First Bean Germplasm
Advisory Committee Meeting

C I A T

~~BEAN~~ PRODUCTION SYSTEMS
GERMPLASM DISCIPLINE

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A STATUS REPORT
(August, 1976)

INTRODUCTION

Phaseolus spp., a genus of american origin, plays an important role in the basic diet of the pre-spanish cultures. Of the four cultivated sp., the common bean Phaseolus vulgaris L. is the w widest distributed in the world. It has also the highest range of variability.

Beans were domesticated since 7000 years ago in two separate sites: Mexico and Peru. This long time under selective process by ethnic groups had generated many variants that are well known today.

In less accessible sites, primitive forms have been maintained by peasant people, but close to population centers, few fixed types grow under modern agricultural practices.

On the other side, beans carried out to Europe and later to Africa, conformed another source of variation, mainly navy beans and green bean types.

Beans are today one of the fifteen major foods for energy sources in the world. Of more than 6' hectares that are annually grown, 34 percent are located in Latinamerica. Brazil and Mexico have the largest growing areas. (Table 1).

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CONTRASTING EXAMPLES IN BEAN PRODUCTION

Country	Average yield kg/ha	Cultivated Area 1,000 has.
Belgium	2365	1
U.S.A.	1458	581
Chile	1 043	79
Mexico	524	1700
Brasil	643	3 700
Colombia	634	101
Venezuela	552	105

Source: Anuario de Producción Vol. 26 FAO 1972.

For a long tim e a psychological barrier has identified beans as food for the poor. Raising population without corresponding yield increases has turned beans into an almost luxury item for the poor people.

When CIAT decided to start a cooperative research program in beans, a general support was given by Latinamerican researchers to this effort for raise bean production. As you can suppose, since we are in the origin centre, the problems to solve are so numerous that it is essential to use a great source of variability fortunatelly present in the Phaseolus sp.

We are in time to save many of our bean resources from genetic erosion and wer are willing to do it.

The present already assembled collection and the rapid development of the Bean Program are the reasons why CIAT has been proposed to be the world Bean Genetic Resources Center.

You can judge the work we have done here at CIAT in less than two years from the starting date of the Bean Germplasm Unit and we sincerely hope that this new center will reflect in the future not only the effort of our people here at CIAT, but the professional capacity and know how many people that, like you, are now engaged in this crusade to save, preserve and use our genetic resources. We are receptive to your criticisms and suggestions.

Objectives:

As conceived in l974, these are the main objectives of our program:

1.- Assemble in this center the world's available genetic resources of beans for the basic and applied research to raise bean production in tropical areas mainly.

2.- To characterize systematically and to record the morpho-agronomic traits of each entry and to make such information available to interested researchers.

3.- To produce and preserve enough seed of each entry to supply bean researchers.

Most of our present stock was adquired through correspondence. The donors were national agricultural research centers, agricultural experiment stations, Universities, commercial seed companies, and individual researchers.

Since 1970 to the present moment, we have received a large amount of seeds, shown on the following Table . The largest donors were the Regional PI Center in Washington, The University of Viçosa in Brazil, and the EA-Panamericana in Honduras. We have already more than 6.500 bean entries accessioned and with enough seed for interchange.

Categories of bean germplasm (See Table .)

An internal review carried out in 1975 revealed many duplications among local selections, obsolete varieties and obscure origin selections. Lack of highland cultivars and primitive types were observed.

Some entries having the same identification have presented different behavior, and the opposite is also frequent.

Table 1.

Number of Bean seed samples in CIAT. (1970-1976)

Country	Number of samples
Australia	13
Belgium	43
Bolivia	41
Brazil	1531
Bulgary	10
Chile	133
Colombia	390
Costa Rica	1010
Dominican Republic	5
Ecuador	19
El Salvador	109
France	14
Germany, Democratic Rep.	110
Greece	15
Guadaloupe	1
Guatemala	354
Haiti	26
Honduras	1707
Jamaica	3
Japan	34
Mexico	747
New Zealand	21
Netherlands	208
Nicaragua	4
Nigeria	176
Peru	305
Puerto Rico	16
Surinam	2
United Kingdom	1338
U. R. S. S.	10
U. S. A.	4169
Venezuela	313
Zambia	15
TOTAL	12.892

Table 2. CATEGORIES OF GERMPLASM ASSEMBLED
Phaseolus spp. cultivated

vulgaris	wild types aborigenous?
	local cv.
	obsolete vr.
	minor var. of obscure origin
	commercial var.
	special types
	breeding lines
darwinianus	
artificial crosses vul. x cocc.	
coccineus	
acutifolius	
lunatus	

Wild sp. such as ritensis, dumosus, polystachius, adenanthus.

Operating system of the bean germplasm

When a seed sample is received, its name is check and written down; also the identification number, and any kind of special features of the seed.

The seed is increased in our screenhouse under stric quarantine. If we obtain enough seed, a minimum amount of 200 seeds is kept. If not, we increase the seed in the field at CIAT headquarters in Palmira; and take some notes on some of the stable characteristics. At this moment, we are ready to do preliminary screening. Bean entomology and pathology which can handle large amount of materials, conduct at the moment special tests for pest and disease reaction in these entries.

In some entries turn out with outstanding characteristics, the next step is an intensive screening. At this point, other bean programs can test the materials for their special purposes: For example:

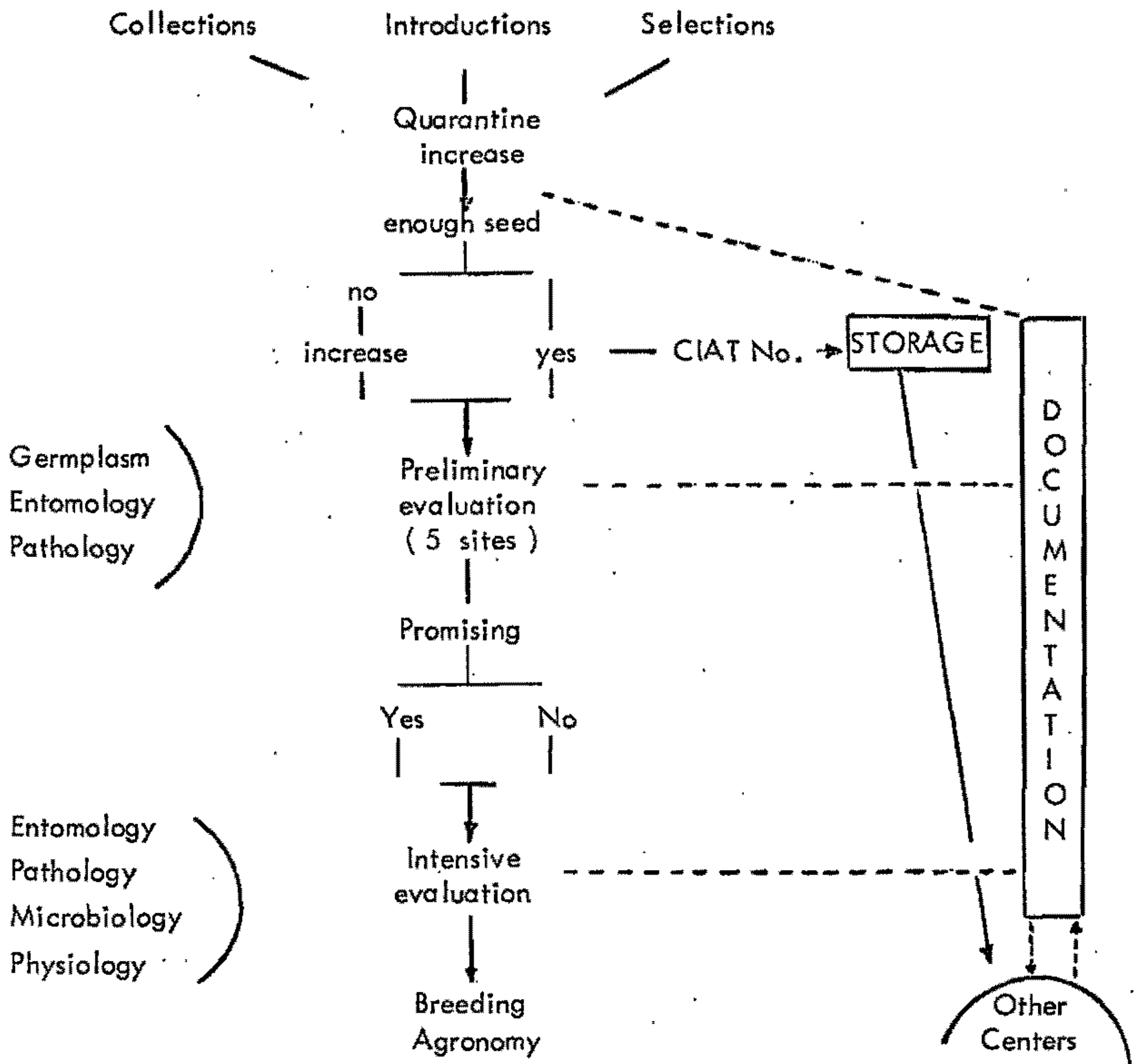
Microbiology may take notes on Rhizobium nodule weight

Physiology could study photoperiod reaction.

Following the process, Agronomy and Breeding can also check these materials.

The process is very flexible according to the circumstances. At each of these steps, we can translate useful information to the computer for recording and retrieval.

CIAT BEAN GERMPLASM



Increase and evaluation

As it is shown on Table , we increase seed in the screenhouse first, and later in the field.

Because of CIAT's location in a tropical zone, beans which are a self-pollinated annual crop, can be handled easily in large numbers all the year round. Exceptions are the wild types, highland beans and certain Phaseolus coccineus.

We normally conduct two plantings per year at CIAT's headquarters. Popayan, 120 Km. south, and 600 m. higher than Palmira, is used to increase non-adapted beans to Palmira, mainly in the first semester.

Observations are made for descriptory and evaluating purposes, subordinated to multiplication of the seed.

Entries with a small amount of seeds and low germination need to be increased in petry dishes or "Jiffy pots" and then transplanted later to pots or to the field.

Field plot layout

We are planting on beds 1 m. apart. Two rows are used with bush beans and only one for long guide indeterminated types. The interplant distance is of 8 cm. and 10 cm. respectively. These densities correspond to 250,000 and 100,000 plants per ha. respectively. In both cases, the plot lenght is 6.0 m.

Since we need to increase seed and due to the fact of having special screenings for pest and disease resistance, we are using in the germ plasm plantings, fertilizers and pesticides appropriate for Palmira conditions.

To establish a difference between growth habit types 3 and 4, we used "bamboo" tutors. Those long guide types climbing on the bamboos are classidired as type 4 beans.

This is the way we increase and observe approximately 4,000 bean entiies per year. For example, in the first semester of the present year, we increased 2,390 entries.

We register 52 descriptors, following the CIAT accession number. Germplasm takes 31 of these, and the other 21 come from: Pathology (9), Entomology (7), Physiology (3), Microbiology (1), and Agronomy (1). All these information coming from other disciplines is also collated by Germplasm, and so is the information obtained outside.

DOCUMENTATION

We can divide the proposed bean system in two parts.

A. A basic register; which has three functions:

- provide a history and basic description of each entry.
- it is a guide to authenticate items when being regrown to replenish the seed,
- provides a basis for breeders to request certain types of major interest.

Most of the above mentioned information came with the seeds, but in some cases additional information must be searched in the literature or through correspondence.

X

BASIC RECORD

1. ACCESSION NUMBER
   G00001 TO G99999

2. CULTIVAR NAME OR UTILITY DESIGNATION
   RED KLOUD
   P.I. 165.426
   N - 203
   HIDALGO 5
   CUVA 168-N
   51055

3. SEED SOURCE, A THREE LETTER ABBREVIATION
   NET = NETHERLANDS
   ELS = EL SALVADOR

4. GENETIC ORIGIN
   1 = BREEDING AND/OR SELECTION
   2 = MUTATION
   3 = COLLECTION

COMPLEMENTARY DATA: ORIGIN OF THE ENTRIE, SYNONYMOUS; PEDIGREE; BREEDING STATUS; SEED DONORS DATA: NAME; YEAR; MONTH; STATION NUMBER; LOCALITY.

THE CROP REGISTER

1) DAYS TO EMERGENCE
2) PLANT VIGOR
3) HYPOCOTIL LENGTH
4) HYPOCOTYL COLOR
5) LEAF SIZE
6) L.A.I.
7) EFFECTIVE PLANT HEIGHT
8) NODE NUMBER AT FLOWERING
9) NODE NUMBER AT MATURITY
10) DAYS TO FLOWERING
11) DURATION OF FLOWERING
12) FLOWER COLOR
13) PHOTOPERIOD SENSITIVITY
14) GROWTH HABIT
15) PLANT HEIGHT
16) STEM THICKNESS
17) No. RACEMES PER PLANT
18) No. PODS PER PLANT
19) No. BRANCHES WITH PODS
20) BRANCH ANGLE
21) SEEDS PER POD
22) SEED SHAPE
23) MAJOR SEED COLOR
24) SECONDARY SEED COLOR
25) SEED BRILLIANCE
26) SEED WEIGHT
27) YIELD/PLANT
28) HARVEST INDEX
29) TOTAL DRY MATTER
30) LODGING SCORE
31) EXPERIMENTAL YIELD
32) RUST
33) ANGULAR LEAF SPOT
34) WEB BLIGHT
35) ANTHRACNOSE
36) ROOT ROTS
37) COMMON MOSAIC VIRUS
38) GOLDEN MOSAIC VIRUS
39) CHLOROTIC MOTTLE VIRUS
40) BACTERIAL BLIGHT
41) EMPOASCA.
42) APION
43) WHITE FLY
44) RED SPIDER MITE
45) TROPICAL MITES
46) ZABROTES
47) BEAN WEEVILS
48) RHIZOBIUM EFFICIENCY
49) REFERENCES TO ACCESSION
50) MIXED SEED
51) CLEAN SEED
52) SPECIES

B. <u>The Crop Record.</u> (Table).

Mostly is field information entered on a separate form describing the attributes of each accession. Such information is coded to conserve storage space, reduce retrieval time and to simplify collation. This section provide sufficient information to describe the more important features of each entry as follows:

1) Days to emergence, is the date on which at least 50% of the seedlings present the cotyledons above the soil surface. (number, 2)

2) Seedling vigor (number, 1)

3) Hypocotyl lenght, distance between collar and cotyledon insertion. Mean of 10 readings in mm. (number, 3)

4) Hypocotyl color, visual observation. Coded:

1 = green
2 = red
3 = purple (code, 1)

5) Leaflet size, lenght and width of the central leaflet situated immediately below the shoot or guide, when is fully expanded. Taken at flowering in mm. (number, 6)

6) LAI, LAI = L x W x 3 x Node number x 0.70 (number, 1)

7) Canopy height, effective foliage height at flowering in cm. (number, 2)

8) Node number at flowering; mean of node number of five plants. (number, 2)

9) Node number at physiological maturity, mean node number of five plants (number, 3)

10) Days to flowering, date on which at least 50% of the plants have one open flower. (number, 3)

11) Duration of flowering; days between first open flower and the latest observed. (number, 2)

12) Flower color, visual observation. Coded:

1 = white
2 = purple
3 = pink
4 = red
5 = different color for wings and standard petals

13) Photoperiod reaction, special screening under l8 yr. day length. Coded as follows:

1 = flowering delay less than 4 days
2 = flowering deaay between 4-10 days
3 = flowering delay between 11-20 days
4 = flowering delay between 21-30 days
5 = flowering delay larger than 30 days

(number, 1)

The code mentioned above would have the following letter to indicate flower abortion at l8 hr. photoperiod.

N = no flower abortion
A = flower abortion or no flowers at all

(code, 1)

14) Growing habit: visual observation after pod filling stage. Coded:

1 = bush determinated
2 = bush indeterminated with a short guide
3 = indeterminated longuided but without ability
4 = indeterminated, true climbing

(code, 1)

15) Plant height, at the same time as l4) is taken. Maan of five observations in cm. (number, 3)

16) Stem thickness, taken at the same time as l5. Mean of five measures in mm. at the first internode. (number, 2)

17) Racemes per plant, mean of five observations at maturity stage. (number, 2)

18) Pods per plant, same as 17. (number, 3)

19) Branches with pods, same as 18. (number, 2)

20) Branch angle, visual observation. Code:
1 = angle minor than 45°
2 = angle equal or larger than 45°
(code, 1)

21) Seeds per pod, mean seed number, in ten pods obtained from five different plants in the plot. (number, 2)

22) Seed shape, visual observation. Code:
1 = round
2 = oval
3 = elliptic or kidney
4 = flattened
(code, 1)

23) Major seed color, visual observation on seeds recently harvested. Code:

1 = white	6 = red
2 = yellow	7 = purple
3 = tan	8 = grey
4 = brown	9 = black
5 = pink	

(code, 1)

24) Minor seed color, as in 23, for the secondary color. (code, 1)

25) Seed brillance, visual observation on seeds recently harvested. Code:
1 = opaque
2 = intermediate
3 = shiny
(code, 1)

26) Seed weight, 100 seeds weight in gr. (number, 3)

27) Yield per plant, mean grain weight of twenty plants in gr. (number, 4)

28) Dry matter, the mean dry weight of twenty plants, excluding leaves and petioles.
(number, 4)

29) Harvest index, obtained after dividing 27:28.
(number, 1)

30) Lodging, visual observation before harvesting. Code:

1 = all plants erected
2 = intermediate between l and 3
3 = fifty per cent of plants lodged
4 = intermediate between 3 and 5
5 = all plants lodged
(code, 1)

31) Experimental yield, grain yield obtained in replicated trials Expressed in Kg/ha. locality especified.
(number, 2)

32 a 40) Disease reaction, special screenings.
Code:

R = resistant
T = intermediate
S = susceptible

If only low levels of resistance are found, the tolerance notation (T) is used.
(code, 1).

41 a 47 Insect reactions, as disease reaction
(code, 1)

48) Rhizobium nodule weight, special screening. Mean weight in mg. of the nodules formed per plant.
(number, 3)

49) Library references, using the abstract number of the BDS.
(number, 4)

50) Genotypic mixture, record of the presence of different plant types in one entry. Coded as follows:

1 = color of hypocotyl
2 = color of flower
3 = growth habit
4 = seeds
5 = differences for more than one character.

51) Clean seed, entries passing or not for a seed cleaning process. Code:
1 = uncleaned
2 = clean (code, 1)

52) Species, according to present taxonomy status.

Computer program

We are using the SAS (Statistical Analysis System) developed by the North Caroline State University. with no problems at all. It is operated on a 370 IBM computer which accepts in the 75 version PL/l computer language.

The computer is located in Bogota at the official colombian statistical office (DANE), and linked with a telephonic terminal line installed at CIAT in the Biometry Unit.

SAS is a versatile and efficient recording and retrieval system which can do any of the present statistical analysis.

Comparisons made of EXIR vs. SAS by the Biometry scientists were done, with hardly any advantage for either of them.

Seed handling:

Our bean germplasm is handled as a library collection; each entry is maintained as an individual accession in evaluation, utilization and conservation. We try to avoid seed damage and stock contamination in all the steps between harvest and planting, and through the growth cycle of the plant.

We are harvesting each entry by hand. The plants in a plot are pulled, tagged and put in a bag to be individually threshed.

Threshing is also done by hand, and afterwards, seeds are cleaned. All broken seeds, seeds with fungus, or any kind of infection are discarted. Then, seeds are dried, and before storing them, a final check up with the original seed is conducted. No seed treatment is carried out.

In the following Table , we can see our present storage facilities and the new ones.

In spite of the impossibility of having a complete static preservation, our future seed storage conditions are the best known way of maintaining the minimum amount of genetic alteration.

Containers

We are using plastic jars at the present moment, pouches of aluminum paper with polyethilene cover will be used soon. Both are moisture proof containers.

The pouches have the great advantage of being used not only to store, but also for seed shipment purposes. This makes seed handling easier and avoids wastes of time in seed preparation for sowing and shipping.

Since we need to store only the highly viable seeds, we will check germination before the seeds are stored; periodically rechecks are conducted.

By reducing seed movements, we can reduce the possibility of mechanical errors on the handling process.

SEED STORAGE DEVICES

	PRESENT	NEW BUILDING
TEMPERATURE	3-5°C	-15°C LONG TERM STORAGE ROOM 15°C SHORT TERM STORAGE ROOM
DRY PROCEDURE	SUN DRYING	AIR DEHUMIDIFICATION
SEED MOISTURE CONTENT	10-12%	5% 8%
SEED LONGEVITY	2-3 YEARS	MORE THAN 25 YEARS 6 - 10 YEARS
SEED CONTAINERS	PLASTIC JARS (0.800 gr.)	POUCHES OF ALUMINUM FOIL LAMINATED PLASTIC JARS
SEED SAMPLES CAPACITY	12,000	10,000 30,000
OTHER FACILITIES	SEED PREPARATION ROOM	SEED PREPARATION ROOM SEED LABORATORY SEED CLEANING AREA

Collections - Plans and needs

On table you can see seed collections held at national centers of the many Germplasm Centers of the world. Many of these centers had transfered to CIAT a great deal of their present available stock. After we finish our increasing step on our present accessions, we will make new requests. We have redently sent to many of our seed donor countries, a list of their collections successfully increased in CIAT and the eliminated ones too. When we finish the field evaluation, we will probably be in better position to plan seed collections or to coordinate some.

Direct explorations are another way of assembling germplasm in the variability centers to collect wild and primitive forms and probably some usefull new variants.

We have to work in coordination with local researchers because variations in beans are closely associated with ethnic groups, elevation, rainfall and soil types.

Considering that the easily accessible materials have been largely sampled, little can be gained now by visiting markets or driving along the highways. What remains to be collected is mostly in remote and less accessible places.

Any orthodoxal procedure can be recomended. It is necessary to judge as how to sample a single place or field. Wild types must be collected in the right place and at the right time. Cultivar collections should be made during the harvest seasons to obtain field information.

APPROXIMATE BEAN GENETIC RESOURCES IN NATIONAL CENTERS

Country		# entries
Argelia	Probably French horticultural types	63
Australia	modern varieties of american origin	300
Belgium	genetic stock	450
Brazil	local collections and foreing collec.	1300
Bulgary	navy beans	3000
Canada	navy beans	2000
Chile	local collections	700
Colombia	local collections and foreing collec.	2100
Costa Rica	Central American collections	3000
France	horticultural types	790
Germany D.R.	many obsolete varieties	515
Greece	navy beans	149
Guatemala	local collections	500
Honduras	Central American collections	1762
Jamaica		160
Japan	large seeded varieties	620
Mexico	local collections, wild types, cocc.	6500
Peru	local and foreign collections	1400
Puerto Rico	P.I. entries	3500
Netherlands	horticultural types	700
New Zealand	navy beans	50
Nicaragua	local cultivars	80
Uganda	P.I. entries, African land races	3500
United Kingdom	P.I. entries, African land races	6000
U.S.A.	International	6000
Venezuela	local and foreign collections	1500

We have made already informal contact with germplasm specialists of CP Chapingo, and CATIE to collect wild types of Mexico and low-land beans of coastal areas of Central America respectively.

Germplasm needs: Specific stocks required:

- Beans with resistance to GBMV
- better keveks if bacterial blight resistance
- beans resistant to web blight
- type 2 bean of non black seeds
- drought tolerant beans adapted to tropical environments
- large and small red beans resistant to antracnose

Physical needs:

- Accomplish as soon as possible the suggested modifications for the building facilities for the Germplasm Development program: Long and short term storage, seed laboratory, etc.
- Adequate equipment for such installations: dehumidifiers, seed screen machines, electronic seed counters, germinators.
- Provide germplasm with one new screenhouse for increasing wild collections.
- Find alternative centers for the increases of certain types non adapted to Palmira conditions.
- Development of a technology to apply electrophoresis to identify duplicates.
- Conclude the description and characterization of our collection to conduct an analysis of available variability, and also to establish the variability required.
- To analize statistically the distribution of the variation according to the geographic origin of the entries as a basis to get new collections.

Plans for next year:

- Coordinate collection with the following institutions: UNA-Peru, CATIE-Costa Rica, CHAPINGO-Mexico, in order to collect ñuñas, low land beans, and wild types respectively.

- Publication of the new cathalogue describing 2,000 entries for January 1977.
- Develop an herbarium in order to get at any time data not included in the present descriptive system.
- Elaboration of maps of the genetic centers of beans for different characteristics of interest.
- Elaboration and distribution of a manual for bean germplasm field evaluation.

Work conducted (1975-1976)

- Adoption of a uniform identification system for CIAT's germplasm.
- Development of a system allowing computer use for documentation in beans (dry grain).
- Shipment of over 2,000 seed samples to different researchers in different parts of the world.
- Cover seed needs for all CIAT's disciplines.
- Conclude and publish the description of 781 promisory materials.
- Continuation of the filling up of the basic register for each one of the entries.
- Obtention of over 1500 collections from other experimental centers.
- Evaluation and increase of over 4,000 materials in 3 semesters.
- Increase of 500 materials in danger of lost, at Popayan conditions.
- Guidance in breeding projects; specially in selecting parents.