero (check)	0 7

Table 129 Experimental bean lines outstanding in their adaptation and tolerance to anthracnose and *Ascochyta* on the Cajabamba Experimental Substation in Cajamarca Peru in 1982-83

Experimental lines	Experimental lines
G 687 (Windsor long pod)	G 13889 PLB 255
G 4453 (Diacol Nima)	G 14288 -336
G 12417	BAT 1222
G 12470 (Peru 14-2 Loja)	VRB 81057
G 12572 (Numa Mani Palida-1)	Flor de Mayo (Chapingo)
G 12730 (Frijola)	

ıable 130 Experımental Be ın lınes outstandıng f r theır
yıeld ın t/ha ın two ı ıes of experıments
done ın the Prov n e of Huart ı ın Ayacucho
Peru ın 1982-83

White seeded (Average 5 trıals)		Red seeded (Average 3 trıals)	
Line	Yield	Line	Yield
BAT 482	1 4	BAT 1296	1 7
Ex-Rıco 23	1 2	BAT 1230	1 5
BAT 1061	1 2	ICA-Lınea 23	1 4
W-126	1 1		
Local Varıety	0 6		

Table 131 Experımental lınes of red and whıte seeded
beans outstandıng for yıeld over two
locatıons ın the Department of Cuzco Peru ın
1983

Experımental lınes	Graın color	Average yıeld (t/ha)
BAT 1276	red	2 1
BAT 127	red	2 0
ICA-Lınea 24	red	2 0
ICA-Lınea 17 (Check)	red	2 0
BAT 1254	red	2 0
Ex-Rıco 23	whıte	2 1
78-0374	whıte	1 8

Table 132 Experimental lines of beans outstanding for adaptation and yield in two experiments in the Tulumayo Experimental Station in Huanuco Peru in 1982-83

Outstanding Lines	Average Yield (t/ha)
CIAT (I-276)	2 0
CIAT (I-204)	1 5
EEUU (I-450)	1 5
CIAT (I-143)	1 4
Guatemala (I-14)	1 6
CIAT (I-92)	1 4
CIAT (I-379)	1 2

Scientific Training

During 1983 Scientific Training continued to support the efforts of bean researchers in the international bean network Emphasis was given to training of scientists from national institutions for the development evaluation and promotion of promising germplasm As last year the major emphasis was on training done outside CIAT headquarters This is reflected in the support given to seven national courses in Brazil Costa Rica Cuba Colombia Honduras and the Dominican Republic (Table 133) The tenth intensive multidisciplinary course on research for bean production was carried out over a period of six weeks with the participation of 20 visiting researchers from Colombia (8) Mexico (3) Paraguay (2) El Salvador (2) Ecuador (2) Brazil (1) Costa Rica (1) and Nicaragua (1)

The advances achieved by the scientists particularly with respect to production of improved lines for these countries has closely linked the academic objectives of these courses with the development of expertise in the conduction of trials at the farm level using the most promising new lines

Taking advantage of prior experience in 1982 with two Colombian institutions the Federacion Nacional de Cafeteros and the CVC course participants continued to receive seed and the corresponding material to carry out trials with these advanced lines in their respective work sites Thus the network of collaborators in the respective national programs is reinforced and stimulated - a network which as a consequence of the course is charged with the responsibility not only of conducting the trials but also of making farmers aware of these new varieties As a specific example of this network s activities the participants from the Federacion Nacional de Cafeteros and the CVC trained in courses coordinated by ICA and CIAT conducted the final yield trials of the variety ICA-Llanogrande and of the lines ICA-L24 and BAT 1297 in the coffee-growing zone of Colombia

Training Oriented to Academic Degrees

Our contribution to national institutions for the dev lopment of scientific leaders through research support for academic degrees such as Ph D and MS guarantees the continuity of the research and stimulates these institutions to conduct independent as well as collaborative research

Two professionals concluded their research at the MS level in 1983 while four researchers began their work for MS degrees and two for Ph D s In addition two reseachers finished their postdoctoral project

Origin of Professionals Trained

Table 134 shows the origin l countries of the 44 professionals who arrived for training at CIAT during 1983 The greatest number came from Colombia (9) It is important to note the presence of five African professionals which indicates the increasing interest of the program in extending the network to Africa

Training by Disciplines

Table 135 shows the training activity by discipline as measured in numbers of professionals total number of training months and number of man months Major emphasis has been on training in breeding agronomy and phytopathology

Training Categories

Table 136 shows the number of professionals by training category The category of Visiting researchers occupies first place with 25 persons and a total of 101 8 months for an average of four months/man (Note the time of residence of four months equals the length of the crop cycle)

Production of Training Materials

As in 1982 the principal emphasis in the production of training materials was on audiotutorials In Table 137 the actual state of the production of audiotutorial units on beans is given

Workshops

Four workshops were conducted in 1983 in which a total of 79 scientists participated Each workshop was characterized by intensive field work which permitted the exchange of selection criteria for promising lines evaluation scales and methodologies for tolerances or resistances to production problems and methodologies for on-farm evaluation of new technology (Table 138)

Table 133 Training courses effected in 1983

Country	Institutions	No of Participants
Colombia	FEDECAFE ICA	33
Cuba	Ministry of Agriculture	31
Brazil	EMBRAPA	26
Colombia	FEDECAFE ICA	13
Costa Rica	Ministry of Agriculture University of Costa Rica	28
Dominican Republic	Secretaria de Estado Proyecto Titulo XII	29
Honduras	Secretaria de Recursos Naturales	29
Colombia	CIAT with the intensive Research training course	20
	Total	209

Tabla 134 Origen of professionals trained in 1983

Country	No of Participants	Total training months
Argentina	1	4 6
Brazil	3	10 4
Chile	1	0 6
Colombia	9	20 0
Costa Rica	1	5 3
Cuba	3	10 4
Ecuador	3	7 0
Honduras	1	3 2
Mexico	4	10 8
Nicaragua	2	8 2
Paraguay	2	10 7
Peru	2	10 8
El Salvador	2	10 6
U S A	3	11 7
Holland	1	9 1
Egypt	1	4 0
Kenya	1	2 9
Tanzania	3	8 4
Zambia	1	4 0
Total	44	

Table 135 Training activity by discipline measured in number of professionals total number of training months and by man/months in 1983

Discipline	No of participants	Total months	Man months
Agronomy	7	31 16	4 45
Economy	1	9 13	9 13
Entomology	5	20 30	4 06
Breeding	15	44 16	2 94
Phytopathology	5	22 40	4 48
Physiology	1	6 70	6 70
Seeds	1	4 03	4 03
Production	8	10 63	1 32
Management of Genetic Resources	1	4 93	4 93
Total	44		

Table 136 No of professionals by training category

Category	No of Participants	Total months	Man months
Visiting research associates for Ph D thesis	2	6 56	3 28
Visiting research for M Sc thesis	4	20 23	5 05
Visiting researcher	25	101 83	4 07
Short course participant	8	10 63	1 32
Visiting research associates	5	14 20	2 84
Total	44		

Table 137 Stage of Audiotutorial Units produced by the Bean Program

Units in Spanish in Distribution

1 Description and damage of pests attacking beans (second edition)

2 Principal insects attacking stored bean seeds and their control

3 The leafhopper (Empoasca kraemeri Ross and Moore) and its control

4 Principal Chrysomelids attacking beans and their control

5 Bean diseases caused by fungi and their control

6 Bean diseases caused by virus and their control

7 Techniques for the isolation identification and preservation of pathogenic fungi of beans

8 Bacterial diseases of beans their identification and control

9 Bean rust and its control

10 Root rots of beans and their control

11 Bean anthracnosis and its control

12 Angular leaf spot of beans and its control

13 Principal nematodes attacking beans and their control

14 Web blight of beans and its control

15 Hybribization

16 Genetic diversity of the cultivated species of the genus Phaseolus

17 Growth stages in the common bean plant

18 Good quality seed

19 Weed control and management in beans

20 Morphology of the bean plant (second edition January/1984)

Units in Spanish to be completed in the next few months

21 Bean breeding through introduction and selection (March/84 approx)

22 Nutritional disorders of the bean plant (March/84 approx)

23 Genetic control of bean common mosaic virus (Jan/84 approx)

Units translated into English in Distribution

1 Bean diseases caused by fungi and their control

2 Good quality bean seed

Units translaed into English and Edited

3 Genetic diversity of the cultivated species of the genus Phaseolus

Unedited units translated into English

4 Techniques for the isolation identication and preservation of pathogenic fungi of beans

5 Principal Chrysomelids attacking beans and their control

6 Bacterial diseases of beans their identification and control

7 Bean rust and its control

8 Anthracnosis of beans and its control

9 Root rots of beans and their control

10 Morphology of the common bean plant

11 Principal insects attacking stored bean seed and their control

Units produced outside CIAT

1 The mechanization of the bean crop (Cuba)

Table 138 Workshops conducted during 1983 and number of participants

Themes	No of Participants
Bean improvement - Central America and the Caribbean	7
Bean improvement - Andean zone and Brazil	15
Development of a collaborative project in research on beans in East Africa	36
Future direction of on-farm research	21
Total	79

Collaborative Bean Research at IVT Wageningen Netherlands

Incorporation of resistance genes into CIAT breeding lines

Program with IVT 7233 x IVT 7214 Nine populations of F_2B_2 CIAT-progenitor x F_3(IVT 7233 x IVT 7214) were tested with the BCMV strain mixture of NL3 + 4 + 5 to select the resistant plants carrying genes bc-3 and I Almost 1 000 plants were screened of which 171 were resistant Test crosses were made with the resistant plants onto Great Northern 31 for detection of genes bc-u and $bc\text{-}2^2$ giving a double resistance together with the already mentioned genes bc-3 and I while F_3 seeds also were harvested of the selected plants The F_1 of the 700 test crosses was screened with BCMV NL3 + 4 and + 5 indicating 21 F_2 plants also carrying bc-u and $bc\text{-}2^2$ The F_3 lines of these 21 F^2 plants were tested with BCMV NL3 + 4 and + 5 for confirmation of the resistance and were all resistant The F_3 lines were also tested with BYMV strain T Eleven lines out of 21 were also resistant to this virus belonging to six out of nine F_2 populations Seed of these lines will be brought to CIAT in January 1984 These 11 F_3 lines behaved as resistant to both viruses and are assumed to have genes bc-u $bc\text{-}2^2$ bc-3 and I homozygously present

Program with IVT 7620 Over 2 800 plants of 15 populations of F_2B_1 CIAT-progenitors x IVT 7620 were screened with BCMV NL3 + 4 + 5 and 105 plants without symptoms maintained for F_3 seed The 105 F_3 lines were tested with BCMV NL3 + 4 + 5 and 25 lines had plants with systemic necrosis (often not visible except in the full grown plant) The remaining 80 lines are now being tested for resistance to BYMV T strain Seeds of these lines will be brought to CIAT in January 1984 while the results of the BYMV-test will be sent to CIAT before the progenitors for the second backcross are chosen

Testing of CIAT breeding lines and progenitors carrying gene I with BCMV for detection of additional recessive genes

Fifty-eight accessions with I gene were tested with NL3 at 20 C and with NL2 and NL6 at 30 to detect additional recessive genes Conclusions could be drawn for 26 accessions the others must be screened also with NL8 Twenty-one out of the 26 CIAT Progenitors had the I gene without additional bc genes four had also bc-1 and 1 $bc\text{-}2^2$

Testing of breeding lines for the Andian Highlands for resistance to BCMV 80 breeding lines were tested with BCMV NL8 Some 126 lines had the I gene of which 96 were resistant to that strain Some 14 of 454 lines without I gene were also resistant to NL8

A total of the 312 lines were considered to have a good red mottled color 13 of them had I gene and also at least one recessive bc-gene likewise 13 did not have the I gene The bc genes in the 13 lines with dominant I gene and those in the 13 lines without I are being identified by tests with BCMV strains NL2 NL3 and NL6

Testing for resistance to races of Colletotrichum lindemuthianum

Sixty-six CIAT gene bank numbers from Africa resistant to anthracnose in field tests in La Selva Colombia were screened with races lambda iota C 236 and some with alpha Brazil in a glasshouse test The infection with lambda was too weak while the test with alpha Brazil only could be done with part of the accessions because of seed shortage The test with this race will be continued next year as soon as seed becomes available while the test with lambda will be repeated and a test with epsilon Kenya will be added Two accessions were resistant to iota and one slightly susceptible while 22 were resistant to C236 and 10 slightly susceptible or heterogeneous resistant to that race None of the accessions was resistant to both iota and C 236

Testing of CIAT progenitors for resistance to halo blight

Thirty-five CIAT progenitors were screened in a glasshouse trial with the Dutch strain Nr 113 of Pseudomonas phaseolicola The inoculation was made by rubbing the primary leaves with bacterial suspension and carborundum powder The bacterium strain could infect all tested accessions The best resistance was found in Wisconsin HBR72 showing only small necrotic lesions and no transparant halos Great Northern Nebraska Nr 1 sel 27 Belami and Jules were only slightly susceptible giving small necrotic lesions with small halos no apical chlorosis and none or very little growth reduction All other accessions had bigger lesions apical chlorosis and considerable growth reduction three weeks after inoculation The experiment will be repeated next year including other sources of resistance like PI 150 414

Testing tepary bean accessions for resistance to Xanthomonas phaseoli Eleven accessions of Phaseolus acutifolius were screened for resistance to CBB with the Dutch strain Nr 482 of X phaseoli fuscans Considerable differences in resistance were found An accession from Yugoslavia and Nayarit 13B from CIAT were resistant as were PI 319 443 and PI 321 638 from University of California Riverside The other accessions were susceptible

Cuadro 3 Materiales de frijol comunes a condiciones de bajo fosforo y alto aluminio y manganeso

Eficientes con respuesta (-B)	Eficientes sin respuesta
A 283	A 254
Carioca G 4017	
Ineficientes con respuesta (-B)	**Ineficientes sin respuesta**
ICA-Pijao G 4525	A 440
A 380	A 391
A 310	

Table 8 Average yield (kg/ha) of the white - seeded materials tested in the 1983 IBYAN at CIAT Palmira 1983 Semester A

RANK	IDENTIFICATION	YIELD	
Experimental Lines			
1	BAT 1592	1847	a
2	Ex-Rico 23	1763	ab
3	78-0374	1650	abc
4	BAC 125	1640	abc
5	BAT 1453	1449	abc
Local Checks			
7	BAT 1469	1353	abcd
12	BAt 1061	1054	d
Mean (n=12)		1423	
CV (/)		19 5	

Table 9 Average yield (kg/ha) of the material developed for the Mexican highlands tested in the 1983 IBYAN at CIAT Palmira 1983 Semester A

RANK	IDENTIFICATION	SEED TYPE	YIELD	
Experimental lines				
1	A 442		2046	a
2	A 114		1923	ab
3	A 410		1876	ab
4	A 429		1866	ab
5	Carioca		1860	ab
Local Checks				
13	C 2858		1653	bcde
17	A 67		1430	cde

Cuadro 4 Número de entradas evaluadas en EP 82 durante 1982-1983

EP ano	Semestre	CIAT-Palmira	CIAT-Popayan
1982	A	304	304
1982	B	304	304
1983	A	226	200
983	B	161	65

Cuadro 5 Ensayos EP distribuidos en 14 grupos de tamano color de semilla y habito de crecimiento

Grupo No	Habito crecmiento	Color	Tamano	Adaptation climatica o geografica	No entradas/semestre 1982 Pal Pop A y B	1983 Pal A	Pop A	Pal B	Pop B
10	Arbustivo	Negro	Pequeno		31	20	22	20	-
20	Arbustivo	Rojo	Pequeño		34	25	18	25	-
25	Arbustivo	Rojo Rojo moteado	Med/grande		53	31	23	31	-
30	Arbustivo	Blanco	Pequeno		11	8	8	8	-
35	Arbustivo	Blanco	Med/grande		13	7	1	7	-
40	Arbustivo	Crema amarillo canela claro	Med/grande	Costa Pacifico	23	15	10	15	-
45	Arbustivo	Crema canela claro sólido moteado y rayado	Med/grande	Mexico zonas templadas secas y humedas	18	11	17	11	-
50	Arbustivo	Crema	Pequeno/med	Brasil	56	44	36	44	-
60	Trepador	Negro	Pequeno	Frio	7	7	7	7	7
65	Trepador	Negro	Pequeno	Caliente	2	2	2	2	2
70	Trepador	Rojo	Ned/grande	Frío	25	25	25	25	25
75	Trepador	Rojo	Med/grande	Caliente	16	16	16	16	16
80	Trepador	Claro	Med/grande	Frío	7	7	7	7	7
85	Trepador	Claro	Pequeno/med	Caliente	8	8	8	8	8

Cuadro 16 Líneas de fríjol arbustivo de grano blanco grande del EP 82 con rendimientos superiores al promedio en ensayos sin y con proteccion química conducidos durante 4 semestres en 1982 y 1983 en Palmira y Popayan Colombia

<u>82 A</u>						
A 493	561	-	-	470	1335	865
X Grupo	493			222	867	
<u>82 B</u>						
A 492	1302	-	-	626	-	-
A 493	1523	1930	-	727	2227	1500
X Grupo	1297	1857		424	910	
<u>83 A</u>						
A 493	636	1492	856	1004	3685	2861
X Grupo	557	1011		855	2946	

Table 17 List of IBYAN trials planted in CIAT Palmira and Popayan in two semesters during 1983

TRIAL	WITHOUT CHEMICAL PROTECT	WITHOUT CHEMICAL PROTECT	WITH CHEMICAL PROTECT	WITHOUT CHEMICAL PROTECT	WITH CHEMICAL PROTEC
10 Black small	X	X	X		
20 Red small	X			X	X
25 Red-mottled large	X			X	X
30 White small	X			X	X
45 Mexican highlands	X			X	X
50 Brazil					
Mulatinho	X	X	X		
Carioca	X	X	X		
Rosinha	X	X	X		

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APPENDIX I List of Associated Centers and Institutions

AVRDC	Asian Vegetable Research and Development Center Shanhua Taiwan
CATIE	Centro Agronómico Tropical de Investigacion y Ensenanza Costa Rica
CDA	Collaboration for Development in Africa
CENARGEN	Centro Nacional de Recursos Geneticos Brazil
CIAB	Centro de Investigacion Agricola del Bajío Mexico
CIAGOC	Centro de Investigacion Agricola del Golfo Centro Mexico
CIANOC	Centro de Investigacion Agricola Norte Central Mexico
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo Londres Mexico
CNP	Consejo Nacional de Produccion Costa Rica
CNPAF	Centro Nacional de Pequisa em Arroz e Feijao Brasil
CIPA	Centro de Investigacion y Promocion Agropecuario (I and II) Peru
CRSP	Collaborative Research Support Program
CVC	Corporacion Autonoma Regional de Valle y Cauca
EEAOC	Est Exptl Agricola Obispo Colonbres
EMBRAPA	Empresa Brsileira de Pesquisa Agropecuaria Brasilia Brasil
EMCAPA	Empresa Capichaba de Pesquisa Agropecuaria Brasil
EMGOPA	Empresa Goiania de Pesquisa Agropecuaria Brasil
EMPASC	Empresa de Pesquisa Agropecuaria de Santa Catarina Brasil
FAO	Food and Agriculture Organization of the United Nations Rome Italy
FEDECAFE	Federacion Nacional de Cafeteros Colombia
IAPAR	Fundacao Instituto Agropecuario de Parana Brasil
IAR	International Agricultural Research
IBPGR	International Board for Plant Genetic Resources Rome Italy
ICA	Instituto Colombiano Agropecuario
ICARDA	International Center for Agricultural Research in the Dry Area Beirut Lebanon
ICTA	Instituto de Ciencia y Tecnologia Agricola Guatemala City Guatemala
INIA	Instituto Nacional de Investigaciones Agricolas Mexico D F Mexico
INIA	Instituto Nacional de Investigacion Agricola Peru
INIPA	Instituto Nacional de Investigaciones y Promocion Agraria Lima Peru
INTA	Instituto Nacional de Tecnología Agropecuaria Mexico
INTA	Instituto Nacional de Tecnología Agropecuaria Argentina
INTA	Instituto Nicaraguense de Tecnologia Agropecuaria Nicaragua
IPA	Instituto de Pesquisa Agropecuaria Pernambuco Brasil
ISAR	

ISNAR	International Service for National Agriculrual Research The Hague Netherlands
IVT	Instituut Veredeling Tuinbouwge wassen
PCCMCA	Programa Cooperativo Centroamericano de Mejoramiento de Cultivos Alimenticios
SDC	Swiss Development Cooperation Switzerland
UEPAF	Unidad de Execucao de Pesquisa de Ambito Estadual Brasil

APPENDIX II

List of G number of accessions in the CIAT germplasm bank used in the Bean Program Annual Report in numerical order and described according to their identification local register and source

G Number	Identification	Local Register	Origin	Source
<u>Phaseolus vulgaris</u>				
01019		PI 246563	Congo	USA
01040		PI 2466563	Mexico	USA
01061		PI 281597	Italy	USA
01089	Pelandron	PI 282045	Chile	USA
01449		PI 255309	Mexico	USA
00153	Aysekadin	PI 164930	Turkey	USA
00159	Cali Fasulya	PI 165078	Turkey	USA
00332	Gelin	PI 169902	Turkey	USA
00568		PI 176712	Turkey	USA
00623	Barbunya	PI 179421	Turkey	USA
00677		PI 181892	South Africa	USA
00688	Barbunya	PI 182268	Turkey	USA
00910		PI 206983	Turkey	USA
02005		PI 310739	Guatemala	USA
02211	Colorado	PI 311824	Guatemala	USA
02587	Col No 19	PI 313709	Mexico	USA
02618	Col No 168	PI 313755	Mexico	USA
02641	Col No 322	PI 313785	Guatemala	USA
02819	Bayo	PI 319621	Mexico	USA
02829	Apetito	PI 319631	Mexico	USA
02858	Zacaticano	PI 319665	Mexico	USA
03366	Puebla 240-A		Mexico	Mexico
03410	Puebla 444		Mexico	Mexico
03736	Alabama 1	I-1012	USA	Venezuela
03804	Bolivia 6	I-1095	Bolivia	Venezuela
03807	Brasil 2-Pico de Oro	I-1098	Brazil	Venezuela
03982	Amarillo 154	C-118	Mexico	Costa Rica
04017	Carioca	P-154	Brazil	
04459	Nep 2		Costa Rica	Costa Rica
04489	Cuilapa 72		Guatemala	Guatemala
04495	Porrillo Sintetico		Honduras	Honduras
04523	Linea 17		Colombia	Colombia
04525	Linea 32		Colombia	Colombia
04724	San Martin I		Peru	Peru
04829	Parana Lote 3		Brazil	Brazil
04835 (35160)				
05054	Mulatinho	BZL 343	Brazil	Brazil
05066		BZL 374	Brazil	Brazil
05129	Sacavem 597	BZL 735	Brazil	Brazil
05478	Tara		USA	Puerto Rico
05653	Ecuador 299		Ecuador	El Salvador
05693	California Small White 643		USA	ATL
05740		PI 165426BS	Mexico	USA

06040	Guatemala 488	HDR-0548	Cuatemala	Honduras
06070	Guatemala 566	HDR-0611	Guatemala	Honduras
06278	Manoa Londer		USA	USA
06388	U F V 283	BZL-283	Brazil	Brazil
06977	Ecuador 131	HDR-0 50	Ecuador	Honduras
07148	211-95/50 P S	Brazil-668	Brazil	Brazil
07160	Tortolas x Diana		Chile	Chile
07249	Apurimac 46	LM-1369	Peru	Peru
07457	Colorada	NI-11	Rwanda	Bulgaria
07613	Aragon			East Germany
07633	Coco Bicolore du pape			East Germany
07635	Coco Rose			East Germany
08892		PI 201290	Mexico	USA
10053	Witte Stokboon Dinxperloo	1 38	The Netherland	The N
10943	Negro	DGD78/014	Mexico	Mexico
10977	Cafe	DGd78/038E	Mexico	Mexico
11506	Mexico 1290		Mexico	El Salvador
12666	Porato Amarillo	NAR -020	Colombia	Colombia
12722	ICA Viboral		Colombia	Colombia
12752	M 7466B-9-2-Bulk		Mexico	USA
12891		PI 417624	Mexico	USA
12952		PI 417778	Mexico	USA
12953		P 417780	Mexico	USA

Phaseolus coccineus

35022		PI 165421	Mexico	USA
35023	Frijolan	P 165436	Mexico	USA
35075		PI 247303	USA	USA
35122		PI 325601	Mexico	USA
35171		NI-015	Zaire	Nigeria
35172		NI-016	Zaire	Nigeria
35174		NI-229	Zaire	Nigeria
35315	Scarlet from Bucarest	NI-132	Rumania	Bulgaria
35317		NI-373	Venezuela	Bulgaria

Phaseolus acutifolius

40005		PI 200902	El Salvador	USA
40034	Nayarit 13-B		Mexico	Mexico

XYZ