Output 4: Improved cultivars and management practices developed and tested in partnership with IP-2 Project (Africa), national agricultural research systems, and regional networks

Activity 4.1 Supporting breeding programs in national agricultural research systems, regional networks, farmers' associations, and Committees for Local Agricultural Research with germplasm and technical knowledge

Highlights:

- The Costa Rican national program has selected a large number of lines with commercial grain and tolerant to low soil fertility.

- Several partners including national agricultural research systems (NARS) and the CIAT Hillsides Program are directing increasing attention to work on drought in the Central American region.

- The Bean Team Nursery (VEF) was revived and specific traits were evaluated on more than 300 breeding lines and germplasm entries with the participation of the entire team (see Table 59 and specific sections [i.e., Entomology] for results on individual traits).

- An important project on bean genomics was approved to facilitate collaboration with national partners and with the Agropolis research center at Montpellier.

- Accessibility to Bean Virology facilities makes possible the advancement of bean breeding materials for sub-Saharan Africa.

- Preliminary testing of climbing beans in Haiti shows that they can be adapted to the environment, but require higher fertility.

- CIAT provided advanced Andean red-mottled breeding lines to the regional Caribbean nursery trials.

- Partners are evaluating a set of 19 genotypes for their response to ALS.

- Continuous support was given to breeding programs in the Proyecto Regional de Fríjol para Centro América, México y el Caribe (PROFRIJOL), the Andean Zone, African networks, and individual country programs.

- Seed was distributed to all collaborating partners.

- 12 CIAT-originated varieties were released during 2000 and 2001 in four countries.

4.1.1 Populations created and distributed

Rationale: Breeding has traditionally been a collaborative effort between CIAT and national programs, combining the strengths of the several institutions. CIAT has been a source of both segregating populations and fixed lines. Reduced budgets require that efficient systems be created that exploit comparative advantages. The strength of CIAT is the genetic variability housed in the gene bank, the novel gene combinations that have been created, and the capacity to create large numbers of populations.

Materials and Methods: Populations were created including parental genotypes that had proven their worth across sites and under multiple stresses in CIAT's trials and in the international nursery for this purpose. These include A 774 and VAX 1, among others. Most populations are derived from multiple crosses. Some countries receive populations as F_1-derived F_2 populations within the gamete selection scheme, others that are not familiarized with this scheme work with bulk F_2 populations.

Results:

Costa Rica: In Costa Rica we work especially closely with three institutions of the national bean research system: the Ministry of Agriculture, the University of Costa Rica, and the National University. In 1999, we sent 192 F_1-derived F_2 populations from nine distinct crosses. These have been systematically selected for several generations in conditions of low soil fertility, inoculation with local isolates of *Colletotrichum lindemuthianum*, and natural pressure of ALS. More than 100 lines have been developed for tolerance to low soil phosphorus and have been selected in a low P nursery on station and with farmers in the south of Costa Rica. These lines combine an excellent parent for low P, DICTA 17, with lines for disease resistance and upright plant habit. Grain quality is excellent and indications are that some of these have excellent yield potential under infertile soil conditions. The elite populations in this set of crosses have been:

MR 13034 = DICTA 17 x (Tío Canela 75 x VAX 3)
MR 13033 = DICTA 17 x ((Orgulloso x Don Timoteo) x (FEB 212 x VAX 6))
MR 13035 = G 18224 x (Tío Canela 75 x VAX 3)
A 785 x ((A 247 x DOR 500) x (VAX 1 x Compuesto Chimaltenango))

Cuba: Work in Cuba is carried out in collaboration with two national institutions, the horticultural institute (Estación Experimental Liliana Dimitrova) and the soils institute (Estación Experimental la René). Much of the work in recent years has revolved around work on genotypic adaptation to low soil fertility—biological nitrogen fixation and adaptation to low soil phosphorus. This selection work has focused on one population in particular, (BAT 477 x DOR 364). BAT 477 is an excellent nitrogen fixer and is also quite good at low P, and in Cuba produced as well at low inputs (rock phosphate and Rhizobium) as DOR 364 did at high fertilizer inputs. This result derived from the PPR (*Phaseolus*-Phosphorus-Rhizobium) project between INRA (Institut national de recherche agronomique)-France and the Cuban Ministry of Agriculture. Out of 314 RILs derived from these two parents, the local breeder selected 19 that were especially promising. This selection work is proceeding satisfactorily, and its goal is to identify progeny that combine the resistance to BGYMV from DOR 364 with the favorable traits of BAT 477. This project is especially unique because it integrates efforts in both genetic adaptation and agronomic innovation to resolve problems of soil fertility. RILs from the cross (BAT 477 x DOR 364) will be utilized in the Agropolis project that was approved recently, thus there will be a coordinated effort that includes a molecular dimension as well.

Mexico: Families from the wild QTL project have been sent to the national program of Mexico (Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias [INIFAP]) for evaluation for local adaptation. From one population of a Colombian wild x DOR 390 ("Tacaná") several high-yielding lines were selected for further study. Other populations developed with the Mexican improved variety "Pinto Villa" crossed to wild beans have also been shipped to Mexico and have been evaluated. These include one with G 10022, the wild bean with the high-iron trait.

Guatemala: The Guatemalan program continues to put high priority on resistance to BGYMV, while their strategy in relation to drought has focused on early maturity. Earliness is in fact an important alternative, especially in light of possible climate change and shorter growing seasons. The locally bred cultivar, ICTA Ligero, is highly resistant to virus and is one of the earliest materials available. Among populations sent from CIAT, none could compare with ICTA Ligero in earliness. For this reason, the use of ICTA Ligero has increased in our breeding program, and it has been combined with sources of physiological drought tolerance.

Haiti: CIAT has coordinated a disaster relief project in Haiti, serving to funnel germplasm of several crops and forages to on-farm trials. The purpose of this project was to test elite germplasm identified in other countries to take quick advantage of research advances already made elsewhere. Because production limitations of bean in Haiti are similar to those for which we have worked in Central America (especially BGYMV), we tested elite resistant materials from this region including DOR 390, ICTA Ostua, DOR 364, and Tío Canela (this latter variety from EAP-Zamorano). Furthermore, we observed during a visit to Haiti that another introduction, BAT 304, was performing very well in an observation nursery with single-row plots; BAT 304 is relatively early maturing and has been a successful variety in Costa Rica, Cuba, and Brazil. Therefore, with the help of the national research program of Costa Rica, we obtained 1 ton of BAT 304 seed for testing widely in Haiti. Figures 56 and 57 present results of on-farm trials. Under well-watered conditions, all introduced varieties displayed an ample advantage over the local check, although Tío Canela and BAT 304 were especially outstanding, nearly doubling yields of the check. Under drought, yields were reduced drastically, but BAT 304 again doubled the yield of the check, and produced 100 kg more than did Tío Canela. Under drought, the early maturity of BAT 304 probably offers a significant advantage. The fact that it yields well compared to other varieties over wide rainfall regimes suggests that it could offer a greater degree of food security than other materials.

Honduras (Secretaría de Recursos Naturales): The bean program of the SRN works basically in the evaluation of finished lines from either EAP-Zamorano or CIAT. The agronomist of the SRN received 39 red-seeded bred lines from CIAT in 2000, and evaluated these in three environments in the same year. Several presented good resistance to BGYMV and excellent grain color, this latter trait being their major advantage over other materials that are available.

Honduras (EAP-Zamorano): The school at Zamorano has one of the most active breeding programs in the region and participates in the USAID-funded Bean/Cowpea CRSP project. CIAT collaborates closely with the breeder at Zamorano, interchanging parental material and nurseries. In the past 3 years, CIAT has supplied over 1400 F_1-derived F_2 populations and/or simple crosses for selection in situ in Central America. The breeder visited CIAT in March of this year to strengthen ties. This year our collaboration has focused on drought stress, as indicated in sections 1.1.1 and 1.1.2. With the aid of Zamorano, the best parents for drought tolerance could be identified, which in turn served the selection of populations in CIAT.

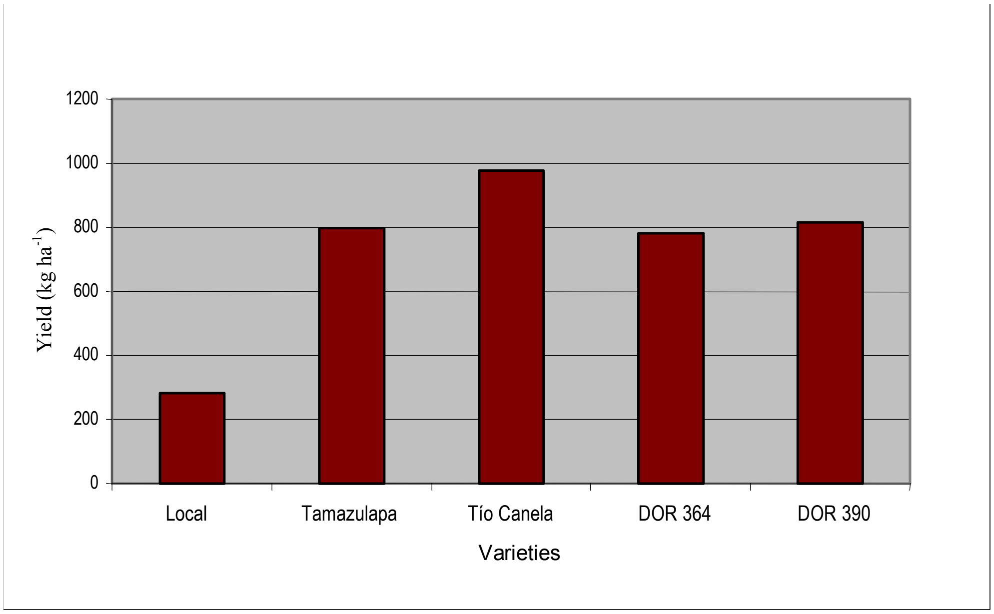

Figure 56. Yields of five bean varieties obtained in five localities in the southeast of Haiti.

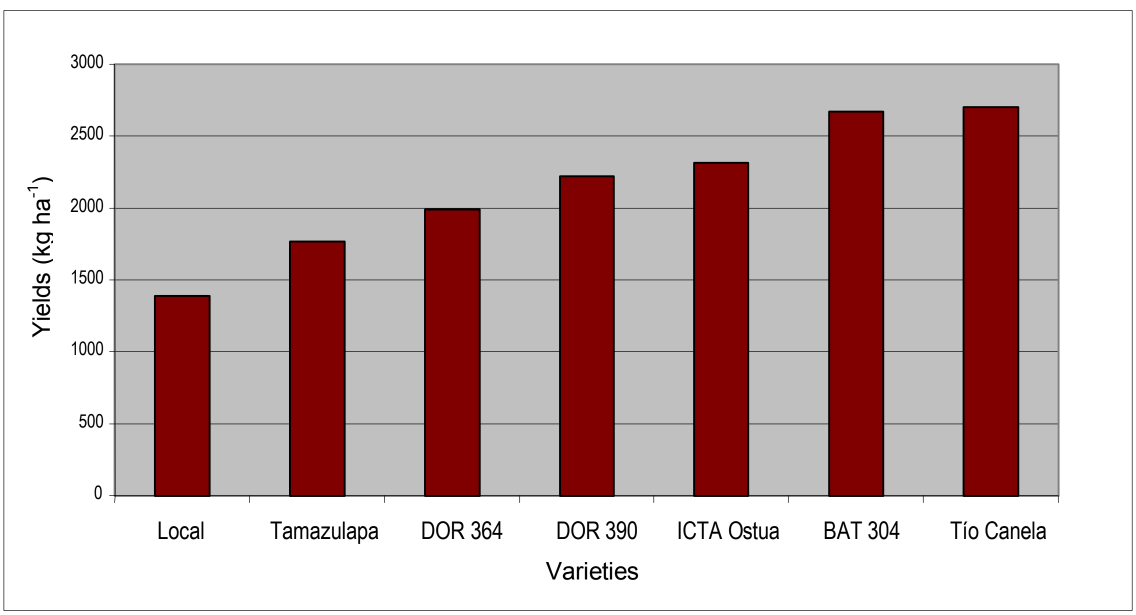

Figure 57. Yields of seven bean varieties obtained in two localities in the southeast and the west of Haiti.

Nicaragua: Our primary partner in Nicaragua in research continues to be the national program of the Instituto Nacional de Tecnología Agropecuária (INTA), the research arm of the Ministry of Agriculture. An INTA breeder collaborates in a regional network of participatory plant breeding (PPB), and we expect to broaden our own interaction with researchers in PPB through this connection. The program in Nicaragua has shown an active interest in drought tolerance, in combination with resistance to BGYMV, and we are making plans to ship populations mentioned in section 1.1.2 to Nicaragua for local selection.

CIAT-Hillsides: We have discussed plans with the CIAT-Hillsides Project, and next year we expect to initiate more intensive collaboration around the topic of drought. We expect to ship populations to research sites (Supermarket of technology options for Hillsides [SOLs]) where the Hillsides Project works for selection with farmers.

Conclusions: It is evident that the breeding priorities of national programs have evolved over recent years to include abiotic stress tolerance as well as disease resistance. Efforts in this regard reflect our own commitment to abiotic stress tolerance, and are starting to bear fruit. Several actors in Central America are committed to addressing the problem of drought and we will collaborate with these partners by supplying tolerant germplasm for local selection.

4.1.2 Reactivation of the Bean Team Nursery (VEF)

Rationale: At the very inception of the Bean Team, a nursery was created that integrated the efforts of the several team members by focusing attention on a common set of lines developed by the team breeders or proposed by any other team member. These lines were evaluated for the priority traits at that moment (primarily disease resistance). Based on these evaluations, lines were selected for preliminary yield trials (ensayo preliminario de rendimiento, or EP), from which lines were selected for the International Bean Yield and Adaptation Nursery (IBYAN), as classed into grain color classes. As the Bean Team evolved, and working relations with national partners moved toward sharing more segregating populations and fewer finished lines, the VEF, EP, and IBYAN were discontinued. However, it became evident that a nursery with the functions of the VEF is still a current need of the team. On the one hand, it still serves to focus the attention of the team on a set of common genotypes and to gauge the state of the art of genetic advance. On the other hand, most national programs have suffered budgetary cuts and have not been able to absorb the breeding work as was foreseen a decade ago. Thus, an active breeding program in CIAT that produces finished lines remains relevant to meeting needs of NARS and farmers, and therefore a nursery to evaluate multiple traits is still a valuable activity.

Materials and Methods: 287 lines were included in this trial; 137 were from the Mesoamerican breeding program, 75 from the Andean breeding program, 36 from bean pathology, and 39 from bean entomology. Unreplicated sets (about 40 seeds per line) were distributed for the evaluation of CBB, ALS (Andean and Mesoamerican races), anthracnose (Andean and Mesoamerican races), *Empoasca kraemeri, Thrips palmi*, BCMV, and drought tolerance. All data were taken on a scale of 1 (immune) to 9 (severely affected or dead). In the case of drought, this reflected pod load, because the effects of drought were so severe in most cases that no seed yield was registered, and thus yield data were not taken.

Disease evaluation: Response of VEF lines to ALS and CBB was conducted under field conditions, while response to anthracnose was done under greenhouse conditions. Field evaluations for ALS were made at Santander de Quilichao (~900 m) and Darién (~1300m), while that for CBB was made at Santander de Quilichao. At each site, single rows were used, and controls (resistant and susceptible varieties) were sown every 20 rows. At each site, inoculations were done using a mixture of Andean and Mesoamerican ALS races from that site (Table 57) or strain XCP 123 for CBB. Inoculations were started 28 days after planting and at weekly intervals thereafter to a total of four inoculations. Evaluations were done using a CIAT 1 – 9 scale; plants that had a rating of 3 or less were considered resistant, 4-6, intermediate, and a rating greater than 6 were considered susceptible.

Table 57. Virulence phenotypes of angular leaf spot isolates used for field evaluation of 287 common bean lines of the Vivero del Equipo de Fríjol (VEF).

Isolates	Differential cultivars[a]												Race
	A	B	C	D	E	F	G	H	I	J	K	L	
Pg 3 COL	a	b	c	d	e	f							63-0
Pg 32 COL	a	b	c	d	e	f	g	h	i		k	l	31-55
Pg 61 COL	a		c	d			g	h	i	j	k	l	13-63
Pg 65 COL	a						g	h	i		k	l	1-55
Pg 254 COL	a	b	c	d	e		g	h	i	j		l	31-47
Pg 66 COL	a	b	c	d	e	f							63-0
Pg 260 COL	a	b	c	d	e	f							63-0
Pg 270 COL	a	b	c	d	e	f							63-0
Pg 44 COL	a	b	c	d	e		g	h	i	j		l	31-47
Pg 81 COL	a		c				g	h	i	j		l	5-47
Pg 85 COL	a	b	c	d	e	f	g	h	i	j			63-15
Pg 261 COL	a	b	c	d	e		g	h	i	j		l	31-47

a. Andean differential cultivars: A = Timoteo, B = G 11796, C = Bolon Bayo, D = Montcalm, E = Amendoin, and F = G 5686. Mesoamerican differential cultivars: G = PAN 72, H = G 2858, I = Flor de Mayo, J = MEX 54, K = BAT 332, and L = Cornell 49-242.

Greenhouse evaluations: Response to *C. lindemuthianum* was done on seedlings under greenhouse conditions. Seedlings 10 days old with a fully expanded primary leaf were inoculated using a mixture of Andean and Mesoamerican races of *C. lindemuthianum* collected from Popayán. Inoculated plants were put in a humid chamber with a relative humidity between 90% and 100%. Disease was rated 10 days after inoculation using a 1 to 9 severity scale. Plants with no visible disease symptoms or with only a few, very small, lesions mostly on primary leaf veins were recorded as resistant (scale 1 to 3). Plants with numerous small or enlarged lesions, or with sunken cankers on both the lower surfaces of leaves and the seedling stem were rated a susceptible (scales 7 to 9). Plants that had a rating of (3.1 – 6.9) were scored as intermediate.

Results: Data were obtained for all traits except *Thrips palmi*, which is pending. Table 58 presents a summary of reactions across all entries.

Complete data for the VEF are to be found in Table 59.

Table 58. Summary of reactions to diseases, one pest, and drought, of entries in the Bean Team Nursery (VEF) 2001 as percentage of total entries.

Trait[a]	Resistant (1-3)	Intermediate (4-6)	Susceptible (7-9)
ALS-Darién	4	27	69
ALS-Santander de Quilichao	26	23	51
ANT-Greenhouse	35	15	50
CBB-Santander de Quilichao	14	40	46
Empoasca		10	90
BCMV	68 (*II*)	2 (*I*i)	30 (ii)
Drought		1	99

a. ALS = angular leaf spot, ANT = anthracnose, CBB = common bacterial blight, and BCMV = bean common mosaic virus.

Table 59. Bean Team Nursery (VEF) 2001: List of entries and reaction to diseases and pests.

VEF2 001 #	Line	Color[a]	Size[b]	Evaluations[c]						
				BCMV	ALS_D	ALS_Q	ANT_GH	CBB	EMP	ADP_DG
Origin: Mesoamerican Genetic:										
1	RJB 1	6	s	*I*	5	7	1.4	7	8.3	8
2	RJB 2	6	s	*I*	8	8	5.4	4	7.8	7
3	RJB 3	6	s	*I*	8	7	7.8	3	7.3	7
4	RJB 4	6	s	*I*	8	8	9.0	7	8.2	8
5	RJB 5	6	s	*I*	8	8	9.0	7	8.7	8
6	RJB 6	6	s	*I*	8	8	9.0	9	8.3	8
7	RJB 7	6	s	*I*	8	8	4.0	6	8.2	7
8	RJB 8	6	s	*I*i	8	8	3.0	6	8.2	7
9	RJB 9	6	s	i	6	7	9.0	4	8.8	7
10	RJB 10	6	s	*I*	8	8	9.0	3	8.5	7
11	RJB 11	6	s	*I*	7	8	9.0	4	8.3	7
12	RJB 12	6	m	*I*	7	7	9.0	2	7.0	8
13	RAB 606	6	s	*I*	8	8	2.0	2	8.3	7
14	RAB 607	6	s	*I*	8	8	4.0	2	8.5	7
15	RAB 608	6	s	*I*	8	3	1.0	7	8.2	8
16	RAB 609	6	s	*I*	8	8	9.0	3	7.8	7
17	RAB 610	6	s	*I*	8	8	1.0	3	8.2	8
18	RAB 611	6	s	*I*	8	8	7.0	6	8.5	8
19	RAB 612	6	s	*I*	8	8	4.0	6	8.3	8
20	RAB 613	6	s	*I*	8	8	7.0	6	8.5	8
21	RAB 614	6	s	*I*	8	8	7.0	6	8.2	8
22	RAB 615	6	s	*I*	8	8	1.0	3	8.5	7
23	RAB 616	6	s	*I*	8	8	1.0	5	8.8	7
24	RAB 617	6	s	*I*	8	8	1.0	5	8.8	8
25	RAB 618	6	s	*I*	8	8	8.0	5	7.8	8
26	RAB 619	6	s	*I*	8	8	9.0	6	8.0	8
27	RAB 620	6	s	*I*	3	7	3.0	4	8.3	8
28	RAB 621	6	s	*I*	8	8	7.3	3	7.5	8
29	RAB 622	6	s	*I*	7	8	4.2	2	7.2	7
30	RAB 623	6	s	*I*i	5	8	9.0	8	8.5	7
31	RAB 624	6	s	*I*	5	8	9.0	7	8.7	7
32	RAB 625	6	m	*I*	8	9	4.0	3	9.0	7

Continued.

Table 59. Continued.

VEF2 001 #	Line	Color[a]	Size[b]	Evaluations[c]						
				BCMV	ALS_D	ALS_Q	ANT_GH	CBB	EMP	ADP_DG
Origin: Mesoamerican Genetic:										
33	RAB 626	6	m	*I*	8	8	4.5	4	9.0	8
34	RAB 627	6	m	*I*	8	8	4.3	5	9.0	8
35	RAB 628	6	m	*I*	8	8	5.0	4	9.0	8
36	RAB 629	6	s	*I*	8	8	9.0	4	8.8	8
37	RAB 630	6	s	*I*	8	8	9.0	3	9.0	7
38	RAB 631	6	s	*I*	8	8	9.0	3	9.0	7
39	RAB 632	6	s	*I*	8	8	9.0	4	8.8	7
40	RAB 636	6	s	*I*	8	8	4.8	6	7.3	8
41	RAB 650	6	s	*I*	8	8	9.0	4	8.0	8
42	RAB 651	6	s	*I*	8	8	9.0	2	8.0	8
43	SEA 15	7	m	*I*	8	8	9.0	8	9.0	7
44	SEA 16	3	s	*I*	7	7	9.0	5	7.7	8
45	SEA 17	2	s	*I*	5	8	9.0	5	7.3	8
46	SEA 18	8	s	*I*	6	8	9.0	4	8.7	7
47	SEA 19	8	s	*I*	8	8	9.0	6	8.5	7
48	SEA 20	6	s	*I*	8	7	9.0	4	8.8	8
49	SEA 21	6	s	*I*	3	4	9.0	5	8.8	8
50	SEA 22	6	s	*I*	3	4	9.0	7	8.7	8
51	SEA 23	5	m	*I*	8	8	9.0	7	8.7	8
52	INB 35	8	s	*I*	6	8	6.6	8	7.5	8
53	INB 36	8	s	*I*	7	8	7.3	7	7.5	8
54	INB 37	8	s	*I*	3	8	9.0	7	7.5	8
55	INB 38	8	s	*I*	6	8	9.0	8	7.0	8
56	G 40068	3	s	i	9	7	9.0	1	8.8	7
57	G 40159	1	s	i	9	7	9.0	1	9.0	7
58	G 21212	8	s	i	8	7	1.0	9	8.7	8
59	G 1977	8	s	i	7	7	6.0	9	7.7	8
60	SEA 5	2	s	*I*	4	8	9.0	7	8.2	7
61	BAT 477	2	s	*I*	4	8	7.0	9	7.5	7
62	Tío Canela 75	6	s	*I*	5	8	7.0	9	6.0	8
63	DOR 390	8	s	*I*	6	6	4.0	7	8.0	8
64	Pinto Villa	Pt	m	*I*	8	8	2.8	4	9.0	8
65	Apetito	7	s	i	8	7	1.0	7	8.8	8
66	ICA Pijao	8	s	*I*	7	7	9.0	7	6.8	8
67	ICA Quimbaya	6	l	i	7	8	1.0	8	9.0	7
68	A 774	2	s	*I*	7	8	3.3	5	8.0	8
69	A 785	8	s	*I*	7	8	4.0	3	7.0	8
70	A 801	2St	s	*I*	7	2	1.0	5	7.3	8
71	AFR 699	6M	l	*I*	6	3	9.0	6	8.2	8
72	BAT 304	8	s	*I*	7	8	6.8	8	7.3	7
73	BAT 881	4	s	*I*	5	8	9.0	7	7.2	8
74	BH 21134-66	8	s	*I*	7	7	1.0	8	7.8	8
75	Carioca	2R	s	*I*	7	8	1.0	7	7.3	8
76	DICTA 17	6	m	*I*	7	8	1.0	7	8.5	8
77	DOR 364	6	s	*I*	7	8		6	6.7	8
78	FEB 192	2	s	*I*	7	7	4.0	5	8.2	8
79	G 18479	8	s	*I*	6	8	8.0	7	7.0	8
80	G 19227A	4r	s	i	4	8	9.0	7	7.7	8

Continued.

Table 59. Continued.

VEF2 001 #	Line	Color[a]	Size[b]	Evaluations[c]						
				BCMV	ALS_D	ALS_Q	ANT_GH	CBB	EMP	ADP_DG
Origin: Mesoamerican Genetic:										
81	G 19842	2M	l	i	8	5	9.0	7	8.3	8
82	G 3513	8	s	i	8	8	9.0	7	8.0	8
83	G 92	2R	s	*I*	8	8	9.0	7	7.7	8
84	G 22041	3	m	i	8	9	9.0	7	8.8	8
85	IPA 7	2	s	*I*	8	7	9.0	7	7.7	8
86	MAM 38	5Sp	m	*I*	7	8	2.0	5	6.0	8
87	MARR 1	2Sp	s	*I*	7	5	3.3	6	7.0	8
88	TLP 39 (BT 2113 8-98)	8	s	*I*	7	8	9.0	6	7.5	7
89	SAM 3	6	m	*I*	5	3	2.0	7	8.0	8
90	TLP 34	8	m	*I*i	5	6	9.0	7	7.2	8
91	TLP 35	6	s	*I*	6	8	7.0	7	8.3	8
92	V 8025	8	s	*I*	7	8	7.0	7	7.5	8
93	VAX 1	2R	s	*I*	7	6	1.0	2	8.3	8
94	VAX 2	2Sp	s	*I*	7	7	1.0	2	8.0	8
95	VAX 6	6	s	*I*	7	4	9.0	2	8.0	8
96	Velazco Largo	5	l	i	9	8	5.4	8	9.0	7
97	XR 12546-21	2R	s	*I*	7	3	6.0	6	7.8	8
98	MA 12129-34	2R	m	*I*	7	2	4.0	2	8.5	8
99	MA 12129-34	2	s	*I*	7	2	4.8	4	8.3	8
100	MN 12688-2	4/8	m	*I*	7	2	3.4	2	8.7	8
101	MN 12688-3	6/2	s	*I*	8	2	3.5	3	8.2	8
102	MN 12688-3	6	s	*I*	8	2	7.0	3	8.0	7
103	MN 12688-7	6/2	m	*I*	8	2	1.5	4	7.8	7
104	MN 12688-8	2R	s	*I*	8	3	1.0	3	7.3	7
105	MN 12688-13	8	s	*I*	7	2	1.0	5	8.3	7
106	MN 12688-13	8	s	*I*	8	2	4.7	6	7.2	8
107	MN 12688-15	2R/6	s	*I*	8	2	1.0	6	8.5	7
108	BM 12721-17	2R	s	*I*	6	3	1.0	6	7.0	8
109	BM 12721-34	2R	s	*I*	6	2	1.0	4	5.8	8
110	BM 12721-34	2R	s	*I*	6	2	1.0	4	6.5	8
111	BM 12721-63	2R	s	*I*	6	3	1.0	7	7.5	8
112	BM 12721-79	2R	s	*I*	6	2	1.0	5	8.3	8
113	BM 12722-5	2R	s	*I*i	5	3	1.0	5	7.0	8
114	BM 12722-44	2R	s	*I*	5	2	1.2	4	5.7	8
115	BM 12722-44	2R/4	s	*I*	6	2	1.0	7	6.0	8
116	BM 12722-45	2R	s	*I*	4	4	3.6	4	6.5	8
117	BM 12722-49	2R	s	*I*	3	3	3.9	3	4.8	8
118	BM 12722-49	2R	s	*I*	3	3	4.0	3	5.2	8
119	BM 12722-57	2R	s	*I*	4	3	1.0	5	6.3	8
120	BM 12722-57	2R	s	*I*	4	2	1.5	5	6.3	8
121	BM 12722-57	2R	s	*I*	4	3	1.0	1	5.3	8
122	BM 12722-60	2R	s	*I*	3	2	3.6	2	5.5	8
123	BM 12722-60	2R	s	*I*	5	2	1.1	6	6.2	8
124	BM 12722-77	2R	s	*I*	4	2	2.2	6	6.0	8
125	BM 12722-77	2R	s	*I*	5	3	3.0	5	7.2	8
126	BM 12722-83	2R	s	*I*	5	4	1.0	7	6.5	8
127	BM 12722-83	2R	s	*I*	4	2	1.2	5	6.8	8
128	BM 12722-84	2R	s	*I*	5	3	1.0	4	5.8	8

Continued.

Table 59. Continued.

VEF2 001 #	Line	Color[a]	Size[b]	Evaluations[c]						
				BCMV	ALS_D	ALS_Q	ANT_GH	CBB	EMP	ADP_DG
Origin: Mesoamerican Genetic:										
129	BM 12722-110	2R	s	*I*	4	6	1.0	4	7.2	8
130	BM 12722-126	2R	s	*I*	4	2	2.0	4	4.8	8
131	BM 12722-127	2R	s	*I*	4	3	3.4	4	6.3	8
132	BM 12722-127	2R	s	*I*	4	2	3.0	6	6.8	8
133	BM 12722-129	2R	s	*I*	4	4	3.0	4	4.8	8
134	BM 12722-132	2R	s	*I*	4	2	4.0	3	6.7	8
135	BM 12722-133	2R	s	*I*	4	2	2.5	2	4.7	8
136	BM 12722-133	2R	s	*I*	4	3	1.0	4	4.5	8
137	MA 12129-66	2R /4	m	*I*	8	2	1.0	2	7.0	8
Origin: Pathology:										
138	AFR 645	2R	l	*I*	7	2	1.0	4	7.5	8
139	AFR 702	6	l	i	5	2	1.0	2	8.8	8
140	AFR 703	6	l	i	4	4	1.0	5	8.7	8
141	AND 279	6M	m	i	6	2	9.0	4	8.7	8
142	AND 1056	2M	l	*I*	7	4	1.0	4	8.7	8
143	APN 47	4M	s	*I*	8	4	9.0	7	8.2	8
144	CAL 123	6M	m	i	7	6	1.0	2	8.7	8
145	CAL 143	6M	m	i	7	5	9.0	2	8.8	9
146	CAL 173	6M	l	i	7	2	9.0	6	8.8	9
147	EMP 364	6M	m	*I*	8	6	9.0	4	6.5	8
148	G 855	3	m	i	5	8	1.0	8	8.3	9
149	G 916	3M	m	i	7	6	9.0	7	8.0	9
150	G 2923	8	s	*I*i	6	5	4.0	8	8.8	9
151	G 4691	2	s	i	4	3	9.0	8	8.8	9
152	G 5207	8	s	*I*	7	3	1.0	7	7.2	8
153	G 5377	2Sp	m	*I*	8	5	9.0	3	8.5	8
154	G 6727	3M	m	i	7	3	9.0	5	8.2	9
155	G 8152	3M	l	i	7	3	9.0	7	7.8	9
156	G 9282	6	s	i	6	2	9.0	6	8.8	9
157	G 10474	6	m	*I*	2	1	1.0	5	7.7	9
158	G 10613	1	s	*I*	5	2	1.0	7	7.8	9
159	G 10736	8	s	i	3	3	1.0	7	8.5	9
160	G 10865	8	s	i	7	3	6.0	8	9.0	8
161	G 10909	6	m	*I*	3	2	1.0	7	8.7	9
162	G 11104 (FPF)	2	m	i	6	3	1.0	8	7.8	8
163	G 14301	2R	m	i	6	5	9.0	9	9.0	8
164	G 14508	2	m	i	6	3	1.0	7	7.3	8
165	G 18970	3	s	i	3	5	1.0	7	8.0	8
166	G 19833	3M	m	i	5	5	1.0	7	8.5	8
167	G 20525	4	m	i	6	5	1.1	6	8.3	8
168	G 22301	6R	l	i	6	6	1.0	7	8.3	8
169	G 22447	3R	m	i	9	4	9.0	8	9.0	9
170	Gordo	2	m	i	7	6	1.0	8	8.8	9
171	ICA Tundama	6M	l	i	7	4	9.0	7	7.8	9
172	ICTA Texel	8	s	i	9	4	2.6	9	8.8	8
173	ZAA 91	4M	m	*I*	5	3		2	8.8	8

Continued.

Table 59. Continued.

VEF2 001 #	Line[a]	Color[b]	Size	Evaluations[c]						
				BCMV	ALS_D	ALS_Q	ANT_GH	CBB	EMP	ADP_DG
Origin: Entomology:										
174	EMP 81	2	s	*I*	5	6	1.0	8	6.3	8
175	EMP 84	8	s	*I*	6	7	3.7	8	6.7	8
176	EMP 124	1	s	*I*	7	7	1.9	7	6.0	8
177	EMP 250	2R	s	*I*	5	3	1.0	7	6.0	8
178	EMP 387	6	s	*I*	8	7	3.2	7	6.0	8
179	EMP 400	2	s	*I*	8	7	9.0	8	5.8	8
180	EMP 415	8	s	*I*	8	7	9.0	8	5.2	8
181	EMP 419	1	s	*I*	7	7	9.0	7	5.5	8
182	EMP 423	8	s	*I*	8	7	9.0	9	5.2	6
183	EMP 446	1	s	*I*	7	7	5.2	6	6.2	8
184	EMP 488	6	s	*I*	6	5	5.4	8	4.7	8
185	EMP 496	2R	s	*I*	7	7	4.4	7	6.2	6
186	EMP 512	2R	s	*I*	7	7	1.0	7	5.5	7
187	EMP 535	8	s	*I*	8	7	9.0	7	6.8	6
188	EMP 539	2R	s	*I*	8	7	9.0	8	6.0	8
189	EMP 585	2R	s	*I*	7	7	4.0	7	6.3	8
190	EMP 589	6	s	*I*	8	7	9.0	9	3.5	7
191	EMP 590	6	s	*I*	8	7	9.0	9	3.7	7
192	APN 18	4	s	*I*	7	7	1.0	8	7.7	7
193	APN 83	6	s	*I*	8	7	1.0	8	8.7	7
194	APN 106	6	s	*I*	8	7	9.0	8	8.3	8
195	APN 117	6	m	*I*	8	7	9.0	9	6.7	8
196	APN 142	6	s	*I*	8	5	4.2	9	7.8	7
197	APN 153	6	m	*I*	.	.		.		.
198	APN 162	6	s	*I*	8	7	1.0	7	8.8	7
199	APN 170	6	m	*I*	8	9	9.0	8	8.7	8
200	RAZ 38	1	s	*I*	8	7	9.0	7	7.7	8
201	RAZ 44	1	s	*I*	7	8	9.0	7	7.5	8
202	RAZ 95	6	s	*I*	8	9	9.0	7	8.2	8
203	RAZ 101	6	s	*I*	8	8	9.0	4	7.2	8
204	RAZ 136	1	s	*I*	7	7	3.5	3	8.8	8
205	RAZ 157	8	s	*I*	8	7	9.0	8	6.8	8
206	RAZ 162	8	s	*I*	8	9	9.0	8	7.0	8
207	RAZ 163	8	s	*I*	8	8	9.0	8	7.2	7
208	FEB 115	2	s	*I*	8	7	1.0	8	6.7	8
209	EMP 486	6	s	*I*	6	5	9.0	7	4.2	7
210	TLP 36 (BH 21134-5)	4	s	*I*	6	9	9.0	7	7.5	8
211	TLP 38 (BH 21134-60)	4	s	*I*	7	6	9.0	7	8.3	8
212	BH 21134-130	4	s	*I*	7	3	1.0	7	7.3	8
Origin: Andean Genetic:										
213	AFR 738	7Sp	m	i	8	7	8.0	7	8.7	8
214	AFR 739	7Sp	l	i	8	6	9.0	7	7.8	7
215	AFR 740	7Sp	l	i	8	7	5.9	6	8.5	8
216	AFR 741	7Sp	l	i	8	5	1.0	6	8.0	7
217	AND 1091	6	m	i	8	7	1.0	8	8.7	8
218	AND 1092	1M	m	i	8	5	7.0	7	9.0	7
219	CAP 25	Cn	m	*I*	8	7	9.0	7	8.5	8

Continued.

Table 59. Continued.

VEF2 001 #	Line[a]	Color[b]	Size	Evaluations[c] BCMV	ALS_D	ALS_Q	ANT_GH	CBB	EMP	ADP_DG
Origin: Andean Genetic:										
220	DFA 67	6M	m	i	7	4	9.0	6	8.8	8
221	DFA 68	6M	m	*I*i	5	2	9.0	4	8.8	8
222	DFA 69	6M	m	i	5	3	9.0	4	8.8	8
223	DFA 70	6M	m	i	4	3	9.0	5	8.8	8
224	DFA 71	6M	m	i	6	3	9.0	5	8.5	8
225	DFA 72	6M	m	i	5	2	9.0	5	8.7	8
226	DFA 73	6M	m	i	4	4	9.0	5	8.5	8
227	DFA 74	6M	m	i	5	3	9.0	4	8.3	8
228	DFA 75	6M	m	i	5	3	9.0	6	7.7	9
229	DFA 76	6M	m	i	6	3	9.0	5	7.5	9
230	DFA 77	6M	m	i	7	4	9.0	6	8.5	8
231	DFA 78	6M	l	i	6	6	9.0	7	8.7	8
232	DFA 79	6M	m	i	7	5	9.0	5	8.3	8
233	DFA 80	6M	m	i	6	6	6.6	6	8.5	8
234	DRK 149	6	l	i	8	7	1.0	9	8.5	8
235	DRK 150	6	l	i	8	7	1.0	7	8.2	7
236	DRK 151	6	l	i	8	7	1.0	8	8.8	8
237	DRK 152	6	m	i	8	5	1.0	6	8.8	8
238	DRK 153	6	m	i	8	7	8.0	8	9.0	8
239	DRK 154	6	l	i	8	7	1.0	6	8.8	8
240	DRK 155	6	m	i	8	6	1.0	7	8.8	8
241	DRK 156	6	l	i	8	7	1.0	7	9.0	8
242	DRK 157	6	l	i	8	7	1.0	7	9.0	8
243	FOT 73	6M	l	*I*	8	6	8.0	5	9.0	8
244	FOT 74	6M	m	*I*i	8	7	8.0	4	9.0	7
245	FOT 75	2M	m	*I*	8	3	1.0	7	8.8	7
246	FOT 76	6M	m	i	8	5	8.0	6	9.0	7
247	FOT 77	6M	m	i	7	3	8.0	7	8.7	7
248	FOT 78	6M	m	i	7	5	8.0	7	8.7	7
249	FOT 79	6M	m	i	8	6	9.0	6	8.8	7
250	FOT 80	6M	m	i	8	6	9.0	7	9.0	7
251	FOT 81	6M	m	i	7	7	9.0	7	8.2	7
252	FOT 82	6M	m	i	7	5	9.0	6	8.7	8
253	FOT 83	6M	m	i	7	4	9.0	3	9.0	8
254	FOT 84	6M	m	i	7	5	9.0	7	9.0	7
255	POA 17	6M	m	i	8	5	9.0	7	8.8	8
256	POA 18	6M	m	i	8	7	9.0	5	7.8	8
257	RAA 36	6	m	i	7	7	1.0	7	8.0	8
258	RMA 1	6M	m	*I*	8	7	1.0	5	8.2	8
259	RMA 2	6M	m	i	7	7	9.0	6	8.7	8
260	RMA 3	6M	m	i	8	7	9.0	7	8.3	7
261	RMA 4	6M	m	i	8	4	9.0	5	8.7	8
262	RMA 5	6M	m	*I*i	7	5	1.0	4	8.2	8
263	RMA 6	6M	m	*I*	6	4	7.0	7	8.2	8
264	RMA 7	6M	m	*I*	8	7	8.0	8	8.8	8
265	RMA 8	6M	m	*I*	8	7	8.0	5	8.5	8
266	RMA 9	6M	m	*I*	7	7	6.0	7	8.7	8
267	RMA 10	6M	s	*I*	7	6	7.0	6	7.5	8

Continued.

Table 59. Continued.

VEF2 001 #	Line	Color[a]	Size[b]	Evaluations[c]						
				BCMV	ALS_D	ALS_Q	ANT_GH	CBB	EMP	ADP_DG
Origin: Andean Genetic:										
268	RMC 1	6M	m	*I*	8	7	8.0	6	8.7	8
269	RMC 2	6M	m	*I*	8	4	9.0	7	8.7	8
270	RMC 3	6M	m	*I*	8	3	7.0	6	8.3	8
271	RMC 4	6M	m	*I*	7	2	9.0	2	8.7	8
272	RMC 5	6M	s	*I*	7	6	9.0	4	9.0	8
273	RMC 6	6M	m	*I*	8	3	9.0	5	8.3	8
274	RMC 7	6M	s	*I*	7	4	9.0	6	8.8	8
275	RMC 8	6M	s	*I*	7	6	1.0	3	8.5	8
276	RMC 9	6M	m	*I*	8	7	1.0	4	8.5	8
277	RMC10	6M	m	*I*	9	7	1.0	6	8.0	9
278	RMC11	6M	m	i	9	7	6.0	7	8.5	9
279	RMC 12	6M	m	*I*	8	7	3.8	4	8.7	9
280	RMC 13	6M	m	*I*	7	6	9.0	7	8.2	8
281	RMC 14	6M	s	i	8	7	1.0	7	8.5	9
282	RMC 15	6M	s	i	8	7	5.0	7	8.7	9
283	RMC 16	6M	m	*I*	8	6	9.0	6	9.0	8
284	RMC 17	6M	m	*I*	8	3	4.0	7	8.7	8
285	SUG 147	2M	l	i	8	7	1.0	7	8.8	7
286	SUG 148	2M	l	*I*	8	7	1.0	7	8.8	7
287	SUG 149	2M	m	i	8	7	1.0	5	7.5	7

a. Color: 1 = white, 2 = cream, 3 = yellow, 4 = brown, 5 = pink, 6 = red, 7 = purple, 8 = black, M = mottled, R = striped, Sp = speckled, Cn = Canario, and Pt = Pinto.

b. Size: l =large, m = medium, and s = small.

c. BCMV = bean common mosaic virus: *I*, dominant *I* gene; i = recessive *I* gene; *I*i = heterozygous for *I* gene. ALS_D = angular leaf spot (ALS) evaluations done at Darién; ALS_Q = ALS evaluations done at Santander de Quilichao; ANT-GH = anthracnose evaluations done in the greenhouse; CBB = common bacterial blight, ratings 1-3 = resistant, 3.1-6 = intermediate, and > 6.1 = susceptible; EMP = *Empoasca* evaluations on a 1-9 score scale where 1= no damage and 9 = severe damage (1-6 resistant, 6.1-7 intermediate, > 7 susceptible); ADP_DG = drought adaptation, evaluations on a scale of 1-9 where 1-3 = tolerant, 4-6 intermediate, and 7-9 susceptible.

Progress in Mesoamerican classes: The small red class was represented by RJB and RAB lines that were selected for traits basically at two sites (Santander de Quilichao and Popayán). Selection at Santander de Quilichao was reflected by the high percentage of lines with a favorable reaction to CBB. Indeed, only eight out of 42 were fully susceptible to CBB. About half of small reds were intermediate or resistant to anthracnose, similar to the overall pattern of the VEF. Most of these lines carry the *bgm-1* gene for BGMYV, and several have expressed resistance in the field in Central America. However, despite selection at Santander de Quilichao, this group continues to be highly susceptible to ALS at both sites, thus this is a continuing weakness for this grain class. Most small reds carry unprotected dominant *I* gene resistance to BCMV, thus the incorporation of recessive *bc3* resistance remains to be achieved.

No lines in the VEF were developed specifically for commercial Carioca type, but crosses for ALS resistance involved Carioca parents that gave Carioca types in the progeny. A few of the lines selected for *Empoasca* resistance (EMP lines) are Carioca type as well. Among Carioca grain type, multiple resistance was especially common. This reflects past efforts in breeding for multiple resistance at Santander de Quilichao and Popayán in this class. Twenty-five of these were resistant or intermediate to all three fungal inoculations, CBB, and BCMV. Of these, 12 also carry resistance to *Empoasca*. These lines have only two important weaknesses. First, they do not carry resistance to BGYMV, and second, the seed is not of commercial quality by present Brazilian standards that demand grain that does not darken in storage. Our experience this semester with other Carioca genotypes also suggests that they do not bear up well under severe drought stress, although under moderate stress some do well.

Progress in Andean classes: Andean (large-seeded) beans were represented by the following grain classes: red mottled (Calima and Pompadour types), red kidney, large red, cream mottled (Cranberry or Sugar), purple speckled (Mwezi Mojo), and yellow (Canario). The proportion of lines from each class reflected the varying importance of each class to the Andean breeding program—with red-mottled beans being the predominant type, followed by large reds and red kidneys, then the cream mottleds, and finally a small number of the other types. The following series of lines were tested: AFR (all purple speckled), AND (mixed), CAP (a single yellow entry), DFA (all red mottled with adaptation to low phosphorous soils), DRK (dark red kidneys), FOT (both red and cream mottled), POA (rounded red mottled), RAA (large red), RMA (large-to medium-seeded red mottled with genes for the Andean zone), RMC (medium to small red-mottled with genes for the Caribbean zone), and SUG (all cream mottled). The pedigrees of RMA and RMC lines include multiple parent crosses, while the other lines were derived mainly from simple crosses. Most of the lines were selected at the Darién site, except for the RMC series, which was selected at Palmira and Darién. Previous testing of the lines had occurred at both sites.

In biotic and abiotic stress breeding of Andean beans significant progress has been made to individual diseases, but there is a need to pyramid some of the resistances together and combine them with drought (and possibly heat) tolerance and insect resistance.

The following is a summary of the reaction to each stress in the Andean types. The lack of insect resistance in Andean beans is being addressed with renewed effort in breeding *Empoasca* resistant, red-mottled beans; however, the current lines tested in the VEF are uniformly poor for *Empoasca*. The breeding of *Empoasca* resistance for other seed classes and thrips resistance for Andean types has not been a priority. For BCMV resistance, the dominant *I* gene was found in 27 lines, mostly from the RMA and RMC series. Among the other lines that were bred especially for East Africa (as well as the Andean zone) the dominant allele was avoided because of its interaction with necrotic strains of the virus that are prevalent in that production region. The RMC lines were selected based on the recessive BYGMV resistance gene *bgm-1* using a SCAR marker, but given that necrotic strains of BCMV have been identified in the Caribbean, the high prevalence of the dominant *I* gene in the RMC lines will have to be reassessed. In ALS testing, none of the lines were highly resistant; however, intermediate resistance was found in the DFA series and this was correlated in both locations (even though disease pressure was more intense at Darién). A few of the RMC lines were also resistant, but at Santander de Quilichao only. At Darién, the best Andean lines were only intermediate for resistance, while at Santander de Quilichao some of the same lines had a score of 2 or 3. The same lines are being tested in the East African sites. Anthracnose resistance was observed in 21 Andean lines mainly from the DRK series. The absence of lines with both anthracnose and ALS resistance may reflect the difficulty of pyramiding these two resistances. As expected, very little CBB resistance is found in the present material, except in two RMC lines that trace part of their ancestry to CBB-resistant parents. None of the Andean genotypes tested showed any drought tolerance. Although drought has not been a priority of the program, it would be interesting to try to incorporate tolerance through a modification of growth habit. What is needed is a program to breed a wider range of growth habits (all the present material are type I or short type II bush beans) into Andean genotypes. A promising source for this effort would be the Andean genotype, San Cristobal 83, a type III small-seeded, red-mottled bean from the Dominican Republic.

Progress by traits: Among drought-selected SEA lines, few have additional resistance traits except for an intermediate reaction to CBB. For example, SEA 15, which was the best parent in drought, was fully susceptible to all diseases except for *I* gene resistance for BCMV. The fortunate exceptions to this trend were sister lines, SEA 21 and 22, which were resistant to ALS at Darién and intermediate at Santander de Quilichao. SEA 21 was the second best parent in drought populations, after SEA 15, and figures in many of our drought populations. Among other entries in the VEF, only three EMP lines presented some tolerance to drought—EMP 423 and EMP 535 (black seeded), and EMP 496 (Carioca). The latter line will be especially useful because the Cariocas that we have seen to data are relatively sensitive to drought. At least in eastern Bolivia, Carioca types with drought tolerance are needed.

For ALS at Darién, only 4% of the lines were resistant, 27% intermediate, and most (69%) were susceptible (Table 58). However, at Santander de Quilichao, 25.8% of the lines were resistant, 22.6% intermediate, and 51.2% susceptible. The higher percentage at Santander de Quilichao is partly because many of the lines were selected for ALS resistance precisely at this site. Only 2% of the lines were resistant at both Darién and Santander de Quilichao. Three of these lines (BM 12722-60, BM 12722-49, and BM 12722-49) were from the Mesoamerican breeding program, while the rest (G 10474, G 10909, and G 10736) were sources of resistance from the pathology program. This is discussed more broadly in section 1.2.4. Lines that had a resistant or intermediate reaction will be evaluated again in the second semester of this year.

Both anthracnose and CBB presented about 50% of entries with intermediate or resistant reaction. Much of this resistance was found in the Carioca and small red classes, because of conscious selection for these traits in the course of breeding. All SEA lines were totally susceptible to anthracnose.

Only EMP lines and lines from cross BM 12722 presented tolerance to *Empoasca*. The cross BM 12722 is derived from A 01, which in turn is a progeny of EMP 250, and part of its tolerance certainly derives from it (see Table 19).

Conclusions: The VEF represents an important step in team integration, and has revealed both strengths and weaknesses in the breeding program. It is also an important contribution to national programs, because it offers a uniform set of data on potential parents and elite lines, and thus is the basis for an information system of value to germplasm users in both Latin America and Africa.

Contributors: C. Cardona, G. Mahuku, M.W. Blair, F. Morales, S. Beebe, H. Terán, C. Cajiao, C. Jara, J.M. Bueno, M. Castaño

4.1.3 Development of bean lines with resistance to bean common mosaic virus and bean common mosaic necrosis virus

Bean Virology has permanently contributed to the development of bean lines possessing multiple resistance to BCMV and BCMNV in improved genotypes developed for Africa.

Bean samples were received from Tanzania, Africa, in the form of inert, desiccated tissue and prepared for serological tests to examine the possibility that whitefly-transmitted viruses had emerged on beans in that region of the world. These samples were tested by ELISA using monoclonal antibodies to geminiviruses and potyviruses, and by PCR to check for the possible presence of tomato yellow leaf curl virus, another whitefly-transmitted virus that infects beans in the Old World. The results of these tests did not reveal the presence of whitefly-transmitted viruses, but showed that the samples were infected by a potyvirus.

Contributors: Research Assistants in Virology Research Unit, M. Castaño (IP-1)

4.1.4 Preliminary testing of climbing beans in Haiti

Rationale: Climbing beans have produced sustainably higher yields for small-scale farmers in many areas of the world. The most outstanding characteristic of climbing beans is their high yield potential. Climbing beans are capable of producing three times the seed yield per unit area of the more commonly grown bush beans. We believe that climbing beans have a similar potential to increase productivity on small farms in Haiti. The principal limitation to the expansion of climbing bean technology into new areas such as Haiti has been the lack of new varieties. Most currently available climbing beans come from high-altitude areas of Central and South America and few are available for regions at lower elevation such as found in Haiti (500 to 2000 m). There is an urgent need for climbing bean varieties that are adapted to these lower elevations and resistant to the diseases encountered there.

Materials and Methods: During the Hurricane George's Relief Project (HGRP), we initiated research to test the feasibility of growing climbing beans in Haiti. The first climbing beans to be tested in Haiti consisted of a set of six climbing bean accessions that are popular varieties in eastern Africa where they are grown at 1500 to 2000 m elevation. We also sent a second group of 49 accessions for more detailed testing with the Organization for the Rehabilitation of the Environment (ORE) at their site at Deron in southeast Haiti.

Results: In field visits to southwestern Haiti, we observed that these climbing beans grew well compared to bush beans despite poor soils at the testing site. Under slightly higher fertility regimes the yield advantage of climbing beans would likely be higher. Further testing under the Hillsides Agricultural Project (HAP) would be needed to confirm these observations.

Conclusions and Future Plans: If climbing beans are to be successful in Haiti, they will need to be resistant to BGMV and BCMNV. Realizing this, we have made crosses at CIAT to develop climbing beans with these resistances. The bean populations developed so far are in the development stage—either BC_1F_1 or F_2 generation. A few climbing bean lines with BCMV resistance will be available next year, while BGMV resistance should be incorporated into climbing beans in the second or third year of the HAP. Farmer-based selection, on-farm testing, extension education, and the transfer of staking technology are likely to be very helpful in the dissemination of climbing beans in Haiti. Although this is a new technology, previous experience shows that farmers are willing to try climbing beans if they fit into their agronomic practices and societal needs. Their participation in the process of testing climbing beans should lead to faster adoption. The success of climbing beans in Haiti will require the coordination of genetic improvement, agronomic research, agricultural extension, and farmer participation.

Contributors: M.W. Blair (IP-1); L. Eugene, G. Galvez (HGRP, CIAT); E. Magliore, M. Finnegan (ORE – Camp Perrin, Haiti).

4.1.5 CIAT entries in the VICARIBE trial

Rationale: Red-mottled beans are an important grain type for Haiti and the Dominican Republic. Although this is the preferred type in many communities on Hispaniola, production of red-mottled beans is insufficient to meet demand. This leads to the importation of dry beans (mainly Pinto beans) from the United States and other countries. Diseases such as BGMV, BCMV, rust, CBB, and ALS limit local production. The objective of this work was to provide advanced lines to national programs in the region and to test these lines for yielding ability and BGMV, CBB, and rust resistance.

Materials and Methods: The VICARIBE nursery included 77 entries. The University of Puerto Rico contributed 21 entries. CIAT lines included the RMC series (15 lines) that were selected for adaptation to Palmira and BGMV resistance based on the *bgm-1* marker; the RMA series - 10 lines, which were selected for adaptation to Darién and ALS resistance; and 14 additional Andean lines from the IBN 2000 nursery (DFA 67, DFA 70, DFA 72, DFA 73, DFA 74, DFA 76, DFA 79, FOT 77, FOT 9, FOT 80, FOT 83, POA 17, POA 18, and RAA 36). Check varieties included a range of CIAT lines (A 36, A 193, BRB 191, BRB 198, RAZ 105, AFR 619, AFR 699, CAL 96, and SUG 131) and local varieties (PC 50, Pompadour Jorgillo 17, Pompadour K, Salagnac 90A, and San Cristobal 83). The BGMV-resistant UPR variety, Morales, was used as BGMV check, and the Colombian variety, ICA Palmar, was used as drought check.

Results and Discussion: Table 60 shows the resistance status and yielding ability of the 15 RMC and 10 RMA lines in Dominican Republic, Haiti, and Puerto Rico. Seed size was smaller in the RMC (Pompadour type) lines than in the RMA (José Beta) lines. The BGMV resistance was higher in some of the RMC lines although they were all positive for the *bgm-1* marker, except for RMC 13 and RMC 15. Common bacterial blight resistance was higher in the lines derived from SAM 1, which contains a marker for one QTL against the disease. Rust susceptibility was variable among the lines. The correlation between yields in Haiti and Dominican Republic was moderate ($r = 0.375$), while the correlations of yields in these countries with yield in Puerto Rico were low ($r = 0.084$ to 0.155). The best yielding lines were RMA 1 and RMC 8, 11, 12, and 13 across the three sites. Seven other large-seeded (36.6 to 55.6 g per 100 seed) red kidney lines (DRK 151 to 157), derived from a drought tolerant Andean genotype, ICA Quimbaya, have also been distributed to the Caribbean.

Table 60. Results from yield trials conducted in Dominican Republic (DR), Haiti, and Puerto Rico (PR) for CIAT entries to the Vivero Caribeño de grano Andino (VICARIBE) 2001 nursery.

Line	Seed coat[a]	100s wt. (g)	Pedigree	*bgm-1*	Disease scores[a]			Yields (kg ha^{-1})		
					CBB PR	BGMV DR	Rust DR	DR	Haiti	PR
Pompadour (small seeded):										
RMC 1	B	38.1	(XR 12308-1 x AND 277)F_1 x (EMP 355 x Montcalm) F_1/	+	4.3	1.0	0.0	896	479	1241
RMC 2	SB	22.6	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	3.3	1.0	10.0	723	574	1853
RMC 3	B	28.1	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	5.3	1.7	0.0	967	1104	1304
RMC 4	SB	24.5	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	2.3	1.0	1.7	1000	462	1487
RMC 5	SB	25.4	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	5.7	2.3	5.0	683	981	1503
RMC 6	B	29.4	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	4.7	3.7	1.7	1033	587	1763
RMC 7	SB	23.0	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	3.3	1.0	2.3	567	761	1366
RMC 8	O	23.4	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	2.7	1.7	5.3	1133	1024	1670
RMC 9	O	30.7	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	2.0	4.3	0.7	767	712	1919
RMC 10	SB	34.4	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	3.7	1.0	0.3	1200	870	1435
RMC 11	B	36.0	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	3.0	1.7	1.7	1317	827	2201
RMC 12	O	39.2	(Calima x (MAM 48 x A 483)) x (PVA 800 A x ((EMP 376 x A 193) F_1 x (NW 63 x A 429)	+	2.3	1.0	1.0	1333	1104	1438
RMC 13	B	45.9	(PVA 800 A x AND 277) x (PVA 773 x ((EMP 385 x A 483) x (NW 63 x A 429)))	No	5.3	1.7	0.3	1533	892	1446
RMC 14	O	29.0	G 18264 x (G 18264 x SAM 1)	+	2.7	1.0	2.0	967	974	1175
RMC 15	B	35.4	G 18264 x (G 18264 x SAM 1)	No	3.3	1.7	0.3	1300	739	967
José Beta (large seeded):										
RMA 1	SB	45.5	(A193 x Montcalm) x ((San Cristobal 83 x ICA Quimbaya) x (PVA 800A x AND 277))	No	2.3	1.0	1.0	1433	1080	1973
RMA 2	SB	32.8	(A193 x Montcalm) x ((San Cristobal 83 x ICA Quimbaya) x (PVA 800A x AND 277))	No	2.3	3.7	0.0	717	297	1517
RMA 3	O	40.3	(A193 x Montcalm) x ((San Cristobal 83 x ICA Quimbaya) x (PVA800A x AND 277))	No	3.0	1.7	2.0	1500	533	1560
RMA 4	SB	34.7	(A193 x Montcalm) x ((San Cristobal 83 x ICA Quimbaya) x (PVA800A x ANDx277))	No	3.3	1.7	0.0	933	688	1495
RMA 5	SB	40.6	AND 279 x ((MAM 38 x CAL 143) x (PVA 800A x AND 277))	No	2.3	1.0	3.7	833	604	2118
RMA 6	B	32.7	AND 279 x ((MAM 38 x CAL 143) x (PVA 800A x AND 277))	No	3.3	1.0	0.3	777	743	1164
RMA 7	B	33.8	AND 279 x ((MAM 38 x CAL 143) x (PVA 800A x AND 277))	No	4.3	2.3	1.7	983	512	1137
RMA 8	SB	33.1	AND 279 x ((MAM 38 x CAL 143) x (PVA 800A x AND 277))	No	4.0	1.0	0.0	967	808	1662
RMA 9	B	37.3	PVA 800 A x ((San Cristobal 83 x ICA Quimbaya) x (PVA 800 A x AND 277))	No	4.7	5.7	2.3	1033	790	1692
RMA 10	B	25.8	PVA 800 A x ((San Cristobal 83 x ICA Quimbaya) x (PVA 800 A x AND 277))	No	2.0	1.0	0.0	583	507	1036
			Average	-	3.2	1.8	2.1	1007.1	746.1	1524.9
			LSD (*P* = 0.05)	-	1.8	na	na	na	468	641

a. Seed coat: B = brilliant, SB = semi brilliant, and O = opaque.

b. Disease scores on a scale of 1- 9 where 1 = resistant and 9 = susceptible; CBB = common bacterial blight, and BGMV = bean golden mosaic virus.

Conclusions and Future Plans: The best BGMV-resistant, high-yielding lines are being used in crosses with additional red-mottled parents to obtain large-seeded BGMV resistant lines. Further confirmation of the association between the *bgm-1* marker and BGMV field resistance is needed. On-farm testing and wider distribution of the best entries to the hillside environments of Haiti and the Dominican Republic needs to occur.

Contributors: M.W. Blair, H.F. Buendía (IP-1); J. Beaver (University of Puerto Rico); J.C. Nin (Centro de Investigaciones Agrícolas del Sureste [CIAS], Dominican Republic); E. Prophète (Ministry of Agriculture, Haiti).

4.1.6 Evaluate genotypes for their response to angular leaf spot

A set of 19 potential sources of resistance is being evaluated for resistance to ALS in Nicaragua, Honduras (Juan Carlos Rosas, EAP-Zamorano), El Salvador, Bolivia, Costa Rica (Carlos Araya, University of Costa Rica), and Haiti (ORE, Camp-Perrin, Haiti).

Results from Honduras have shown that the lines G 5686, G 6727, G 8152, G 14301, AFR 702, AFR 703, and AFR 735 have high levels of resistance.

Haiti: Very little incidence of ALS was observed, partly because the trials were established under very high temperatures and little rainfall. The conditions were not conducive for disease incidence. These materials will be screened again during the main October season. The genotype AFR 702 showed very good heat tolerance.

Contributors: G. Mahuku, C. Jara.

4.1.7 Distribution of seed to partners

Dry bean breeding nurseries

Germplasm characterization

Others

DIFALS	(Angular Leaf Spot Differentials)
DIFANT	(Anthracnose Differentials)
DIFRUST	(Rust Differentials)

I. Dry bean breeding nurseries[1]

Nursery	Country	No. of lines	Institution
Common bean lines	East Timor	6	East Timor Development Agency
	USA	156	Idaho University
Common bean lines - BAT 477	Belgium	1	Katholieke Universiteit Leuven
Common bean lines - VAX 1 x Jules	USA	6	Nebraska University
Common bean lines – low fertility and aluminum	Bolivia	7	CIF-UMSS
	Chile	7	Universidad de Chile
	Germany	4 kg	University of Hanover, Institute for Plant Nutrition
Common bean lines for drought - SEA 5, SEA 13	Rumania	2	Institute for cereals and industrial crops
Common bean lines for white mold - Z AA 98, A 197	USA	2	Wisconsin University
Common bean lines with multiple resistance	USA	5	Idaho University
DOR 500	Haiti	40 kg	PADF Huracan Georges/ ORE, Haiti
International drought trial	Cuba	216	Instituto de Investigaciones Horticolas
	El Salvador	36	CENTA
	Mexico	36	INIFAP
International drought trial + Carioca lines	Haiti	44	Ministerio de Agricultura
International drought trial + VIPADOGEN	Haiti	236	ORE
	Honduras	236	EAP-Zamorano
	Puerto Rico	236	Universidad de Puerto Rico
International drought trial + populations + parents	Iran	1213	SPII
International drought trial + parents for aluminum + germplasm of Durango race + small red line	Nairobi	243	University of Nairobi
International drought trial + red and black F_6 populations	Guatemala	290	ICTA
International drought trial + red and black F_6 populations + advanced red lines	Nicaragua	545	CENIA - INTA
International low fertility trial + F_2 and F_6 populations with Sacapobres red and Bribri + advanced lines for ALS	Costa Rica	138	Ministerio de Agricultura y Ganaderia
International low fertility trial + International drought trial + nursery of DOR 364 x BAT 477 + advanced Pinto lines + G 19892 x Pinto Villa and G 10022 x Pinto Villa families	Mexico	517	INIFAP
Jamapa x J 177 RILs	Mexico	77	INIFAP
Red common bean lines trial	Honduras	40	CIAT-Honduras
	Nicaragua	40	CIAT - IICA
Red and black - F_2 and F_6 populations	Costa Rica	74	Ing. T. Guzmán
	Honduras	83	EAP-Zamorano
Small red line + advanced pinto lines	Malawi	99	Chitedze Agricultural Research Station
Snap bean bush lines	Argentina	2	EE Obispo Colombres
	Laos	10	CIAT-FLSP Project
Snap bean bush lines and black F_6 populations	Argentina	60	EE Obispo Colombres
Snap bean climbing and bush lines	Tanzania	20	Selian Agricultural Research Institute
Tío Canela 75	Haiti	360 kg	PADF Huracan Georges/ ORE

[1] For acronyms and abbreviations used see page 179.

II. Germplasm Characterization[a]

Nursery	Country	No. of lines	Institution
Bush bean lines - Andean type	Colombia	39	CORPOICA - Obonuco
		39	University of Nariño
		20	CORPOICA - Santander del Norte
		20	CORPOICA - Tolima
		20	FENALCE - Santander del Sur
		20	FENALCE - Antioquia
		20	CORPOICA - Cauca
		20	FENALCE - Huila
		20	UMATA – Nariño
		20	MINEDUCACION – Nariño
		20	CORFOCIAL – Cauca
		20	UMATA – Cauca
	Ecuador	40 (3 reps.)	INIAP
	Bolivia	40 (3 reps.)	UAGRM
VICARIBE	Puerto Rico	46 (12 sets)	University of Puerto Rico
Climbing beans	Malawi	49 (2 sets)	Chitedze
	Haiti	90	CIAT-HGRP-ORE
	Kenya	49 (2 sets)	University of Nairobi
Candidates to IBN 2001	Haiti	58	CIAT-HGRP-ORE
Candidates to IBN 2000	Malawi	70 (2 sets)	Chitedze
	Kenya	70 (2 sets)	University of Nairobi
	Uganda	43 (2 sets)	Kawanda Research Station
Ñuñas accessions	Colombia	10	CORPOICA – Rionegro
BGMV and *Empoasca* parents	Haiti	11	CIAT-HGRP-ORE
F_{12} populations of DOR 364 x G 19833	USA	89	University of Pennsylvania
F_9 populations of G 2333 x G 19839	USA	86	University of Pennsylvania
F_7 additional populations of DOR 364 x G 19833	USA	175	University of Pennsylvania
Bean lines - red, mottled red, and cream	Colombia	10 (500 g)	CIAL Pescador
Core collection accessions	Haiti	6 (4 sets)	CIAT-HGRP-ORE
G 685 and G 2333	Colombia	2 (500 g)	University of Ocaña – Santander

a. For acronyms and abbreviations used, see page 179.

III. Others[a]

Nursery	Country	No. of lines	Institution
DIFALS	Brazil	12	Centro Nacional de Recursos Genéticos y Biotecnológicos
DIFANT	Brazil	12	Centro Nacional de Recursos Genéticos y Biotecnológicos
	Costa Rica	12	University of Costa Rica
DIFRUST	Brazil	20	Centro Nacional de Recursos Genéticos y Biotecnológicos
Resistance sources of ALS	Uganda	26	Kawanda Research Station
	Haiti	62	CIAT - HGRP - ORE
ALS differentials	Uganda	1	Kawanda Research Station
Anthracnose differentials	Mexico	1	Depto. De Ingeniería Genética - CINVESTAV
	Slovenia	1	Agricultural Institute of Slovenia

a. For acronyms and abbreviations used, see page 179.

4.1.8 Varietal releases

The following CIAT-originated varieties were released during 2000 and 2001.

Country of release	New name	Original identification or code	Type of germplasm[a]	Seed color or class	Year of release
Argentina	TUC 241	AFR 241	2	Cranberry	2001
	TUC 310	RAB 521	2	Small red	2001
	TUC 510	DOR 605	2		2001
	Gateado	EMP 250	2	Carioca	2000
	Azabache	CEGRO 96/6 (NAG 12 x Camba)	4	Black	2000
Colombia	Frijol Oro Sevilla	Native climbing bean	6	Red purple	2000
	FrijoLAS 220		6	Bola roja	2000
	Unipal Milenio	HAV 124	2	Snap Bean	2000
El Salvador	CENTA 2000	MD 3075	5	Small red	2000
Mexico	Pinto Saltillo		4	Pinto	2001
	Flor de Mayo 2000	FF 94050	3	Flor de Mayo	2000
	Negro Vizcaya	NG 93060	3	Black	2000

a. 2 = CIAT line, 3 = CIAT cross locally selected, 4 = national agricultural research system (NARS) cross with CIAT parent, 5 = varieties or advanced lines from NARS distributed through CIAT Network, 6 = selection on local varieties or land races.

Contributors: IP-1 Team

Progress towards achieving output milestones:

- Several lines were identified with ALS resistance to highly virulent isolates over two sites, although these must be tested with isolates from production regions.

- Improved disease management practices were implemented for African cultivars and improved lines.

- Trials of climbing beans were established for the first time in Haiti. Recommendations were made on adapting climbing beans to local farming systems.

- Andean red-mottled breeding lines were tested at four sites throughout the Caribbean in regional nursery trials.

Activity 4.2 Collaborative projects developed and executed with NARS and regional networks

Highlights:

- CIAT scientists participated in the planning of activities of PROFRIJOL, the Andean zone, and African networks.

- Individual training of national scientists was provided.

- BAT 304 and Tío Canela were identified as highly promising cultivars in Haiti.

- Joint collaboration and concept notes were prepared.

4.2.1 Regional bean project for Central America (PROFRIJOL)

In 1980, CIAT established a formal regional research project in Central America with funding from the SDC. The project has evolved to the point that today its operative administration is in the hands of a five-member Executive Committee that in turn carries out the decisions of the General Assembly in which all participating countries are represented. The Bean Project Manager represents the CIAT-based Bean Team on the Executive Committee. Furthermore, CIAT headquarters gives administrative backstopping in financial management.

With regard to research, priorities are set in consultation with NARS in a joint planning session. All CIAT activities are coordinated with the planning matrix, and CIAT delivers a yearly work plan relating goals to budget allotments. Thus, CIAT activities are totally coordinated with the regional project structure and CIAT functions as a full partner with NARS.

The project structure involves five main subprojects:

(1) Improved bean varieties of the Mesoamerican gene pool, including red- and black-seeded types.
(2) Improved bean varieties of the Andean gene pool, for use in the Caribbean basin and Panama.
(3) Support to breeding efforts, including analysis of genetic variability of pathogens, broadening the genetic base of resistance, and developing molecular markers for traits.
(4) Developing improved crop management techniques including soil conservation and fertility management.
(5) Socioeconomic studies including adoption and impact studies.

CIAT participates directly (with project funds) in subprojects 1 and 3, and indirectly (with core funds) in subproject 2. Technical results are presented in the respective sections under output.

The IP-1 team members participated in the Project Planning by Objectives for preparation of the next phase of PROFRIJOL and the following contributions are to be made and are consistent with the overall plan for the next phase:

- Varietal improvement in both black and red small-seeded beans. Emphasis on resistance to biotic constraints (BGMV, ALS, anthracnose, *Apion*, CBB, bean severe mosaic virus (BSMV), BCMV, and web blight), and abiotic constraints (drought and low soil fertility).
- Pathogen diversity, specifically, ALS and anthracnose.
- Marker-assisted selection for BGMV and CBB.
- Germplasm characterization.
- Collaboration (mainly by supplying populations) with participatory breeding initiatives in the region.
- Artesanal seed production (with emphasis on seed quality, especially in relation to phytosanitary standards).
- Statistical analysis of Ensayo regional de Rendimiento (ECAR) trials.

CIATs IP-1 Project has been active in supporting PROFRIJOL and the SDC in their efforts to create a foundation tentatively called Fundación Regional de Investigación y Desarrollo Agropecuario (FRIDA). The SDC donor is planning to create FRIDA with 'the International Maize and Wheat Improvement Center (CIMMYT), national programs, the private sector, and other partners interested in bean research in Central America and the Caribbean. In 2001, the IP-1 Team worked closely with the PROFRIJOL and Programa Regional de Maíz (PRM) Coordinators in developing a concept note on the future of research on beans and maize in Central America. This proposal will be submitted to SDC in 2002.

Contributors: C. Cardona (IP-1); A. Viana (PROFRIJOL)

4.2.2 Regional bean project for the Andean zone (PROFRIZA)

The national bean programs of Bolivia, Ecuador, and Peru continued to be important partners for the CIAT bean project this year. The regional PROFRIZA project, which previously linked the countries formally into a network, ended. However, the programs remain in contact with one another and with the CIAT bean project. In the new phase of the bean project for the region, the national programs are interested in continuing their strong historical ties and close interaction with the CIAT bean project. Germplasm from CIAT has been instrumental in the past successes of these programs and will continue to be important to their advances. Each national program has prepared rough drafts of the new bilateral projects, and in the new format CIAT will be subcontracted for germplasm and specific services that are of interest to the country.

As part of the planning stage for this project, visits were made during the past year to each of the principal sites for bean research in the region. The plant breeder for Andean beans visited Peru during the irrigated winter season on the northern coast / sierra (Chiclayo and Cajamarca) and visited Bolivia during the winter season in the Inter-montane valleys (Santa Cruz and Cochabamba). The purpose of these trips was to discuss breeding strategies, observe the Vivero de Padres Donantes de Genes Necesarios (VIPADOGEN) and IBN 1996 nurseries, and to see CIAT germplasm that has been released recently as varieties. Both the bean pathologist and Andean breeder visited sites in Ecuador (Chota, Ibarra, Bolivar, and Quito) during the first semester plantings to observe bush and climbing bean trials, collect pathogen isolates, and consult on future breeding goals and methodologies.

Breeding of Andean and Mesoamerican beans, IPM, and MAS are highly important areas of research for the new phase of the project. Joint breeding objectives across the region are needed to get the most varieties from each program. Bolivia covers lowland breeding and Ecuador covers highland breeding, while CIAT covers the full range of adaptation zones including mid-elevation breeding. Peru has no formal breeding programs, but has plant breeders placed at universities and the export board. Therefore, CIAT can continue to contribute to the national programs with germplasm and research. New interest has been expressed in applications of biotechnology to plant breeding in the region. The program in Bolivia plans to invest in some equipment for DNA extraction and in a screenhouse where they can carry out controlled inoculations and pathotyping. The DNA extraction will be used for collaborative work with CIAT on MAS and pathogen strain characterization. Ecuador has a modest laboratory working on molecular markers and genetic diversity characterization and is interested in applying MAS for resistance breeding.

Germplasm exchange has continued over the last year. An Andean bean nursery of advanced lines with commercial seed types was distributed to Ecuador and Bolivia for their upcoming planting seasons. The most important genetic resources for the region are the traditional commercial classes, new seed classes with export potential, and sources of disease and insect resistance. Although Colombian bean researchers are no longer within a formal Andean network, they can benefit from the germplasm developed in the region. For example, 10 local and regional research entities in Colombia have received the same CIAT advanced lines as their counterparts in Ecuador and Bolivia and will be trying them at the same time.

Training has been an important benefit of the regional network. A course was offered during the past year for the principal bean researchers from the region in modern techniques of the use of

MAS, and pathogen characterization in plant breeding and pathology. Training and regional collaboration will continue in the upcoming year with a visit to CIAT of a student from Ecuador for anthracnose isolation, inoculation, and resistance breeding.

Possibilities for joint fund raising and collaborations in the region are promising. Many donors would be receptive to projects presented to them by the national programs. Future projects might revolve around specialty grain types and small-scale farmers who are growing beans for commercial and export production (as on the Peruvian coast and Bolivian lowlands). The Peruvian government is interested in capitalizing on and conserving their genetic resources, especially popping beans, or ñuñas, and the yellow- and white-seeded Canario and Caballero beans typical of Peru. Ecuador has started work in PPB and export production. Bolivia has an interest in expanding bean production at higher elevations.

Contributors: M.W. Blair, O. Voysest, G. Mahuku, C. Cardona

4.2.3 Special project in Haiti

CIAT's Bean Project has embarked on a new initiative to help raise the incomes and improve the food security of Haitian farmers. In collaboration with the Haiti Hillside Agriculture Program, funded by USAID, the project will conduct adaptive research on improved bean varieties as well as integrated approaches for managing diseases and soil fertility. In addition, the project will provide group and individual training on aspects of bean improvement and production.

The bean project participated in the training course on tropical crops carried out at the Université Americaine in Les Cayes, Haiti, as part of the new initiative to strengthen staple food production in Haiti. Special topics covered during this training course included agronomical crop management, genetic diversity, pests, diseases, bean breeding, and nurseries management.

Dra. Monique Finnigan and Agr. Eliassaint Magloire of ORE and Agr. Levael Eugene of CIAT-Instituto Interamericano de Cooperación para la Agricultura (IICA) visited CIAT as part of the ongoing project in Haiti.

4.2.4 Joint collaboration and concept notes

This year we started a collaborative project with four other CIAT projects (IP-2, SB-2, IP-5, and PE-2), one network, the Pan-Africa Bean Research Alliance (PABRA), and two systemwide programs, the Soil Water Nutrient Management program (SWNM) and Systemwide Livestock Program (SLP)-TROPILECHE. This project is funded by BMZ-GTZ. The project is entitled "An integrated approach for genetic improvement of aluminum resistance of crops on low-fertility acid soils". This project will finish in 2004.

Another collaborative project funded by the European Commission was also initiated this year. This project involves participation of three advanced research organizations from Europe (University of Freiburg, Germany; University of Sheffield, UK; University of Pisa, Italy) and two NARS partners from South America (University of Chile, Chile; CIF-UMSS, Cochabamba). The project is entitled "Characterization of South American genotypes for optimal use of light under abiotic stress".

Projects approved:
"Real digestibility and stimulating effect of phaseolin, the bean storage protein, on endogenous secretion in rats", a proposal developed with the Universidad Nacional de Palmira to study the effects of different morphotypes of phaseolin protein on endogenous protein loss from the gut, to be submitted to the Volkswagon Foundation.

"Candidate genes for tolerance of symbiotic nitrogen fixation (SNF) to phosphorus deficiency in common bean (*Phaseolus vulgaris* L.)". Submitted to Plate-forme de recherches avancées Agropolis – 2ème appel d'offre (2001 – 2003).

"Mejoramiento de frijol voluble de la región alto Andina" submitted to the Fondo Regional de Tecnología Agropecuária (FONTAGRO) with partners in Colombia, Ecuador, and Peru.

A collaborative project with IP-2 was prepared and approved for funding by Rockefeller. The project is entitled "Increasing food security and rural incomes in eastern, central, and southern Africa through genetic improvement of bush and climbing beans". This project will finish in 2003.

The Department for International Development (DFID), UK, approved the second 3-year phase of Sub-Project 1 of the Whitefly Project (Whiteflies as Pests in Tropical Highlands).

Projects submitted:
"Bioavailability and clinical response to the consumption of high mineral beans and quality protein maize" presented to the Micronutrient Initiative for funding of nutrition research in Colombia (submitted by Universidad del Valle with CIAT).

"Manejo de germoplasma local y aumento de la agrobiodiversidad de frijol y maiz con variedades biofortificadasí para mejorar la nutrición en comunidades rurales y urbanas de Nariño" Cuenta de las Américas (submitted by the Fundación para la Investigación y el Desarrollo Agroindustrial Rural [FIDAR] with CIAT).

"Mejoramiento de la nutrición humana en comunidades pobres de América Latina utilizando maíz (Quality Protein Maize [QPM]) y frijol común biofortificado con micronutrientes" presented to FONTAGRO, to improve nutrition in rural and urban communities in Colombia and Guatemala with NGO partners (submitted by FIDAR with CIAT).

Projects in preparation:
"Breeding staple crops for improved micronutrient value", a proposal submitted to a consortium convoked by the Gates Foundation, to improve the nutritional status of bean consumers in Africa and Middle America.

"Coping with dry times: Improving common bean and tropical forages for drought resistance". Concept note presented to the Global Environment Facility.

"Maize-bean production systems in Central America". Proposal to the SDC.

"Breeding staple crops for improved micronutrient value", a proposal submitted to a consortium convoked by the Gates Foundation, to improve the nutritional status of bean consumers in Africa and Middle America.

Concept notes prepared:
Coping with dry times: Improving common bean and tropical forages for drought resistance – As part of a Challenge Program of the Consultative Group on International Agricultural Research (CGIAR) on Climate Change.

Improving bean production through integrated N and P management in southern and eastern African agro-ecosystems – In collaboration with ETHZ, Zurich, Switzerland.

Identification of resistance to soil zinc deficiency in tropical versus temperate common bean landraces and improved cultivars – In collaboration with University of Idaho, USA.

Caracterización molecular y por virulencia de aislamientos argentinos de *Phaeoisariopsis griseola* e identificación de fuentes de resistencia en frijol común.

2nd International Workshop on ALS of common beans proposal to solicitor for funds to hold an international ALS workshop.

Contributors: S. Beebe, M.W. Blair, G. Mahuku, I.M. Rao, C. Cardona.

Activity 4.3 Supporting national agricultural research systems and regional network researchers on soil and crop management

Highlight:

- Partners are evaluating a set of 49 genotypes for adaptation to abiotic constraints such as drought, aluminum toxicity, and low nutrient supply.

4.3.1 Evaluate elite bean genotypes for their tolerance to low fertility conditions in soil on farmer fields in Costa Rica, Mexico, Cuba, and Haiti

A set of 49 promising genotypes is being evaluated for tolerance to low fertility in soil by the following collaborators: in Mexico, Javier Cumpian Gutierrez, INIFAP, Cd. Isla, Veracruz; in Costa Rica, Rodolfo Araya, University of Costa Rica, Alajuela; in Nicaragua, Aureliano Llano, INTA, Masatepe, Nicaragua; in Cuba, German Hernandez, Ministerio de Agricultura (MINAG), Quivican, Cuba; and in Haiti, Eliassaint Magloire, ORE, Camp-Perrin, Haiti.

Mexico: The most promising genotypes identified from the field evaluation of 49 genotypes at an acid soil site in Veracruz, Mexico based on grain yield were: V 8025, G 3593, A 785, G 3513, G 20003, and G 21212. Among these five genotypes, V 8025 and G 21212 were not only adapted to acid Al-toxic soil conditions, but also were responsive to lime and fertilizer inputs. Among the plant attributes measured, number of pods per plant was identified as an important trait related to seed yield.

Costa Rica: Evaluation in Costa Rica was carried out at Alajuela site using 23 genotypes from the 49 genotypes evaluated before. Eight genotypes including A 774, VAX 1, FEB 190, VAX 4, A 321, FEB 192, A 483, and Carioca were identified as low-P adapted as well as P-responsive genotypes (Figure 58). These materials markedly out yielded local check, UCR 55, and the new commercial red variety, Bribri, under both low and high P supply conditions.

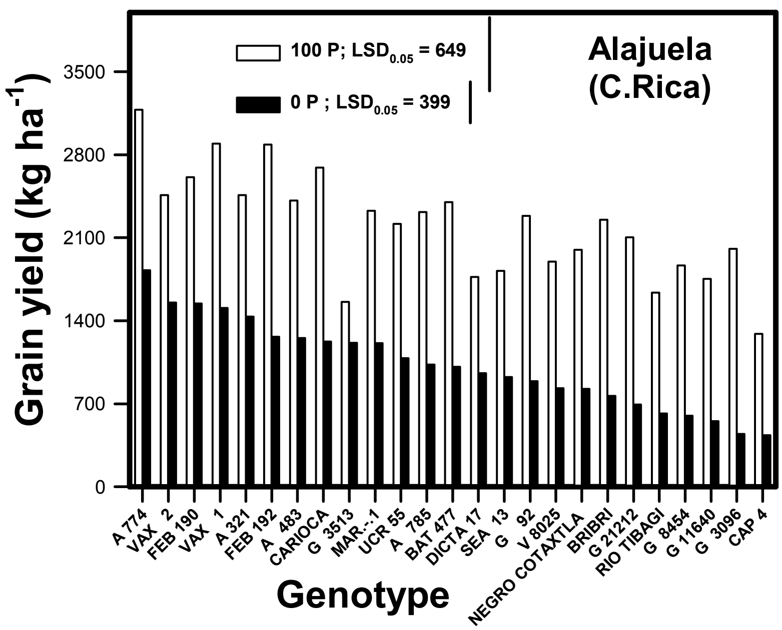

Figure 58. Genotypic differences in grain yield of 23 genotypes grown at low P supply (0 P) and high P supply (100 kg P ha^{-1}) at Alajuela site in Costa Rica.

Nicaragua: Evaluation in Nicaragua was carried out at Carazo site using 16 genotypes selected from commercial varieties, advanced lines, and from the 49 genotypes evaluated before. Three genotypes including A 774, EAP 9510-77, and EAP 9506-14 were identified as efficient in using nutrients. Three genotypes, FEB 190, EAP 9503-46, and INTA Jinotepe were identified as responsive to fertilizer input.

Cuba: Eight promising genotypes (A 321, A 774, G 92, DICTA 17, FEB 190, CAP 4, SEA 13, and MAM 46) with adaptation to soil and climatic conditions of Quivicán were identified. Multiplication of seed of these materials is in progress.

Haiti: Field studies were conducted at two sites, an acid soil site at Deron (mid-altitude) and a high temperature site in lowlands at Camp-Perrin. Genotypes that performed better than others under acid soil conditions were BAT 304, BAT 477, BAT 881, FEB 192, ICTA-Ostua, BH 21134-66, DOR 364, DOR 390, G 18479, G 21212, BT-21138-98, and Tío Canela. Genotypes that showed better adaptation to high temperature stress were A 774, BAT 304, BAT 477, DOR 364, DOR 390, BT-21138-98, Tío Canela, and ICA Quimbaya.

Contributors: I.M. Rao, S. Beebe, H. Terán (IP-1); R. Araya (Costa Rica); Javier Cumpian Gutierrez (Mexico); Aurelio Llano (Nicaragua); German Hernandez (Cuba); Eliassaint Magloire (Haiti).

4.3.2 Evaluate elite bean genotypes for their tolerance to drought on farmers' fields in Nicaragua

A set of 49 promising genotypes was evaluated, along with a regional yield trial, to obtain baseline data on drought tolerance or susceptibility of regional breeding lines in relation to some well-known, drought-tolerant genotypes. Evaluation at San Diego identified G 18479, G 21212, and SEA 13 as promising materials for adaptation to drought. One of the bred lines, SEA 5, was affected by BGMV and therefore was not among the best performers.

Contributors: I.M. Rao, S. Beebe, H. Terán (CIAT); Aurelio Llano (Nicaragua).

Progress towards achieving output milestones:

Improved cultivars are tested under different soil fertility conditions

- NARS partners in Central America and the Caribbean region tested a set of landraces and advanced lines under low and high soil fertility conditions and identified several promising genotypes.

Activity 4.4. Supporting human resource development in national agricultural research systems and regional networks

Highlights:

- CIAT bean project scientists are actively participating in the international conferences and meetings that they attend.

- Individual and group training of national and international scientists and students was provided.

- The Web page for IP-1 was adapted to the new Web site at CIAT.

4.4.1 Trips and attendance at meetings

The Bean Project Manager attended the Executive Committee of PROFRIJOL in Costa Rica in January, the General Assembly meeting of PROFRIJOL in Costa Rica in April, and visited Haiti in May, in order to follow the Pan American Development Foundation (PADF) current project and the new HAP with the Development Alternative Inc.(DAI).
The team entomologist, plant nutritionist, breeder, Andean breeder/germplasm specialist, and plant pathologist, together with the research assistants in the germplasm characterization laboratory and pathology attended the XLVII annual meeting of the Programa Cooperativo

Centroamericano para el Mejoramiento de Cultivos y Animales (PCCMCA) in San José, Costa Rica.

The research assistant in entomology attended the "VIII Congreso Latinoamericano y del Caribe de Manejo Integrado de Plagas" and "IX Taller Latinoamericano y del Caribe sobre Moscas Blancas y Geminivirus", in Panama, in November 2000.

The bean breeder, plant nutritionist, and plant pathologist visited Costa Rica, Nicaragua, Honduras, and Guatemala, to review field trials in November 2000.

The bean breeder and the Andean breeder/specialist germplasm visited Mexico to attend a workshop on *Phaseolus* genomics in March, and visited Haiti to review field trials in April-May.

The plant nutritionist attended the XIV International Plant Nutrition Colloquium in Hanover, Germany and presented an invited paper on abiotic stress adaptation of beans in a symposium on Productive soil management for high yielding crops organized by the Colombian Society of Soil Science in Palmira, Colombia.

The breeder visited the following countries:

- El Salvador and Costa Rica, to review field trials including heat tolerance studies, in October 2000.
- Ibagué, Colombia, to attend thesis defense of Ing. Hector Fabio Buendía, in April.
- Washington, D.C. to assist in preparation of the micronutrients project in May.
- Virginia Polytechnic Institute, Blacksburg, VA, to attend conference on geographic information systems (GIS) and biotechnology in May.
- Costa Rica, to attend annual meeting of the national bean program (PITTA), in August.

The Andean breeder/germplasm specialist made the following visits:

- Santa Fe, New Mexico, USA, to design software for CGIAR bio-informatics program in January.
- Bolivia, to review field trials and discuss future collaborations in Santa Cruz and Cochabamba in February.
- Dominican Republic, 4 – 12 May 2001, to review field trials.
- Brazil, to attend the RedBio 2001 meeting and visit collaborators in Piracicaba and Goiania, 31 May - 9 June.
- Washington, D.C., USA, to assist in preparation of the legume genomics project in August.

The Plant Pathologist made the following trips:

- Uganda to attend the stakeholders meeting for the Rockefeller Foundation project in February.
- AAFC, Ottawa, Canada, for collaborative work on developing micro arrays for *Pythium* diagnosis in April.

- Uganda, to teach a course on use of molecular techniques in pathogen detection and characterization as well as introduce participants to the concepts of MAS breeding in July.

4.4.2 Training and courses

A course was given in Uganda on the use of molecular techniques in pathogen detection and characterization as well as introducing participants to the concepts of MAS breeding.

The bean project participated in the training course on tropical crops carried out at the Université Americaine in Les Cayes, Haiti as part of the new initiative to strengthen staple food production in Haiti. Special topics covered during this training course included agronomical crop management, genetic diversity, pests, diseases, bean breeding, and nurseries management.

An Argentinean Ph.D. candidate was hosted for 2 weeks to prepare data analysis for his thesis work, involving a statistical analysis of multi-locational trials carried out over a 15-year period in the northwest of Argentina. The study was conceived to orient a strategy for future bean trials in the region, but the relationship of yields and climatic variation may aid in explaining year-to-year variation in yields and in predicting likely yields.

A thesis plan including fieldwork was solidified with a Cuban M.Sc. student. The student will carry out a physiological analysis of lines derived from the cross of DOR 364 x BAT 477, the latter of which has expressed resistance to multiple abiotic stresses. The study will reveal the physiological relationship between resistances to low P, nitrogen, and drought stress.

Two Ecuadorian researchers participated in training activities. One was trained in methods for handling *Colletotrichum lindemuthianum* in laboratory and greenhouse, and screening materials for resistance to *C. lindemuthianum*, and the other was trained on management of whiteflies during 4 weeks.

Three students from the Universidad Nacional de Colombia, Palmira, one from Universidad del Valle, and two technicians from the PE-2 Project at CIAT received training in molecular biology techniques for 5 weeks.

Two students from the Universidad Francisco de Paula Santander, Cúcuta, Colombia have started projects under the student training program in molecular biology, looking at inheritance of ALS resistance genes and molecular markers linked to resistance genes.

One student from the Universidad Cooperativa de Colombia received training for 5 weeks in order to develop a program for pathogen characterizing.

Three students from the Universidad de Caldas and two from the Universidad de Santander received training on management of whiteflies.

4.4.3 Ph.D., M.Sc., and pregraduate thesis students

- A German Ph. D. student from the University of Freiburg is conducting research work on physiological and biochemical responses of bean genotypes to multiple abiotic stress factors.
- A Ph.D. student from ETHZ, Zurich Institute, Switzerland is conducting her thesis research on mechanisms of resistance to *Thrips palmi*.
- A Ph.D. student from Pennsylvania State University (collaboration M. Blair, S. Beebe, J. Lynch) is researching the QTLs governing adventitious rooting as a mechanism of low phosphorous tolerance in beans.
- A Chilean researcher from the University of Chile is conducting molecular characterization of Chilean and Bolivian bean germplasm.
- A Ph.D. student from Universidad Nacional, Palmira is conducting research into the inheritance of climbing ability in common bean and the influence of genotype by environment interaction on this trait.
- A Ph.D. student from the Ecology and Crop Production Science Dept., Swedish University of Agricultural Science (SLU) - Uppsala - Sweden and Universidad Nacional Agraria, Nicaragua, continues analysis of on-farm genetic diversity in Nicaragua, where he is a germplasm specialist with the University.
- A student from Universidad Nacional, Palmira, is conducting a joint thesis on arcelin and bruchids.
- A pregraduate student from the University of Tolima continues conducting her project in a wild QTL study to see whether cultivated beans of Andean and Mesoamerican gene pools can be improved via crosses with wild bean accessions from divergent gene pools.
- Two students from the Universidad del Valle continue their thesis research. One studies the inheritance of micronutrient content in bean seeds, especially for the minerals iron and zinc, and the other is testing microsatellite markers from other legumes, such as soybean and cowpea, in common bean.
- A pregraduate student from Pathology finished his thesis studies on using molecular markers to study the genetic diversity of *Colletotrichum lindemuthianum*.

Contributors: S. Beebe, M.W. Blair, C. Cardona, G. Mahuku, I.M. Rao