ESTABLISHMENT OF A PROGRAM IN BRAZIL FOR PRODUCING DISEASE-FREE SEED OF BEANS (Phaseolus vulgaris)

by

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Report on the establishment of a program in Brazil
for producing disease-free seed of beans (Phaseolus vulgaris)

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Diseases of beans are more numerous in the tropics than in temperate zones, Wellman citing 280 diseases in the tropics as compared with 95 in the temperate zone. In the tropics their presence on this crop is not only affected by temperature, humidity, and association with other crops, but also their severity is connected with ecological conditions such as the altitude at which beans are grown. The high incidence of bean diseases is a major factor in the low average yield (600 kg/ha.) for the region in addition to other related factors. Most of the important bean diseases are seed-borne, thus transmitting the primary inoculum into new seasons and plantings.

Seed quality of beans in not only genetic, physical and physiological, but also phytosanitary; i.e., the presence of disease-causing bacteria, fungi, and viruses which affect seed germination, seedling emergence and vigor, and subsequent plant development. Latin American certification programs at present certify seed lots for varietal purity and germination only.

When disease-free seed produced at CIAT was planted on 80 small farms (1.1 ha/farmer) in Guatemala, yield increases of up to 300% were obtained; therefore, it may be possible to increase production up to 100% (without breeding new varieties) through the use of disease-free seed.

Siqueira and his co-workers in Rio Grande do Sul increased yields up to 1200 kg/ha. by the use of virus-free seed. The yield average in the region was 500 kg/ha. This success notwithstanding the use of certified seed in Brazil is almost nil (0.2%) at the present time, according to the information gathered during visits to several institutions in Goiania, Vicosa, Campinas and Brasilia.

Disease-free seed production

The production of basic disease-free seed is easy to carry out, and does not require sophisticated equipment. It does need, however, trained personnel to be successful. The program is based on the fact that seed-borne pathogens of beans are not carried in 100% of the seeds. A general plan to clean disease-affected seeds of local Brazilian varieties could be as follows:

1. To select at least 200 plants of each of the most commonly planted varieties from commercial fields, selecting for agronomic characteristics as well as for sanitary conditions.
2. To plant 2 seeds/pot (15 - 20 cm. diam., 25 cm. depth), in sterilized soil. The pots are kept under greenhouse or very fine screenhouse conditions.
3. The plants have to be irrigated carefully, and an expert technician in bean diseases must observe them daily, hopefully twice a day. If any diseased plant is found, the whole pot is eliminated.
4. A program of intensive chemical control has to be implemented to ensure that seed cannot be reinfected from external sources.
5. At maturity, the remaining plants are harvested individually to avoid possible contamination of apparently healthy plants, found to be infected after laboratory tests. This is the Basic seed for Foundation seed production.

Foundation disease-free seed production

Foundation seed has to be produced in regions where climatic conditions are unfavorable for disease development or for high populations of vectors. A rainfall of 100 - 300 mm, a low relative humidity (40 - 60%), and temperature during the day of 25 - 35 C with full sunlight are ideal conditions for disease-free seed production in the field. Furrow irrigation facilities are needed.

Under these conditions, bacterial and fungal diseases, except root rots, are eliminated, and "clean" seed is produced. Common bean mosaic virus and its aphid vectors survive these conditions, therefore, careful inspection and excellent insect control is necessary to prevent infection.

Unfortunately the conditions mentioned are not easy to find in Latin America, making it necessary to prevent the presence of diseases by planting either in regions similar to those described above, or in seasons that approach these conditions. Brazil has the best ecological conditions in regions close to the San Francisco River Valley. However, its present infrastructure makes it impossible to think of this area as the only one to meet the bean seed requirements for the whole country. Furthermore, it would be necessary for the Government to declare this area restricted for seed production. The cost of disease-free seed produced there would be very high becuase of transportation costs.

There are three possibilities for the production of Foundation seed:

1. Use new land at Experiment Stations of Embrapa or other agricultural institutions during the dry season.
2. Use leased land in regions with low rainfall and low relative humidity in the large bean-producing states but distant from commerical bean production areas.

3. Have an Embrapa Experiment Station in the San Francisco Valley devoted to seed production only.

Once the site is selected, the seeds must be planted 25 - 30 cm apart in furrows, in rows 1.00 m apart, it would be advisable to plant some rows of maize to separate varieties to avoid natural crossing, as well as to serve as relatively natural barriers for the dissemination of seed-borne pathogens. A minimum of four, preferably five, inspections of each field should be made during the crop season: 15, 30, 45 and 60 days after germination. The 15-day inspection is useful to detect common mosaic virus-infected plants; 30 days for bacterial blights, angular leaf-spot, web-blight, etc.; 45 and 60 days for bacterial blights and anthracnose. Any plant showing an apparent symptom of any seed-borne disease must be rogued. A programmed chemical control of diseases and insect vectors is necessary. The ideal situation is not to have any plant infected with anthracnose, bacterial blights, wilts, common bean mosaic, etc.; however, under tropical environmental conditions this tolerance could be extended a little to 0.5 - 1%.

Only the pods not touching the soil should be harvested. Time of harvesting is critical; the mature pods should be picked as soon as possible. Delayed harvesting can result in reduced germination <u>in vitro</u> and field emergence, as well as in increased seed infection by several organisms.

Before threshing, a windrow inspection is advisable. Seed must then pass a serology and greenhouse test for the presence of seed-borne diseases. This seed is the Foundation seed, the basis for the production of Certified seed. Certified seed should be planted in bean disease-free regions or under a program with considerable protection against the spread of diseases from adjacent commercial fields.

Special strategies for the small farmer

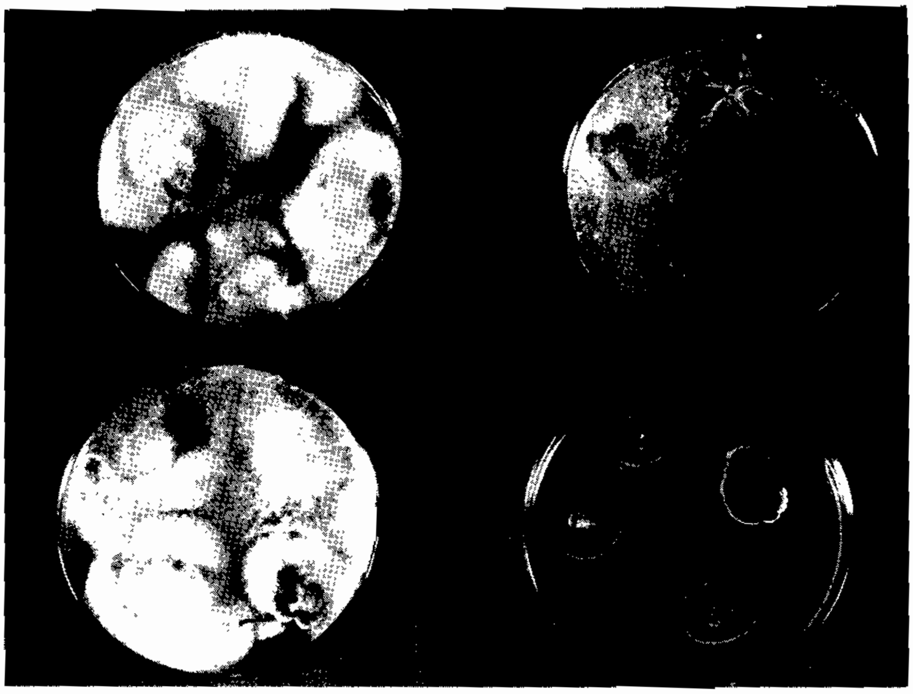
The final results of this program will not be seen unless the farmer-the final client-is taken into account. In Brazil the great majority of commerical bean growers are small farmers who are poor, uneducated traditionalists. Therefore, it is difficult to convince them to buy certified seed for the first time and even more so for each consecutive planting with an autogamous plant. Special strategies are needed. Among them, ICTA (Instituto de Ciencia y Tecnologia Agricolas) in Guatemala used to give the "clean" seed, fertilizers and pesticides as part of the credit. This credit has to be on time for this short-term crop. ICTA then bought the seed produced under their technical supervision giving the farmer a substantially better price than they could obtain on the local market.

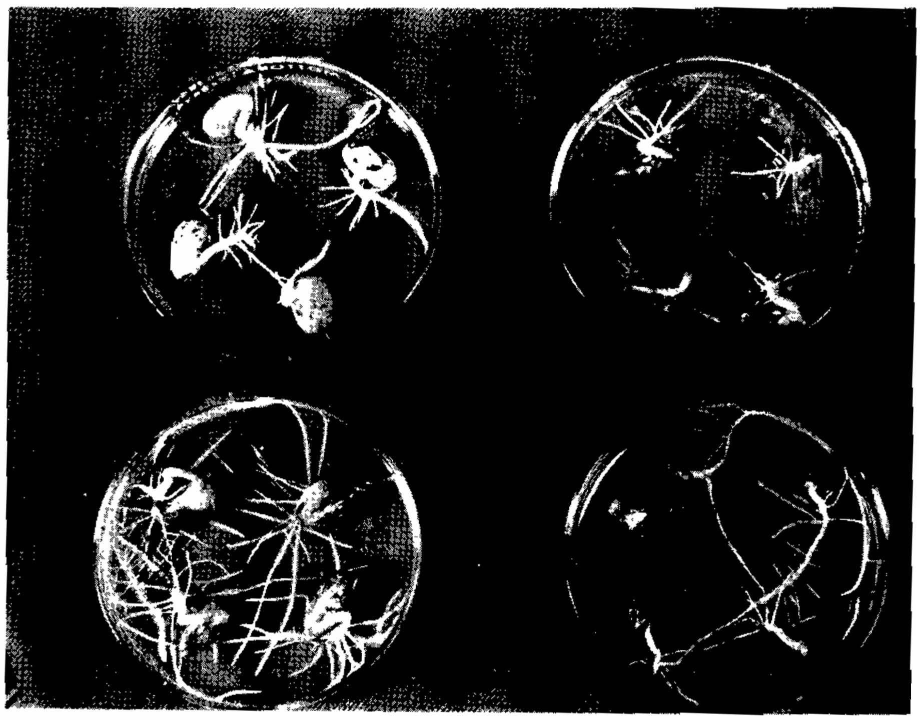
The small farmers could change technology if they are shown *in situ* the beneficial results. In Guatemala, for example, the neighbors wanted to buy clean seed from the seed producers, paying even higher prices than ICTA. And, of course, there is education, perhaps the key point of the whole process.

Certified seed production

The production of certified seed in large quantities could be stimulated through government tax exemptions, special prices and credit given in time to meet with crop needs. The seed growers do not want to deal with small farmers; they want to sell large amounts of seed; therefore, government agencies have to look for ways to buy seed and distribute it in small quantities. This is also true for fertilizers, pesticides, etc.

It is necessary to establish special regions within the country for seed production only. Any region where beans are produced for consumption or where experimental plots exist should be avoided.





A = Seeds obtained from a small farmer. They are 100% infected with seed-borne organisms.
B = Clean seed obtained at CIAT.

TABLE 2. Percent germination in-vitro, total fungi, and seeds with fungi, which did not germinate of seeds from the department of Huila, Colombia.

Lot No.	Germination	Total fungi	Seeds no germ. with fungi
104	66	97	34
118	10	100	90
122	25	95	74
095	8	97	92
096	86	16	14
051	43	84	57
094	24	93	76
110	46	87	54
120	55	67	45

1/ Based on 100 seed from each lot.

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TABLE 3. Mean percentage 1/ recovery of fungi by genera from bean (*Phaseolus vulgaris* cv. Tui) seeds treated with three fungicides.

Treatment	Fungi recovered 2/							Total fungi
	Pen.	Asp.	Fus.	Coll.	Phom.	Macro.	Rhiz.	
Captan	6	3	4	1	3	0	0	14
Thiram	7	3	4	0	2	0	0	15
Benlate	3	5	3	0	1	0	0	12
Nontreated	22	14	23	10	7	6	5	88
LSD .05								13.94
.01								21.13

1/ Based on three replications of 100 seeds per replication.

2/ Pen. = *Penicillium* sp., Asp. = *Aspergillus* sp., Coll. = *Colletatrichum lindemuthianum*, Phom. = *Phomopsis* sp., Macro. = *Macrophomina phaseoli*, Rhiz. = *Rhizoctenia solani*, and Fus. = *Fusarium* sp.

CIAT, 1976

TABLE 5. Stand at 15 and 30 days after planting of good and poor quality bean seed (*P. vulgaris* cv. Tui) either treated or nontreated with fungicide.

Treatment	Percentage stand 1/			
	Good quality seed		Poor quality seed	
	15 days	30 days	15 days	30 days
Captan	92	92	53	54
Thiram	90	91	52	53
Benlate	86	88	47	47
Benlate + thiram	87	90	49	51
Carboxin	91	92	47	50
Carboxin + captan	90	91	51	52
Nontreated	86	90	35	35
LSD .05	NS	NS	8.8	8.5
.01			12.0	11.9

1/ Based on four replications of 200 seed per treatment.

CIAT, 1976

TABLE 6. Mean percentage germination in-vitro, total internally seed-borne fungi, *Colletotrichum lindemuthianum*, *Fusarium* spp., other fungi, and yield in kilograms/hect. for seeds from plants treated or non-treated with fungicides. Popayan 1975B.

Treatment	Rate	Germination in-vitro	Total internally Borne Fungi	Colletotrichum	Fusarium	Other fungi	Yield kg/H
Benlate	500 g/H	94.0	6.3	4.3	2.0	0.7	988.1
Benlate	1000 g/H	95.0	1.7	0.0	1.0	0.3	994.9
Benlate + Difolatan	250 g/H + 1500 g/H	91.0	9.0	3.0	3.3	0.7	436.4
Difolatan	3000 g/H	80.0	40.0	16.0	11.3	11.7	126.5
Non-treated control	- -	- -	- -	- -	- -	- -	0
LSD .05		3.5	3.1	2.5	2.7	3.0	16.8
.01		5.4	4.8	3.7	4.2	4.6	24.1

1) Germination in-vitro, total internally borne fungi, C. lindemuthianum, Fusarium sp., and other fungi based on 3 replications of 100 seeds.
2) Yield based on mean total seed weight from the center 2 rows of each of 4 replications per treatment.
3) All control plants were killed within 50 days after planting by anthracnose.

TABLE 7. Mean percentage germination in-vitro, emergence in the field (15 days), total internally seed-borne fungi, and 1000 seed weight for dry bean (*Phaseolus vulgaris* vc. Tui) either treated or non-treated with systemic fungicides and harvested at maturity and 4 delayed harvest dates.

Treatment	Control					Benlate					Benlate + Plantvax					Plantvax				
Date of harvest in weeks after maturity	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Germ. in-vitro	87	79	63	64	60	95	92	92	93	76	94	95	92	86	74	98	97	91	82	75
Emergence in the field	86	75	69	67	61	87	84	87	82	71	85	84	86	84	72	86	86	84	82	67
Total int. seed-borne fungi	13	48	86	100	100	4	15	26	38	96	4	17	27	54	98	5	13	26	56	99
1000 seed weight	152	149	147	150	154	201	205	201	205	206	201	208	203	203	205	194	207	204	198	197

1/ Germination, emergence and total fungi based on 3 replications of 100 seeds per replication for each treatment and harvest date.

CIAT, 1976

TABLE 8. Mean percentage recovery of internally seed-borne fungi by genera for dry bean (*Phaseolus vulgaris* cv. Tui) treated or nontreated with fungicides at 5 harvest dates.

Treatment	Cont.					Benlate					Benlate + Plantvax					Plantvax				
Date of harvest in weeks after maturity	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Fusarium	9	32	63	69	84	1	2	1	4	4	1	9	9	8	4	2	5	14	45	79
Alternaria	2	2	2	8	3	1	12	22	33	85	2	4	11	39	84	1	5	8	1	7
Rhizoctonia	1	6	5	6	7	1	0	0	1	4	1	1	1	4	5	1	0	0	3	4
Phomopsis	2	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macrophomina	1	0	0	2	4	0	0	0	0	1	0	0	0	1	2	0	0	1	3	2
Penicillium	1	1	1	2	2	0	1	1	1	2	0	1	2	1	2	1	0	2	2	3
Aspergillus	2	2	2	2	1	1	0	1	1	2	0	2	1	1	1	0	1	1	1	3
Rhizopus	0	3	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Cladosporium	0	1	1	3	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	2
Monolinia	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cheatomium	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isariopsis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Botryis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unq	2	1	4	0	0	1	0	2	0	0	1	1	2	0	0	1	1	1	0	0

1/ Based on 3 replications of 100 seed per replication for each treatment and harvest date.

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TABLE 9. Mean percentage germination in-vitro, total internally seed-borne fungi, and recovery of fungi by genera from seeds removed from pods in contact with soil 1/(C) and from pods without soil contact 2/(NC) for 5 bean (*Phaseolus vulgaris*) cultivars.

Cultivar	Huasano		Porrillo Sintetico		Tui		Calima		Guali	
	C 1/	CN 2/	C	NC	C	NC	C	NC	C	NC
Germ. in-vitro	50	95	47	97	59	99	57	100	46	92
Percent viability	65	91	65	100	78	95	75	95	68	91
Total fungi	88	26	92	19	78	14	64	3	90	30
Fusarium	51	14	56	10	34	8	31	2	45	22
Rhizoctonia	6	0	10	0	2	1	5	0	9	2
Phomopsis	6	0	10	0	4	0	5	0	4	0
Macrophomina	3	0	3	0	2	0	1	0	6	0
Alternaria	8	5	6	7	9	3	8	1	4	1
Cladosporium	0	0	1	1	4	2	2	0	5	1
Aspergillus	2	2	1	0	3	0	2	0	4	1
Penicillium	2	2	1	1	4	0	1	0	3	1
Rhizopus	0	1	2	0	0	0	0	0	1	0
Iasriopsis	0	0	0	0	0	0	0	0	1	0
Pestalotia	0	0	1	0	2	0	0	0	5	1
Monilia	1	1	0	0	5	0	1	0	0	0
Phoma	2	0	0	0	0	0	0	0	0	0
Nigrospora	0	0	1	0	0	0	0	0	0	0
Unknown	7	1	0	0	9	0	8	0	3	1

All figures based on 3 replications of 100 seeds, except percent viability, which is based on 100 seeds.

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TABLE 10. Mean percentage field emergence of seeds from pods in contact with soil and pods without contact with soil, both treated and non-treated with fungicide[2] for 5 cultivars of bean (*Phaseolus vulgaris*). Stand counts were taken at 15[1] and 30[2] days after planting.

Cultivar	Huasano		Tui		Porrillo Sintetico		Calima		Guali	
	15[1]	30[2]	15	30	15	30	15	30	15	30
No. contact	83	84	95	95	82	83	92	92	85	86
With contact	57	58	67	69	48	51	61	63	44	47
No contact treated	85	86	93	94	86	86	93	95	88	90
With contact treated	68	69	84	85	67	68	81	82	74	75

1/ Based on 3 replications of 100 seeds/replication.

2/ Seeds were treated with arasan 75% wettable powder at 2.5 g/kilo.

CIAT, 1976

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