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Regional project to increase bean production and consumption, and to strengthen national bean research in the CDA countries of Eastern Africa

Primary Project Countries: Uganda, Kenya, Ethiopia, Somalia

Collaborating Projects:
- CIAT Central African Regional Bean Project.
- SADCC Regional Legume Project.
- Title XII Bean/Cowpea CRSP projects in Africa and USA.

CIAT Centro Internacional de Agricultura Tropical

REGIONAL PROJECT TO INCREASE BEAN PRODUCTION AND CONSUMPTION, AND TO STRENGTHEN NATIONAL BEAN RESEARCH IN THE CDA COUNTRIES OF EASTERN AFRICA

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-CIAT Central African Regional Bean Project in Rwanda, Burundi, and Zaire.
-SADCC Regional Legume Project (when formalized).
-Title XII Bean/cowpea CRSP projects in Africa and U.S.A.

25 November 1983

Project:	To increase bean production and consumption, and to strengthen national agricultural research in *Phaseolus* beans in CDA countries of Eastern Africa.
Purpose:	The purpose of this project is to develop, in collaboration with national programs in the region, new bean production technology components for traditional and improved cropping systems, and to further strengthen national research capacity, in order to increase bean production and productivity in the Eastern African bean production zones of CDA countries.
Executing Agency:	Centro Internacional de Agricultura Tropical (CIAT).
Donor Agencies:	Member nations of Cooperation for Development in Africa (CDA).
Project Countries:	Kenya, Uganda, Ethiopia, Somalia.
Collaborating Projects:	a) CIAT Regional Bean Project in Francophone countries (Rwanda, Burundi, and Kivu Province of Zaire). b) Regional legume projects in SADCC countries. c) ean/cowpea CRSP of Title XII in Kenya with University of Nairobi and elsewhere.
Project Duration:	10 years, with budget covering first five years.
Base Location of Project Staff:	Kenya: Ministry of Agriculture, Thika. Uganda: Ministry of Agriculture, Kawanda; Agricultural Research Station, Kampala.
Project Staffing:	Four bean research scientists.

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PREAMBLE

The regional bean research and development project presented here is a direct outcome of a regional workshop held in Lilongwe, Malawi, in March 1980, which brought together national legume program leaders in the region and CIAT representatives. This workshop provided base line data on the bean production sector in Eastern Africa, and identified the production constraints, and the potential of new bean production technology. This workshop concluded with the national program leaders strongly requesting that CIAT developed a systematic regional effort which would provide a bridge between the solid base of bean germplasm and bean research in Latin America, and bean research and extension agencies of bean producing countries in Eastern Africa. With this mandate, and based on the data generated at the Malawi workshop, CIAT prepared a second draft project which was shared with the national legume programs and Ministries of Agriculture in the region for their comments and in-puts, from which a draft project document resulted. This phase was followed by a workshop held at CIAT In November 1983 at which national program leaders, university representatives, plus representatives from related project efforts, and donors represented in the CDA, were consulted by CIAT on the development of the definitive project proposal. This present proposal is the product of this consultation and has the full endorsement of the countries representatives present at the Workshop (Kenya, Uganda, and Ethiopia).

I. PROJECT SUMMARY

Beans (Phaseolus vulgaris L.) are a basic component in the cropping systems of the small farmers and in the diet of the people in Eastern Africa. However, bean productivity in the region is low, and national capacities to develop and deliver improved technology are in need of further development.

National agricultural research institutions in the region, in collaboration with CIAT, have agreed to mount a systematic, joint effort in support of developing improved production technology and in strengthening the research capacity of national bean programs so as to ensure increased availability of common beans in the region which is to benefit both the bean farmers and the consumers--particularly the lower income sector of the consumers--of the region.

The development of improved bean technology and the strengthening of collaborating national bean research capacities require a sustained, long-term effort. The project presented here assumes a duration of the regional project of initially ten years. The resource requirements stated in this proposal are those that are considered to constitute a reasonable minimum to assure the success of the project. It is hoped that the CDA donor community is in a position to carry the full cost of the project. In addition, the donor community is urged to consider the allocation of additional resources channeled directly to the participating countries and which are to be utilized to further strengthen agricultural research capacities, to develop the infrastructure available for agricultural research, and to strengthen the technology delivery mechanisms of participating countries.

This regional project is based on the realization that the principal bean production constraints in participating countries can be overcome through the development of improved genetic materials that have improved resistance to pests, diseases and drought, are efficient in the utilization of available nutrients and, at the same time, meet the requirements and preferences of producers and consumers alike. The project staff, accordingly, is composed of one plant breeder, one plant pathologist, one agronomist, and one agricultural economist. (At the November 1983 workshop held at CIAT, national legume program leaders from participating countries suggested the addition of a soil scientist which would allow the project also to concentrate on soil constraints, which closely follow in importance the pest, disease and drought problems referred to above. If future developments should make a project expansion feasible, the addition to the project of a soil sciences component would therefore be assigned highest priority.)

The project here does not intend to form separate CIAT-managed nurseries. Rather, the project staff is to be stationed in the existing national programs in Kenya and Uganda where new, yet to be introduced germplasm, together with local germplasm, will be evaluated jointly in greatly expanded national program nurseries and from where promising materials will be distributed to the other collaborating countries in the region. The project will request collaborating national bean research programs to execute a series of research tasks to be carried out for the benefit of the regional effort. Budgetary provisions for this activities are included in the project. Also included are resources for capital items which national bean research programs will need to obtain to be able to benefit fully from the regional project.

Also, under the auspices of the project, a series of regional seminars/workshops will be conducted to stimulate regional collaboration and technology transfer. Finally, under this project, extensive training opportunities will be developed in the form of (a) in-service training at CIAT; (b) academic training scholarships; and (c) assistance to in-country training courses designed primarily for the extension sector.

The chances of success of this project are very high. After eight years of genetic improvement at CIAT, highly superior germplasm has been developed which has shown to be superior in the highlands regions of Eastern Africa. This project will attempt to combine this superior germplasm with locally adapted African germplasm. It is expected that this effort will rapidly result in the availability of superior lines for testing under real farming conditions, and subsequent dissemination to the bean farmers of the region to improve the productivity of existing cropping systems. It is expected that within the initial five years of funding, the project will have identified and extensively evaluated superior germplasm, and will have developed associated agronomic practices that make the new technology acceptable and economically attractive for its incorporation in traditional and improved farming systems.

At the same time, through the development process of this technology, combined with the extensive training activities of the project, the national program infrastructure and research capacity of national bean research programs will have been strengthened. And finally, the systematic efforts of the project to stimulate regional collaboration and horizontal technology transfer will have resulted in a strong and viable bean research and development network, and have improved the economic and nutritional status of the people in the region.

II. PROBLEM CONTEXT

Beans (Phaseolus vulgaris L.) were introduced into Africa from the Latin American gene center by West European traders over the last centuries. Currently Africa is the second most important common bean producing region of the tropics, following Latin America. The total average annual African production, according to FAO production statistics, amounts to 1.4 million tons per year over the last decade. Production estimates vary greatly, as was documented in a workshop in Malawi (March 1980) on the potentials for field beans in Eastern Africa (see proceedings attached). A large part of the total bean production is locally consumed, and thus is not captured in the FAO estimates. For example, Kenya and Uganda report production of 467,000 tons and 300,000 tons, respectively, while FAO estimates are 161,000 and 150,000, respectively, indicating the difficulty in estimating production of a basic food crop, mainly kept for home consumption. Table 1 presents a summary of FAO bean production statistics for African countries; Figure 1 shows the location of the most important bean production areas in the region.

Total bean production in Africa has increased over the last decade. However, this has been achieved through area increases, while productivity has been stagnant, and is currently at around 500 kg/ha. Production increases have not kept up with population growth rates. Per capita consumption is therefore falling, and price increases have been above normal inflation rates in most countries. Extrapolations from data provided by the Kenyan delegation to the CIAT workshop indicate that if these trends continue, and assuming no change in population growth patterns, by the year 2000 Kenya will have to import approximately 120,000 tons of beans, which is the equivalent of about US$60 million. Similar situations are expected to hold true in the other project countries. This project seeks to ensure greatly increased per capita availability of beans in the region, specially for the poorer section of the population.

Beans are rich in protein (over 22%) and play a critical role in the human nutrition in Eastern Africa, providing as much as one-third of total protein consumption in Burundi and Rwanda (the highest in the world) and over 10% of protein consumed in Kenya and Uganda (Table 2). These estimates of protein consumption are probably significantly underestimated, especially for the main production regions in the Highlands Zone. Beans contribute nearly as much protein to average national diets as all animal products combined (milk, meat, fish, eggs) in Malawi and Uganda, and far more in Burundi and Rwanda. Moreover, because beans are cheaper than animal products, they are of even greater significance in the diet of the poor, who are obviously most vulnerable to malnutrition. This applies especially to many African countries where diets based on cassava and plantain are associated with serious protein deficiencies.

Small farmers are the principal producers of beans in most of the majority rule countries in Africa. The vast majority of beans are cultivated in associated cropping systems with maize, or, occasionally, with other grain legumes. In Kenya for example, only 6% of total production is estimated to be in monoculture. Most bean production is for subsistence, with less than a third of the output being marketed. Use of fertilizers, pesticides and fungicides in bean production is rare (see proceedings of Malawi Conference, and Workshop to develop a collaborative project for bean research in East Africa, conducted Nov. 17-22, 1983 at CIAT, for details).

Diseases and insects, low soil fertility, and periodic water deficits form the principal production constraints associated with the low average yields. The Regional Bean Workshop in Malawi and the CIAT workshop identified anthracnose, bacterial blight, angular leafspot, bean common mosaic virus, and rust as the most important diseases across countries, and the beanfly as the principal insect problem. Although sources of resistance to the above problems have been identified, they often occur in materials with grain types without commercial acceptance, or are in poorly adapted materials and are, therefore, not appropriate for farmers' circumstances. For example, the most important cultivars in Kenya, Rose Coco and Mwezi Moja, are susceptible to most of the above pathogens. To reduce disease pressure farmers traditionally plant at sub-optimal densities; and to avoid disease enhancing humidity, they plant their beans dangerously close to the next dry season.

Beans in Africa are mostly consumed as fresh, physiologically mature beans, but before the seed drying process has started. Dried beans or green pods are also important, and young tender leaves are sometimes consumed as a vegetable. Large red, or red- and brown-mottled or speckled seed types are preferred, but seed color preferences seem less stringent than in Latin America. Short cooking time is very important given the critical firewood problem in many areas.

The bean production situation in Africa is described in detail in the Proceedings of the Malawi workshop and were confirmed by the CIAT workshop. The information presented by African scientists at these workshops indicates that there are many commonalities between the bean production systems and production problems in Africa and Latin America. In both regions, beans are produced primarily on small farms in association with maize, and with little use of chemical inputs. In both Africa and Latin America, drought is an important limiting factor on production, and many of the most important diseases constitute severe problems: anthracnose, angular leaf spot, bean common mosaic virus, rust, and bacterial blight. Due to these many commonalities between the production systems and key constraints, prospects appear promising that important bean technology components may be readily transferable from Latin America to Africa, particularly new, high-yielding, multiple-disease resistant lines developed at CIAT. Of course, there are also differences between the African and Latin American bean situation. While halo blight and necrotic strains of bean common mosaic virus (BCMV) are relatively more important in Africa

than in Latin America, neither the beanfly nor beanscab are found in Latin America. Consequently the strengthening of adaptive research capability in Africa is necessary in order to overcome these additional factors and adapt currently available high-yielding disease resistant bean germplasm to African conditions. Self-sufficiency in research at the national level is the ultimate objective of the project. Socioeconomic production conditions also differ between the two continents. For example, in Africa, a higher percentage of bean production is used for home consumption. In contrast to Latin America, beans for domestic consumption are produced primarily by women.

III. NATIONAL BEAN RESEARCH PROGRAMS IN THE REGION

Bean research has a long history in Africa and has continued to increase in importance over the past few years. However, there is a shortage of trained personnel, and collaboration in the exchange of research methodologies, germplasm, literature and other results among the various national and international programs is largely lacking. The national programs are backed by a reasonable infrastructure, but in some countries the research deteriorated over the last years. A good start in increasing national research capacity has been achieved through an in-service training program at CIAT for fifteen national program researchers from the region. This training was mainly funded from extra-core sources. Scientists from the region involved in this project who have received training at CIAT are listed in Table 3.

The following is a brief inventory of national research efforts and needs in the region (Table 4):

°The Kawanda Research Station of the Ministry of Agriculture and the University of Makerere in Uganda have the longest tradition of bean improvement in Africa, which resulted in the release of several new lines, including K12, 18, 19, 20, and 28. Later K lines (such as K20, 130) provided increased anthracnose resistance. Lines developed in these programs, like Kabanima and Banja 2, are currently found in many African countries. However, less than 10% of the farmers are using these varieties.

°Kenya currently has a large bean research program (largely funded with Dutch Foreign Aid support which is now being phased out), centered within the Ministry of Agriculture and the University. Lines resistant to anthracnose and bean common mosaic virus, as well as improved agronomic practices, are under development. The first lines released include GLP-2, GLP-24 and GLP-1004. Later, lines with halo-blight resistance were proposed for release. The current national bean performance trial contains eight improved lines.

°Bean research in Ethiopia is conducted by the Pulse Research Team at Nazareth of the Institute of Agricultural Research. Research has concentrated on white navy beans, and resulted in the recommendation of the varieties Mexico 142, Ethiopia 10 and Tengeru 16 (from Tanzania). The team has identified optimum zones for bean production in Ethiopia and has developed a package of improved agronomic practices.

°Information on bean research production in Somalia is not yet available; thus far, no contact has been made regarding the participation of Somalia in the project, but will soon be initiated.

The present regional project can thus build upon, and collaborate with, relatively large programs with much relevant experience. The national bean research programs can support the regional project through their research staff, reasonably well-equipped experiment stations, some research support, and in-depth knowledge of the bean production situation. In turn, the regional project can enhance the research capacity of the national programs and assist them on the road towards self-sufficiency in research through the offering of advanced training opportunities. The project will also enhance the research output of the national programs through the provision of new genetic variability and the introduction of innovative screening and other research methodologies. It also will be able to make an important contribution in compiling base-line data which will orient the genetic improvement efforts, and in the development of relevant on-farm testing methodologies which is to provide continuous feedback on the performance of newly developed bean lines and associated agronomic practices. Also, through the regional project, participating national bean research programs will have access to selected resources to improve existing research facilities and to obtain critically needed research implements and field equipment items.

By stationing the project personnel within participating national programs, a high degree of integration between the regional and national programs is assured. Furthermore, the project's emphasis on developing and strengthening cooperative activities between the participating national bean programs is expected to lead to a strong regional network that will integrate the individual efforts by the different national programs into a region-wide collaborative effort.

IV. COLLABORATION WITH OTHER REGIONAL PROGRAMS

Several international programs involving beans are active in Africa and are potential collaborators with this project.

A. Bean/Cowpea CRSP

The Bean/Cowpea CRSP will interact with and strengthen the present project. The CRSP, mostly based in the Universities of developing countries and in the USA, will principally provide basic information, and develop methodologies, that will lead to a better understanding of the production constraints. In the complementary document, entitled "Protocol for Defining Areas of Work and Responsabilities Between CIAT and the Bean/Cowpea CRSP on Regional Research in East Africa," the interaction of this regional project with the CRSP is spelled out.

B. CIAT Bean Project in Francophone Countries of Central Africa

This Swiss-funded bean improvement project for Rwanda, Burundi, and Zaire involves three internationally recruited bean scientists. This project initiated activities in the second half of 1983. Many production problems in the Francophone region of Central Africa also apply to the bean production areas in the Highlands Zone of Eastern Africa. A very close collaboration between the two projects will exist throughout the life of the two projects so as to assure mutual sharing of research results.

C. SADCC Grain Legume Project

This project idea (which is yet to be fully developed) could bring together the SADCC countries and international agricultural research Centers and bilateral donors who are working on grain legumes. When designed and funded the project is expected to produce research results which are potentially relevant to the regional project in the East African countries. Close collaborative ties between the two projects (when established) will be expected.

D. International Board for Plant Genetic Resources (IBPGR)

To preserve existing genetic variability in the region the project will seek collaboration with the IBPGR to obtain financial and technical support for collection expeditions with national programs, co-sponsored by CIAT.

E. Other Projects

FAO has a nitrogen fixation program mounted in Eastern Africa (Burundi and Rwanda), plus a soil fertility research program which also involves bean research. Links with the future FAO "Coordinated African Food Crops" development program will also be sought in order to avoid duplication of effort. The project also expects to profit from links with the AID-funded bean storage project in Rwanda and Burundi, and the FEC-funded project in Uganda on seed production for maize and beans. It also will seek interaction with the proposed CDA-funded CIMMYT maize project in the region , in order to assure collaboration in the development of improved production technology for cropping systems based on bean/maize association in the region.

The Malawi workshop clearly outlined the need for CIAT to form a collaborative research program with Eastern Africa to increase bean production. The conference concluded that such a project must be primarily based on the development, distribution and use of improved germplasm. The experiences with the International Bean Yield and Adaptation Nurseries (IBYAN) in Africa are of great value (see Tables 5 and 6). In the countries in which these trials were planted, superior germplasm was identified. In two countries CIAT materials have already been released as new varieties. This indicates that technology developed in Latin America can be transferred to Africa. Local adaptive research will further improve these varieties and develop improved technology components for local cropping systems through extension of new bean technology, specific disease resistance, and use of specific local adaptation to particular environmental conditions.

V. PROJECT PROPOSAL

A. Goal

To improve the nutritional and income status of African bean producers, with emphasis on the small holders in the East African bean production areas.

B. Purpose

To develop, in collaboration with national programs, new bean production technology components for traditional and improved cropping systems, and at the same time to strengthen national research and technology delivery capacity in order to increase bean production and productivity.

C. Strategies

The project will seek to achieve these objectives through three principal and interrelated strategies.

1. Germplasm Improvement and Distribution

Genetic variation exists in beans to overcome most production constraints as identified in the workshops. Most farmers have limited resources available to overcome such constraints through purchased inputs. Therefore the project seeks the development and distribution of multiple disease and pest resistant lines, either as pure lines or in genetic mixtures, of grain types acceptable to consumers and with plant-types fitting into cropping systems of the producers. The project seeks not only to distribute CIAT-improved germplasm to national programs but also to have germplasm developed by national programs transferred horizontally to other potential users, and to utilize improved materials from other international sources (i.e., the Bean-Cowpea CRSP Projects). The project will initially base a significant proportion of its germplasm improvement program upon an active crossing and selection program involving African commercial varieties which is currently in progress in CIAT in order to make an early impact on production.

2. Improvement of Cropping Systems

As in Latin America, new multiple disease resistant germplasm is often the most important motive to adopt new agronomic practices. Not only is a new variety a stimulus to better management, but it can be a

necessary prerequisite for improved management to pay off. Often farmers can maintain reliable but low yields with traditional disease-susceptible varieties only by maintaining unproductive, low plant populations. With new disease resistant varieties higher plant densities may be possible. New germplasm can be developed to fit into existing or new cropping systems including agroforestry when tested at an early stage of development under such conditions. These new varieties can thus form components of improved cropping systems in which beans play an important role. The project seeks to develop and recommend optimum plant densities, crop associations, and fertility levels. Economic analyses of existing and new cropping systems will need to precede these recommendations and help set priorities for the germplasm development activities. Biological nitrogen fixation and soil fertility research will ensure that the input levels used will be within the reach of the economic capacity and the risk avoidance behavior of the small farmers. Many of the latter research areas will receive strong back-up from CIAT headquarters staff. A strong extensionist training program may be required to assure delivery of the new technology to the farmer.

3. Development of Research Capacity in National Programs

The project seeks to develop self reliance in research by national programs. This self-reliance will be developed through an active training program. Training plans call for in-service training at CIAT for individualized research training (6-7 individuals per year, 30 man-months/year), academic scholarships (12 scholarships during the initial first five years of the project), and assistance to the organization and conduct of in-country training courses. It is expected that national research plans will be developed according to which a long-term training plan can be established. One regional workshop per year is planned, plus four monitoring tours over a five-year period. Consultancies of three CIAT staff per year to Africa are budgeted. All senior project scientists are expected to travel once a year to CIAT to strengthen research collaboration with headquarters. The project also includes the translation into English and adaptation to African conditions of audiotutorial training materials. (An existing audiotutorial series has proven to be highly successful as training materials on newly developed research and production technologies in Latin America. These will need to be modified for African conditions.)

D. Modus Operandi

1. Operational Principles

a) Execution: The project will be executed by CIAT.

b) Cropping Systems: Beans are conventionally produced in association with other crops. The project will therefore have a strong cropping systems emphasis. This will mean that early in its development, new technology will be tested through on-farm research for

its agronomic and economic validity under farmer production conditions. If such technology appears inadequate, it will return to the research part of the project for further adjustment. If found profitable it will be used as improved components in the traditional cropping systems in the region. All project staff are expected, to be involved in some aspects of cropping systems research.

c) Germplasm Development: The project scientists will not execute their own CIAT nurseries; rather, they will incorporate CIAT and other improved lines with multiple disease resistance and improved architecture into the existing national program nurseries. The staff will help to plan, execute and evaluate such nurseries, consisting both of national program materials and CIAT germplasm, and help in planning further use of selected material and needed crosses. Therefore, the project plans to attach project staff to national programs, instead of a heavy concentration of separate nurseries in one location.

To make use of the infrastructure at CIAT headquarters and the ability there to produce four bean crop cycles per year, it is proposed that in the initial phase of the project, crossing and early generation bulk selection for disease-resistance will be carried out at CIAT. Such highly variable but disease resistant populations will be pedigree or bulk selected in the national program nurseries in Africa. Once superior germplasm is available, crossing activities will be encouraged in the national programs as local capacity for this work improves. Emphasis will have to given to the improvement strategy for genetic mixtures.

2. Location of Project Staff

The project proposes to locate scientists in the most important bean growing countries of the region. Within the countries included in the present proposal the most desirable base locations for the project staff are Kenya and Uganda. These two principle research locations will permit germplasm evaluation under representative ecological conditions (principally rainfall and temperature regimes and disease and insect pressures). The two locations will facilitate close contact with the national programs involved. Kenya, with well developed infrastructure and a large national program within the Ministry of Agriculture, is an obvious base location for the project. The Uganda location is proposed in order to help rebuild a research program which has had a long history in bean improvement activities and where well-trained scientists are still in place. Local conditions at project initiation will determine whether the project staff will have to move at a later date to that country. The choice of Uganda as one base location will have budgetary implications since much of the existing infrastructure will need to be upgraded if the project is to be effective in that country. Due to the lesser importance of beans in Somalia, collaboration with that country will not be as pronounced as in the

other countries, but will be in accordance with present importance and future potential of beans in Somalia. Project results will be available to all interested bean producing countries in Sub-Saharan Africa.

International germplasm introductions into Africa will enter the continent mainly through the quarantine station of KARI at Muguga in Kenya and from there will be distributed to the participating countries in the project. (CIAT will negotiate with Kenyan authorities an agreement on this.) The reputation and vigilance of this station will provide added assurance that no new diseases or pests will enter Africa via the project. The project proposal includes funds to cover the added expense of increased quarantine work which will be necessary at Muguga, including some capital requirements.

3. Project Personnel

The project proposal calls for four experienced, internationally recruited senior research scientists, three of whom with breeding-agronomy or breeding-pathology training, and one with a background in agricultural economics. The following distribution of disciplines among the two base locations is considered optimum:

a) One breeder and one pathologist located at the National Horticultural Research Station at Thika in Kenya;
b) One agronomist and one economist preferably to be located with the Kawanda Research Station of the Ministry of Agriculture in Uganda.

The senior research personnel of the project will be supported by locally hired research support staff. One of the project scientists will be designated as Project Leader, who will carry out this function in addition to his/her research duties.

a) Role of Project Leader. Duties will include the following activities:
(i) to establish close research collaboration with and among African national research programs and with the CIAT Bean Program;
(ii) to encourage technology and germplasm flow from CIAT and other organizations and among national programs via the strengthening of national and regional germplasm evaluation nurseries;
(iii) to strengthen research capacity of national programs through the organization of conferences and workshops and the selection of candidates for projected training activities, in collaboration with the ministry officials;
(iv) to orient the overall research effort of the project to adapt new technology to African production conditions in direct collaboration with national programs;
(v) to ensure close collaboration of project staff with related activities/projects in the region; and
(vi) to ensure close collaboration of project staff with the

CIAT Swiss-funded regional bean project in the Francophone countries of the Great Lakes (Rwanda, Burundi and Zaire).

b) Role of Project Scientists. Each of the project scientists, including the Project Leader, will be involved in the following activities:
(i) The evaluation of improved germplasm and adaptive research necessary to assist national programs in identifying improved varieties from international and national sources, either from segregating populations or from more advanced materials, where available;
(ii) to assist national program personnel in the evaluation of new technology components in traditional cropping systems through both research station and on-farm research in the various countries covered by this proposal.

In addition, the economist will develop economic base line data to set genetic improvement priorities, and measure project impact.

Each senior research scientist will be supported by one technician and three laborers (except for the economist, who is supported by one technician and temporary help). The Project Leader will be provided with full-time secretarial assistance, and one secretary will be available to support the scientists in reporting, training material development, and administrative tasks.

4. Non-Personnel Requirements

Capital and operational budgets will provide the needed support funds for a smooth execution of the project (see Section VI, Justification of Budget Line Items). Capital funds are included to assist collaborating national programs in upgrading equiment and facilities to ensure that they can operate at a level where they can fully benefit from this regional project. Work plans for the regional project and participating national bean research programs will be discussed in a yearly basis by the Steering Committee (see below), and capital needs by national programs will be identified in relation to these work plans.

5. Network Research by National Programs

It is expected that participating national programs will be requested to conduct research with regional applications. The Project includes funds to cover these expenses. The Steering Committee described below will play a central role in drawing up the regional work plan annually to allow efficient utilization of the available resources in this critical area of work. The Steering Committee will also review the results of research projects and make recommendations on their continuation.

6. Project Duration

It is anticipated that the overall project will require at least ten years to provide sufficient time for the national programs to develop to full capacity. Funding is being requested for the first five years after which the project will be evaluated to determine the desirability and nature of an extension. A core-funded regional cooperation position in beans has been projected in CIAT's Long-Range Plan for the Eighties. Thus, one of the project positions, i.e., Project Leader, can hopefully be absorbed in CIAT's core budget in five years, but this will depend on the funding situation of CGIAR.

The initial period of five years under the present proposal is considered sufficient to encourage regional cooperation in research as well as to strengthen national efforts. It is expected that at the end of this period the results of the project evaluation will justify the extension of a possibly modified project which responds to national needs at that time.

7. Steering Committee

It is proposed that the project leader, and the heads of the bean programs of participating countries, will form a steering committee which will meet once per year, or when needed, to consider and discuss matters concerning project execution such as: selection of training participants, organization of monitoring tours, equipment needs, and the like. National training plans will be developed to utilize training funds optimally.

8. Expected Achievements

The results of the IBYAN (International Bean Yield and Adaptation Nursery) program in Eastern and Southern Africa have demonstrated that germplasm, improved in Latin America, with multiple disease resistances and improved architecture can greatly outyield locally available commercial cultivars which have been included in these experiments as local control varieties. The basic function of this project is to combine these desirable characteristics with materials adapted to African production conditions and select resulting populations for specific local adaptation. By capitalizing on such genetic recombinations the project is expected to rapidly identify germplasm for on-farm testing. Once the superiority of such germplasm has been confirmed, a close association with national seed programs, will be sought to ensure that commercial seed is available to farmers in the shortest possible time. The project during the first five years will also have identified key areas for further research by both CIAT and the national programs. As this new germplasm will have been developed in national programs, the national capacity to develop new technology will have been strengthened and national programs will begin to tackle those outstanding problems which have resisted earlier research efforts.

Specific Outputs. It is anticipated that at the end of the first five year-period, the following outputs will have been achieved:

°Cultivars superior in disease and pest resistance, yield, architecture and acceptable to farmers and consumers will have been identified in on-farm trials. These will have been released to the public, and the seed industry will have provided farmers with seed, and their commercial production of these lines will have initiated.

°Sources of resistance to important diseases and pest will have been identified.

°Factors involved in consumer acceptance will be known.

°The majority of bean research scientists from participating countries will have received specialized in-service training in the latest techniques of bean research, to be applied in national research programs.

°The first Africans will have received M.S. and Ph.D. degrees under the auspices of this project.

°Collaborative research links will have been established among scientists of project countries. The first in-country training courses will have been conducted in research, including on-farm research.

E. Benefit/Cost Analysis

As is generally true with technical change, new high-yielding bean varieties lower the per unit cost of production thereby increasing social welfare as the supply function shifts rightward. Here the Akino-Hayami methodology for calculating the impact of investment in research is utilized. This methodology requires several parameters. The elasticity of supply has been estimated as high as 0.80 in Africa for commercial crops, and between 0.10 and 0.20 for small holder food crops. The demand elasticity for a basic food like beans is typically inelastic, with Latin American estimates usually falling in the -0.30 to -0.60 range. Research benefits from this project were estimated with several combinations of elasticities, with the smallest of the resulting benefits estimate being presented here. A border price for beans of $500/metric ton is utilized in this analysis, well below the average international price of $626/ton prevailing from 1981 through mid-1983.

New technology developed by this project in collaboration with national programs is expected to be available by the end of five years. The best bean varieties coming directly from Latin America that have been tested in 13 sites in Africa have demonstrated yield increases averaging well over 50% when compared to best local checks (Table 5). Here it is estimated that after local selection for adaptation to African conditions, it will be possible to raise farm level yields at least 25%. The adoption of this technology by farmers is assumed to begin in the sixth year after the initiation of this project. Adoption is assumed to attain a ceiling of 80% by the twelfth year, with the diffusion curve

following a stylized logistic functional form. A twenty year time horizon is used in this analysis, and a discount rate of 10%.

Since the CIAT regional project will be collaborating with on-going national programs, only 50% of the benefits estimated to accrue from new bean technology are attributed to CIAT, with the remaining 50% of benefits being attributed to the efforts of national research, extension and seed production programs. Given these conservative assumptions about benefits, and taking into account the full costs of the project, a benefit/cost ratio of 20.8 is computed for this project, while the internal rate of return is 56.2%.

This estimate of project impact excludes from consideration several other benefits which will result. The spillover benefits from the use of new bean varieties in countries outside the direct mandate of the project, are taken to be zero, even though it is probable that other countries will adopt these varieties. Moreover, the future productivity of the scientists trained and national institutions strengthened by this project, is also assumed to be zero, even though future benefits will undoubtedly be derived from the efforts of project trained scientists. Finally, the increased labor productivity and improvement of health that will occur due to improved human nutrition from higher protein consumption, is also discounted from the economic analysis.

F. Environmental Impact

The objective of the project is to develop technology that will allow increased yields without increasing input levels. Through the development of disease- and insect-resistant varieties farmers do not need to rely on pesticides which can be harmful to man and his environment. Present levels of pesticide application are limited, and the deployment of the new materials with genetic pest resistance is not expected to increase pesticide use.

Increased yields are expected to result from improved varieties which are able to make efficient use of the existing, moderate levels of soil fertility. In the second part of the project, biological nitrogen work is expected to become an integral part of the project activities and will make an important contribution to biological nitrogen fixation by improved cultivars. Phosphorus and other critically needed minerals to sustain higher yields can be obtained from modest increases in chemical fertilizer applications, or through the use of green manure, composting, and the like--all viable alternatives to be developed in collaborative projects and the agronomy component in the project. These alternatives also hold much promise to develop improved erosion control.

The critical firewood situation is Eastern Africa is well known. Beans with shorter cooking time requirements will be selected for in the project. Through existing and future CRSP projects the inheritance mechanisms for this characteristic is expected to be uncovered. Through this collaboration, the possibility of soaking beans prior to cooking will also be explored as a means to reduce firewood needs.

VI. FINANCIAL REQUIREMENTS

The financial projections for the project have been specified in detail for the first five years. The amounts shown for each line item are estimates based on CIAT policies governing outposted staff, or are estimates of local costs at each of the base locations. Price increases during the five-year projections are included in the estimates for each line item.

Although the project as described in this proposal has an initial time horizon of ten years, the budgetary request is limited to the first five years of the project. Given the project objectives as stated in this proposal and considering the existing resource base in participating countries upon which the project is to build, the resources stipulated in the budget request are considered to constitute a reasonable minimum to assure success of the project.

The budget calls for a group of four senior scientists to provide for regional coordination of technology development and the enhancement of the institutional capacities in support of bean research and development in the region. This team is to harmoniously interface its program of work with the respective national bean research and will closely coordinate its work with other relevant regional and national bean research and development efforts. The team will receive full backstopping from CIAT headquarters in Cali, Colombia. The project disposes over travel, operations, and capital items that are considered necessary for its successful functioning. Also included in the budget are resources for the training of researchers from participating national bean research programs, and for the organization and conduct of various workshops and seminars in the region. The budget also calls for resources that allow the project to reimburse national bean research programs for expenses for specific, well defined bean research tasks that have direct relevance to the regional effort. Finally, resources are included to assist participating national programs in obtaining installations and capital equipment items which are critical to enable national programs to fully participate in the regional program. A description of the major budget items follows.

Senior Staff

The regional project is to be staffed by four internationally recruited senior scientists representing plant pathology, plant breeding, agronomy, and agricultural economics. This team composition reflects the realization that the principal constraints to increased bean production in the region can be overcome primarily through genetic improvement of bean cultivars to impart disease and insect resistance and tolerance to existing adverse climatic and edaphic conditions. It also takes into consideration the critical need for agronomic and

economic evaluation of new technology, seed production, and the establishment of an interface with technology delivery mechanisms in participating countries.

Plant breeder. The principal responsibility of the plant breeder is to transfer from Latin America promising germplasm, to assist national bean improvement efforts in the evaluation of introduced and local germplasm, and to support breeders in participating national programs in their crossing and selection efforts. The breeder also is expected to play an instrumental role in the identification and recommendation of lines for on-farm testing and varietal release.

Plant pathologist. He is responsible for the screening, in collaboration with national program scientists, local and introduced germplasm for disease tolerance and to identify promising sources of resistance. The pathologist will also develop integrated disease and insect control strategies.

Agronomist. Much of his work will concentrate on on-farm testing of improved germplasm and to provide continuous feedback to the bean breeders regarding the performance of newly developed materials and further characteristics which are in need of genetic improvement. The agronomist is also expected to closely interface with the extension sector and to assist in the selection of superior germplasm to be considered for commercial production. Furthermore, the agronomist is expected to develop improved agronomic practices (including insect and disease control), and to contribute to improved cropping systems for enhanced bean production. Finally, he will also play a major role in the production of breeder seed for regional testing, and will collaborate with research programs and the seed industry in the increase of seed for newly developed varieties.

Economist. He closely collaborates with the agronomist in the design, execution, and analysis of on-farm trials. He will assume major responsibility for the characterization of the bean production sector and in the development of base line data, and--once new technology is available--in the impact assessment of improved technology. In the technology development process, the economist is to analyze the socioeconomic implications of new varieties and associated agronomic practices. He will also monitor bean consumption and production patterns at the macro and micro level.

Postdoctoral Fellow. To reinforce the germplasm development section at CIAT which will need to provide on a continuing basis this regional program with appropriate breeding materials, a position for a postdoctoral fellow in plant breeding will be attached to the CIAT Bean Program at headquarters in Cali, Colombia, for the duration of the project. (The line item for postdoctoral fellow includes the cost for salary and other emoluments, plus a modest amount for research support.)

The line item for senior staff includes the cost for salary and all staff benefits (health insurance, retirement, housing assistance,

education subsidy), plus relocation costs, all in accordance with the CIAT outposted personnel policies.

Support Staff

Each of the project senior staff positions is budgeted with one technical assistant, three laborers (except for the economics position) and temporary help. Initially, one secretary is budgeted. With the phasing in of the agronomist and economist positions in Year II of the project, one additional secretary is budgeted. The technical assistants and permanent laborers are requested to provide assistance in field experiments which are expected to considerably increase in numbers and size with the onset of this project. The technical assistants are particularly important to provide continuity when the senior staff is travelling. Temporary help is budgeted to help absorb peaks in the work programs of the senior scientists.

Travel

Funds are budgeted to cover travel to all countries in the project at periodic intervals for each staff person plus one trip to CIAT once per year of each senior staff project member to maintain contact with CIAT researchers. In addition, funds are included for three technical consultations per year from the headquarters Bean Program scientists. Additional such visits may be required but will be covered from CIAT resources.

Operations

Resources are budgeted to cover all supplies and services required for the operation of the project and for absorbing selected direct experiment station costs where project activities are carried out. Resources are included to cover selected operational costs at the quarantine station in Kenya through which the new introductions from Latin America will pass. Resources for the improvement of the infrastructure for nursery management in Uganda are also included.

Under operations is also included a major item for financial support to national bean programs in participating countries to enable them to carry out selected aspects of the project's research work. Research projects to be conducted by national programs might include specific bean character improvement work, nursery evaluations, screening work, and the like. All projects to be conducted by national programs are to be specific in terms of the work to be performed, time limits involved, and size of the budget.

Training and Workshops

Regional workshops are considered to be of basic importance to stimulate interaction, to encourage horizontal transfer, and to build up

and maintain a regional bean research and development network. The budgeted amounts for regional workshops cover one annual workshop (to be initiated in Year II of the project), for an average of 4-5 participants per country who would meet for a period of five days in a selected location that is to be decided upon based on relevance of the site, costs, and efficiency. Included are air fares, per diems, and the input from two external resource persons.

Related to these regional meetings are the monitoring tours which are to be organized yearly (starting in Year II) for the purpose of stimulating regional collaboration and horizontal transfer of improved technology. Each monitoring tour would include about 15 scientists and would cover all important bean research locations in the region. The duration of any one tour is scheduled for 10-15 days. All transportation costs and per diems are included in this line item.

Three distinct types of training are budgeted for; in-service training at CIAT is budgeted for 6-7 professionals per year. Participants in this training are researchers from national bean programs who wish to specialize in specific aspects of bean research which can only be effectively offered at CIAT headquarters in Colombia. The average length of training is 4-5 months. Budgeted are all costs for travel, sustenance, and training of the participants.

The project will encourage national programs in participating countries to initiate in-country training programs for professionals in research and extension. These courses would utilize mostly national professionals with previous CIAT training. The in-country training courses are scheduled to be supported by training specialists from CIAT. A total of nine in-country courses are included in the budget. The costs covered are mostly CIAT inputs into the respective courses, including training materials.

A total of twelve academic scholarships are included in the budget. These are for the postgraduate training at the M.S. and Ph.D. level. Whenever possible, the thesis portion of the advanced training will be carried out either at CIAT or under the auspices of the project personnel in the region. Funds budgeted cover all travel, tuition, and living costs of the students involved. Scholarship recipients will be selected in collaboration with national programs. All candidates are to be selected from among the research staff of collaborating programs and the awarding of a scholarship will be conditional upon the assurance that the candidates will return to their home institutions after obtaining their degrees.

Under the heading of training, resources are also incorporated for the translation and adaptation to African production conditions of CIAT-produced technical training materials on bean research and related topics. These materials presently are available in Spanish only. They are directed at young research scientists and are scheduled to be heavily utilized both in the respective country research programs as well as in the in-country training courses. Resources are included that will make it possible to distribute the training materials on a limited basis to collaborating national programs.

Capital

The capital requirements include a total of five vehicles for project personnel, basic office equipment, and limited field equipment to carry out the project's activities at each base location.

A major sum is also included for capital equipment and infrastructure development for the development or rehabilitation of the capital resources base of the bean research programs in collaborating countries. The types of items expected to be included in this rubric are seed storage facilities, equipment for land preparation, irrigation facilities, and laboratory equipment.

Budget for Phase I of Project
(Years I-V)

Regional Bean Research in Eastern Africa: Budget for Initial Five-year Period.

			Year I*	Year II	Year III	Year IV	Year V
1.	Personnel						
	1.1	Pathologist (1)	96,800	82,100	90,310	99,342	109,275
		Technical Assistant (1)	14,300	15,600	17,100	18,810	20,691
		Laborers (3) & Temporary Help	17,300	18,600	20,500	22,550	24,805
	1.2	Breeder (1)	93,600	78,500	86,350	94,985	104,484
		Technical Assistant (1)	14,300	15,600	7,100	7,810	8,591
		Laborers (3) & Temporary Help	17,300	18,600	20,500	22,550	24,805
	1.3	Agronomist (1)	------	102,960	86,350	94,985	104,484
		Technical Assistant (1)	------	15,600	17,100	18,810	20,691
		Laborers (3) & Temporary Help	------	18,600	20,500	22,550	24,805
	1.4	Economist (1)	------	102,960	86,350	94,985	104,484
		Technical Assistant (1)	------	15,600	17,100	18,810	20,691
		Temporary Help	------	5,000	5,500	6,050	6,655
	1.5	Postdoctoral Fellow (CIAT-based)	51,000	62,000	68,200	75,020	81,422
	1.6	Secretary	10,500	23,000	25,200	27,720	30,492
2.	Travel						
		Project Staff	40,000	37,500	41,300	45,433	49,973
		CIAT Staff	18,000	22,900	25,200	27,720	30,492
3.	Operations						
		Field & Office Supplies & Services	60,000	54,000	59,400	65,340	71,874
		Research Station Support	40,000	27,500	30,300	33,330	36,663
		Network Research by National Programs	------	95,000	104,500	114,950	126,445
4.	Training and Workshops						
		In-CIAT Training	50,000	55,000	60,500	66,550	73,205
		In-Country Courses	6,600	14,600	16,000	17,600	19,360
		Audiotutorial (Translation)	16,500	18,200	20,000	22,000	24,200
		Audiotutorial (Distribution)	2,700	3,000	3,300	3,630	3,993
		Academic Scholarships	------	80,000	176,000	193,600	205,769
		Monitoring Tours	------	40,000	44,000	48,400	66,000
		Regional Workshops	------	36,300	39,900	43,890	48,280
5.	Capital						
		Vehicles (5 pickups)	39,600	29,000	------	------	-----
		Office Equipment	20,000	4,000	------	------	-----
		Field Equipment	30,000	------	------	------	-----
		Equipment/National Programs	------	150,000	165,000	170,000	170,000
6.	End of Project Evaluation						72,000
7.	Overhead (15%)		95,775	186,258	203,034	221,613	252,665
8.	Contingencies (10%)		63,850	124,172	135,356	147,742	168,457
		Total	798,125	1,552,150	1,691,950	1,846,775	2,105,711
			=======	=========	=========	=========	=========
		Grand Total	US$7,994,711				

* Assumes a starting date of 1 July 1984

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Tables and Figures

Figure I.

BEAN PRODUCING AREAS IN EASTERN AFRICA

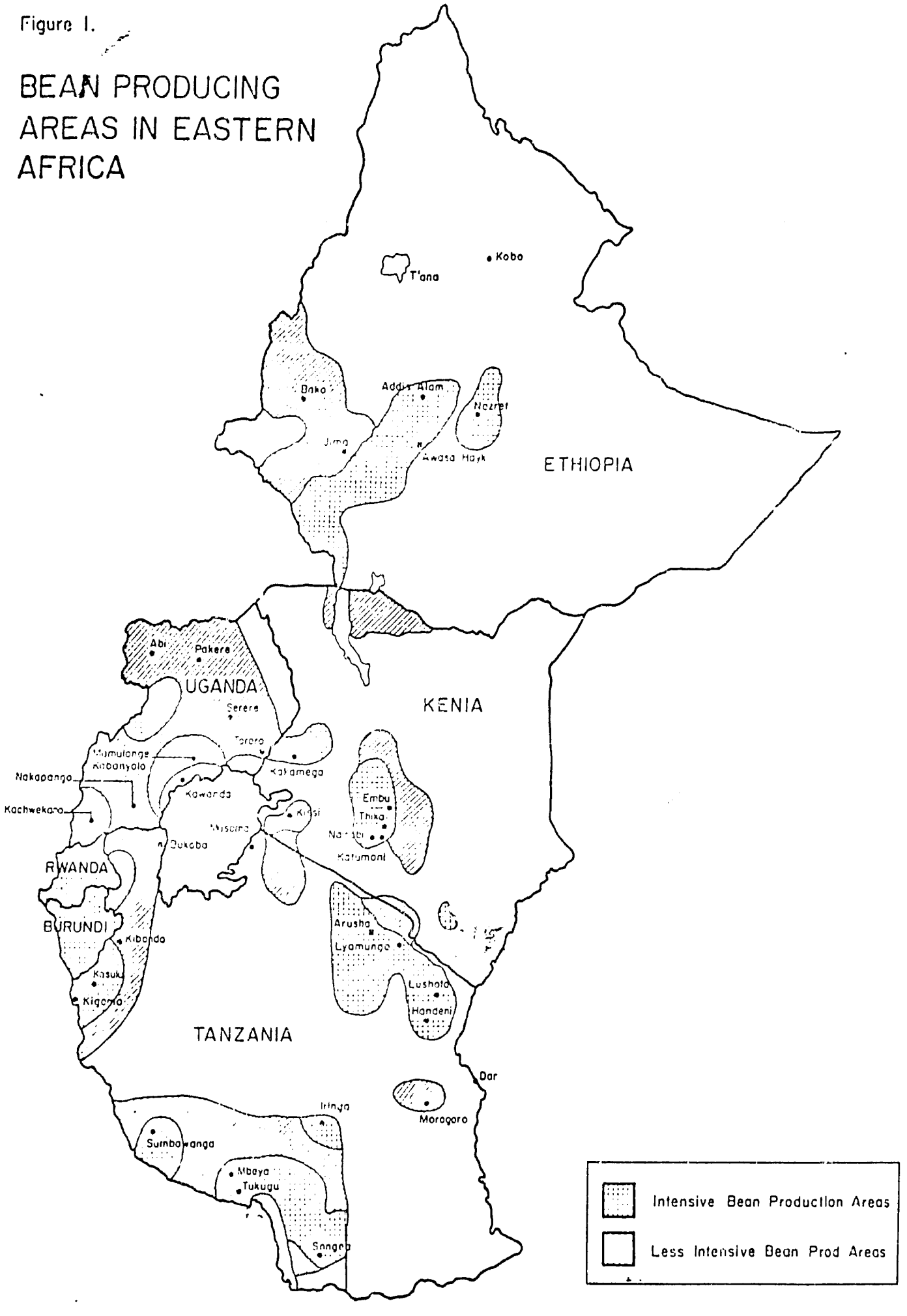

Table 1. African bean production in the last decade, 1966-68 to 1977-79 (FAO Production Yearbook, various years).

Country	Annual production ('000 tons) 1966-68	1977-79	Annual area and yield increase 1962-1979 (%) Area	Yield	Apparent annual per capita grain legume consumption (kg/capita) 1977-79
Principal Producers					
Uganda	175	175	6.7	-2.3	29.3
Burundi	133	162	3.6	-0.9	44.0
Kenya	133	161	-	-	21.0
Rwanda	126	174	3.7	0.3	50.6
Tanzania	108	150	2.7	0.9	12.0
Other Producers					
Ethiopia	68	13	-8.8	-0.2	21.2
Angola	64	64	2.7	-2.1	10.5
South Africa	50	75	-1.6	4.7	3.1
Madagascar	49	47	0.1	0.4	5.6
Cameroun	24	82	6.7	0.4	13.1
Zimbabwe	23	25	0.4	1.7	5.2
Togo	20	16	1.4	-0.6	10.1
Others	54	206	-	-	8.0
Total	1,027	1,350	3.8	-0.1	11.7

Table 2. Nutritional role of beans in Eastern Africa. Percent of total calories and proteins from beans, 1975-77.

	% calories from beans	% protein from beans
Burundi	13.9	33.8
Kenya	4.6	10.2
Malawi	2.9	6.0
Rwanda	13.5	33.6
Tanzania	6.8	16.5
Uganda	6.8	16.5

Source: FAO Food Balance Sheets.

Table 3. Eastern African bean scientists trained at CIAT.

Country	Scientist	Organization	Discipline	Level of training
Kenya	Juliet Gathee	Ministry of Agriculture	Economics	PGI (5)[1]
	Albert Owino Okongo	Ministry of Agriculture	Agronomy	VRA (4)
	Robin Arani Buruchara	University of Nairobi	Pathology	VRA (14)
	George Odhiambu	National Agricultural Laboratories	Pathology	PGI (4)
Tanzania	Geoffrey H. Semuguruka	Ministry of Agriculture	Breeding	VRA (1)
	Anatolia Mpunami	Ministry of Agriculture	Pathology	PGI (3)
	Cosmas M. Mayona	The Uyole Agric. Center	Agronomy	PGI (3)
	Federica Shao	The Uyole Agric. Center	Pathology	PGI (4)
	Betty Gondwe	Tanzania Agric. Res. Org. (ARIS)	Entomology	PGI (5)
	Catherine Madata	The Uyole Agric. Center	Breeding	PGI (2)
	Ashok Kumar Karel	Univ. of Dar es Salaam	Breeding	PGI (5)
	Robert N. Misangu	Univ. of Dar es Salaam	Breeding	PGI (5)
Uganda	Deborah Mulindwa	Ministry of Agriculture	Pathology	VRA (4)
	Theresa Sengooba	Ministry of Agriculture	Virology	VRA (4)
Zambia	Coy Haciwa	Ministry of Agriculture	Pathology	PGI (4)

[1] Number of months spent at CIAT. Funding for most of this training was obtained from non-core sources.

VRA: Visiting Research Associate.
PGI: Postgraduate Intern.

Table 4. Available and needed manpower, equipment and operational support for bean research in participating countries. (Data summarized from presentations made by African scientists during workshop at CIAT, Nov. 17-22, 1983.)

	Kenya	Uganda	Ethiopia
EXISTING RESOURCES			
Bean research staff	Breeding: 1 MSc, 1 BSc Agronomys: 6 MSc Pl. protection: 1 PhD, 1 MSc Economics: 1 MSc, 1 BSc	Breeding: 2 MSc Pathologys: 1 MSc Entomology: 1 MSc Agronomy: 1 MSc, 1 BSc Economics: 1 BSc	Breeding: 1 MSc (50%) Agronomy: 1 MSc 1 BSc 4 (25%) Pl. protection: 2 MSc (both (25%) Food science: 1 BSc (25%)
Research stations	5	6	6
Total yearly bean research acreage	12 ha	10 ha	18 ha
ADDITIONAL NEEDS			
Manpower	Staff degree and in service training. Additional labor support.	1 food scientist, training to update scientists, including degree training; Additional labor support.	Microbiologist and physiologist.
Vehicles	One car for on-farm research	None available	One car for on-farm research
Operational	Imported supplies; farm chemicals, etc.	No research monies available.	No foreign exchange available for supplies.
Station support	Plot tractor, thresher, planter, screen house. Upgrading seed storage facility and some capital (dehumidifier) for Muguga quarantine station.	Germplasm store, repair and refurnish existing laboratories, screen house, field plot equipment, library, etc.	Upgrading screen house, some additional laboratory equipment, a seed storage facility, and threshing equipment.
Literature	Lack access.	Access is lacking	Access is lacking

Table 5. Performance of best test entries in the CIAT International Bean Yield and Adaptation Nursery (IBYAN) planted in Africa as compared to best local check variety.

Location	Year	Yield (kg/ha) Best CIAT entry	Yield (kg/ha) Best local check	% difference
Bunda College, Malawi	1977	2641	1580	76
Bunda College, Malawi	1978	917	365	151
University College, Swaziland	1978	2398	1726	39
University College, Swaziland	1979	1501	1227	22
Agric.Res. Inst., Tanzania	1977	1324	954	39
ISABU, Burundi	1979	1797	1303	38
IRAF, Cameroon	1979	2615	2111*	24
Minister, Sao Tome	1979	497	244	104
ISABU, Burundi	1980	835	678	23
ISABU, Burundi	1980	1797	1281	40
Zanzibar, Tanzania	1981	444	187	137
Zanzibar, Tanzania	1981	507	111	357
Sotoubova, Togo (A.R.A.C.)	1979	2083	1423	46

* Best check was best CIAT entry in previous yield trial.

Table 6. International Bean Yield and Adaptation Nursery (IBYAN) Program in Sub-Saharan Africa: Number of nurseries shipped since 1976.

Country	1976	1977	1978	1979	1980	1981	1982	Total
Angola						4		4
Burundi				2		5	6	14
Cameroon			1	1		4	1	7
Gabon					2	1		3
Ghana							1	1
Guinea-Bissau				1	3		4	
Kenya						1		1
Lesotho			2	1				3
Malawi	1	1		1		2	2	7
Mauritius					2	2	1	5
Rwanda				1	3	3	6	13
Sao Tome			3					3
South Africa		1	1	1	1	2	6	12
Sierra Leone				1	4	1		6
Swaziland		1	1	2	2	1	4	11
Tanzania	1				6	1	11	19
Togo				1	2	1		4
Uganda					2	1		3
Zaire					4	3		7
Zambia					2		2	4
Zimbabwe					3	7	10	20
Total	2	3	8	11	34	42	50	150