THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

REPORT OF THE THIRD EXTERNAL PROGRAM REVIEW OF THE CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT)

CIAT

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

JANUARY 1990

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

Alex F. McCalla
Chair

Davis, California, January 31, 1990

Dear Dr. Hopper,

I have the pleasure to submit to you the report of the Third External Program Review of CIAT which was conducted in September 1989 under the chairmanship of Dr. John Coulter. The report was considered together with that of the External Management Review in the presence of its Chairman, Dr. Vijay Vyas, at the 50th Meeting of TAC in Washington D.C. in October 1989. CIAT was represented by Dr. Frederick Hutchinson, Chairman of the Board of Trustees, Dr. John Nickel, Director General, and other members of senior management.

TAC has prepared a commentary summarizing its reactions to the EPR and EMR reports and their recommendations. This commentary, together with the reactions of CIAT to the external reviews, is attached to the report.

TAC was pleased that both Panels found CIAT to be a well-managed institution with solid achievements, excellent staff, strong links with national programs and advanced institutions, and generally approved of CIAT's vision as it entered its third decade. TAC endorsed the recommendations of the Review Panels and offered some additional points for CIAT's consideration. CIAT has recently developed a draft strategic plan for the 1990s which it has shared with the Committee. TAC would welcome an opportunity to discuss CIAT's strategic plan when finalized.

We concluded that CIAT is a productive and efficiently organized Center. TAC is pleased to recommend continued strong CGIAR support for the Center.

Sincerely,

Alex F. McCalla
Chairman, TAC

Dr. W. David Hopper
Chairman, CGIAR
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TAC COMMENTARY ON CIAT EXTERNAL REVIEW REPORTS

TAC commended the Chairmen and Members of the External Review Panels of CIAT for the in-depth appraisal of the work of the Centre. It was pleased that both Panels found CIAT to be a well-managed institution with solid achievements, excellent staff, strong links with national programmes and advanced institutions, and generally approved of CIAT's vision as it entered the next decade. TAC endorsed the recommendations of the Review Panels and offered some additional points for CIAT's consideration. TAC had received a draft of CIAT's Strategic Plan for the 1990s and would welcome an opportunity to discuss CIAT's response to TAC's commentary on the External Reviews as the Strategic Plan was finalized.

Conduct of the Review

TAC approved of the procedures the Panels used in conducting their Reviews. It appreciated the efforts made in conducting country visits, and the intensive consultations with CIAT staff and their collaborators. TAC was aware that the External Programme Review Panel based its conclusions on an extensive analysis of the issues considered, but all of these were not included in the report. This was unfortunate because the Committee's consideration of the Review would have been facilitated if the analysis had been presented more fully in the written report. However, this did not imply a disagreement with the observations of the Panel.

Strategy and Programmes

TAC was in general agreement with CIAT's approach in developing a strategy for the 1990s. TAC would welcome greater clarity as to the analyses that led to CIAT's judgements as reflected in its draft Strategic Plan. The Committee supported CIAT's efforts to ensure an appropriate balance between programmes, and appreciated the Panel's observations on this matter. TAC would like to be kept informed of the results of ongoing studies on this issue by CIAT such as the congruence analysis now in progress. Specifically, TAC would welcome more information from CIAT as to the justification for the retention of its ongoing programmes, and the exclusion of possible new initiatives.

The Panel, as does TAC, commended CIAT for its commitment to attend to the needs of disadvantaged producers which was reflected in its focus on low-input strategies; but the Panel also expressed doubt about the long-term viability of this strategy. In a subsequent version of the Strategic Plan, TAC would appreciate a clearer articulation of CIAT's low input strategy with respect to the sources and amounts of the additional inputs required to sustain the yield increases CIAT projects to be necessary, and to time-scale considerations.

TAC was in general agreement with the Panel's recommendations on the Centre's activities. The Committee would like to make the following further comments on CIAT's commodity research programmes.

Beans: TAC recognized the progress made by CIAT in varietal development but was concerned about the slow adoption by farmers of improved bean varieties. The Committee would appreciate elaboration of the rationale for the present size of the Bean Programme, both in absolute terms and in relation to the other three commodity programmes of the Centre.

Pastures: TAC was impressed by the improved technologies developed by the Pastures Programme, and welcomed CIAT's efforts in studying the problems of their adoption by farmers. The Committee suggested that CIAT consider giving greater attention to integration of pasture production in smallholder farming systems of Central America and Asia. The Committee also supported CIAT's efforts to obtain pasture germplasm from other institutes and agencies such as ILCA and CSIRO.

Cassava: TAC would welcome more information as to how the results of the CIAT cassava demand study had helped to shape the directions and activities of the Cassava Programme. It noted that the study on cassava demand in sub-Saharan Africa was not yet completed, and referred to the critical comments previously made by TAC about the nature and size of the Cassava Programme. In a revision of the Strategic Plan, TAC would appreciate provision of more information on the rationale and justification for the present allocation of efforts to various components of the Programme, especially post-harvest activities such as drying, processing and marketing.

Rice: TAC noted the significant impact of the Rice Programme and agreed with the Panel's recommendations with respect to this Programme. It was pleased to note the Centre's efforts to improve the methods used in the research process.

Socio-Economic Research

TAC concurred with the Panel that CIAT's strategy of inclusion of socio-economic research within multidisciplinary commodity programmes had worked very well. The Committee was pleased to note the strong interactions that took place between the commodity team workers and the contributions by social scientists in the process of setting priorities for biological research within programmes.

TAC noted that CIAT's management was giving greater attention to setting priorities across programmes and that its programme economists were making a contribution to this process. The Committee wished to encourage this type of intradisciplinary activity across programmes. If CIAT implemented its plan to create an additional programme on agro-ecological research and resource management that would work across commodities as well as ecosystems, it may consider the incorporation of socio-economics research that would focus on this and other activities.

Training and Information

TAC commended the Panel for its thorough review of CIAT's training and information activities and concurred with the Panel's recommendation that CIAT explore ways to achieve wider awareness and

greater use of its SINFOC (Scientific Information Centre) commodity collections. It also supported the Panel's recommendation that CIAT review the scope and timing of its training programme in consultation with commodity programme and national research leaders.

Programme Organization and Management

TAC concurred with the External Review Panels that CIAT was a well managed and efficiently organized Centre. The Committee agreed with the recommendations made by the Panels with respect to optimal organization of management and awaited the new Director General's initiatives in this regard. The Committee would like to stress that the incoming Director General should have flexibility to implement the recommendations of the Panels based on his judgement, and that of the Board of Trustees, in the context of the long-term strategy of the Centre.

TAC supported the Panel's recommendation that CIAT establish a biosafety committee to ensure coordinated supervision of bioresearch activities and to monitor requirements for the release of genetically altered material. Inter-Centre consultation on this topic would be desirable.

Resources and Facilities

TAC noted with satisfaction the Panel's conclusion that CIAT's facilities were excellent and that the level of resources available to the Centre was adequate in relation to its present activities and planned future programmes.

Relationships with Other Organizations

TAC was very pleased that the Panel found excellent relations to exist between CIAT and its staff and its collaborators in national programmes, advanced institutions and other CGIAR Centres. TAC was pleased about the high regard in which CIAT was now held in the countries where it worked. The Committee would welcome further information on the role of the private sector and of the non-associated centres in CIAT's future research strategy.

Centro Internacional de Agricultura Tropical CIAT

CIAT RESPONSE TO THE REPORT OF THE THIRD EXTERNAL PROGRAM REVIEW

The CIAT Board and Management commend the TAC for the selection of a well qualified and balanced External Program Review (EPR) panel. We commend the team members for the great diligence, thoroughness and sound judgment exercised in their prodigious and complex task carried our within a very tight schedule and involving arduous travel to distant points. We wish to particularly register our appreciation for the adroit leadership given to this task by the EPR Chairman. We also value the openness and thoroughness demonstrated by the team in the many discussions they held with program leaders and scientists and with the Center management.

The CIAT Management, the Board Program Committee and the full Board of Trustees have thoroughly reviewed the information contained in the written and verbal reports of the EPR Panel and are in general agreement with the overall conclusions and recommendations made. We particularly appreciate and agree with the overall assessment of the Center's program activities and the endorsement of the strategic plan.

We have carefully considered the recommendations, suggestions and observations contained in the report, and have given particular attention to those that might require some modification to the strategy and operations of the Center and its programs. We recognize that the EPR report is addressed to the TAC and will be submitted for final approval by the CGIAR; thus we will reserve final judgment on key issues until we have received the views of the TAC and the CGIAR. However, we also considered the report of the EPR as a valuable input into the strategic planning exercise, now being completed. The presentation of the EPR report was especially timely in that it came at the same time the Board was considering the final draft of the Center's strategic plan for the 1990s. We have, therefore, already taken some of the recommendations and suggestions into account in the final version of that plan. Specifically, we agreed with the comments in section 3.7.2 (p. 67) of the report drawing the attention of CIAT's policy makers to the need to pursue the topic of resource allocation among commodity programs in greater depth and be eventually prepared to modify the use of CIAT's resources in the coming years. The matter, although discussed during the planning process, had not been explicitly stated in the draft version of the strategic plan. In response to this recommendation we have added a section in Chapter 3 of the strategic plan on "commodity balance," in which we elucidate the criteria that have been used in the past to evolve the current commodity mix and resource allocations among them, and those that will be used in considering any modifications to these allocations when the operational plan is developed.

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Three recommendations came out of the joint chapter on "Organizational Structure and Process" (Chapters 6 of the EPR and 3 of the EMR report). These are:

* **that top management of CIAT be redefined to incorporate the third level in the hierarchy (the Program Leaders) and that a Management Committee be established, to be chaired by the Director General and to meet regularly and frequently, with an advance agenda and formal minutes recorded;** (23)

* **that the incoming Director General, in consultation with the Board of Trustees, evaluate the current organizational structure in the light of the criteria listed by the Panels;** (24)

* **the appointment of a Coordinator of Research Support to supervise the work of CIAT's advanced biology units as well as the other research services in the interim.** (25)

The CIAT Board and Management considered these issues as important and interrelated and initiated a thorough discussion of them. There was broad agreement with the general objectives of these recommendations but misgivings about the practicality and desirability of some specific aspects. We considered that it would be premature to make final decisions on these until the incoming DG has had the opportunity to study these matters and make his recommendations to the Board. Early action on these matters is anticipated.

On all other recommendations we are in substantial agreement with the EPR Panel; in most cases steps to implement them were already underway before the Review, and the recommendations usefully drew attention to the need to give greater emphasis to these matters. We record our comments on them below, chiefly for clarification purposes.

Panel recommendations:

(1) **that a greater effort should be made in the Bean Program, with the GRU, to increase germplasm screening activities and to speed up the processing of backlogged materials;**

CIAT agrees with the need for more rapid processing and screening of the germplasm collection in beans. CIAT has successfully negotiated with ICA for the construction, near Bogotá, of a long-awaited facility which will provide greatly increased quarantine capacity in Colombia. While CIAT has had contracts with other organizations in third-country quarantine projects, these have proved insufficient in relation to the backlog of those 9,000 viable materials which remain unprocessed at this time. This increased

quarantine capacity in Colombia, combined with the continuing activities in third-country quarantine, should reduce the backlog to a normal level within the next three years. Screening of germplasm is a continuing activity and most of the 25,000 presently-processed materials have been screened for a range of disease and insect resistances and specific plant and environmental characters. As new material is processed through quarantine it undergoes the same screening process. (See strategic plan, p. 30.)

(2) **that CIAT take steps to assemble information on the occurrence and distribution of major constraints to bean production in Africa;**

CIAT agrees that the information on major constraints in Africa should be assembled in one analysis. At the moment information is available from all three regional programs with respect to the major constraints in each country. A bean map has been prepared for Africa and this is being revised and updated with new information being gathered by the economist who was recently appointed to the African program. This information, combined with what is already available, and together with an updated map, will be analyzed in the near future and presented in one report which will outline the degree to which biological, environmental and socioeconomic constraints are affecting bean production in Africa.

(3) **that the Rice Program pursue more actively the use of population improvement methodologies like recurrent selection;**

CIAT agrees, as evidenced by the fact that the Rice Program recently recruited a breeder with such an expertise. The Program has also developed male sterile lines for recurrent selection in the uplands and is transferring this character to the irrigated lines. (See strategic plan, p. 37.)

(4) **that, since the yield trials have frequently shown rather poor statistical precision, the Rice Program make a serious effort to explore the reasons;**

CIAT agrees, noting that the area in question is an ecosystem in which neither it nor other IARCs have previous rice experience, and with a unique set of environmental constraints. Having identified many of these constraints, the Program has responded by increasing the size of its experimental plots, the number of replications and the sampling methodology.

(5) **that the GRU should intensify the effort to have experts decide on a manageable core collection consisting of a limited number of accessions that contain an appropriate amount of genetic variability;**

CIAT agrees on the need to create core collections. At the moment, however, consensus within the scientific community as to what precisely constitutes such a grouping is lacking. It is agreed that core collections would allow the assembly of a key, representative set of materials which could be used for characterization studies, including work at the molecular level, and for provision of germplasm which is generally representative of the wide range of germplasm availability in the various collections at CIAT. CIAT will closely monitor the current debate on this subject to assist in formulating its own policies towards core collections. In the meantime there is need to reduce the collections to more manageable numbers by identifying duplicates. The GRU will continue to work along these lines using various genetic markers. (See strategic plan, p. 45.)

(6) **that, considering the increased activities necessary for the tropical pastures and cassava collections and its great genetic variability, CIAT seek resources for adequate staffing for the Genetic Resources Unit;**

CIAT agrees that increased resources for the Genetic Resources Unit will be necessary as the Unit increasingly takes over responsibilities for the tropical pastures and the cassava collections. The arrival of the new Unit Head in late 1989 will facilitate reassessment of the Unit's requirements, which will be addressed within the limits of funding available to CIAT.

(7) **that CIAT considers duplication of the collection and the maintenance of a collection of sexual cassava seeds, as insurance against the possible loss of the living cassava collection maintained in tissue culture;**

CIAT agrees on the need to duplicate the cassava collection. This will have to be done comprehensively using various methodologies. The cost of duplicating international collections by meristem conservation in other institutions tends to slow the use of this methodology for duplication. A collaborative project proposal has been presented to IBPGR for a feasibility study on the use of sexual seed as a conservation media. It seems appropriate for CIAT to develop basic research on the concepts underlying the use of sexual seed conservation in cassava as one complementary means for conserving the collection. The other possibility

is the use of cryopreservation, which is already under study at CIAT in collaboration with IBPGR. If a breakthrough can be achieved in this area it may be possible that the whole collection (either as meristems or sexual seeds) can be duplicated and stored in liquid nitrogen at far lower costs than any of the other methodologies. (See strategic plan, p. 45.)

(8) **that even greater efforts be made to find special funds and other resources to allow the BRU to expand;**

CIAT agrees with the need for the BRU to expand its activities and every effort has been made to develop collaborative research projects in developed and developing countries which can provide an expanded overall effort on the CIAT commodities in which the BRU would play a crucial part. The development of the advanced research networks should be seen as a particularly effective means by which collaborators in advanced laboratories can increase and better coordinate their research efforts on CIAT commodities. CIAT is also seeking special funds for advanced research at headquarters on work for which we have a comparative advantage. Many such special projects at CIAT will be in conjunction with collaborative research projects taking place in other institutions. (See strategic plan, p. 46.)

(9) **that an internal biosafety committee be established very quickly;**

CIAT agrees that a biosafety committee should be established. A survey will be made of similar committees in other institutions in order to establish the guidelines by which the CIAT committee should operate. In establishing this committee CIAT will take into account any biosafety guidelines which may be established by the Colombian Government.

(10) **that CIAT management give greater attention to clarifying the role and future responsibilities of the AESU;**

In its strategic plan CIAT has proposed the undertaking of a study to determine what role the Center should have in an ecosystem-focused approach, and whether or not a new program should be created to deal with sustainability issues. Any alteration of the Unit's current role will await the outcome of such a study. (See strategic plan, p. 21.)

(11) **increased attention to the needs of program experiments in decisions on commercial cropping by Station Operations;**

CIAT agrees that a proper balance is required between commercial operations and the need to attend program experiments. The Deputy Director General in charge will be evaluating the needs of the programs in order to ensure that experimental use continues to receive preferential treatment.

(12) **integrated strategies across CGIAR Centers in dealing with national programs, particularly in non-mandate specific activities such as management training, on-farm research and networking, and in areas of overlapping mandate such as the maize/bean intercropping so important in Latin America, the Caribbean and Africa;**

CIAT agrees, and has already initiated such efforts, as shown by the agronomy trials training course held in Ethiopia in conjunction with CIMMYT, the joint training courses on grain legume research held in Africa in conjunction with IITA, and the forthcoming Central American regional training program in on-farm research (also with CIMMYT). (See strategic plan, p. 13.)

(13) **being selective in responding to the broad range of demands that have come out of NARDS consultations;**

CIAT agrees that it cannot respond equally to all requests or suggestions that result from our constant interaction with NARDS. We believe that we should be involved in only those in which we have a comparative advantage. It is encouraging to note that, in contrast to the consultations related to the development of the first plan "CIAT in the 1980s," when many suggestions were made that various commodities be added to our portfolio, 19 of the 20 NARDS' leaders who responded on this subject in our recent questionnaire agreed with the statement: "CIAT's current commodity mix is the right one." However, the "demands" are usually not in relation to additional commodities but rather for types of technical assistance, training, development activities and location-specific research that might best be done by others. We agree that we need to strike a balance between being responsive and saying "no" when appropriate. (See strategic plan, p. 13.)

(14) **that, commending CIAT's effective development of the steering committee model and network activities in Africa and Latin America, the Center continue its support for these efforts;**

CIAT agrees that steering committees are an effective means for regional integration and participation and will continue such efforts. An important consideration is the financial resources required to guarantee the future existence of network activities and steering

committees as CIAT involvement in a particular regional network is scaled down. (See strategic plan, p. 22-23)

(15) **that in view of CIAT's success in working out a model for collaboration with EMBRAPA in Brazil, in cooperation with IITA, in relation to the Cassava Program for the semi-arid parts of Africa, the Center continue to work toward similar outreach plans with other highly developed national systems;**

CIAT agrees that the model being proposed for Brazil/ CIAT/Africa cooperation is an example of the type of cooperation that can be effective without the inherent dangers of other bilateral arrangements. At the moment negotiations are in progress and it is expected that extra-core funding will be obtained. The possibilities for other such arrangements will be limited by the rate at which national programs develop sufficient strength to assume international responsibilities. (See strategic plan, p. 12.)

(16) **that CIAT headquarters reinforce the efforts of its staff in Africa for inter-Center collaboration in training and research;**

CIAT agrees on the importance of inter-Center cooperation, a primary feature of our regional programs, particularly in Africa. CIAT and CIMMYT have also developed joint activities more recently in Latin America. It is felt that this type of inter-Center cooperation is an effective means for reaching national programs so that training efforts avoid duplication and are fully integrated with one another. CIAT will continue to seek collaborative linkages with other international centers and regional organizations.

(17) **that CIAT pool its knowledge and experience with others, including ISNAR, for the training of research managers;**

CIAT is still exploring ways of making its research management experience available to NARDS. Any specific training activity on this subject will be coordinated with ISNAR, as agreed at last year's IARC workshop "Human Resources Development through Training."

(18) **CIAT contact with other Centers for an integrated approach on sustainability;**

This is the approach envisioned by CIAT, particularly if the Center expands sustainability activities to the ecosystem level. The strategic plan (p. 20) refers specifically to the need for an interinstitutional approach to the American tropical forest ecosystem. In addition, the joint CIAT/IFPRI project "Natural Resource Management and Agricultural Development in the

Humid Tropics" began a year ago and the first workshop will take place in Peru in November 1989. (See strategic plan, p. 20.)

(19) **that CIAT systematize its on-going inventory of national program training needs and its schedule for filling them. This will require consultation not just with leaders in commodity research programs but with national research leaders;**

CIAT agrees, and a specific objective to this end is included in the strategic plan (p. 51).

(20) **that CIAT explore ways to get wider awareness and greater use of its SINFOC commodity collections and other bibliographic resources;**

CIAT recognizes the need to improve NARDS' use of its information services. Improved mailing list software has recently been incorporated and activities to get better distribution lists from CIAT and NARDS' staff are in progress. (See strategic plan, p. 50-51.)

(21) **attention to the balance between demand for services from the publication program and resources available for it;**

CIAT agrees. We consider the solution to be categorization and prioritization among publications rather than increasing resources.

(22) **careful analysis of policies for pricing publications and other CIAT materials to make sure they accomplish the desired distribution;**

CIAT agrees. A recent example of careful pricing comes from one of CIAT's latest publications: traditional production would have lead to a cost of US$38.80 per unit. After careful analysis of the various cost components, a high-quality product was produced and made available for $16.00. However, it is recognized that money transfer is also an important barrier to a wider distribution in the Latin American market, where CIAT has a unique language role to play.

(23, 24 and 25)
See third page of this response.

AGR/TAC:IAR/89/11

THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

REPORT OF THE

THIRD EXTERNAL PROGRAM REVIEW OF THE

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

(CIAT)

Review Panel: Dr. John Coulter (Chairman)
Dr. Abdalla Ahmed Abdalla
Dr. Peter Brumby
Prof. Bryant Kearl
Dr. Edgardo Moscardi
Dr. Ruben L. Villareal

Dr. Ernesto Paterniani (TAC Member)

Dr. Michael Collinson (CGIAR Secretariat)

TAC SECRETARIAT

September 1989

27 September 1989

Dear Dr. McCalla,

On behalf of our Panel I have pleasure in forwarding the report of the Third TAC External Program Review of the International Center of Tropical Agriculture (CIAT). We used the terms of reference for external program reviews and the list of additional questions which the Panel received from TAC as our guidelines.

Due to changes in dates of Board and Program Committee meetings at short notice, I alone was able to attend these meetings. However, the Panel visited CIAT from June 10-17, when it heard presentations by the Program Leaders and their staff and was able to visit field activities both in Colombia and Ecuador. Subsequently some of the Panel members visited Brazil and Costa Rica while others visited Thailand, Ethiopia, Tanzania and Rwanda. These field trips gave the Panel members an excellent opportunity to understand CIAT's networks and the national research programs supported by them. During the field trips we were accompanied by members of the EMR Panel and the two Panels had joint discussions with the CIAT scientists and with host government officials.

These initial meetings, visits and discussions gave us a very good overview of CIAT's research, an opportunity to meet with most of its outposted staff, to assess host government reactions and the chance to collect the more relevant literature on the Center activities.

During the course of the main review from Sept. 10-29 the Panel's work focussed particularly on the planned developments of CIAT's programs as expressed in the Strategic Plan. At the same time the Panel discussed in some detail the on-going research, training and research support programs to study how they might meet the challenges of the future.

We would like to express our special thanks to the Board, the Director General and his Deputies, and the staff of CIAT, including the outposted staff, for the extremely helpful way in which they approached the time-consuming task of providing us with information and an understanding of their work.

/...

Dr. Alexander F. McCalla
Chair
Technical Advisory Committee/CGIAR
University of California
Davis, CA 95616
USA

It has been a pleasure for us to work with our colleagues in the EMR Panel. Our many joint discussions gave each of the Panels a better understanding of the other's tasks. Panel members have asked me to express to you their appreciation of the opportunity to serve on the Panel and I, in turn would like to extend to them my sincerest thanks for the enthusiasm and industry with which they tackled the task.

Finally, we would like to give our special thanks to Dr. Michael Collinson of the CGIAR Secretariat and Ms. Marioara Lantini from the TAC Secretariat. Their industry and willingness to work long hours made our task very much easier.

Yours sincerely,

John Coulter
Chairman
CIAT External Program Review Panel

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EXECUTIVE SUMMARY

This Third External Program Review sees CIAT entering its third decade with twenty successful years behind it. The Center has a longstanding reputation for imaginative decisions on changes of course and, more recently, for innovative links with its national system partners in the global agricultural research system.

Strategy

The Center's strategy paper "CIAT in the 1990s" reflects the emergence of food self-reliance as a philosophy for freeing production forces to feed the world's poor. Prominent features of the strategy are an evolving interface with CIAT's national system partners - including the devolution of some crop improvement and training activities to stronger partners - and a move upstream towards a higher proportion of strategic research. Both are underpinned by a heightened awareness of the need for sustainable land management and sustainable national research efforts.

While the strategy paper carefully addresses the question of balance in these important dimensions, it is less explicit on the balance across CIAT programs. This has been relatively stable over the last decade and the Center's plans see this historical balance continuing. The Panel asks CIAT to carefully consider whether the balance across programs will continue to be appropriate through the 1990s.

Achievements

The Center has had solid achievements from its commodity programs. National systems have released forty-six bean varieties incorporating CIAT material and these are grown on some 350,000 ha annually, mainly in Latin America and the Caribbean. The Bean Program's nationally driven regional networks are leading the way to a closer partnership with national systems in Africa.

The Cassava Program has played an important role, collaborating with IITA and others, in the successful biological control of the mealybug, rampant in the major cassava growing areas of Africa. It has stimulated an opening of new markets through novel utilization technology in both Colombia and Ecuador.

The Rice Program maintenance research has helped to sustain the major increases in rice production in Latin America. Its new joint venture with the Tropical Pastures Program into rice/pasture systems for the Llanos is an exciting prospect.

Andropogon gayanus and Stylosanthes capitata, developed by the Tropical Pastures Program, is being used commercially on substantial areas of the Colombian Llanos and Brazilian Cerrados, and on a smaller scale in other countries. Grass legume mixtures from the Program offer improved

productivity and more stable production systems. Given appropriate policies such systems will inhibit further encroachment into the humid forest areas.

Training offered within commodity programs has done much to reinforce national capacity. The Panel recognizes the effectiveness of the CIAT 'Training Associate' model for headquarters training and notes user satisfaction with both course content and training materials. Similarly users have high praise for CIAT's information service.

CIAT also has solid achievements as a Center. Its perceptions of the future drew it to support upstream research units which have already made significant contributions to the commodity programs. Its philosophy and close interactions with its national system partners have driven the Center to identify productive collaborative mechanisms. Results are seen in the use of steering committees by its regional programs, in the energetic fostering of research networks, in the use of funds for contracting out research to developing country institutions, and in the willingness to support a role for strong national programs in regional research.

Research

The Panel commends CIAT scientists for their commitment and hard work. It commends Center management for fostering an atmosphere in which commitment flourishes. The Panel was impressed with the scientific work pursued by CIAT's Programs and Units. It appreciates the increasing understanding of the physiological basis of resistance and the new ideas on the intensity of challenge, and the nature of durable and partial resistance, flowing to the breeding programs. The Panel was pleased with the widening collaboration with centers of excellence, enlarging the resource base focused on solving problems of key importance to CIAT's clients.

The Panel endorses the shift to research on yield potential and abiotic stresses in the Bean Program and urges it, together with the GRU, to accelerate the processing of the backlog of collected genetic material. The Cassava Program and BRU are commended for the in vitro tissue culture collection. The Panel feels it important to duplicate the collection as soon as possible; it needs constant care and events beyond CIAT's control may threaten this. The Rice Program has made a significant contribution to the rapid development of rice research in national systems. The Panel commends the program for its awareness of this growing capacity and its planned response to move upstream in its germplasm improvement. Some extra attention to experimental design and analysis would be justified by the Program. The Tropical Pastures Program faces the dilemma of a reduction in its germplasm collection activities at a time when the rapid expansion of land use in its mandate areas threatens the survival of many species.

The Panel recognizes the serious and effective efforts made by the Center in setting up the advanced research support units; the GRU, which holds the world collections of genetic material in beans and cassava and many tropical pasture species; also the BRU and the VRU which represent

CIAT's stake in the new biology. The Center should take early steps to establish a biosafety committee.

These and other common facilities have led an increase in disciplinary research and have encouraged intra-disciplinary interaction and a synergy among the scientists concerned. The Panel commends this development and would urge similar interactions in other disciplines to capture similar benefits. Understanding crop behavior across a variety of environments would be a fascinating focus for both physiologists and agronomists and would be of great potential value to CIAT's research.

The Seed Unit and the Agroecological Studies Unit are also of great value. The latter may form a platform for CIAT to pursue the issue of sustainability at the system level, supplementing the stronger sustainability perspective that the commodity programs plan to bring to their work.

National Systems, Training and Information

CIAT has innovated effectively in its interactions with national systems. The Panel can only encourage the enthusiastic continuation of the trends which have already emerged. It has one reservation. Although CIAT acknowledges that many national systems remain weak, its plans for the devolution of some breeding work, and particularly its plans for the devolution of training, assume strength in the national systems.

The Panel would encourage a review of these plans after a careful evaluation, with its partners, on the status of national systems, treating the different sub-regions in Latin America and Africa independently to ensure plans are properly adjusted to the circumstances of each.

CIAT has restructured its Training and Communications Support Program. Although the new structure cannot be fully evaluated, it seems to have clarified lines of responsibility and encouraged forward looking leadership. The Panel would ask the Program to look carefully at the role of and demands on the Training Associates as CIAT changes its mix of in country, regional and headquarters training.

Because the goal of CIAT's commodity programs is to improve crop yields and profitability, especially for small farmers, the Center must ensure the delivery of appropriate, problem solving technologies to the user. The Seed Unit, the Farmer Participatory Research Project as well as the on-farm research training, all have this objective. Yet every CIAT investment in this delivery process competes with the scientific work for which the Center was created. The challenge, as now defined at CIAT, is to find a least cost strategy for communicating useful research information to users and getting feedback from them.

The Center wants to make its scientific information widely accessible but has only had partial success. In the light of the budgetary and foreign exchange problems in many developing countries, CIAT needs to look at the pricing policies for all the information it distributes to make sure it reaches the intended audiences.

RECOMMENDATIONS

The Panel recommends:

- that a greater effort should be made in the Bean Program, with the GRU, to increase germplasm screening activities and to speed up the processing of backlogged materials;

- that CIAT take steps to assemble information on the occurrence and distribution of major constraints to bean production in Africa;

- that the Rice Program pursue more actively the use of population improvement methodologies like recurrent selection;

- that, since the yield trials have frequently shown rather poor statistical precision, the Rice Program make a serious effort to explore the reasons;

- that the GRU should intensify the effort to have experts decide on a manageable core collection consisting of a limited number of accessions that contain an appropriate amount of genetic variability;

- that, considering the increased activities necessary for the tropical pastures and cassava collections and its great genetic variability, CIAT seek resources for adequate staffing for the Genetic Resources Unit;

- that CIAT considers duplication of the collection and the maintenance of a collection of sexual cassava seeds, as insurance against the possible loss of the living cassava collection maintained in tissue culture;

- that even greater efforts be made to find special funds and other resources to allow the BRU to expand;

- that an internal biosafety committee be established very quickly;

- that CIAT management give greater attention to clarifying the role and future responsibilities of the AESU;

- increased attention to the needs of program experiments in decisions on commercial cropping by Station Operations;

- integrated strategies across CGIAR Centers in dealing with national programs, particularly in non-mandate specific activities such as management training, on-farm research and networking, and in areas of overlapping mandate such as the maize/bean intercropping so important in Latin America, the Caribbean and Africa;

- being selective in responding to the broad range of demands that have come out of NARDS consultations;

- that, commending CIAT's effective development of the steering committee model and network activities in Africa and Latin America, the Center continue its support for these efforts;

- that in view of CIAT's success in working out a model for collaboration with EMBRAPA in Brazil, in cooperation with IITA, in relation to the Cassava Program for the semi-arid parts of Africa, the Center continue to work toward similar outreach plans with other highly developed national systems;

- that CIAT headquarters reinforce the efforts of its staff in Africa for inter-Center collaboration in training and research;

- that CIAT pool its knowledge and experience with others, including ISNAR, for the training of research managers;

- CIAT contact with other Centers for an integrated approach on sustainability;

- that CIAT systematize its on-going inventory of national program training needs and its schedule for filling them. This will require consultation not just with leaders in commodity research programs but with national research leaders;

- that CIAT explore ways to get wider awareness and greater use of its SINFOC commodity collections and other bibliographic resources;

- attention to the balance between demand for services from the publication program and resources available for it;

- careful analysis of policies for pricing publications and other CIAT materials to make sure they accomplish the desired distribution;

- that top management at CIAT be redefined to incorporate the third level in the hierarchy (the Program Leaders) and that a Management Committee be established, to be chaired by the Director General and to meet regularly and frequently, with an advance agenda and formal minutes recorded;

- that the incoming Director General, in consultation with the Board of Trustees, evaluate the current organizational structure in the light of the criteria listed by the Panels;

- the appointment of a Coordinator of Research Support to supervise the work of CIAT's advanced biology units as well as all the other research services in the interim.

CHAPTER 1 - INTRODUCTION

1.1. The External Review Process of the Consultative Group on International Agricultural Research (CGIAR)

From its inception, the CGIAR was concerned that the research efforts it supported be effective in achieving its objectives. To that end its Technical Advisory Committee (TAC) was specifically charged with undertaking "independent external assessments on the overall scientific quality and effectiveness of each Center". Commencing with the International Rice Research Institute (IRRI) in late 1975, TAC established a pattern of periodic external reviews (originally known as quinquennial reviews) of Centers funded by the CGIAR.

Over time, the objectives and terms of reference of these reviews have been refined to take into account the experience and the needs of members of the Group. Part of this evolutionary process was the separation in 1983 of external program and management reviews, although they are still generally undertaken simultaneously.

In its review of the CGIAR Priorities and Future Strategies 1/ during 1983-85, TAC developed a goal statement and eight program objectives as a framework for reviewing the diverse research and research-related activities in the System. TAC also called for a thorough study of how external reviews could contribute more effectively to the management of the System. One outcome is the development of Terms of Reference which the CGIAR is expected to consider in October 1989. Interim Terms of Reference, based on findings of the TAC review of CGIAR priorities and the impact study, have been used for this Third External Program Review of the International Center for Tropical Agriculture (CIAT).

1.2. The CGIAR Goal, Objectives and Program Approaches

In May 1986 CGIAR adopted a statement of its goal: "through international agriculture research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well-being of low income people are improved". It accepted eitht program approaches to advance this goal through research and related activities of the System. 2/

1/ CGIAR Priorities and Future Strategies, 1987.

2/ Program approaches: Resource Management and Conservation Research, Crop Productivity Research, Livestock Productivity Research, Commodity Conservation and Utilization Research, Analysis of Human Nutrition Linkages, Food and Agricultural Policy Research, Strengthening National Research Capacities, Integration of Efforts.

TAC foresaw a relative long-term decline in crop productivity research, the largest program approach. As elaborated in the TAC Review of Priorities, continuing research efforts by the CGIAR were needed in technology generation, food and agriculture policy, and institution building. TAC considered that the technological challenge would be significant. With limited land reserves for expansion, production would have to be intensified under diverse environments. At the same time, such environments must be carefully managed if gains in productivity were to be sustained over the long term. As population pressure on natural resources mounted, there would be a growing tension between urgent short-term demand for food and the longer-term goal of protecting the natural resource-base on which agricultural productivity depends.

Ecologically sound technologies and management practices for improved production would need to be tailored to the specific conditions of a wide range of agroecological zones and socioeconomic conditions. Demand would grow for a broader range of technologies, responding to greater complexity in technological requirements, as the more difficult environments were brought under intensive production. Post-harvest and processing technologies would also be needed to address changes in food consumption patterns resulting from growth in urbanization and income. A particular challenge would be increasing the productivity of rainfed agriculture, especially in the less-favoured environments, many of which are ecologically fragile, have already undergone significant degradation, and are under continuing pressure. Technologies would be needed not only to increase productivity in the short term, but also to rebuild the natural-resource base for future agricultural production.

TAC recommended that the System strengthen its research activities in resource management and conservation, integrating concerns for long-term agricultural sustainability into its multidisciplinary commodity research programs. Further, TAC recommended that the CGIAR assume a more prominent catalytic role within the global system to encourage expanded efforts in resource management and conservation among national research systems. It was the intent of TAC's recommendation to stress the need for a long-term perspective when evaluating productivity, and to underscore the principle that short-term gains at the cost of the stability and quality of the natural-resource base were unacceptable.

In evaluating research activities, TAC examined the commodities currently in the collective mandate of the CGIAR. After applying the indicators for determining the priorities among commodities, it concluded that changes in current priorities should be made. Those recommendations which affect CIAT's mandated commodities, are enumerated below:

Roots and tubers

Cassava: TAC recommended that while current global (and Asian) effort on cassava be maintained, there should be a small shift in effort from Latin America to sub-Saharan Africa, pending the outcome of a global market study. It was expected that this global study would help elucidate the complex situation in Latin America, where demand for cassava for food seems to be declining and its use in animal feeding is dependent on government policy.

Food legumes

Phaseolus Bean: TAC recommended maintaining research on phaseolus bean at current levels. It endorsed CIAT's expansion of this work into Eastern Africa and urged greater attention to enhancing yield stability.

Cereals

Rice: TAC recommended that CGIAR's support for the overall rice research effort be reduced and that future concentration should be more on non-irrigated systems and on basic research on irrigated rice, in collaboration whith specialized institutions. TAC strongly supported the shift of research to non-irrigated rice, which had already occurred in Latin America. Overall the relative allocation to rice research for Latin America should remain at current levels.

Livestock

TAC recommended that research on ruminant production be moderately increased and that such research should concentrate on improving ruminant nutrition. Rangeland and pasture improvement programs, together with the management of livestock, should be strengthened considerably. For Latin America, in order to help reduce pressure for further land clearance, TAC also endorsed research to increase the productivity and carrying capacity of degraded pastures in the humid tropics and in mixed crop/livestock systems on moderately acid soils.

1.3. The Third External Review of CIAT

At its 45th meeting at FAO in Rome, TAC confirmed that the Third External Program Review (EPR) of CIAT, with a simultaneous External Management Review (EMR), should be undertaken in the second half of 1989. Subsequently, in consultation with the Director General of CIAT and the CGIAR Secretariat, the dates of 11-29 September 1989 were approved and, in consultation with the Board of Trustees and management of the Center, TAC constituted a seven-member EPR Panel with Dr. John K. Coulter as Chairman; the CGIAR Secretariat constituted an EMR Panel with Dr. Vijay S. Vyas as Chairman. Membership of both Panels is given in Annex I.

1.4. Terms of Reference and Background Documentation

The EPR Panel was formally charged with evaluating the relevance and appropriateness of CIAT's programs, its past achievements and scientific stature, and - in the context of the CGIAR goal - its priorities, policies, and strategies for achieving the objectives set out in its mandate. The charge specifically implied that the Panel should take a strategic forward-looking view of the Center, and be concerned with matters of scientific detail only as necessary to carry out the charge.

In accordance with the Interim Terms of Reference (Annex II), questions and issues were collated which are specific to CIAT and raised by CGIAR members, the CIAT Board and management, the Chairman of the

Panel, and the Chairman and members of TAC. The list of questions is an integral part of the Terms of Reference.

Background documents on the mandate, history, program evolution, and previous external reviews were provided to Panel Members by CIAT and the TAC Secretariat. The list of documents available to the Panel is given in Annex III.

1.5. EPR Activities

Prior to the Panel Members assembling for the first time at CIAT headquarters, 11-17 June 1989, the Chairman attended the CIAT Board Meeting from 31 March to 4 April and with one other Panel Member visited the CIAT program in Thailand, 20-23 April 1989.

In June, the Panel was briefed on CIAT's research programs and visited its field stations in Colombia. Some panel members visited CIAT collaborative programs in Ecuador. Meetings with government officials and senior research scientists were also arranged to discuss cooperative activities. Subsequently, the Panel split into two sub-groups, one visiting Costa Rica and Brazil and the other Ethiopia, Rwanda, and Tanzania. Finally, the Panel returned to CIAT, 10 September 1989, to complete its assessment and write its report. Details of the Panel's activities and visits are provided in Annex IV.

1.6. The Structure of the Report

The Panel has structured its report so that this introduction is followed by a series of analytical chapters dealing with CIAT's origins, the evolution of its mandate since the Second External Review in 1984 and its strategies for the future, plus its current research and research-related programs, research management and support services, and interactions with national, regional and international institutions. These chapters are followed by the Panel's overall assessment of CIAT's program content and direction, the likely effectiveness of proposed directions, the size and scope of its activities in the future, and its relationships with the countries it serves.

The Panel has felt free to make any observations and recommendations it considered significant. It recognizes that the report it has prepared, for which it accepts sole responsibility, in no way commits TAC or the CGIAR to any consequent action. It wishes to emphasize that the Panel Members reached consensus with respect to the report and were unanimous in support of its recommendations. The final chapter, "An Overview and Recommendations", presents the Panel's main conclusions and recommendations. A summary has been provided.

1.7. Follow-up to the Report

On completion of the review and oral presentation of the findings to the CIAT Board and Senior Staff, the Chairman of the Panel will formally transmit the Panel's report to the Chairman of TAC. TAC will request the Chairmen of the EPR and the EMR to present the Panels' findings, and CIAT its reactions, at the 50th TAC Meeting at the World Bank, Washington, D.C., 23-27 October 1989. TAC will consider the report in the presence of the CIAT Board Chairman, the Director General, and a number of CIAT senior staff. Following the preparation of a written commentary on both reports, the Chairman of TAC will transmit the EPR report to the CGIAR, together with the TAC Commentary and the reactions of CIAT.

CHAPTER 2 - MANDATE, STRATEGY AND RESEARCH PRIORITIES

2.1. The Challenge of the Tropical Environment: Its Resource Base and Food Economy

During its first ten years the Center directed most of its efforts towards the American tropics. CIAT's original geographical orientation was the tropical lowlands of Latin America and the Caribbean; all four of its commodities are basic staple foods in this region. CIAT has since been given world responsibilities for cassava and beans, expanding its mandate into Asia and Eastern Africa. However, Latin America remains the main regional focus of CIAT in the development of its research programs. An assessment of the resource base of these regions is found in Annex VI.

The food economy of the regions of the world where CIAT concentrates its actions has to be analyzed in the setting of a broad international food and agricultural sector.

A remarkable food and agricultural system has emerged on the international scene, based in large part on new technologies in transportation and communication. In fact, for almost every country the food and agricultural sector is the best integrated internationally, despite the barriers to trade in agricultural commodities. Most countries either import or export agricultural products; some countries do both.

This system should permit governments to reduce, cautiously, the importance they attach to food self-security or self-sufficiency, allowing them to exploit more fully other comparative advantages. The concept of achieving food self-reliance has been defined as the capacity of a nation to provide a sufficiently stable food supply to all of its inhabitants, either from domestic production or from production of exportable goods to cover the cost of commercial imports.

Implications for CIAT, within the actual mandate of commodities, are that biological and social scientists working together with partners of national programs should be able to generate the most efficient technology in the most efficient place, so as to ensure the highest social rate of return for the resources invested.

2.2. CIAT's Origin and Mandate

In the mid-1960s the Rockefeller and Ford Foundations collaborated to establish an international agricultural research center in Latin America. An agreement was signed by the Colombian Government and the Rockefeller Foundation on 12 May 1967, to create CIAT. The Center was officially decreed as a Colombian institution on 4 November the same year. CIAT headquarter facilities were dedicated on 12 October 1973, by which time the Center had been brought under the aegis of the CGIAR System. The Foundations, the original founders, intended to create "an institution serving tropical Latin America and the Caribbean."

In 1977 the Board further stated:

> "the CIAT programs have evolved to encompass the following responsibilities:
>
> - Principal responsibilities for beans (Phaseolus vulgaris and related species) and cassava (Manihot esculenta);
>
> - Principal responsibilities for tropical pastures (specific responsibilities for the acid, infertile soils of the American tropics).
>
> - Regional responsibilities for rice (specific responsibilities for the American tropics)."

In recognition of the broader obligations assigned to CIAT by the CGIAR System for given commodities, the Center defined the two categories of "principal" and "regional" responsibilities:

Principal

- Assemble, maintain and make available the world germplasm collection.
- Conduct specialized strategic research.
- Generate improved production technology components for, and develop cooperative activities with, national systems in all regions of the developing world where the commodity is important and no sister CGIAR Center is assuming regional responsibilities.
- Provide in-service training for professionals in the specialized/strategic areas of research on a global basis.
- Provide specialized in-service and product oriented training for professionals from countries where no other CGIAR Center has regional responsibilities.
- Collect, process and disseminate information on the commodity on a global basis.
- Backstop the activities of other institutions with regional responsibilities for that commodity.

Regional

This category applies when a sister CGIAR Center has principal responsibility for a commodity. In close cooperation with that center, CIAT takes on selected responsibilities, especially the generation of improved production technology and in-service production oriented training. Together with national research systems it identifies principal production constraints and, in close collaboration with the responsible center, "seeks to facilitate such activities as are required to overcome such constraints".

The Board of Trustees eventually approved the following mandate for CIAT, as one of several agricultural research centers within the CGIAR:

> "To generate and deliver, in collaboration with national and regional institutions, improved technology which will contribute to

> increased production, productivity and quality of specific food commodities in the tropics, principally countries in Latin America and the Caribbean, thereby enabling producers and consumers, especially those with limited resources, to increase their purchasing power and improve their nutrition".

The Second Review in 1984 commented on the wording in the description of principal responsibilities, preferring "no sister center has been assigned responsibilities in the region" to "is assuming responsibilities", to avoid confusion among Centers and between Centers and national programs. The Panel encouraged the Tropical Pastures Program to consult with ILCA in operationalizing its principal, world-wide mandate for pastures in the lowland tropics and sub-tropics on acid and infertile soils. The Panel also agreed that the Tropical Pastures Program should not assume responsibility for all tropical pasture species.

There have been no changes in CIAT's mandate in the five years since the Second External Program Review in 1984. The recently prepared long-range plan "CIAT in the 1990s: A Strategic Plan" (Revised Draft September 1989) describes CIAT as:

> "a development-oriented, agricultural research institution dedicated to the application of science toward lasting alleviation of hunger and poverty in developing countries".

and makes a restatement of its mission;

> "to contribute to economic development and poverty reduction in developing countries by applying modern science to the generation of new technology that will increase food production and productivity. This mission can be accomplished only by working in partnership with various institutions, especially national agricultural research organizations".

2.3. CIAT's Development since the Second EPR in 1984

The Board statement of CIAT's operational mandate in 1977 was followed by further focussing and development prior to the Second EPR in 1984. The Swine Unit was phased out in 1979 and a Seed Unit created the same year. The Rice Program broadened its focus to encompass upland rice in favoured environments in 1981. From 1983 CIAT began to accelerate the implementation of its mandate for beans and cassava outside Latin America.

Since 1984 there has been expansion of staff in all programs and a change in the balance of staffing, with a higher proportion located in the regions outside Colombia. These developments are summarized in the following table extracted from the staffing information in CIAT documentation; it excludes visiting scientists and post-doctoral fellows.

Table 1. Change in staffing balances, 1984-1988 (30 September) *

Program	1984				1989			
	CIAT No.	Outposted No.	TOTAL No.	%	CIAT No.	Outposted No.	TOTAL No.	%
Bean	10	8	18	39%	11	16	27	42%
Cassava	7	1	8	17%	7	4	11	17%
Rice	4	1	5	11%	7	3	10	15%
Pasture	13	2	15	33%	12	5	17	26%
TOTAL	34	12	46	100%	37	28	65	100%
%	74%	26%	100%		57%	43%	100%	

* Senior Staff and Senior Research Fellows. Excludes Postdoctoral Fellows and Visiting Scientists.

Table 1 shows only marginal changes in the balance across Programs over the period, with Beans, Cassava and Rice gaining slightly at the expense of Pastures. There is a marked shift in the balance of CIAT and outposted staff reflecting the policy of increased decentralization.

The other significant development at CIAT since the Second Review in 1984 is the establishment and expansion of units independent of the programs. The Seed Unit, already established in 1984, still has two senior scientists now assisted by two senior research fellows. Three other units have been established since 1984: the Agroecological Studies Unit with two senior scientist supported by two post-doctoral fellows; the Biotechnology Research Unit with two senior scientists supported by two post-doctoral fellows; and the Virology Research Unit with two senior scientists.

2.4. Issues Related to CIAT's Mandate

An issue relating to CIAT's mandate which has now been resolved very satisfactorily is its global responsibility for cassava vis-à-vis IITA's mandate for research on the crop in Africa. By posting a CIAT scientist to IITA, the transfer and testing of the Center's materials in Africa will be greatly facilitated. CIAT will work, in collaboration with IITA, to breed cassava for the drier and also the cooler regions to which the crop is now spreading quite rapidly as population pressure increases.

As indicated in Section 2.3. CIAT has increased its outposted staff by 17 since the last Review. This has given it greatly increased capacity for bean research in East Africa, cassava in Asia and pastures, beans and rice in Latin America. This expansion in outposted staff is part of CIAT's development supported by the last Review. However the expansion of

outposted staff in the System generally, especially in East Africa, where there are now six IARCs and several non-CG centers operating, can burden the national systems. Alleviation of this will require cooperation among all the international institutions operating there and progress is being made in inter-Center collaboration in both training and networking.

2.5. Strategies and Research Priorities for the Future

2.5.1. Background

In 1987 TAC presented its final version of its paper on CGIAR priorities and future strategies; 1/ this document, which had been debated at considerable length in several meetings of the CG, addresses the long-term evolution of the CG System. As the document emphasizes, TAC does not dictate Center strategies but the System through TAC seeks to coordinate and balance the activities among the 13 largely independent Centers.

The Panel has therefore used the TAC paper as a background document against which to discuss CIAT's strategies and research priorities. The TAC paper sets the System-wide objectives and the strategies for attaining these objectives. The Center's strategic plan for the 1990s defines its specific objectives and the operational processes proposed to achieve these. 2/

The Panel has examined CIAT's plan and its priorities against these objectives and against current concerns for food production, environmental degradation and national research system development, more specifically in Latin America and Africa. In doing so it has attempted to address the question as to how well CIAT is prepared, both scientifically and managerially, for the decade of the 1990s and beyond.

2.5.2. CIAT's strategic plan

The planning process for CIAT's strategy for the 1990s is described in section 6.2.4. It is based on projections for trends in CIAT's commodities, its view of the evolution of national agricultural research and development systems and the trends in science and technology research. It also adds, as an explicit objective, one which has always been implicit in its work, namely natural resources management and agricultural sustainability. To the year 2000 CIAT expects regional self-sufficiency in beans, though with strong sub-regional differences, a deficit in beef, a developing industrial market for cassava and a deficit in rice in Latin America. In Africa a very large deficit in bean production is expected

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1/ CGIAR Priorities and Future Strategies, TAC Secretariat, 1987.

2/ CIAT in the 1990s: A Strategic Plan.

and an increasing role for cassava is predicted; grass legume pastures could contribute to sustainable agricultural production in certain areas. Demand for cassava in Asia for industrial use is expected to increase and cassava is expected to play an important role as a food in some of the poor countries of Southeast Asia (Kampuchea, Laos, Vietnam). CIAT also sees some opportunities for tropical pastures in Southeast Asia to replace Imperata or to provide forage under plantation crops.

CIAT expects the national programs to change in both quality and number of scientists; it expects these to remain highly variable, especially in respect to their financial resources. Though the long-term trend is likely to show an improvement, there are likely to be continual fluctuations in quality and support.

CIAT expects that the rapid advances in biophysical and social sciences will make new approaches to research possible. Its strategy is to ensure that these advances are used to solve problems of poor farmers and low resource consumers, and it expects to implement this by developing linkages with laboratories in both developed and developing countries. As a consequence of its move upstream CIAT plans to reduce its efforts in applied research, especially in conventional breeding; part of this would be taken over by national programs. CIAT's accomplishments to date in applied research are expected to free resources for strategic research by making possible diversion of efforts, usually within disciplines.

CIAT plans to increase its involvement in developing technologies that would slow down or halt the degradation of fragile ecosystems and that would lead to the reclamation of degraded land. The challenge facing CIAT as a research institution is to define which of the problems involved in sustainability are susceptible to and require research, and then to select from among them those problems for which CIAT has a comparative advantage. Clearly CIAT's main advantage is the ability to give research on its mandate crops a sustainability perspective. This includes developing varieties that grow better in the specific environments; better crops provide better ground cover and more root mass in the soil. Improved cultural practices enhance this, as does pest and disease resistance.

It will be seen that CIAT is deeply involved in five of the eight objectives of the CG System, namely:

(1) Managing and conserving natural resources for sustainable agriculture.
(2) Increasing the productivity of essential food crops.
(3) Increasing the productivity and ecological stability of livestock production systems.
(4) Strengthening national agricultural research capacities.
(5) Integrating efforts both between and among Centers of the CG System.

The strategic plan envisages a growth in financial resources. Through 1993, it does not envisage any major changes in balance among the Programs though, as indicated in Chapter 3, there will be substantial changes in emphasis within Programs.

CHAPTER 3 - RESEARCH PROGRAMS

3.1. Bean Program

3.1.1. Background

"In Brazil, Mexico, and Central America, beans constitute between 10-30% of dietary protein. In these countries and East Africa beans are the main source of non-cereal protein, because they are generally the most inexpensive form of protein. In countries such as Rwanda and Burundi, people derive more protein from beans alone than from all animal products combined. Static yields, and highly variable output and price, create a critical problem to millions of small farmers and poor urban consumers." (EPR 1984).

Beans face biotic (pests and diseases) and abiotic (drought, low P, acid soil, etc.) stresses which the poor farmers who generally grow them often lack the inputs to handle. A more sustainable solution to overcome these problems is through genetic improvement.

CIAT's Bean Program has the critical mass of scientists, unequalled collection of bean genetic resources, excellent facilities and well-established networks for a concerted attack on this problem. Significant progress has been made, but major problems remain.

3.1.2. Objectives

The Bean Program describes its overall goal as improving availability and income for poor people by improving the productivity of beans through the rapid development and transfer of technology in collaboration with national agricultural research institutions in countries where beans are an important food. Specific objectives are to:

(1) Develop scientific innovations that overcome major productivity-limiting constraints.

(2) Strengthen national capacity for bean research and technology transfer.

(3) Accelerate the transfer of bean production technology by exchanging germplasm, scientific methodologies and information through international networks.

The Program continues to emphasize genetic improvement, the development of practical and rapid screening techniques, the study of mechanisms conferring desired traits, the study of genetics of inheritance of traits, and the development of breeding materials with desired traits in useful backgrounds. CIAT's focus is increasingly on developing parental materials and methodologies, as national programs assume more

responsibility for the selection of advanced lines and developme finished products or varieties.

The Program focuses on the genetic improvement of resistance to important pests and diseases. Improved materials developed from this approach would require low input, thus offering resource-poor farmers the opportunity to grow them. Improvement is also sought for yield potential, drought resistance, earliness, nitrogen fixation, and adaptation to acid and low phosphorus soils.

The Panel endorses these objectives and strategies. It also concurs with the 1984 EPR recommendation that larger effort should be given to breeding for higher yield potential under conditions of higher soil fertility, primarily to develop beans that could be competitive under favoured environments.

3.1.3. Activities

3.1.3.1. Germplasm

Since the 1984 EPR, the collection of bean germplasm has increased to 41,061 introductions, to which 6,545 new accessions were added in 1985-88. During the period, CIAT distributed a total of 34,352 accessions to at least 22 countries and 123,200 accessions to CIAT's Bean Program. The Panel commends the Bean Program and Genetic Resources Unit for assembling, evaluating, maintaining, utilizing and distributing this collection. Duplication of the entire collection for safe deposit in other countries should be a continuing activity.

Of the 41,061 individual samples in the Phaseolus collection (four cultivated Phaseolus species and wild species), 5,200 were received in a very poor state from existing national collections and are considered non-viable seeds. Of this group the number likely to be permanently lost (i.e. not recoverable from duplicates in other collections received or not easily and correctly identified in new collection missions) is of the order of 800. Continuing work in processing this large number of materials has placed a total of 25,758 in the active collection and a backlog of 9,692 now remains. The new CIAT-financed quarantine facility at ICA Bogota, now under construction, will be a major step toward accelerating the quarantine clearance of this backlog. The Panel recommends that a greater effort should be made jointly with the GRU to increase screening germplasm activities and to speed up the processing of backlogged materials, especially those coming from the primary centers of diversification, so that they can be fully exploited.

The Panel recognizes the progress the Bean Program has made in finding safe ways to move seeds from high risk to low risk areas and from Africa. The partial success achieved is based on two approaches. For seed of African origin, CIAT has been funding the Institute of Horticultural Research in the UK to provide third-country quarantine of bean seed. To date at least 1,000 accessions have passed through this route. CIAT-bred materials have been put through a "cleaning process" to

ascertain freedom from bacterial, fungal and viral diseases prior to exportation, under the supervision of the CIAT Plant Quarantine Committee and the Plant Health Laboratory. About 6,000 bred materials have passed through the process before going on to national programs.

3.1.3.2. Plant breeding

Between 1985 and 1988 CIAT breeders made 11,236 crosses in their efforts to arm plant types with resistance to biotic (i.e. diseases and pests) and abiotic constraints (i.e., drought, soil acidity and low phosphorus availability, nitrogen needs). The crossing program was planned in consultation between national bean leaders, regional and headquarters staff. This procedure in deciding what crosses to make has assured the participation of national programs in attending to priorities previously identified by them.

Breeding has been increasingly done in collaboration with national institutions. By 1989, over 40 new varieties from the CIAT international network had been released by NARS and were in widespread production in Latin America and six new varieties were getting wide use in Africa. (CIAT in the 1990s).

The level of activities with respect to high yield potential has increased substantially during the period in review. The most recent findings showed that selection for yield directly was more effective than index selection based on a wider range of factors. It was possible to improve seed yield by crossing the germplasm group of high-yielding, small-seeded, middle American cultivars with medium-seeded germplasm from the highlands of middle America. Furthermore, analysis of data for 1984-1986 showed that 25% of 1,257 lines are high-yielding with varying degrees of resistance to one or more diseases.

CIAT has achieved modest snap bean improvement since it began work on the crop in 1983. The principal objective has been to incorporate disease resistance and tropical adaptation from the dry bean improvement program into green beans. Improved germplasm has been evaluated in a number of locations throughout Colombia. One climbing snap bean line is presently being grown and marketed by farmers in the Cauca Department.

Interspecific hybrids of P. vulgaris x P. acutifolius have been obtained by embryo rescue, offering the possibility of obtaining hybrids with other related species and thus exploiting resistance genes and other desirable traits from them.

Studies to identify the mechanism of popping in popbeans (common beans which burst when heated like popcorn) have been initiated. Toasting popbeans requires much less fuel than boiling beans; hence they have potential in areas with scarce firewood like Central Africa.

3.1.3.3. Plant protection

Plant diseases

Work in pathology has been focused on identification of sources of resistance, development of screening techniques, studies on pathogen variation, studies on resistance mechanisms and studies on genetics of resistance.

Techniques developed to identify resistant germplasm for several major diseases have led to identification of the sources of resistance to them.

The genetics of resistance were established for the first time for anthracnose and angular leaf spot.

Viral diseases

Twelve germplasm accessions possessing different mechanisms of resistance were selected as the most promising new sources of bean geminivirus resistance among the 1,660 accessions evaluated in six Latin American Countries. The combination of such genotypes with different expression of BGMV-resistance/tolerance has resulted in even higher and more stable levels of resistance in several non black-seeded breeding lines.

The characterization of the principal bean golden mosaic virus isolates existing in Latin America has been undertaken and efforts are now in progress to characterize them at the molecular level in collaboration with scientists from the University of Wisconsin. A breakdown of genetic linkages between seed colour and resistance to common mosaic virus has been accomplished for beans of Central America.

Invertebrate pests

Significant progress has been made in understanding the mechanism and inheritance of resistance to a storage pest known as weevil bruchids and on techniques for selection of resistant materials in segregating populations. Confirmation of arcelin as the factor responsible for resistance to the Mexican bean weevil (*Zabrotes subfasciatus*) but not to the bean weevil (*Acanthoscelides obtectus*) introduced important changes in the selection of bruchid-resistant genotypes. As soon as nutritional safety of arcelin is confirmed lines with confirmed, resistance to *Z. subfasciatus* and commercial seed size and colour will be released to national programs for evaluation.

Techniques for selection of bean materials for resistance to leafhopper (*Empoasca kraemeri*) have been refined and have led to the selection of numerous promising lines of red, white, black and cream seeded materials.

3.1.3.4. Biotechnology

Tissue culture technique for regenerating wild relatives of P. vulgaris and accessions of P. acutifolium has been developed. Interspecific hybrids of P. vulgaris and P. acutifolius have been obtained by embryo-rescue techniques. Protein (phaseolin) and isozymes electrophoretic characterizations of P. vulgaris gene pools have been established and have been utilized to study germplasm evolution, variability and dispersal. Collaborative research projects in bean biotechnology have been established in various advanced institutions and universities.

3.1.3.5. Abiotic constraints

Studies for Latin America conducted by the Agroecological Studies Unit show that 60% of the bean production area is affected by drought, whereas 85% of the area has serious soil constraints.

Physiology

Studies on limitations to yield potential confirmed that remobilization of N during pod-filling is associated with declining photosynthesis. Mechanisms to improve N uptake and partitioning are being sought.

Greater drought tolerance has proved to be associated with more efficient and abundant roots, differences in leaf water use efficiency, and drought escape through earliness. The outstanding tolerance of tepary bean (P. acutifolius) has been confirmed, so mechanisms studies and interspecific crosses (produced by the BRU) are also being pursued.

Biological Nitrogen Fixation (BNF)

Modest progress in breeding for improved N-fixation has been obtained in small-seeded indeterminate genotypes. Studies are under way on screening methods and inheritance for such characteristics as early nodulation, late nodule senescence, and insensitivity to mineral N.

Genetic diversity of Rhizobium phaseoli for characteristics such as potential effectiveness, stress tolerances, and competitiveness has been demonstrated. Inoculation studies show responses in plant growth and yield on some farms. Priority is being given to mechanisms of R. phaseoli survival and competitiveness.

Plant Nutrition

Low phosphorus availability has been identified as the greatest single soil constraint, and research has been initiated to identify traits conferring superior adaptation to soil P deficiency, such as root structure and function, superior mycorrhizal symbiosis, and efficient P partitioning.

Demonstrated cultivar and species differences in adaptation to soil constraints make the Program optimistic for progress through genetic improvement, but increasing production through agronomic improvement is not neglected. Headquarters activities will include research on novel fertilizers (e.g. foliar applications of P) and backstopping of soil fertility research of regional programs and NARS.

3.1.3.6. Economics and social science

The bean economics section provides socio-economic guidelines for technology development and release and also assesses the degree of success obtained with new technology.

During the period in review, the section studied such issues as impact of new technology, consumer acceptance of new varieties, etc. Results could assist plant breeders in developing new varieties. Similarly, development of production-oriented training courses could benefit from the feedback of economists and sociologists.

The section conducted a snap bean potential study showing the importance of this crop for small farmers, for local consumption in Asia and Latin America and for export in Africa. Snap beans are effective income generators for small farmers due to their labour intensity and high productivity. Estimates show that demand for snap beans will increase by 45% by the year 2000. Population growth and urbanization represents 31% of the expected demand growth, equally shared by China and the rest of the developing world. Preliminary results from Colombia suggest that the yield increase potential of 30% from IPM technologies and improved varieties will be important in meeting growing demand. There is also great potential for the disease and pest resistance already developed for tropical dry beans being transferred to snap beans. The Panel endorses and encourages this activity.

Tannins and sypsin inhibitors in beans detract from their value in human nutrition. CIAT recently established a tannin screening technique which discriminates amongst tannins in respect to their protein-binding capacity. A collaborative research project with Italy is investigating the importance of sypsin inhibitors.

3.1.3.7. International activities

Developing countries

The Bean Program has helped establish or strengthen national programs in several developing countries, particularly in Latin America, the Great lakes region of Africa and Eastern and Southern Africa. A similar effort is being made for snap beans.

A study on the distribution and importance of viruses naturally infecting the common bean and its relatives in Africa has been initiated in collaboration with the Institut fuer Viruskrankheiten der Pflanzen, Braunschweig, FRG. Similar studies should be accelerated on the major

biotic and abiotic constraints to bean production. Such a larger study could be undertaken by the Bean Program and the national programs in Africa to supply objective data for planning and implementation. The Panel recommends that CIAT take steps to assemble information on the occurrence and distribution of major constraints to bean production in Africa.

International Agricultural Research Centers

CIMMYT has been working with CIAT on the use of suitable maize for trials with climbing beans. The Bean Program is also collaborating with AVRDC in breeding for disease resistance in bean fly and with IBPGR on germplasm activities.

Other institutions

Good collaborative research exists between the Bean Program and numerous advanced research institutions and universities in both developed and developing countries.

3.1.4. Staffing, facilities and budget

There are at present 12 senior scientist essential positions at headquarters: one leader, three plant breeders, one pathologist, one entomologist, one physiologist, one plant nutritionist, one microbiologist, two agronomists and one economist. One Rockefeller Foundation-funded anthropologist is stationed in Africa.

Outposted staff consist of 17 scientists of which 11 are in essential positions and 6 financed through special funds. Two scientists are in the Central America Regional Bean Network (Costa Rica). A coordinator (plant breeder) is in Costa Rica, and agronomist in Guatemala, a coordinator (pathologist) in the Andean Regional Bean Research Network stationed in Peru, an agronomist in Ecuador, a coordinator (cropping systems agronomist), an anthropologist and a breeder in the Great lakes of Africa (Rwanda); one agronomist (Pan-Arica Coordinator) in Ethiopia; a breeder, an economist and an agronomist in Uganda serving the Eastern Africa Network; five scientists in Southern Africa, four of whom are stationed in Tanzania (one pathologist who is coordinator), one entomologist, one plant breeder, and a cropping system agronomist). The breeder position in Malawi is vacant.

The gradual phasing out of CIAT staff in regional programs which has been effective in the Central American Regional Program needs to be reviewed periodically in regard to the three areas of CIAT regional programming in Africa, but there is a feeling that it will take more than five years to adequately strengthen the current local staff there.

The Bean Program has a working budget of US$6,748,000 to support its varied activities. With the exception noted in the germplasm section, the CIAT laboratory and field facilities are still adequate both at Palmira, at substations, and at ICA collaborating research stations.

3.1.5. Achievements

Like any other IARC with a commodity orientation the Bean Program has emphasized the collection and identification of diverse germplasm to serve as a pool from which desirable genes can be used when needed. Most local cultivars from Latin America are stored at CIAT and thus it serves as a repository for their valuable genetic resources.

From 1985 to date, in collaboration with NARS, many new sources of disease and pest resistance have been discovered and incorporated into commercially acceptable cultivars. The 46 new CIAT-derived varieties are grown on at least 350,000 ha. in Latin America and Africa, and the resulting value of increased production is nearly US $50 million annually, more than seven times the cost of CIAT bean research.

The Bean Program has been able to contribute substantially in advancing the frontier of knowledge in bean science by reporting its work through workshops/symposia with published proceedings, annual reports, technical bulletins, newsletter, bibliographies and journal reprints. Between 1985 and 1988 the Bean Program published 235 articles, an average of 39 a year, compared to 16 in 1984. In scientific journals the Bean Program staff published three in 1984 and an average of 11 articles a year from 1985 to 1988.

The Bean Program has also contributed immensely in strengthening the bean research capacity of national programs, through a major training effort and through the formation of international and regional networks as in Eastern, Central and Southern Africa, Central America and the Caribbean and the Andean Region.

3.1.6. Future activities

Although the Bean Program will continue to place its main emphasis on genetic improvement, this type of research will change both in methods and priorities. Increased attention will be given to germplasm enhancement and pre-breeding, and less effort will be made on developing finished lines. (CIAT in the 1990s). This strategy can be seen in the change of resource allocation from 1982 to 1990 and 2000 (Table 2).

The Panel endorses the aforementioned new work-plan on beans for the 1990s. Emphasis on research to cut losses from pests and diseases is expected to be reduced as current work offers better control measures. Yield potential will continue to merit priority attention. Regional programs and networking will be expanded to permit better service to the weaker or smaller national programs in Africa and Central America. The Bean Program expects simultaneously to encourage joint scientific efforts with large producing countries where national research programs are strong.

Table 2. Resource allocation (%) in bean activities

	1982	1990	2000
Research			
Biotic stresses	44.4	22.3	17.0
Abiotic stresses	11.0	10.9	16.6
Yield potential	4.5	5.3	10.3
Cropping Systems	10.3	16.1	12.1
Biotechnology/genetic resources	1.5*	4.2	9.3
Others		0.6	4.4
Institution Strengthening			
Training	11.1	15.5	13.7
Networking	17.2	25.1	16.6

* Shared by Biotechnology/Genetic Resources and others.

3.1.7. Assessment

The Panel acknowledges the dedication and outstanding work of the Bean Program in fulfilling its stated objectives in collaboration with the national programs. The rapid acceptance of improved germplasm collaborative developed by CIAT and national programs, its release and commercial production on at least 350,000 hectares in Latin America and Africa, has confirmed the value of this improved germplasm.

3.1.8. Recommendations

The Panel recommends that a greater effort should be made with the GRU to increase germplasm screening activities and to speed up the processing of backlogged materials.

The Panel also recommends that CIAT take steps to assemble information on the occurrence and distribution of major constraints to bean production in Africa.

3.2. Cassava Program

3.2.1. Background

Demand potential studies in Latin America and Asia confirm cassava's continued role both as a source of food and income for the less privileged in the tropics. In terms of calories it is the fourth most important crop grown in the tropics after rice, sugarcane and maize.

Cassava is grown mostly by small farmers. Consequently, improved production and processing technologies must be simple, low-cost, and self-sustainable.

CIAT's comparative advantages in germplasm evaluation and pre-breeding, generation of knowledge, networking and communications, and links with former trainees can be harnessed to continue improving cassava production around the world, particularly in Africa, Latin America and Asia.

3.2.2. Objectives

The Cassava Program's stated goals are to contribute materially to increased income and food supplies for small farmers and to improve food availability in developing countries in the tropics. In close collaboration with national programs, it seeks to:

(1) Develop basic components of production technology for stable, cassava-based cropping systems with low costs per unit output.

(2) Develop technology that allows cassava to be grown on presently under-exploited lands.

(3) Develop processing technology that makes cassava a low-cost high quality, convenient food.

(4) Develop both production and processing technologies that are cost-competitive, increase farmers' income, and are sufficiently labour intensive to generate employment for landless labour.

(5) Develop marketing strategies that reduce the marketing margin.

(6) Stimulate the development of markets for cassava that provide a stable price floor for the raw material, thus giving farmers the incentive to increase production and thereby reduce price fluctuations for the consumer.

(7) Assist in the development of new uses that increase the overall cassava demand.

(8) Develop waste-reducing technology to increase the percentage of total production that is finally consumed.

(9) Stimulate other agencies to play an active role in cassava research and development.

(10) Increase the capacity of national programs to carry out R&D projects". (Annual Report, Cassava Program 1987).

The Panel endorses the Cassava Program's research strategy of focusing on the complete commodity system, effectively integrating research on production, processing, post-harvest utilization, consumer

preferences, market demand and appropriate methodologies for technology introduction.

3.2.3. Activities

3.2.3.1. Germplasm

The cassava germplasm collection has increased from 3,680 to 4,566 accessions since the 1984 EPR. Seventeen IITA hybrids with cassava mosaic disease resistance were also introduced to the collection. In addition to storage as living collections in the field and as seeds in a cold room, 4,200 clones representing 92% of the collection are in in vitro culture. About 1,200 clones in vitro have been introduced to CIAT during the period. A descriptor list for cassava based on morphological traits plus biochemical descriptor-polymorphic isozyme markers have been developed.

During the period in review, the Program has distributed 992 elite cassava clones in in vitro (disease-free) condition to at least 20 countries in Latin America and Asia. (In vitro introduction from Latin America to Africa is prohibited by quarantine regulation.) Moreover, 188,636 seeds from the cassava collection and elite crosses have been distributed to Latin America, Asia and Africa. Noteworthy is the introduction to Africa of elite materials with mite resistance which have been crossed with mosaic resistant germplasm from IITA and of materials with highland adaptation.

The Panel commends the Cassava Program for assembling the largest collection of cassava germplasm, evaluating it, maintaining it in in vitro conditions, and making it available to potential users around the world.

3.2.3.2. Plant breeding

Since the 1984 EPR, the Program has produced 2,040 crosses combining resistance to various disease and pests and tolerance to soil stresses. These have generated at least 82,916 hybrid seeds, in addition to at least 500,000 seeds derived from open pollination of over 300 parents. Choice of parentals for the crossing program is based both on performance in Colombian testing sites and on consultations with national programs. Over the past five years 17 new varieties based on CIAT germplasm have been released or are in final stages of pre-release in eight countries: three in Mexico, one in Panama, six in Colombia, two in Thailand, one in China, two in the Philippines, and one each in Malaysia and Indonesia.

Preliminary trials have shown that cassava can successfully be grown from true seed under experimental condition. Although many problems have to be resolved in this area, the possibility exists now of understanding and developing the technology to benefit resource-poor farmers who face problems in using the traditional cuttings as seed. The Panel encourages the Cassava Program to pursue this new lead.

3.2.3.3. Plant protection

Work in cassava pathology has focused on the identification of resistant genotypes, problems involving vegetative planting materials, identification of resistant genotypes, and integrated disease management. Resistant genotypes were identified for cassava bacterial blight, superelongation, fusarium root rot, phytophthora root rot, anthracnose and diplodia root rot.

The integrated disease management (IDM) approach, which includes the use of cultural practices, biological control, varietal resistance, and sanitary measures has been explored and has shown promising results.

From research on the storage of meter-long cuttings the Program has demonstrated that cuttings should be stored in at least 80% relative humidity; that treated cuttings kept under a tree or in indirect sunlight can provide good establishment; that size of bundles does not affect establishment; but that storage of cuttings should only be done when necessary, since yield is affected by using stored cuttings for planting.

A new method has been developed for the interchange of indexed vegetative cassava planting materials that makes it possible to obtain 90-100% establishment 20 days after packing and adult plants 7-10 months later.

The virology section has identified whitefly (Bemesia tuberculata) as a suspected vector of the mosaic component of the frogskin disease of cassava. The virus indexing protocol of CIAT has been refined. The combination of thermotherapy with meristem-tip culture and virus indexing of the meristem-tip cultured plants can assure freedom from known viruses.

The cassava entomology program focuses on mites, mealybugs, the cassava hornworm, whiteflies and the burrowing bug.

Work on biological control of mites has been done in close collaboration with IITA. CIAT efforts have concentrated on the use of agroecological data to focus the search for effective natural enemies. A number of natural enemy species have been shipped to IITA for mass rearing and liberation.

Since low levels of mealybug resistance are available in the cassava germplasm, research efforts have focused on natural enemies. Predators and parasites of Phenacoccus manihoti are being evaluated and the Venezuelan Llanos have been identified as a possible new source of effective natural enemies.

The most practical control for hornworm is the use of virus, a natural enemy that can be manipulated, maintained and managed at a relatively low cost. Use of this virus is being applied by farmers in Colombia and Brazil. No research on the safe use of Baculovirus has been conducted at CIAT but it has been used as a biocontrol agent in the United States where very strict food and drug regulations are enforced.

ICA (Colombia) is now in the process of releasing three cassava varieties based on CIAT germplasm with resistance to whiteflies. Furthermore, intercropping cassava with cowpea reduces whitefly populations under certain circumstances and may offer an alternative for whitefly management.

As an alternative to chemical control of the cassava burrowing bug, the allelopathic properties of crotolaria are under investigation. Although intercropping with crotolaria is not practical because of the resulting decrease in cassava yield, the repellant chemicals released by crotolaria roots are being studied.

3.2.3.4. Biotechnology

Since the 1984 EPR, significant activities in biotechnology have been undertaken in support of the Cassava Program.

Plant regeneration has been obtained by somatic embryogenesis of cassava clones, and this methodology has been used to demonstrate genetic transformation of cassava tissue culture. Work towards transformed plants is underway. Cassava reproductive biology studies have been initiated to develop *in vitro* pollen germination, ovule culture and isolated pollen culture as a means of obtaining haploidy in cassava.

Isozymes electrophoretic analysis for germplasm characterization and genetic studies have been developed and the technique is currently used to screen the entire cassava collection for duplicates as well as to develop geographic relationships. Moreover, the research network for advanced cassava biotechnology was established in 1988 and key constraints to cassava production and utilization were identified for priority attention by the network.

The Panel commends the Biotechnology Research Unit for its support of the Cassava Program and urges it to continue these activities.

3.2.3.5. Plant physiology/soils

Plant physiology research has continued to provide breeding and management with basic understanding of physiological processes.

Photosynthetic characteristics of cassava have been closely studied. Cassava leaves were found to possess relatively high photosynthetic rates achieved at high temperature, high light intensity and high relative humidity. They also showed lower photorespiratory rate, lower CO_2 compensation point, initial fixation of CO_2 by both C_3 and C_4 cycles and elevated activity of the key C_4 enzyme PEP carboxylase. These traits indicate high photosynthetic efficiency of cassava compared to C_3 crops. Such traits enhance the ability of cassava to withstand prolonged drought and increase its water use efficiency. Cassava is as efficient a user of water as C_4 crops like maize, sorghum, millet and sugarcane.

Cassava tolerates a relatively long period of drought once the crop is established. The explanation rests on the capacity of cassava leaves to fix atmospheric CO_2 and partially close their stomata and the plant's ability to maintain a predawn leaf water potential. It also reacts to changes in atmospheric humidity by closing its stomata in dry air when evaporative demands are high.

The aforementioned observations suggest the possibility of selecting cassava cultivars with higher photosynthetic capacity and drought tolerance for use in the semi-arid conditions of Northeast Brazil or in sub-Saharan Africa.

Planting cassava on contour ridges effectively reduced run off and soil loss. Also, application of fertilizers, leading to better cassava canopy cover resulted in less soil erosion compared to traditional practices. Using grass barriers at seasonal intervals and planting cassava with permanent soil cover in the form of forage legumes have also proven effective in controlling soil erosion. Several cassava genotypes with more dense fibrous roots in the surface soil have shown their ability to compete and produce well in association with forage legumes.

The Panel recognizes the excellent upstream activity in the physiology section and encourages it to maintain such activities.

3.2.3.6. Agronomy/cropping systems

The objective of this section is to develop improved cassava-based cropping systems for representative agroecological areas, particularly of Latin America. On-farm testing of improved technological components and development of methodology for on-farm research with national institutions are also part of this section's responsibilities.

The cropping system section has established a network of cassava researchers in the North Coast of Colombia to plan and coordinate field research and to discuss more specific topics such as cassava seed production by farmers and the coordination with ICA and CIAT's Agroecological Studies Unit. Similar groups of scientists conduct cropping systems research in Panama, Ecuador and Paraguay and a group of research/extension personnel will soon implement their first on-farm trial with cassava in Northeast Brazil.

The on-farm testing of newly released varieties in association with other crops and the testing of available technology to seed control, seed protection and seed selection are receiving special attention. Intercropping studies show that improved maize varieties not only outyield the traditional variety but also allow the cassava intercrop to yield more.

3.2.3.7. Utilization

The utilization section concentrates its work on storage of fresh roots for human consumption and small-scale drying for the production of cassava flour as a human food and cassava meal for animal feed. Product and process development follows a three stage process: research, pilot plant testing, and commercial introduction of the technology in development projects.

Since the 1984 EPR, the technology for cassava root storage has been refined to yield a new method that is easier, faster and simpler to carry out, uses less water and less fungicide, and thereby reduces costs.

CIAT, in collaboration with engineers from the University of Valle, has improved the capacity of the chipping machine from 3-4 tons/hr to 10 tons/hr. A pedal operated cassava chipper has been developed that can chip 400 kg/hr when operated by two people taking 10-minute turns. It costs US $235, of which 60% is the cost of materials. The section has been looking into development of simple artificial drying techniques and is collaborating with ICA and the National Agrarian University, to produce feed concentrates with cassava as the principal source of energy.

In a joint project with the University of Valle, a small scale process for the production of cassava flour (1 ton/day) has been developed. The technology is being tested under real conditions in a pilot plant established in the north coast of Colombia in cooperation with the Colombian Integrated Rural Development Fund and a farmers' cooperative.

3.2.3.8. Economics

Studies of the potential of cassava, as recommended by the 1984 EPR, have been conducted in several countries of Latin America and Asia and are under way for Africa. The findings confirm the importance of cassava as source of food and income for the less privileged in the tropics. Moreover, related studies have shown that cassava can compete in a multiplicity of markets with other basic starch sources if there are no price distortions.

A workshop sponsored by CIAT, CIP and IITA in September 1988 in Colombia discussed possible ways of improving the diagnostic capabilities for roots and tubers production systems.

The section works closely with the utilization section on the development of cassava flour as a partial substitute for wheat flour in bakery products. An 85% wheat-15% cassava mix (or composite flour) has been produced in Colombia at a cost of $83 (1988 prices) a kilo, which is profitable up to a 50% margin between the cassava producer and the wheat mill. An "at home use test" (consumer acceptability trial) indicated that consumers will purchase composite flour bread if the price and quality of the product are maintained.

In support of the integrated cassava projects, studies were conducted to determine the economic profiles and cost structures of wheat flour mills as well as Bogota's bakeries; to assess current outlets for fresh cassava/flour in Ecuador and the current usage of cassava in farmer households in Paraguay; and to identify changes in cultivated cassava area in Ecuador and Colombia. A monitoring system has also been designed for use in the integrated pilot projects to provide information on the distribution of benefits and the adoption of technology.

3.2.3.9. International activities

Developing countries

CIAT has been playing a significant role in the establishment of national programs in cassava in several developing countries.

Asia

The activities of the CIAT regional program in Asia, which is based in Thailand, are centered around breeding and agronomy. Its objectives are to facilitate exchange of germplasm between CIAT headquarters and Asian national programs and among national programs and to strengthen national program capabilities in varietal evaluation and selection. In agronomy, the accent is on the setting up of collaborative research projects to tackle problems of erosion control and maintenance of soil fertility.

Latin America

In Latin America CIAT maintains close links with national cassava programs through technical cooperation and training of research and extension personnel. CIAT is particularly active in helping national programs set up integrated cassava production, processing and marketing pilot projects. These projects are underway in Mexico, Cuba, Panama, Colombia, Ecuador, Paraguay and Brazil. In Panama, Colombia and Ecuador they have led to the stablishment of cassava drying industries on a commercial scale.

Africa

The Cassava Program's efforts in Africa are channeled through IITA. Since the 1984 EPR, the extent of cooperation between CIAT and IITA has grown substantially.

A liaison scientist (plant physiologist/breeder) who will be involved also in testing improved germplasm in selected locations in Africa has been posted to IITA. A Brazilian project funded by CIAT in the northeast will develop improved cassava germplasm for the semi-arid sub-Saharan Africa via IITA. CIAT has received 17 hybrids with resistance to mosaic and has sent to IITA 15,205 seeds of elite materials with mite resistance. Crosses combining mosaic and mite resistance were begun in 1988. CIAT has been sending IITA the most promising species of natural enemies of mealybugs for mass rearing and liberation.

Human resources development for generation and transfer of root and tuber crops is a UNDP-funded project in collaboration with IITA and CIP.

The collaborative study of cassava in sub-Saharan Africa, being executed by IITA with the assistance of CIAT and funded by the Rockefeller Foundation, started in September 1988 through a meeting in which experts and resource persons were invited to prepare details.

The Panel commends CIAT and IITA for this significant expansion of cooperation and encourages its continuance.

Problem areas in the Cassava Program have been prioritized for the most part on secondary data supplied by national programs or obtained by CIAT staff. This is understandable because incidence and damage, particularly of diseases and pests, vary greatly due to seasons, years, and locations. More objective data on the constraints affecting cassava production could further sharpen CIAT's program focus. The Panel urges that joint efforts be mounted to initiate this activity in the major growing areas.

Other institutions

Good collaborative research exists with various universities and advanced research institutions in both developed and developing countries. The Panel particularly commends the Cassava Program for increasing these linkages with basic research institutes that have a comparative advantage in methodology that make the partnership cost-effective for CIAT.

3.2.4. Staffing and facilities

There are 12 senior staff in essential positions in the Cassava Program: a leader (vacant), one entomologist, a utilization specialist, a physiologist, two plant breeders (one assigned at headquarters and the other stationed in Thailand), a soil scientist/agronomist stationed in Thailand, a plant pathologist, an agronomist and a physiologist/plant breeder stationed at IITA to act as liaison between CIAT and IITA, an economist (vacant), and an agronomist/breeder to be stationed in Brazil (vacant). In addition there are three senior research fellows: an anthropologist stationed in Ecuador, a utilization specialist and a cassava specialist stationed in Brazil; post-doctoral fellows in entomology and in plant breeding, and a visiting food technologist. The Program is supported by 8 associates, 22 assistants and an administrative assistant.

The Program has adequate laboratories and greenhouse facilities at CIAT headquarters, a house at Pivijay on the north coast of Colombia, and field facilities as well as on-farm sites that cover five of the six edaphoclimatic zones. Support services also are available at all stations. The inauguration of a new facility for cassava photosynthesis work has significantly increased the level of this activity, particularly in the physiology section.

The Program has a working budget of US $3,239,000 for 1989.

3.2.5. Achievements

The Cassava Program has emphasized the establishment, identification, and characterization of a world germplasm collection maintained in vivo and in vitro, virus indexed, and available for safe international distribution to national programs. The bank has been especially successful in broadening the germplasm base in Asia and Africa.

Materials tolerant to African mosaic have been introduced to Latin America for the first time using sophisticated techniques to ensure that they are virus free. The first hybrids from these crosses have been sent to Africa for testing. In the past five years 17 new varieties based on CIAT germplasm have been released or are in final stages of pre-release in eight countries. To date all improved germplasms released have been evaluated under pest and disease pressure in marginal areas (i.e. low P and drought prone) and also under favoured environments.

The Program has developed system packages of recommendations for soil conservation and fertility maintenance, production of quality planting material, cultural practices for insect and disease control and planting patterns. Moreover, its research activities in various disciplines have contributed immensely in the identification of problems and in finding suitable solutions.

The technology for fresh cassava root storage has been refined and is now in commercial use on a small scale in Colombia. The cassava drying industries for animal feed have already taken off in Mexico, Panama, Colombia and Ecuador and are being piloted in Paraguay, Brazil and Cuba.

The Cassava Program's involvement in the training of more than 400 scientists, extension agents, university professors, etc., has resulted in the strengthening of existing or the formation of new cassava programs.

3.2.6. Future activities

Although the new goal of the Program does not differ substantially from the long-term plan as expressed in "CIAT in the 1980s", the new plan gives the following strategic objectives:

(1) "Augment and characterize the Manihot germplasm collection for more effective utilization.

(2) Develop and make available production systems for sustainable and improved cassava production in different agro-ecosystems.

(3) Improve the quality of cassava products for human consumption and animal feed.

(4) Facilitate the movement and adoption of new production and post-harvest technologies to stabilize and increase the production of high quality roots and leaves.

(5) Strengthen and improve research and technology transfer capabilities of national research and development."

These new strategies will call for some change in resource allocation. Activity in crop improvement is expected to increase with growing demand from national programs for new elite germplasm and populations for specific ecosystems, whereas collection and characterization of the manihot germplasm will decrease as work on this is completed. Projects in integrated activities and cultural practices will move toward national programs over the decade. Research on true seed as a propagation material will be given emphasis because of its promising potential. Crop management research with national programs will focus on the complete cropping systems, including intercropping, biological control, plant resistance, other pest management, and true and asexual production. Strong emphasis will continue on soil conservation and fertility maintenance research with national programs. Utilization and processing will see a shift toward product development on flour and starch for human consumption and research on root and leaf quality.

Special attention will be given to Africa because of the opportunities cassava offers there. Vigorous regional programs and the placement of a CIAT liaison officer at IITA are creating a favourable climate for the kind of studies of germplasm tolerance to stresses that will be needed. Joint research activities with strong country programs are being planned.

3.2.7. Assessment and recommendations

The Panel recognizes the outstanding team work of the Cassava Program. Together they have successfully generated a considerable body of knowledge where little was known before. This knowledge has been effectively used in developing improved germplasm, better production technology and improved utilization of cassava by national programs. The commercial growing of improved materials developed collaboratively between CIAT and national programs, and the rapid expansion of the cassava drying industries in several countries particularly in Latin America, are opening new markets. The Panel supports the proposed Cassava Program strategies expressed in "CIAT in the 1990s".

3.3. Rice Program

3.3.1. Background and objectives

The CIAT Rice Program traces back to the 1950s, when the Colombian Ministry of Agriculture and the Rockefeller Foundation undertook a collaborative rice-breeding effort with the objective of solving the hoja blanca (white leaf) virus problem. Eventually, the Program evolved to emphasize breeding in order to bring the Green Revolution in rice to Latin America, with special attention to irrigated environments. Today's Rice Program focuses on Central and South America and the Caribbean, with the necessary adjustments to deal with a broader range of ecosystems and issues. Breeding varieties tolerant for acid and high aluminum content soils are now included among the major objectives.

Having a regional mandate, rice is the smallest of the Center's commodity programs but it takes advantage of the great amount of research resources available from other Centers with global (IRRI) and regional mandates (WARDA, IITA and IRAT/CIRAD). Emphasis continues to be on germplasm development, but integrated crop management and socio-economics were recently incorporated into the program.

Rice is an extremely important food in a region that faces an annual deficit of 1.2 million MT. Annual per capita consumption averages about 30 kg and ranges from less than 5 kg in Guatemala to over 60 kg in Panama. Demand has grown in the last 20 years at an annual rate of about 3.5%. If this trend continues, by the year 2000 production will have to nearly double, corresponding to an increase from the current 17 million tons to over 30 million. The Rice Program's mission has been defined as:

> "to contribute to the improvement of the nutritional and economic well-being of rice growers and consumers in Latin America and the Caribbean by supporting NARDS efforts to increase rice production and productivity through the development, dissemination and implementation of appropriate technology and information".

3.3.2. Charact :ization of rice growing environments

Rice is grown in a wide range of environments in Latin America: tropical lowlands, acid soil savannas, Andean valleys, coastal deserts and temperate climates. The Rice Program has recognized three broad ecosystems for rice production: (1) lowland, (2) mechanized upland and (3) traditional upland.

The lowland system (irrigated, rainfed lowland and poorly drained valley bottoms) is by far the most productive, accounting for about 60% of the harvest, yet occupying only 33% of the area. The mechanized upland systems cover over 4 million ha of primarily savanna and cerrado environments but produce only 26% of the harvest. Traditional upland farming systems are particularly important in Brazil and on a smaller scale in Peru, Bolivia, Colombia and Panama. The distribution and environmental characterization of the different systems are poorly understood for the region as a whole. This should be solved by the collaborative projects under way with CIAT's Agroecological Studies Unit (AESU) aimed at characterizing and mapping the rice production systems.

The region may also be subdivided into four geopolitical zones: Central America and Mexico, the Caribbean, Tropical South America, and Temperate South America.

Most of the rices grown on irrigated and favoured upland are modern semidwarfs. Improved tall varieties are commonly grown in the mechanized upland area, and unimproved traditional tall materials predominate in traditional upland systems. Yields for the upland materials average only around 1 t/ha. These varieties are reasonably well adapted to common soil stresses such as low pH and high aluminum saturation, but do not respond to inputs and tend to be susceptible to lodging and to the principal biotic stresses. It can be seen that there is great need for improvement

of upland systems of cultivation. But, even for lowland and favoured upland the genetic basis of improved varieties is rather narrow and an effort to widen it is highly desirable. Also there is a great need for improved crop management so that modern varieties can express their yield potential and be produced at lower cost. Important in this regard is research on IPM (Integrated Pest Management).

3.3.3. Activities

CIAT's intensive rice program initially emphasized breeding for more favourable environments. Recently greater attention has been directed to more harsh environments, especially the acid soils of the tropical savannas and cerrados. The Program undertakes intensive research in its experimental stations, coordinates networks, offers training courses, and supports regional meetings, workshops and conferences. Rice is plagued by a number of pests, weeds and diseases, and farmers have been continuously using greater amounts of agrochemicals. CIAT is strongly dedicated to developing an Integrated Pest Management (IPM) program to deal with the resulting environmental, toxicological and economic concerns by reducing the level of pesticides farmers must use to control pests, weeds and diseases. Other current activities of the program are also directed by a sustainability perspective and oriented to the appropriate and efficient use of inputs.

CIAT maintains good interaction with scientists from NARS, including reciprocal field visits, which contributes to improved selection of materials suited to the different environments.

CIAT also collaborates with NARS within the International Rice Testing Program (IRTP), which provides advanced lines in nurseries and informs developing countries of the latest rice research.

The Experiment Station of Santa Rosa (Villavicencio), located in the Llanos of Colombia, is a good place for selecting for resistance, since practically all of Latin America's major rice diseases, especially blast, are found there. Similar "hot spot" sites have been identified and used in Peru, Panama and Guatemala. Most countries of the region have released improved varieties developed through breeding activities based on CIAT germplasm.

Extensive rice crossings are continuously made, yielding early generation breeding lines (F_1, F_2 and F_3) that are routinely sent to stronger NARDS. The genetic base of the tropical irrigated germplasm is now being broadened through the incorporation of African and Asian germplasm.

The Program carries on an increasing amount of anther culture in F_1 and F_2 generations seeking to speed up the process of obtaining homozygous lines. On the whole, the number of plants regenerated is rather low for indica tropical irrigated types (about 10 plants per cross), which limits the possibility of genetic recombination. For upland types and japonica grown in areas which permit only one generation advance per year, the response is substantially greater.

Somaclonal variation study yielded 325 somaclones from Oryzica-2. Although preliminary results showed some promise, the technique is considered to offer more limited possibilities than a few years ago.

A better characterization of the rice-growing environments of the region is underway in collaboration with the AESU (Agroecological Studies Unit).

Rotation systems involving rice and pastures (legume and grass) are being evaluated for the acid soil savanna regions of Colombia in collaboration with the Tropical Pastures Program.

Socioeconomic studies to diagnose rice production constraints have been conducted in collaboration with NARS for several countries (Chile, Colombia, Ecuador, Central America, Venezuela and Brazil).

A survey of the human resources and activities of all national rice programs was conducted in 1988, which provided a clearer picture of the strengths and weaknesses of these national programs partners.

3.3.4. Staffing and budget

The Program is well assisted by qualified staff scientists who are seriously involved and dedicated to solving the problems and improving the production of rice in Latin America.

At headquarters the Program is staffed by one program leader (a pathologist), two breeders, one pathologist, one agronomist, one entomologist involved in IPM, one economist and one liaison scientist from IRRI dedicated to IRTP (International Rice Testing Program).

At the Sta. Rosa Experimental Station (Villavicencio), there is one breeder for tropical irrigated rice and for population improvement and one post-doctoral fellow working as agronomist for the integrated rice-pasture management.

For the Caribbean Rice Improvement Network, the Program maintains one agronomist-breeder and one agronomist engineer for small machinery development and utilization in the Dominican Republic, and one agronomist in Haiti.

It is felt that the addition of one physiologist especially to carry out studies to understand root development in the harsh upland conditions is desirable.

The Rice Program is well supplied with facilities and equipment to carry out all activities in a satisfactory way. Its total budget is US $1.912 million.

3.3.5. Achievements

One of the most significant achievements of the Program is its close relationship with NARS that contributes to a substantial strengthening of those partners. Recent accomplishments indicate that some NARS are becoming increasingly self-sufficient in applied rice breeding. For instance in 1987, from a total of 24 new varieties released in Latin America, 12 were the result of crosses made by national programs. CIAT has helped some programs characterize their germplasm banks and working collections and has encouraged them to make their own crosses. Twelve of the national programs, representing 90% of the Latin American rice-growing area, generated their own crosses during the period 1983-87 by making an average of 1,900 crosses per year, a figure higher than that of CIAT. Although this indicates a substantial amount of breeding work, the number of improved varieties that resulted is comparatively small; this issue that should be addressed by CIAT.

Some other research achievements are also worth mentioning:

- Characterization of the rice blast fungus population at Sta. Rosa has revealed its extreme pathogenic variability rather than a few "super races".

- CIAT breeding lines are now characterized for a large number of important agronomic and economic traits such as disease and insect reaction, tolerance to edaphoclimatic stresses, and grain quality.

- A semi-controlled field screening method developed in Palmira for the hoja blanca virus permits the evaluation of thousands breeding lines per season.

- Thirty-one rice varieties for irrigated and favoured upland conditions based on CIAT-developed germplasm have been released in 11 countries.

- The savanna breeding project, based on traditional and improved African and Brazilian material, has produced advanced lines with desired traits that are tolerant to acid soils with aluminum saturation levels above 80%.

- Genetic mediation of the ability of the Sogatodes oryzicola plant hopper to support replication and therefore transmit the rice hoja blanca virus has been determined, together with the mechanisms of tolerance and antibiosis against that pest.

- A simpler and cheaper crossing method, based on a technique originally developed by CNPAF and IRAT scientists, has been adapted for use by national programs to increase their effectiveness in making and exploring the potentials of their own crosses.

- CIAT has succeeded in using, very successfully, anther techniques; it has been a joint activity between the Program and the BRU.

3.3.6. Future activities

Testing and releasing new varieties is a lengthy process, in many cases taking over a decade. CIAT is looking for ways to expedite the process; expansion of anther culture in national programs would be one of these. The process is also being speeded through closer cooperation among research, extension programs and the development process. Early on-farm testing, cooperation with the seed industry, and early multiplication of basic and foundation seed of promising lines are accelerating the process. For example, Oryzica Llanos 4 and Oryzica Llanos 5, obtained from lines assessed from crosses made in early 1984, were in farmers' fields in 1989.

CIAT is facing the challenge to develop a rice production system with long-term stability. To achieve this goal CIAT is planning to integrate classical areas of research (germplasm development and management of diseases, pests and weeds) with others such as crop rotation, institutional issues and marketing.

Since the germplasm base of improved varieties for the region is rather narrow, an effort will be made to diversify the genetic basis of lowland germplasm by incorporating African and Asian materials in combination with the CIAT acid soil upland breeding population.

A promising area for germplasm enhancement should be the development of breeding methodologies for population improvement. The use of recurrent selection in heterogeneous materials, after the incorporation of the male sterile characteristic or with the use of hand crossing, should be successful and is an area where CIAT has comparative advantage. Research aimed at increasing the frequency of desirable genes, linked to the pedigree methodology, should provide better parents of broader genetic basis to be used more effectively by NARS.

The link with the Tropical Pasture Program is being enhanced to develop rotations in which rice will serve as an economic means to establish improved pastures.

Over the coming decade the Rice Program should reinforce its efforts to develop into a center of information on rice research and development of relevance to the region. This will be done in conjunction with IRRI.

In the area of varietal improvement CIAT will give much more emphasis to breeding for the high rainfall upland system, where opportunities for substantial improvement are greatest. In order to accomplish the desired goal for soils that are quite variable and characterized by high acidity and aluminum content, a better understanding of root physiology is badly needed.

Since experience has shown that the variability of results obtained in replicated yield trials is often rather high, especially under the adverse conditions of the acid upland soils, an effort should be made to better understand the factors responsible and develop appropriate experimental techniques.

To effectively accomplish these shifts CIAT plans to phase out many activities that should be undertaken by NARS. This should be carefully assessed, since there has been great variability among as well as within NARS along the years. In any case, a more explicit definition of the activities where more reliance is to be placed on NARS is advisable.

3.3.7. Assessments

The Panel is pleased to acknowledge the effectiveness of the activities carried out by the Rice Program, which have led to significant contributions for rice improvement in the region.

Considering the great number of crosses that are being made, especially by national programs, and the limited number of improved cultivars that have resulted, CIAT should intensify its effort to identify genetic materials that might have greater potential for improvement, aiming at the same time at increasing the germplasm base of the breeding programs. Some consideration should also be given to the question of whether the crosses have been adequately exploited in order to yield new varieties.

Many national programs continue to benefit from the research developed at CIAT. CIAT must also be commended for its excellent comprehensive studies of the rice situation in countries of the region, most recently in Venezuela and Ecuador. This kind of study should be expanded in other countries to try to minimize critical constraints by addressing those problems in training courses.

The Panel notes impressive progress in breeding activities undertaken in collaboration with national programs. Improved cultivars derived from CIAT materials have been released and are being widely grown by farmers in most countries of the region.

3.3.8. Recommendations

The Panel recommends that the Rice Program pursue more actively the use of population improvement methodologies like recurrent selection.

Since the yield trials have frequently shown rather poor statistical precision, the Panel recommends that the Rice Program make a serious effort to explore the reasons.

3.4. The Tropical Pastures Program

3.4.1. Background

Meat and milk continue to provide an important part of the diet of the people of tropical Latin America. Their share of the food budget exceeds 20% even amongst the poorest quintile, and relative consumption by the poorer groups increases sharply with rising income. Not surprisingly

these commodities usually are given a high priority in the formulation of national food policies.

In the last decade low domestic prices for feed grains, coupled with technical change in poultry production, stimulated a large increase in poultry output while beef and milk production failed to keep pace with population growth. Net imports of milk powder doubled to about 4 million tons annually and beef prices rose. Projections of the food production deficits expected in tropical Latin America (Trends in CIAT Commodities, 1989) suggest a change from the present small surplus of beef to a decreasing self-sufficiency with imports of 360,000 MT in the year 2000. A doubling of the present deficit in milk output, from 4.2 MT to almost 9 MT (about 21% of production), is also anticipated.

Beef and milk production have increased in the last decade approximate 1.3% annually, roughly 1% below the rate of increase in human numbers. Previously almost all the production increase had come from an expansion in stock numbers, but in the last decade productivity increases per animal have become evident, particularly in milk production (Trends in CIAT Commodities, 1989). The potential for further increases in productivity per animal as well as per unit of land area are very large; the work of CIAT and others indicates that with improved pastures in the tropical savannas a ten-fold increase in output per hectare is possible. A five-fold increase could be achieved by replacing degraded grasslands in the rain forest with improved pastures.

3.4.2. Objectives

Successive statements of the goal, strategy and priorities of the pasture work at CIAT indicate a progressive evolution and clarification of the program. The Beef Production Systems Program, initiated in 1969, sought to increase cattle productivity in the lowland tropics through a combination of animal health, herd management and mineral nutrition measures. A 1976 reorganization of this Program emphasized the improvement of tropical pastures as the means of achieving the beef production objective. The first long-term plan, "CIAT in the 1980s", added the tasks of:

(1) promoting the economically and ecologically sound expansion of the agricultural frontier, and

(2) releasing more fertile lands (from livestock grazing) for expanded crop production.

The conjunction of the increased research experience in tropical livestock and pasture development, the recommendations of the last EPR, and increasing concern with environmental issues now leads the TPP to a further modification of these earlier statements. The basic objective of increasing livestock output remains unchanged but the new strategic plan, "CIAT in the 1990s", notes the goal of the TPP is:

> "To contribute to the overall economic growth and social welfare of both rural and urban populations in the tropics by increasing their

access to beef and milk products through increases in the production of sustainable, pasture-based production systems."

The immediate objectives of the Program are now stated as:

(1) "Document the soundness and commercial feasibility of using grass-legume pastures.

(2) Enhance the capacity of improved pastures in maintaining or recovering soil quality of pasture-based production systems on marginal lands.

(3) Develop sustainable pasture-based production systems on marginal lands.

(4) Strengthen national capabilities in the context of supply and demand for legume-based pasture technologies within the region."

3.4.3. Special features of the Pastures Program

Simply stated, the aim of CIAT's Pastures Program is to improve beef and milk production by means of improved grass/legume pastures. Pasture improvement in tropical acid soils necessitates the use of a wide range of legume and pasture species, many of them new to agriculture and with biological characteristics that are quite unknown. These plants must be collected from the wild, screened for adaptation and useful attributes, manipulated genetically to modify performance, and managed and fertilized in a manner compatible with both persistence and high productivity. The difficulties and time requirements of these tasks are large and easily overlooked; they are also complicated by an interaction with changes occurring in other sectors of agriculture.

Over the last decade a significant shift of major cattle populations towards the more marginal areas of Latin America is evident, driven essentially by the intensification of cropping in more densely settled regions. Although CIAT has sought to promote a low cost, low use of fertilizer approach by selecting grass and legume species adapted to the acid and infertile soils of the frontier zones and resistant to pests and pathogens, the costs of pasture improvement are still relatively high in relation to land prices. In years past the choice between expanding the land area in use or intensifying the productivity of existing pastures was a simple one. As land values increase and pasture improvement techniques become more easily and cheaply attained, 31 million ha of the 92 million ha pasture area in the Brazilian cerrado have already been planted to improved grasses. An awareness of the fertility building role of legume-based pastures is also increasing. It is in these circumstances that CIAT expects to overcome the still widespread lack of knowledge amongst farmers that investment in legume-based pastures is a credible option. Attractive rates of return to pasture improvement are now evident, although the adverse cash flow associated with it in its early years remains a significant barrier. The use of cash crops in combination with pasture establishment will further enhance the adoption of new pasture technology.

3.4.4. Staffing and achievements

Five themes recur in considering the current workplan of the TPP:

(1) A greater choice of technology and germplasm is now available as a result of earlier efforts to identify promising pasture species;

(2) Regional pasture networks provide increasing capacity to evaluate and distribute this material and document its commercial viability.

(3) National authorities are recognizing the value of improved pastures to protect the natural resource base while increasing the productivity of land already in use.

(4) There is heightened awareness of the possible impact of biotechnology on the technological efficiency of pasture improvement.

(5) Much more collaborative research with other units in CIAT and elsewhere will be required.

CIAT's TPP has a modest staff and budget. Professional staff number 18 positions and range across the biological disciplines; 5 are outposted to the regional centers. The present budget is US$ 3,653,675. In the next few years TPP plans to reduce current efforts to broaden variability in the germplasm collection in order to provide resources to explore promising opportunities in pasture-crop integration, in silvo-pastoral systems and in nutrient cycling through soils-plants-animals. One "essential" additional staff position is requested to strengthen work on production systems in the isohyperthermic savannas and the humid tropics, and two "desirable" posts are proposed to support the expansion of work in Africa and in Southeast Asia.

Improvements in animal production in tropical Latin America resulting from CIAT's pasture work are still modest; it could not be otherwise given the time scale required for such change. But the signs of change are there. For the first time an improvement in animal productivity underpins the statistics available. Large areas (500,000 ha) of the continent have been sown with Andropogon gayanus, one of the improved grasses introduced by CIAT, and Stylosanthes capitata is now being widely planted in the Llanos. Early estimates of the benefit:cost ratio of CIAT's pasture research suggest a 33:1 response. More importantly, a continued research effort into pasture improvement provides the only feasible approach to improving the feed base for Latin American's urgently-needed increase in livestock production without decimating the forest resources of the region.

3.4.5. Program activities

Germplasm collection and plant breeding

The CIAT collection of tropical grasses and legumes now numbers about 23,000, amongst which herbaceous pasture legumes from acid savanna

soils predominate, including a small number of shrub legumes. The legume collection accounts for about 83% of the inventory.

The loss of the availability of genetic diversity in uncollected plants, arising from a rapid intensification of agriculture, is an increasing worry; CIAT collection teams, when making repeat visits to previous collection sites, note the reduced prevalence of target species. Quite apart from its immediate utility to pasture improvement, the CIAT germplasm collection provides some safeguard against the genetic erosion now evident in wild populations.

Duplication of similar accessions within the collection enlarges storage and screening costs. Maximizing genetic variability in smaller collections is now becoming more practical via "genetic fingerprinting". The Panel encourages CIAT to continue to support germplasm diversification, screening and culling initiatives.

CIAT's policy of providing ready access to germplasm resources ensures widespread availability of this material. To date, internal quarantine and disease control practices have been seen as giving sufficient reassurance about the potential danger of spread of pathogens by the wide distribution of pasture germplasm. Nonetheless, this remains an area of concern, and the Panel encourages CIAT to pursue its current efforts to eliminate the possibility of the transmission of viral and other pathogens via seed distribution.

The strengthening of ongoing work to expand the "in vitro tissue culture" storage of germplasm is also warranted. These techniques facilitate:

(1) the conservation of species that form little or no true seed;

(2) a means of more rapidly propagating species with late sexual maturity;

(3) the distribution of germplasm free of pathogens;

(4) the growing to maturity, via embryo-rescue or protoplast fusion, of crosses of plants that would not otherwise produce viable progeny.

(5) the induction of new genetic variability.

Insect, fungal and viral problems are particularly severe in the sub-humid and humid tropics. CIAT has chosen to tackle these constraints primarily through the selection of resistant or resilient accessions. They have on staff a pathologist, entomologist, microbiologist and a plant breeder; they also have access to the services of the CIAT Virology Research Unit. TPP adaptation studies are increasingly oriented to problems associated with the optimization of nutrient cycling and to nitrogen fixation and phosphorus uptake by legumes. These topics are also being pursued by encouraging their study at research institutes elsewhere.

Plant nutrition

The TPP continues to base its evaluation of accessions under conditions of very limited soil amelioration. Its scientists seek to assemble pastures adapted to limited soil nutrients and tolerant to low pH and high Al levels. Results from the increasing work on crop rotations that make use of improved pastures with legumes are documenting the nature of the positive changes occurring in soil fertility as a consequence of pasture improvement. The large increase in yields of upland rice production following improved pastures in the Llanos of Colombia provides practical testimony to this soil fertility effect.

Pasture development

Evaluation of new accessions to the Pastures Program follows a stepwise procedure in which CIAT is seeking a declining role at the farm testing stage. Evaluation proceeds from initial row evaluation, through small plot cutting and grazing trials, to farm paddock experiments. To an increasing degree national research institutions, particular in Colombia (ICA) and in Brazil (EMBRAPA), are assuming responsibility for evaluation and performance studies at the farm level. CIAT is now planning to explore the ecological reasons for changes in plant populations to seek a better understanding of soil-plant-management interactions and of the factors contributing to the differences observed in the nutritive value of different accessions.

Seed production

The supply of an adequate quantity of seed from the increasing number of promising accessions emerging from the TPP is a critical bottleneck in achieving widespread impact of an improved species. Seed production begins with initial multiplication of the very few seeds associated with a new accession. This enables field screening and applied research on the reproduction and harvesting of the accession. Subsequent work is required to find ways to promote the commercial production of that seed. Responsibility for different aspects of seed production are shared with the CIAT Seed Unit, as are components of training in seed production. The Panel endorses the current seed production efforts of the TPP and encourages attempts to seek additional special funding to support an expansion of this work.

Training

Pasture training by CIAT is carried out in three main ways: (i) training at headquarters, (ii) training in CIAT regional centers (iii) training assistance to national institutions. In the period 1980-1988, 420 professionals have received 2,000 man-months of specialized training in pasture agronomy, in the assessment of pasture quality, in soil-plant nutrition and in seed production.

The regional centers of the TPP in Costa Rica, Brazil and Peru enable an increased decentralization of pasture research training and facilitate greater assistance to national training programs. In 1989 CIAT plans a special effort to encourage the further training of university

lecturers in pasture agronomy. An agressive program of adding to the pool of NARDS scientists through M.Sc. and Ph.D. training is also envisioned. The Panel strongly supports the multi-faceted approach to pastures training taken by the TPP.

International cooperation

Four regional RIEPT sub-networks (Central America, Llanos, Humid Tropics and Cerrado) are now in operation. Others in West Africa and Southeast Asia are in the planning phase. Selected accessions of germplasm of likely utility to each network are provided by CIAT and subjected to a series of evaluation trials at diverse sites within each region. The first trials were essentially concerned with viability and seasonal production. Selected material is now moving into farm grazing trials using both beef and milk production to assess pasture improvement. RIEPT has an advisory committee made up of national pasture research leaders. CIAT publishes, in an attractive quarterly journal (Pasturas Tropicales), the results of network trials along with current research information from its own research as well as other sources. Through these networks the TPP is clearly reaching field scientists in national programs and enjoys particularly productive relationships with national pasture and livestock organizations. These networks are proving to be a most valuable means of strengthening information flows, technical training and pasture improvement. Linkages of the TPP to other international groups such as CSIRO (Australia) and university groups in North America are close, but constrained in effectiveness by the funds and time available to cultivate them.

3.4.6. Assessments

The possible reduction of efforts to seek wider germplasm variability is a cause of concern to the Panel, because the loss of wild plants of potential importance to pasture improvement is now widespread. To the extent the proposed strengthening of the central germplasm unit of CIAT (GRU) compensates for a reduction in TPP collection activities, this concern is mitigated, but if the GRU is unable to sustain this work TPP faces a dilemma: will it be necessary to consider modest reductions in the effort to seek a better understanding of the pasture complex in order to ensure that unique germplasm is collected and stored before it is lost forever? There is no easy answer that the Panel seeks to recommend, but it does wish to highlight this difficult issue.

It is also evident that viral infection is present in many pasture legumes. Ensuring freedom from infection in germplasm available for distribution is of highest priority, and present linkages between the CIAT Virology Research Unit and TPP deserve every support.

A similar dilemma occurs in regard to the support to be given to attempts to use biotechnology to resolve specific pasture problems. The likely impact of biotechnology on CIAT's pasture work is promising, particularly as Stylosanthes is most amenable to tissue and protoplast culture, but practical results remain to be demonstrated. To what extent should CIAT invest scarce resources in the biotechnology potential? The

Panel believes biotechnology is likely to have an important impact on certain aspects of plant improvement that are of great importance to the TPP, and believes CIAT will need to make a continuing judicious investment in it.

The work of the TPP has been characterized by flexibility as needs and opportunities change. To an increasing degree its work involves close collaboration with other programs and units and its success increasingly depends on the strength and viability of this collaboration.

The staff of TPP are clearly a productive, hardworking and cooperative group, and they are strongly motivated, well trained and aware of the large responsibility they carry to produce early practical results. Their output could be enhanced if further funds for upstream training and collaborative research (particularly in certain aspects of biotechnology), and a few items of relatively expensive but potentially very useful analytical equipment were available. The publication record of TPP scientists is reasonable. More importantly, they are a stable group whose work is highly respected by the staff of national programs. The overall conclusion of the Panel is that the TPP continues to make good progress and well justifies the continued support of the CGIAR.

3.4.7. Recommendations

The Panel endorses the proposed work plan of the Tropical Pastures Program. It also urges particular attention to the following points:

The pasture improvement efforts of CIAT are of particular importance to the protection of rain forest and to minimizing land degradation in fragile areas. Forest protection would be enhanced by encouraging a wider understanding of the progress now possible through tropical pasture improvement. Current work at CIAT on the integration of crops, pastures, livestock and agroforestry provides a critical component of improved systems of sustainable land use. The Panel encourages CIAT to pursue this work.

The particularly fragile lands of tropical Latin America are found principally in areas of piedmont and at higher altitudes. It seems likely that the present range of CIAT pasture material could be used at higher elevations than are presently accepted as the target area; an attempt to extend the range of their present use is desirable.

CIAT has assembled an invaluable collection of pasture material and in so doing has developed particular skills in locating, assembling, documenting and screening the pasture plant resources of the world. The Panel considers it is essential that these efforts are continued through the joint efforts of the GRU and TPP.

While biotechnology has yet to make an important impact on agricultural output, the potential it offers in many aspects of CIAT's work on grasses and legumes warrants an increasing involvement in this area.

Understanding the physiological processes which underlie successful management of pasture production systems is critical to long-term improvement. It is an increasingly important part of the TPP work plan.

The major task now is to convince Latin American farmers and their governments that land improvement through legume based pastures is already possible, thereby building political support for the broader and longer-term effort required.

3.5. Supporting Research

3.5.1. Genetic Resources Unit

3.5.1.1. Background and objectives

Germplasm conservation is receiving increasing attention in recent years because of the increasing risk of genetic erosion, combined with an increased demand for wider germplasm diversity in international and national breeding programs in both developed and developing countries. The Germplasm Resources Unit (GRU) was created at CIAT in 1976. Initially the work was related mainly to the Bean Program, taking care of the large Phaseolus collection. Gradually the GRU took responsibility also for tropical pasture germplasm and cassava. This move will be consolidated with the availability of the new facilities under construction.

The primary goal of the GRU is to ensure conservation and distribution of germplasm of the three commodities for which CIAT is responsible. It embraces both the cultivated and wild relatives of domesticated species of Phaseolus vulgaris and Manihot esculenta, as well as selected genera of tropical pastures.

3.5.1.2. Activities

In order to achieve its objectives, the GRU's activities are basically similar to most of the germplasm banks, and refer to the following:

(1) Assembly of a germplasm collection through specific collecting missions and by incorporating accessions from existing national collections and also by taking the advance selected materials produced by breeding programs, as is the case of beans.

(2) Documentation on the origin, morphological and agronomic characteristics of the accessions.

(3) Conservation of the samples of seeds under appropriate conditions, i.e., low temperature and low seed moisture content, plus the tight packing, and maintenance of the Manihot collection in in vitro shoot tip cultures. For security reasons, there is always an

effort to duplicate the accessions to be stored in other institutions.

(4) Distribution of seed samples and tissue culture (Manihot) to other programs under request and subject to plant health checks in the CIAT Plant Health Laboratory.

(5) Training members of NARS counterparts in order to qualify them for the proper germplasm conservation and utilization. This is done in collaboration with IBPGR.

(6) Research activities related to the application of modern genetic finger-printing tools to help understanding the genetic structure of the accessions. Other research is planned to provide a better understanding of the collection, including work in cytogenetics.

The GRU maintains a collection of 41,061 accessions of Phaseolus germplasm that is the largest of the world, 20,500 accessions of tropical grass and legumes species and 4,000 accessions of the cultivated species of cassava plus 32 wild species.

3.5.1.3. Staffing and budget

The GRU has a senior staff level head, and a newly appointed person will take up the position in October. In addition there are three associates, one M.Sc. for beans and one B.Sc. each for cassava and pastures, plus one B.Sc. assistant for beans. There are also two M.Sc. associates doing collaborative research on Phaseolus in the CIAT-University of Gembloux project, one Ph.D. IBPGR liaison scientist plus a further one to be incorporated soon, and one senior research fellow on CIAT-IBPGR studying the wild Phaseolus collection. A newly appointed post-doctoral fellow will soon begin research on the pasture species in the collection. Also related to the GRU, the Plant Health Laboratory has one M.Sc. associate and one B.Sc. assistant.

The core budget assigned to the GRU is US $115,000. In addition, special funds are received for the Gembloux and IBPGR activities. Considering the further needs of work on pasture and cassava an increased budget will be necessary for the Unit.

3.5.1.4. Achievements

The world's largest collections of Phaseolus beans, tropical legumes and grasses, and cassava (Manihot) have been assembled and are serving as foundations to achieve the goals of the three main commodities CIAT is responsible for.

The above collections are not only an invaluable reservoir of genes but also a back-up solution in case of partial or complete loss of national collections. CIAT has already returned original germplasm collections of beans to several countries in the Middle East and Central America that had lost their collections. The availability of germplasm to

national programs is a continuous and dynamic service. The Unit has distributed more that 60,000 bean accessions to 64 countries.

The bank has served the purpose of stopping the tremendous genetic erosion that has been underway for several years in the national bean germplasm collections, due mainly to a lack of adequate facilities and/or of specialized personnel for a proper management.

Variability studies in Latin American collections have been made using morphology and isoenzymes.

The GRU is also involved in an active research program with P. lunatus where the entire collection of 2,833 samples are being rejuvenated for seed increase. Activities are underway regarding morpho-agronomic evaluation, catalogue of accessions, seed-borne BCMV, electrophoretic survey and embryogenesis survey in collaboration with BRU.

Studies on P. vulgaris and P. lunatus in Africa and America, have indicated differential variability between the two areas. These studies have given guidance and priorities for collecting strategies.

Research is under way on interspecific hybridization involving P. coccineus and P. polyanthus as donor parents in order to introduce desirable traits into P. vulgaris.

Studies comprising gene pools of P. vulgaris from Mesoamerican and Andean regions disclose some cases of genetic incompatibility indicating an incipient speciation process within the common bean.

3.5.1.5. Future activities

The GRU is supplied with facilities and equipment for maintaining the accessions of beans and pastures both for short- and long-term conservation. New facilities are being built (scheduled to be ready by early 1990), that will allow a significant increase in the capacity of the GRU. This will permit the maintenance of 50,000 accessions of beans, 50,000 accessions of pastures and 10,000 samples of cassava in vitro tissue culture. The CIAT-IBPGR in vitro germplasm conservation project on cassava has provided the scientific basis for the maintenance of the in vitro collection in the new facilities.

The GRU will also give emphasis to identifying duplicates, which will contribute to decreasing the number of samples to be maintained.

There is an increasing trend in collecting and evaluating wild Phaseolus. The projects on P. coccineus and P. lunatus are underway with evaluation and rejuvenation of seeds. Conservation in situ of land races of Phaseolus is being considered seriously by the GRU.

The GRU also is considering the possibility of the establishment of a core collection that would comprise a limited number of accessions that contain an appropriate amount of genetic variability.

The strategic plan for the 1990s has strongly suggested a priority for the "cleaning" of the germplasm stored in the Unit. This recommendation, although expensive, should be initiated for beans as soon as possible.

Gradually, the GRU will take complete responsibility for the management of the germplasm collections of cassava and tropical pastures. This means not only conservation, but also introduction, multiplication, morphological and genetical characterization, distribution and data management. All the above work in the three commodities is conducted in close association with the respective commodity program.

The measurement of the available genetic variability in the three commodities will be a very large task but will provide a necessary background for all the scientists world-wide who are involved in the improvement of those crops.

3.5.1.6. Assessments

The Panel recognizes the seriousness with which CIAT is dealing with germplasm conservation and related activities carried out by its GRU.

Substantial genetic variability of the three commodities (beans, cassava and tropical pastures) is already available for use in the breeding programs of CIAT as well as of the national programs. Also continued interest is maintained in increasing the collections.

Good facilities are available for seed storage in cold chambers, both for short- and long-term. To guarantee the security of the germplasm collection, duplicate samples are being sent both to Centro Nacional de Recursos Geneticos (CENARGEN), to Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), in Brasilia, Brazil, and to Centro Agronomico Tropical de Investigacion y Enseñanza (CATIE), in Costa Rica.

The GRU counts on the most efficient equipment for seed and in vitro storage, including spare equipment for emergency problems. However, in this regard, the living collection of in vitro cassava tissue culture is at risk. Its care cannot be interrupted. Duplication of the collection would be valuable insurance. The storage of sexual seed, while not identical to the living collection, would reduce the risk of loss of irreplaceable germplasm.

3.5.1.7. Recommendations

The Panel recommends that the GRU should intensify the effort to have experts decide on a manageable core collection consisting of a limited number of accessions that contain an appropriate amount of genetic variability.

Considering the increased activities necessary for the tropical pastures and cassava collections and its great genetic variability the

Panel recommends that CIAT seek resources for adequate staffing for the Unit.

As insurance against the possible loss of the living cassava collection maintained in tissue culture, the Panel recommends that CIAT considers duplication of the collection and the maintenance of a collection of sexual cassava seeds.

3.5.2. The Biotechnology Research Unit

CIAT initiated work on tissue culture techniques in the 1970s. Shortly thereafter it became apparent that the progress being achieved in cellular and molecular biology made it desirable to expand the initial research on tissue culture work into a unit capable of utilizing other new biological techniques for manipulating the germplasm used at CIAT. Justification for this approach was also evident in the comparative paucity of research on cassava, beans and tropical pastures in the major research centers of many countries. The Second EPR of CIAT recommended the establishment of an inter-disciplinary research structure to interact with the commodity programs in biological research applications. The Biotechnology Research Unit (BRU) of CIAT was established in 1985, and provided CIAT's response to this recommendation.

The goal of the Unit, as defined in the CIAT strategic plan is "to increase the application of new methodologies derived from the new biology for greater efficiency in plant improvement and to develop means for increased utilization of a wider range of germplasm variability in the crops and pasture species of CIAT's mandate".

Currently, most efforts in the BRU comprise cell and tissue culture applications, with an increasing emphasis on the use of biochemical and chromosome fragment markers to assist conventional breeding practices. The in vitro cassava bank comprises 4,200 clones and 27 wild manihot species, making up 90% of the global cassava collection. The cryopreservation of germplasm, induction of haploids through microspore and anther culture, the electrophoretic analysis of genetic variability and the use of wide hybridization techniques through embryo rescue and protoplast fusion are now in common use at CIAT and these technologies are being passed to the commodity programs as they come into routine use.

The BRU, like other programs and units, has been particularly active in developing collaborative research with advanced research institutions elsewhere, especially in respect of seeking a better understanding of plant resistance mechanisms to stress. The direct work of the BRU concentrates on those problems where traditional research approaches have been inadequate and where the new biological tools can aid in solving specific commodity problems. This work is undertaken jointly with the commodity programs and a sense of practical utility pervades the effort.

The staff of the Unit is made up of two essential senior staff position, one CIAT-funded and two special project funded post-doc

positions, plus research associates and technicians. The budget is $ 406,000 plus $ 115,000 in special funds.

In the next five years the network approach of linking research workers in advanced research laboratories to practical problems of cassava, beans, rice and pasture which are susceptible to biotechnological solutions will be consolidated. The utilization of established techniques will be steadily devolved to the CIAT commodity programs, and new technological developments will be incorporated in the work program. An advanced research network is now working on a series of priority problems defined by a cassava workshop at CIAT. A similar exercise is now under way for beans. In the case of rice the BRU links the Rice Program to the Rockefeller Rice Biotechnology Network.

Assessments and recommendations

The formation of the BRU responds to the needs of CIAT to keep pace with new developments in biological research. It is a productive, efficient Unit, competently staffed and well regarded by the plant breeders at CIAT. It is a growth center in the organization and will be hard pressed to supply the many demands already being made upon it. The Panel commends CIAT for its initiative in establishing this Unit and recommends that even greater efforts be made to find special funds and other resources to allow it to expand.

The establishment of an internal biosafety committee at CIAT is now a necessary adjunct to the expansion of the BRU. The Panel strongly recommends that this committee be established very quickly. It should base its guidelines on those now published for similar committees in Australia, the USA and the OECD countries.

The BRU also has the potential to generate technologies with significant commercial application. The Panel encourages CIAT to explore these opportunities within the guidelines for commercial ventures presently being established by the CGIAR System.

3.5.3. The Virology Research Unit

The CIAT Virology Research Unit (VRU) was established in 1988. It is associated with but separate from the Biotechnology Unit. The VRU arose out of the increasing need of the commodity programs for specialized and sophisticated assistance in resolving the many virus problems that limit the production of CIAT mandated crops and which inhibit the transfer of germplasm across national boundaries. The VRU now consists of a well equipped general virology laboratory, electron microscopy facilities and a radioisotope laboratory used principally for diagnostic purposes (cDNA probes) and for characterizing viral nucleic acids. Currently the VRU has two staff virologists capable of covering studies ranging from the isolation of viruses to the molecular characterization of their genomes; they are supported by four M.Sc. associates. The current budget is $364,000. The Unit provides support to the four commodity programs and is production-oriented. Its goal, as defined in the CIAT strategy paper, is:

" To develop, in collaboration with the commodity programs, appropriate virus disease control and phytosanitary procedures for the species in the CIAT mandate".

Virology research at CIAT has a distinguished record. In 1979 CIAT implemented an intensive germplasm screening methodology for bean common mosaic virus (BCMV) and was quickly able to introduce resistance to this virus in most of the breeding lines produced by the Bean Program to date. More recently the VRU identified several sources of resistance to bean golden mosaic virus (BGMV) and there is now hope that beans will be brought back into production in large areas where the crop could not be grown because of this virus. Bean dwarf mosaic virus was a further problem that caused the loss of thousands of hectares planted to beans in South America, but now susceptible cultivars have been replaced with resistant genotypes.

The isolation and characterization of rice hoja blanca virus (RHBV) and the implementation of a reliable screening methodology to develop lines resistant to RHBV is another important achievement, considering that this virus had been causing major epidemics in Latin America since 1935.

The viruses isolated from cassava in Latin America have proved so far distinct to those found in Africa. Rapid diagnostic tests are now available for those cassava viruses of wide geographical distribution. The VRU is now concentrating its efforts on two cassava diseases of unknown etiology which exist in Colombia and complicate the certification of virus-free cassava clones. Cooperative work between the Biotechnology and Virology Units has allowed the development of protocols to produce virus-free germplasm of cassava through tissue culture and indexing techniques.

In pasture legumes it is now apparent that plant viruses, some seed-borne, are present in some accessions. The immediate task is to isolate these viruses and develop diagnostic techniques to detect infected germplasm and ensure the availability and distribution of disease-free material.

In conducting its work plan the VRU maintains good contact with national research programs and provides them with training and support in the technologies it uses. In the next five years the VRU will increasingly seek to incorporate, through conventional plant breeding and genetic engineering, resistance to plant viruses affecting CIAT's commodities.

Assessments and recommendations

The VRU is an excellent Unit providing highly specialized research as well as diagnostic support to CIAT's plant improvement programs. Its work, particularly in genome characterization and genetic engineering, overlaps some aspects of the work of the BRU and there has been active discussion within CIAT on the desirability of merging the BRU, the GRU and the VRU. In the view of the Panel there is no particular virtue in the merger of these Units. Each has a clear and specific responsibility, while equipment and knowledge-sharing, and collaborative work are in

place. The responsibility of CIAT to ensure the virus free status of its germplasm, and its role in ridding production crops of viral infection, dictate that every effort be made to maintain the integrity and work of the Virology Unit.

3.5.4. The Agroecological Studies Unit

This Unit arose from two CIAT initiatives of the late 1970s. One was the classification of the major agroecological zones of the tropical lowlands of Latin America using remote sensing, the other was an agroclimatic study of the bean crop in Latin America based on its crop geography. Subsequent work has emphasized the study of crop distribution to analyze and classify the environment experienced by various crops. This has entailed the formation of an extensive database of climatic records, soils data and crop distribution information. More recent efforts focus on using this information by means of geographic systems and adding socio-economic data.

The formal goal of the Unit is:

> "To collect, catalog and analyze biophysical and socio-economic information to aid in both the adaptation of mandated crops to different environments and understanding the way land is being used in selected eco-systems".

The AESU seeks essentially to identify homolog areas across regions and to provide base data to examine agricultural systems within specific ecosystems.

The Unit is lead by an agronomist/agroclimatologist and has one other senior staff position supported by two post-doctoral fellows, with two technicians and other support-staff. Its annual budget is $330,000.

Data base maintenance and improvement occupies a substantial part of the work of the Unit, as does the assistance it provides to CIAT staff in accessing this material. Project work is presently centered on the classification and mapping of environments for beans and rice in Latin America and cross continent comparisons for cassava between Africa and Latin America. Future projects include identification of cassava regions in Asia.

The AESU has assembled a large quantity of valuable data and is making good progress in making this available in usable form. In the next decade CIAT plans to strengthen this Unit to provide information on the natural resource status of specific eco-systems. This work is expected to provide a focus for the increasing emphasis on the sustainability of farming systems. But there is some vagueness and uncertainty as to where it seeks to go and how it can best complement CIAT program activities. The Panel recommends that CIAT management give greater attention to clarifying the role and future responsibilities of this Unit.

3.5.5. Farmer Participatory Research

This special project, funded by the Kellogg Foundation, grew out of the IFDC/CIAT project on soil fertility studies with phosphate. Initially concerned with eliciting farmers' perspectives on the design and evaluation of fertilizer experiments, its objectives have widened on becoming an independent project in 1987;

> "to develop, evaluate and disseminate participatory methods for putting agricultural scientists in regular contact with an important client group, small farmers, so that technology design, testing and transfer is carried out with an accurate knowledge of the criteria and preferences small farmers are likely to use when making decisions about adoption". (Project Annual Report 1988, March 1989.)

The project has four main types of activity: development and pilot testing of methodology for involving farmers in research design and evaluation; monitoring and evaluation of farmers' own experimentation; training; and development of training materials.

The project has recently made a commitment to ICA, the Colombian national program, to help train farming systems research teams which are being set up under a new ICA Division, ISPA (División de Investigación en Sistemas de Producción). Training trainers from ICA and the subsequent work of the ISPA teams will be the first test of the efficacy of the methodologies and training materials developed by the project.

The project is staffed by one senior scientist, a Ph.D. sociologist, supported by two assistant agronomists (B.Sc. level) and an assistant Sociologist. In August 1988 this team was joined by a fulltime training associate with a Masters Degree in sociology. The projected budget for 1989 is US $ 167,350.

One project achievement is the adoption of farmer evaluations for selection work in beans both at CIAT and in ICA, the Colombian national program. For the first time ICA is evaluating a new bean variety with approximately 100 farmers to obtain their opinions about whether to release it. Similar evaluation methodology is being adopted by the CIAT and the ICA Cassava Programs.

As mentioned, the project has responded to a request from ICA to help provide training in participatory methods. The projected audience is approximately 270 Colombian researchers. The ICA Training Manual for On-Farm Research incorporates major principles of participatory research due to CIAT collaboration in its preparation.

Four modules are in preparation for wider international dissemination of the training materials used by the project.

The project has a worldwide reputation among professional peers for its innovative approach to on-farm research methodologies. The project is modifying the interface developed in farming systems research, where the social scientist represented the perspective of the farmer in experimental

design and evaluation. It is moving towards a direct interface be the farmer and the biological scientist. It will make a uniquely v contribution to the debate on whether informal, community-based rese can be an effective alternative to formal, costly, adaptive research structures within national research systems.

3.5.6. Seed Unit

3.5.6.1. Background and objectives

Technology generated by CIAT is essentially seed-based, and lack of properly produced seed commonly limits the ability of small farmers to take advantage of new improved cultivars. For this reason the Board of Trustees decided that, unlike other IARCs, CIAT must incorporate seed research into the core of its activities. The Seed Unit has been in operation since 1979 and became a core activity in 1987.

The goal statement for the Seed Unit in "CIAT in the 1990s" is:

> "To complement the commodity programs by developing technologies and methodologies that facilitate the availability of improved seed to farmers and ensure longer productive life to genetically improved varieties".

The strategic objectives of the Unit are also elaborated there as:

(1) Produce basic seed of promising lines and newly released varieties of CIAT commodity programs.

(2) Develop low-input technologies to overcome the most pressing problems related to field deterioration, drying, conditioning, and storage.

(3) Design, test, and promote institutional models appropriate for nonconventional seed production by small farmers.

(4) Train national partners on three essential components of seed supply systems: basic seed production; seed quality control; and seed production by small farmers.

The Seed Unit recognizes three major systems of seed production: traditional systems (farmer seed), conventional systems (industrial seed), and non-conventional systems.

The Unit places great emphasis on non-conventional systems, which comprise a broad range of production and distribution schemes to provide high-quality planting materials in regions unattended by certification programs.

Non-conventional systems, designed to produce good quality seed using somewhat simplified technology, are the only way, in some regions, to facilitate channelling and transfer of resources, services and existing

technologies to small farmers. Although the rules and standards followed are usually less demanding, the qualitative results achieved are close to those of conventional systems. In fact, non-conventional systems may gradually evolve to more advanced systems.

3.5.6.2. Activities

The Seed Unit, during the period in review, focused on development of human resources, research on seed quality, development of information materials, and production of breeder seeds of bean, cassava and selected forage crops and distribution of other seeds of non-CIAT mandated crops.

CIAT began workshops and seminars on seed questions as early as 1985. Development of seed production capabilities within each country has continued primarily through training, conferences and technical collaboration. In 1988 the Seed Unit conducted three training courses at headquarters and three abroad (in Salvador, Guyana, and Brazil), with a total of 145 participants. It cooperated in 14 other courses in Central and South America and Africa. These workshops provided a forum where professionals could develop plans, recommendations and approaches to help seed activities advance more rapidly.

The Seed Unit research has involved seed quality in *Centrosema spp.* during storage, effect of agrochemicals on bean seed quality, effect of moisture on storage of beans, and effect of drying methods on rice seed quality.

Nine publications were completed in 1988, including several designed to give practical advice on application of improved technologies.

The Unit produced breeder seeds of three bean varieties for release in 1989. Tropical pasture seed production has been contracted with a third party, using special funds jointly managed by TPP and the Seed Unit. Several agreements have also been achieved, working jointly with CIAT's Cassava Program and cooperatively with ICA's Seed Division, to help private and public organizations produce improved cassava planting materials.

3.5.6.3. Staffing and budget

The Seed Unit has two approved essential staff positions, a seed technologist and a seed production specialist. An anthropologist, funded by the Rockefeller Foundation, and a senior fellow trained in agricultural economics support the Seed Unit. For 1989, the Unit has a working budget of US $595,000.

3.5.6.4. Achievements

The Seed Unit reports substantial progress in:

(1) Training seed technologists.

(2) Heightening awareness at the leadership level of the importance of seed programs.

(3) Generating technology and agronomic practices which improve seed quality.

(4) Providing information support to the regional seed network.

3.5.6.5. Future Activities

Acceptance by CIAT of the core budget status recommended by the 1987 Seed Unit Study Report has given the Unit a firm base from which to plan for the immediate future. Its strategy in the 1990s will focus on development of the artesanal seed supply by generating component technologies, commodity-specific thrusts, and human resource development.

3.5.6.6. Assessments

The Panel considers that the Seed Unit has made fully satisfactory progress in its period of operation. The rapid adoption of improved varieties depends to a large extent on the capability of national programs and their seed production agencies, whether public or private. In several Latin American countries the Seed Unit has cleary demonstrated its ability to develop the technical skills and leadership support for a healthy seed industry. It is generating new technology and developing agronomic practices that promote seed quality, and it has contributed to the strength and integration of a regional seed network.

The Panel finds the strategies of the Seed Unit as expressed in "CIAT in the 1990s" appropriate and likely to be effective. The Panel encourages an effort to gather available information on the seed situation (availability, production, marketing and distribution) in Latin America, Asia and Africa for forage legumes, beans and cassava. Issues of seeds are worldwide. The Panel believes that the time has arrived for an international workshop on the subject, and urges CIAT to consider conducting such a workshop, in cooperation with other CGIAR commodity Centers and including other interested parties.

3.5.7 An overview assessment of the Units

Section 3.5 has considered five Units and one special project in their roles of supporting the four commodity programs at CIAT. The Genetic Resources and the Seed Units were established prior to the second EPR, the other four are relatively new. The Agroecological Studies Unit was made independent of the Data Services in 1984, the Biotechnology

Research Unit was set up in 1985, the Virology Research Unit in 1987, and the Farmer Participatory Research Project became independent of the IFDC/CIAT Phosphate Project in 1987. Four of the Units (Genetic Resources, Biotechnology Research, Virology Research and Agroecological Studies) are upstream feeding into, and in the case of the Agroecological Unit focussing, the research of the commodity programs. The other two (Seeds and Farmer Participatory Research) work downstream, seeking methods, processes and organizational forms to move research products to commodity program clients, particularly to small farmers.

The proliferation of these Units is of concern to some scientists who feel the successful model of the multi-disciplinary commodity programs to be threatened. The Panel, however, commends CIAT for its initiatives with both upstream and downstream Units. As well as servicing the needs of the programs effectively, the Panel believes the cross-program units are an economic means to identify principles, methods and processes useful to more than one program. It also believes that the intra-disciplinary interaction that the common facilities and common objectives of several of the units stimulate is healthy for science in CIAT. The Panel urges CIAT management to further encourage intra-disciplinary interactions across programs. Such interactions should be limited to perhaps 15% of scientists' work programs and should always address an opportunity or problem area with potential benefits to more than one commodity program.

The Panel believes that these Units represent a substantial investment in CIAT's future and, together with the central services similarly facing more sophisticated demands, deserve coordinated supervision. As noted in the discussion of the Biotechnology Unit the Panel also recommends the immediate setting up of a biosafety committee.

Finally the Panel has noted the uncertainty of direction within the Agroecological Studies Unit. It may be that this Unit can be strengthened and developed to provide CIAT with a broader systems perspective. This could aid management in balancing its program and regional commitment and supplement the sustainability perspective in the commodity programs.

3.6. Research Services

3.6.1. Visiting scientist and PDF's

A listing of CIAT's postdoctoral fellows, senior research fellows, and visiting scientists makes clear the vital importance of this category of staff to the Center's programs. The numbers alone are impressive. The roles these staff members fill are even more so. At this point the programs of the Agroecological Studies Unit, the Biotechnology Research Unit, and the Seed Unit depend heavily on postdoctoral fellow support. Fellows are also critical to outreach programs in Rwanda, Brazil, Costa Rica, Haiti, Peru, and the Dominican Republic. Throughout the biological research programs they have been used to introduce areas of specialization not otherwise likely to be available (anthropology, for example). They have added vitality to almost every program by bringing in new ideas and technologies.

As of March 1, 1989 these were the placements in various Programs and Units:

	Postdoc. fellows	Sr. res. fellows	CIAT or Rockefeller fellows	Visiting scientists
Beans	3	1	2	0
Cassava	1	2	0	2
Rice	1	4	1	0
Tropical pastures	3	2	0	0
Training/communic.	0	2	0	0
Agroecological	3	0	0	0
Biotechnology	2	1	0	0
Genetic resources	0	1	0	0
Seeds	0	1	1	0
TOTAL	13	14	4	2

The Panel sees no evidence that commodity programs are overly dependent on what is, by definition, a temporary personnel group. Certain support units rely much more heavily on fellows for staffing. For the time being this is acceptable, because the missions of some of these Units have not yet fully taken form. A flow of postdoctoral and senior research fellows can help in that process. Later a more balanced staffing approach will be desirable.

The Panel understands that the issue of recruitment of core personnel from the pool of fellows has been discussed in the Center. It sees problems if such recruitment is seen as an easy substitute for the careful worldwide search through which senior staff positions should be filled. It would equally be reluctant to see a categorical ban on appointing ideally-equipped persons from the fellows and visiting scientist group.

3.6.2. Station Operations

Station Operations is the major research service at CIAT; others are the Analytical Services Laboratories and the Data Services Unit. Each of these is described briefly.

Station Operations is responsible for the management of the CIAT research stations in Colombia with the exception of Carimagua, which is jointly run by ICA and the CIAT Tropical Pastures Program. In addition to the Palmira headquarters site there are stations at Quilichao, Popayan, and Sta. Rosa. Six other sites in varying agroecologies are operated from the Sta. Rosa Station, including 45.0 ha on ICA's La Libertad Station. Equipment and staff are located at each of the five main stations.

Table 3 shows the allocations of experimental areas to the Programs at the different sites.

Table 3. Experimental Areas at Stations by Program

Descriptor		Palmira	Popayan	Quilichao	Sta.Rosa
Area	(ha)	819	73	234	327 *
Precipitation	(mm)	949	2000	1800	2500
Altitude	(m.a.s.l)	965	1700	990	333
Pasture	(ha)	7.3	-	75.0	181.9
Beans	(ha)	101.8	21.0	23.0	-
Rice	(ha)	33.8	-	-	117.3
Cassava	(ha)	98.5	2.5	11.0	10.0
Units	(ha)	45.2	1.5	3.0	-
Other	(ha)	11.3	1.5	37.5	24.7

* Sta. Rosa program totals include the areas outside the station site managed from the station.

Station Operations is headed by a senior scientist supported by five staff at the scientific and supervisory level. It has a current annual budget of $784,000. It has a mandate from CIAT management to maximize income by cropping the unused and off-season land for commercial purposes. If commercial targets are achieved, Station Operations receives a $50,000 supplement to its budget as an incentive for good performance. In 1988 income from commercial operations realized $203,549 against expenses of $136,706, a profit of $66,842.

Carimagua occupies 22,000 hectares in the Llanos and is the main station for the Tropical Pastures Program. The Station administrator is an ICA staff member and CIAT and ICA share the budget. CIAT's share is currently $616,000, including four scientific and supervisory staff to support the management of the station. The CIAT Cassava Program also works on the Carimagua station.

The Panel commends the well maintained appearance of CIAT stations and facilities. However, there is evidence that the mandate for Station Operations to maximize commercial production is distorting priorities for machinery and labour and sometimes jeopardizing experimentation. The husbandry practices followed in some of the crops grown for sale leave the land unsuited for planting trials. The net contribution to CIAT income (some $66,000 in 1988) is being obtained at a cost in terms of the extras needed to ready land for experiments and the goodwill between scientists and Station Operations. The Panel recommends increased attention to the needs of program experiments in decisions on commercial cropping.

3.6.3. The Data Services Unit

The DSU is a central group to support and advise CIAT programs in mathematical statistics and computing techniques. The Unit reports to a Deputy Director General and has three functions:

- Biometry and data analysis;
- Information management with emphasis on data bases for information storage and use; and
- Provision and maintenance of appropriate computer hardware and software to serve scientific program needs through CIAT's IBM 4331 and its 60 terminals.

These responsibilities are fulfilled by two sections in the Unit; A Biometry Section composed of statistical consultants and statistical programmers, and a Database Development and Management Section composed of analysts and programmers.

As a further, fourth function, the Unit currently provides some six one-week training courses a year for NARDS researchers as well as for CIAT's associates and assistants in the use and interpretation of quantative techniques via mainframe and microcomputer software.

The Unit head, its only senior scientist position, has been vacant for almost a year. Current staffing is of four local staff at the Masters level and seven at the Bachelors level or equivalent. Attached to the Unit are six staff paid for by the Programs, including two from Tropical Pastures at the Masters level. The current budget is $522,000.

Since the second EPR, the use of microcomputers has expanded within CIAT. There are now some 170 microcomputers under the control of individual staff, some used by program scientists as a substitute for the mainframe. The DSU does not support microcomputer software. The effects of the introduction of the microcomputers has been to reduce scientists' demands for routine statistical processing and shift it to advice and support on more complex statistical questions.

Four commodity-oriented databases have been developed using IDMS/R software for each of the CIAT programs. Each is designed to keep records on germplasm accessions, accession performance at each selection stage, accession evaluation across selection stages, and experiments in pathology, plant nutrition, etc., which support accession evaluation. The Tropical Pastures data base is the most complete. Work on the Rice database only started two years ago and has benefitted from experience with the others.

DSU holds the agroecological database developed by the Agroecological Studies Unit, itself an offshoot of DSU. This has data on climate, land systems, maps and microregions for the four CIAT commodities. Other general databases include the CIAT trainee information system, FAO information on production and trade, and UNESCO CDF/ISIS, a bibliographic database.

The introduction of microcomputers to CIAT, particularily the use of desk-top machines by some scientists for both routine and more sophisticated analysis, presents the current organization of the Data Services Unit as something of a dilemma for management. This is evidenced by the fact that the Unit has had no head for almost a year, despite the fact that the former head's resignation could be anticipated perhaps as much as two years before his actual departure. Scientists seem to be seeking more sophisticated advice on experimental design and analysis, and a further move in this direction will arise from an increased amount of upstream work. At the same time the application of the data bases, given the cost of assembling them, is an urgent need.

There have been two fruitless searches for a new head of the DSU; since then the Panel understands that a consultative process is ongoing aimed towards the reorganization of information management in the Center. Recruitment to the DSU position will be delayed until the framework for this reorganization is clear. The Panel understands the delay. It recognizes the need for coordination of the various aspects of the information function but is somewhat sceptical of the utility of integrating all sources of data to meet Center-wide information needs.

Finally the Electronic Processing Committee has taken a hard line on microcomputor software for particular scientific applications. Young scientists coming to CIAT will continue to be highly computer literate and have a good grasp of the specialized software in their own fields. The Panel believes that Program funds should be available for such purchases. The sums are very modest.

3.6.4. The Research Services Unit

The largest section in the Unit is the Analytical Services Laboratory (ASL) providing analyses of soils, plants, water and fertilizers as a service to the Programs and the Research Support Units. Recently the ASL has taken over the water unit for producing distilled and pure water. Other sections are for the greenhouses, screenhouses and growth rooms and the instrument maintenance service.

There has been no senior scientist in the Unit, which is supported by four scientific and supervisory grade personnel. The Unit comes under the supervision of the Research Services Committee and the current annual budget is $320,000.

Evidently the situation is similar to that in the Data Services Unit. The demands on the ASL are becoming more sophisticated than it can adequately handle. A post-doctoral fellow has recently been appointed to the ASL.

An early decison is needed on whether to upgrade the equipment and provide appropriate technicians to raise the quality and speed of the existing service and cope with increasingly sophisticated needs from Programs and Support Units. The issue of whether to have service contracts or carry equipment repair costs as failures occur also needs resolution to allow prompt attention.

3.6.5. Recommendations

The Panel recommends increased attention to the needs of program experiments in decisions on commercial cropping by Station Operations.

3.7. Themes from CIAT Research

3.7.1. An assessment of the mandate area

CIAT's operational mandate has not been static but has evolved over time influenced by a number of interacting concerns over and above the perceived needs for research as defined by the Center. The nature of the expertise of CIAT, the recognition of opportunities for research, the political realities in which the Center finds itself and the experience developed through the years with regard to things it can do best have been the driving forces to find action space regarding the geographical area covered as well as commodities and related activities.

The Panel commends CIAT and its staff for advances being made; highlights of these have been noted as achievements in the individual sections of this chapter.

The Panel considers that the central themes around which CIAT must maintain lasting research strength are those related to research problems in tropical and sub-tropical regions for the mandate commodities. Relative to the temperate world these are the regions where accumulated knowledge, geared to the generation of improved agricultural technologies, is still modest and CIAT has a clear role for contributions.

Since CIAT's mandate covers areas in Asia, Africa and Latin America, where other CGIAR Centers also have mandates and responsibilities for commodities that are common to many important production systems, the Panel recommends integrated strategies in dealing with national programs, particularly in non-mandate specific activities such as management training, on-farm research and networking, and in areas of overlapping mandate such as the maize/bean intercropping so important in Latin America, the Caribbean and Africa.

Finally, the Panel recommends being selective in responding to the broad range of demands that have come out of NARDS consultations. A more rational division of labour in the global system, guided by the comparative advantage of each of the components, has been pointed out by TAC. The regions in which CIAT operates differ in many ways, and a continuous effort is required to monitor and evaluate regional capabilities and better define the Center's intervention policies in each region.

3.7.2. Measuring CIAT's contribution

Latin America and the Caribbean region became net food importers after the 1970s, and food deficits are expected to reach double the current level by the year 2000. Discrimination against agriculture due to early industrialization substitution policies has caused agricultural output growth rates to decrease, and food deficits have increased imports. For the whole of the region, food imports rose at an annual rate of over 7% between 1979 and 1984. Of particular importance for the region are cereals, vegetable oils and milk, but also rice, beans and beef. Comparative advantages remain for production of foods now imported, and increased efforts to save the foreign exchange now committed to imports are warranted.

CIAT's related commodities for tropical Latin America will count for approximately $2.5 billion of imports by the year 2000.

The 1979 plan of CIAT provides estimates of the likely benefit:cost ratios associated with its major research activities. These range from 8:1 for beans, to 15:1 for tropical pastures, at a 10% discount rate (see section 3.7.3.).

The opportunities associated with increased agricultural research have in the past encouraged the countries of the region to increase expenditures in their national research programs from about $140 million in 1960 to about $269 million in 1980 (Scobie, 1987). CIAT's research budget is only about 5% of this amount. It follows that the impact of CIAT lies not in the additional funding it brings but in its influence, through collaboration, on national research programs. Its sustained and stable funding, its international linkages and the excellence of its work provide the basic dimensions of its potential to contribute to increased agricultural production.

In bean production the influence of CIAT on technical change is most apparent in Costa Rica. Up to 1986 Costa Rica imported an average of 10,000 tons p.a. of beans. In the last five years bean production more than doubled, allowing exports of 10,000 tons. New technology via the release of new varieties accounted for much of this large change.

Argentina, Bolivia, Nicaragua and Guatemala have also released improved bean varieties now grown on 44% of the total bean area in those countries; their annual production growth rate of beans averages 8%.

The influence of CIAT on rice production is notable. Approximately half of the total of rice production in the region now comes from varieties originating from CIAT germplasm. This incremental production adds about US $2 billion per year to the value of regional rice output. The recent development of new varieties adapted to the acid savanna lands, and new production systems based on the intercropping of rice with legume pastures, are adding still further to this impact.

Cassava is grown only in tropical areas. It is essentially a crop of small and poor farmers in marginal areas, and until recently little was known of its biology, genetics and improved utilization. Better

varieties, biological control of pests and pathogens, the production of true seed, and integrating production, processing and marketing will be key components of any improvement in the technology of cassava growing. CIAT is achieving progress in these topics. Its impact on overall cassava production is still small, but its work is providing the elements essential for the production increases now predicted.

In its work on tropical pastures CIAT has demonstrated the marked improvement possible in animal performance and productivity as a result of establishing legume-based pastures on the poor acid soils of the extensive savanna areas. Low productivity is a characteristic even of well-managed native savanna. The grass legume mixtures which CIAT has identified have more than doubled liveweight gains per animal and shown a ten-fold increase in productivity per ha. CIAT's results enable a large increase in low cost animal production to occur in savanna lands, with the potential to protect forest lands by relieving the pressure to expand continually the grazing area to provide for the necessary production increase.

CIAT's impact to date has been insufficient to reverse Latin America's decline in food self-sufficiency, but without its contribution the situation would have been worse. Policies influencing agriculture are becoming more favourable in many countries, and the momentum of technical change that CIAT is helping to stimulate is steadily increasing. The juxtaposition of these two events raises the possibility that, with continued support of CIAT's activities, production deficits in Latin America could be overcome within the next decade.

3.7.3. Balance among programs, regions and activities

The budget of CIAT is balanced amongst:

- the commodities it deals with
- the major agroecological zones of its mandate area
- both social and production objectives
- a combination of research and other activities
- upstream and downstream research and the mix of scientific-social disciplines in use.

The starting point for ensuring adequate support to each commodity program is the concept of a "minimum research budget" (MRB), i.e., the budget which is necessary to maintain the essential activities of that program. In commodity research programs like those at CIAT, the activities generally regarded as essential include:

- germplasm collection and exchange
- filling the research gaps of major importance and wide applicability
- linking advanced and developing country research
- providing a focal point of commodity information and training.

There are no absolutes in determining the size and cost of these activities. It is unlikely that the MRB for any commodity would be less

than US $2 million per annum, an amount that would maintain the research unit but allow only limited active research.

In considering any allocation of funds among commodity programs a further series of considerations come into play. Amongst these are:

- the size of the industry
- the likely productivity of research
- the likely relevance of the commodity to the future of the region
- the scientific capability of national programs and the private sector.

The "size" of each commodity industry is a useful abbreviation for the agglomeration of four factors in assessment including: (i) the contribution of the commodity to the value of agricultural production at the national and regional level, (ii) its role in the diet, (iii) its production and use by different income groups, and (iv) the projected gaps between market demand and national production. Table 4 provides estimates from a congruence analysis for the first of these factors together with benefit:cost ratios for research. 1/

The broadest classification of the agroecological zones of tropical Latin America provides three groupings: (i) the Andean zone, (ii) the humid forest area, and (iii) the lowland savanna. Further classification of each by area in crops, pasture, forest and natural grassland follows with a listing of human and livestock densities and possible crop types. In considering commodity activities and their social implications across these regions, the general picture which emerges is that beans are largely found in Brazil and Mexico and on small farms in the highlands of other countries of Latin America and the Caribbean and in Africa. Rice is essentially a lowland activity of both small and larger farmers. Cassava is confined to small farms in the more marginal lowland soils and is especially important in Brazil and Paraguay. Livestock are widely distributed across all zones and sizes of farms. Land degradation is a particular problem in the upland areas, where intensive cropping is leading to erosion, and in the humid forest zone where, deforestation both for opportunistic cropping and for pasture expansion, is prevalent.

When the commodity allocations of CIAT are examined in relation to the components of industry size and other factors influencing priority setting, a number of additional observations arise.

1/ Congruence analysis is utilized as a first approximation for examining the allocation of a research budget among commodities. Value of production is taken as a proxi for the social value of each commodity. Other things equal, the rule is that each commodity should be given research resources in the same proportion as their share in the total value of production, i.e. research intensity equal to one.

Table 4. Congruence analysis and benefit:cost ratios for CIAT's commodities

Commodity*	Balance of** CIAT's research (%) R	Share of value of prod. (%) V	Research intensity (R/V)	Ben./Cost ratios***
Beans	35	9	3.90	8:1
Cassava	24	26	0.92	9:1
Rice	14	17	0.82	10:1
Trop. Pastures	27	48	0.56	15:1

(*) Bean production is taken for tropical Latin America (TLA) and Africa, cassava for TLA and Asia, rice for TLA and tropical pastures as beef and milk for TLA.

(**) 1989 budget: essential activities

(***) For a 10% discount rate; from "CIAT in the 80s"

Significant deficits in beef and milk, rice and beans are likely in the next decade even though many parts of the region do not lack a comparative advantage in increasing their production.

In rice CIAT's budget allocation is congruent with its relative economic and dietary importance, although the IRRI contribution to global rice improvement provides an argument for lower expenditure for research at CIAT, especially for irrigated areas. Rice yields appear to be approaching a physiological barrier, and improvements through CIAT research seem most likely, in the short term at least, through the breeding of strains adapted to new production areas and resistant to a wider range of biotic and abiotic stresses. In seeking to achieve these objectives in relation to areas where rice is most important, it is apparent that Brazil dominates production and has good national research facilities for this commodity. The emergence of a strong private sector, including research in rice, is also now apparent in Colombia and Brazil. In Colombia, Central America and the Caribbean, rice has particular importance, but in the latter two regions it also faces particular deficiencies in production and in research support.

Cassava production in Latin America is also dominated by Brazil, the producer of 80% of the region's total output. Paraguay and Colombia account for a further 15 percent. In Asia the largest producers are Thailand (40%) and Indonesia (40%).

In Africa cassava provides about 26% of caloric intake in the equatorial countries and 18% in the eastern and southern region. It is a crop which shows large differences in yield between experimental stations

and small farms, in part because the usual vegetative reproduction makes disease control particularly difficult.

Possibilities of producing cassava varieties which yield true seed are particularly attractive, while the emergence of the crop as a significant source of livestock and fish feed and starch encourages further research efforts. CIAT's overall allocation to cassava research is somewhat below what the economic importance of the crop might suggest, but as Brazil is the critical cassava center in Latin America, the national program in that country might reasonably be expected to carry much of the load, leaving CIAT to concentrate on modifying germplasm to produce greater disease resistance and true seed and strengthening its collaborative work in Africa with IITA.

Unlike those for cassava and rice, research allocations for beans at CIAT appear large, about three times what their relative economic importance would suggest. The contribution of beans to protein consumption is important in Brazil (20%), Mexico (11.4%) and in some countries of Central America and the Caribbean and throughout the highland areas of Eastern, Central and Southern Africa but not in most other areas.

Beans, like cassava, constitute an important part of the production system of small farmers. It is a crop on which limited research has been done in the past and where considerable improvements should be possible, particularly in stress tolerance. Somewhat hired research intensity might be justify on these grounds, particularly if bean research in Africa offers the opportunity for significantly higher benefits.

Livestock production based on tropical pastures is a major component of Latin America's agricultural economy. Meat and milk provide an important part of the diet of all income groups, and animal agriculture makes up an important part of small farm, as well as large operations. By those standards, research in tropical pastures appears significantly underfunded at CIAT.

Projected benefit:cost ratios are particularly high although advances in pasture research may take longer to achieve, given the nature of the crop and the adoption problems that come along.

New technologies in pastures offer significant promise as a deterrent to deforestation. Elsewhere in this report it is argued that destruction of forests is strongly associated with unsound policy measures and past failures to improve sufficiently the productivity of existing agricultural lands. Brazil and Mexico produce 65% of the total beef and milk in tropical Latin America, but tropical pastures research is relatively poorly developed in both national systems. The potential for improving large areas of low productivity pasture lands, particularly in the Llanos and Cerrado areas, is very large. Yet, present pasture research and development efforts in these areas, and particularly in upland regions, are extremely modest.

The data on which this analysis is based are not as good as one might wish, but they suggest that CIAT should consider whether it is giving too much relative attention to beans and insufficient to pastures

and livestock. Geographical focus may also warrant revision, with the Rice Program needing to give greater relative emphasis to Central America and the Caribbean, the Cassava Program to Africa, the Bean Program to all three areas and the Pastures Program to the upland areas of Latin America.

The dominance of Brazil in all these products, and the strength of its research system, suggest scope for even greater collaboration in research with that country and a greater devolution of some CIAT research to it.

The increasing urbanization of Latin America emphasizes the role of the urban poor as beneficiaries of CIAT's work. Their need for food adds urgency to CIAT's work on raising productivity and reducing production costs. No particular change in CIAT's relative emphasis on the efficiency vs. distribution problem seems needed at present.

The Panel is particularly sensitive to the complexity and detail required for any valid review of the allocation of resources. It is also aware that the principal usefulness of any formalized process of priority setting is to inform and make more explicit some of the elements involved in the decisions to be made regarding the allocation of the research budget. The purpose of the analysis in this chapter is not to suggest allocations, but to draw the attention of CIAT's policy makers to the need to pursue this topic in greater depth and be eventually prepared to modify the use of CIAT's resources in the coming years. The Panel would not wish to commit CIAT to a change in resource use based on the above observations.

3.7.4. Trends towards strategic research

3.7.4.1. Introduction

The Strategic Plan states that CIAT should move upstream in the 1990s. It supports this planned move on the grounds that recent developments in cell biology and genetic engineering offer great opportunities, that some national programs are growing stronger, and that the accomplishments to date in applied research make possible a diversion of efforts (usually within disciplines) to more strategic research.

The Panel would agree that recent developments in biotechnology present practical opportunities for problem-oriented research, and sections 3.1 - 3.4. discuss both the ongoing work and the opportunities that are being opened up. These sections draw attention to the crucial questions that need answering if the commodity programs are to make the needed progress. Increments in technology are usually gradual, but creative ideas are needed if major advances are to be made, and the Panel supports the move upstream to help provide these advances.

3.7.4.2. Intra-disciplinary collaboration

The Panel considers that another area where the Center can move further into the realms of strategic research, as well as providing improved coverage of some of the applied research areas, is in the field of intra-disciplinary research.

CIAT headquarters does not always have a critical mass of a particular discipline within a program, though it may have across programs. The Panel arranged informal discussions with intra-disciplinary groups (plant breeders, pathologists/physiologists, sociologists/economists, agronomists and post-harvest/seed unit staff) to learn how they collaborate across programs. The Panel was also interested in areas where intra-disciplinary collaboration could improve the support to commodity programs, in particular because young scientists today come to CIAT with a greater degree of specialization than ever before and thus have a greater interest in and capacity to contribute to upstream research.

At present the degree of collaboration varies considerably from discipline to discipline. The Panel is not advocating a formal matrix; it believes that scientists collaborate when it is to their advantage to do so and that collaboration works best when there is a well-defined problem focus. However, the multiple objectives espoused by CIAT (production of feed as well as food, income generation, post harvest processing and storage, sustainability of the environment and the recognition of the need to develop locally adapted germplasm) all add to the need for an across commodity as well as a within commodities focus. The Panel have therefore expanded on this theme for physiology and agronomy.

3.7.4.3. Plant physiology

Physiology research can lead to the improvement of crop productivity in terms of yield potential (e.g., photosynthetic efficiency, canopy structure, phenology), soil adaptation (e.g., resistance to mineral toxicities, efficient acquisition and use of mineral nutrients), climatic adaptations (e.g., drought, temperature, photoperiod), or crop quality (e.g., forage digestibility, consumer acceptability, nutritional value).

CIAT physiology research has been somewhat limited but recent appointments have strengthened the effort. Early appointments were a cassava physiologist in 1972 and a bean physiologist in 1974. More recently a bean physiologist was hired in 1983, a bean microbiologist in 1984, a pastures ecophysiologist in 1985, a cassava physiologist in 1985, a bean plant nutritionist in 1988, a pastures N cycling specialist in 1989, and a pastures plant nutritionist in 1989. The total number of plant physiologists is now seven.

CIAT has developed modest facilities for physiological research since 1980. These are now being upgraded to meet the research needs of the recently appointed physiologists. To keep pace with the demand further expansion of the facilities, particularly for the study of soil-plant relations, is presently being planned. Inter-program

cooperation will facilitate the purchase and use of advanced research equipment, the collaboration of universities or advanced research institutions in developed countries, the availability of graduate students (perhaps from LDCs), the assistance of experts in short-term consultancies, and increased instrumentation support at CIAT. Specific research themes which cut across commodity programs, such as root function in acid soils, might be among the subjects of formal upstream networks.

3.7.4.4. Crop agronomy

There is a very large gap between farmers' yields and those on experiment stations in three of CIAT's crops, as in most others. CIAT's breeding program and its production of new varieties have raised the yield ceilings for both experiment station and farmers, but they will not, of course, close the gap. It exists for many social, economic and technical reasons, and its reduction offers a good opportunity for productivity gains in the next five to ten years.

On-farm research programs have been able to elucidate several of the factors, often cultural and economic, which contribute to this gap, but agronomic research in the development of suitable soil and crop management technologies must surely present an important opportunity to help reduce the disparity. During the Panel's field visits, attention was drawn to the influence of CIAT's research philosophy; its high profile in plant breeding had induced some national programs to follow the CIAT role model and devote more resources to plant breeding than to agronomy. CIAT's strategy paper states that its Bean Program will stimulate national programs to develop sustainable and productive crop management systems. The Rice Program has expressed its interest in generating integrated crop management technologies for a more judicious use of agrochemicals. The Pasture and Cassava Programs also have agronomic work. All of the commodity programs have agronomic components in their regional programs. The Panel believes that each of the programs will have to generate crop management technologies; though these will be location specific in detail, the principles and the CIAT role model will be important. A better understanding of the problem posed by soil acidity, for example, would serve all the programs well, especially in their breeding work.

CIAT, with its large data base on crop performance over a wide range of environments, its Agroecological Studies Unit and its group of commodities covering a large number of environments, is in a strong position to use its intra-disciplinary strengths to understand crop behaviour under a range of agronomic and meteorological conditions. Breeding could be more sharply focused if the abiotic as well as the biotic factors were clearly understood, and the Panel believes that intra-disciplinary research could contribute to these and other aspects of strategic research.

3.7.5. Target groups and gender issues

Equity considerations have long influenced CIAT's orientation. This is clearly stated in "CIAT in the 1980s: Revisited":

> "CIAT has identified limited resource producers and consumers as the principal beneficiaries of its work. This orientation clearly associates quality of life objectives with production goals, thereby influencing commodity choice and technology design."

The "CIAT in the 1990s" strategy paper (September 1989) is similar in tone. It demonstrates further thought on both the geographic and research strategy implications of the general commitment and is explicit in mentioning both men and women. It highlights the fact that:

> "Consumers benefit most from agricultural research as increased productivity and reduced production costs lower food prices.....CIAT's strategy cannot aim exclusively at increasing production by low income farmers. The highest social return on research investment must be an important criterion in the formulation of the Center's strategies and its programs."

The more sophisticated discussion of outcomes and beneficiaries is also evident where the commodity programs spell out the targets of their own strategies. The dual targets of poor consumers and poor producers offer a strong rationale, particularly valuable to CIAT because of the dichotomy among programs. Beans and cassava are social crops, largely produced by small farmers. Most commercial output of rice and livestock products is from larger farms. Where markets are supplied almost exclusively by small farmers, technology development is particularly complicated in having to meet the acceptability criteria of both sets of producers, related to their production conditions, and of consumers related to their preferences.

In the June draft of "CIAT in the 1990s" (p.41), The Bean Program clearly relates its regional focus to its orientation to poor producers and consumers. The Program emphasizes that Africa and Central America deserve a high priority on all counts, while other areas merit are lower priority as fewer objectives can be achieved with each effort. The Cassava Program detects the beginnings of a shift in some Latin American countries to industrial cassava, produced on more commercial units, as rural population declines, and underlines its intention to reorder its priorities as the shift occurs. Finally the Pastures Program, while acknowledging that its major potential impact will be on the prices poor urban consumers have to pay, an issue increasingly important as urbanization proceeds apace, is also able to highlight a potentially vital contribution to stabilizing the activities of poor colonists on the forest fringes.

The Panel commends CIAT and its Programs for offering strategic conclusions which show great sensitivity to the physical and human circumstances within which they operate. They offer testimony of effective integration of social scientists into the Programs and they

validate difficult management decision on structure earlier in the Center's life.

Through the Agroecological Studies Unit and the Farmer Participatory Research Project CIAT is also continuing the development of methodologies to improve the targeting of research. The AESU is notable for its pioneering attempt at the macro-level to reconcile physical and socio-economic circumstance in identifying target areas, termed micro-regions, for the programs. It is a complex task properly thought of as strategic research. At the other end of the spectrum, at the micro-level, the Farmer Participatory Research Project is seeking ways to draw men and women into the research process in their capacities as producers, processors and consumers.

3.7.6. Socio-economic research

Socio-economic research at CIAT has long been integrated into commodity programs to ensure its inclusion in the work of multi-disciplinary teams. The Panel is of the opinion that this strategy has worked well. Everybody has benefited from strong interaction among commodity team members, and social scientists have been able to contribute to the setting of priorities in biological research. The work of the economists has been regarded as a team product rather than independent contributions. This has been instrumental for serious discussions and for consideration in diagnostics and proposals.

The opportunities economists have had to contribute have been greater than their capacity to respond. Methodological research for on-farm research work, strategic planning of commodity research, micro-economic support for development activities, adoption studies for generated technologies and ex ante analysis of the likely impact of research are the main areas around which economists have worked jointly with commodity scientists. Their productivity has been quite high with more than 300 publications in the last eight years.

Economic information on CIAT's mandate commodities was initially very scarce and, in the case of cassava, almost non-existent.

Economists and other social scientists can provide several classes of socio-economic information required within CIAT, by its crop scientists, by its administrators, and by the donors in allocating funds to CIAT. Crop scientists have clearly benefited from the integration of socio-economic research into the multi-disciplinary commodity teams. However, little use has been made of economic research capacity by CIAT administrators for Center-wide management decisions.

The Panel believes socio-economic research should contribute more to CIAT's work in the following additional areas:

(1) Issues of sustainability in estimating externalities of sustainable technologies,

(2) Ex ante analysis of likely impacts of research, second round effects, and the monitoring of impacts,

(3) Setting of priorities across programs and in other areas in support of research management decisions; and

(4) Issues related to the competitiveness of agricultural production in developing countries, production diversification, and adjustment problems, topics which are ready for inter-center cooperation in a scheme of regionally differentiated program thrusts.

The knowledge that CIAT social scientists have of farmers' adoption behaviour and their production systems, and other economic information pertaining to superior crop varieties and associated additional farm inputs and market priorities, is seen as a crucial input for some of the suggested areas of socio-economic research.

3.7.7. Sustainable agriculture and the challenge of the environmental degradation

3.7.7.1. The issues

CIAT's strategy paper states that sustainability is one of the three issues of most critical importance to the Center in the future. TAC has defined sustainable agriculture as "the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources". 1/ The converse would be the use of the wrong farming systems, in the wrong way on the wrong landscapes, to satisfy short-term needs.

The Panel interprets the TAC concept as embracing two objectives: maintaining a positive growth in agricultural production, while sustaining the resource base. Growth with sustainability would present no problem given unlimited resources, but sustainability is essentially a search for efficient long-run agricultural growth when resources are exhaustible. This means that social benefits must cover the social costs. The problem remains one of how to quantify some of the inherent problems. Negative indicators (loss of rainforest, loss of germplasm, sedimentation in reservoirs) are measurable. Some work has been done in Zimbabwe on the relationship between population density and land degradation; in well-defined agroecological systems this seems to give useful correlations.

1/ Sustainable Agricultural Production: Implications for International Agricultural Research, TAC, 1988.

The Panel's interpretation of the TAC concept is illustrated by some of the problems in tropical Latin America. The CIAT strategy states that much of the increase in bean production has come because of increases in land under cultivation, often in marginal areas. Cassava is also a crop of marginal areas. Current production practices put large areas of forest land at risk when brought into cropping and livestock production. In a very broad sense Latin America's marginal lands are the Andean hillsides and the Amazonian forests. Of CIAT's four mandate crops, only rice is produced on the better soils. Cassava, beans and pastures are grown in marginal areas in the sense that the soils are very low in nutrients and/or the topography so steep that soil losses occur under usual farming practices. However, environmental degradation is more than the loss of soils or vegetation. It is also the intensification of soil borne pests and diseases as cultivation intensifies and as fallow periods disappear.

The national governments with their control of policies and agricultural services, the international and bilateral development agencies with their funding, and the International Agricultural Research Centers as leaders of the global community of tropical agricultural research have vital roles in the effort to control environmental degradation. The CG Centers have two major roles. The first is to help define the approaches that will be needed to provide the technical and policy inputs for solutions of the problem. The second is to participate in research programs in which they have a comparative advantage in providing information, new knowledge and new technologies that will contribute to sustainability. In the area of policy, CIAT and IFPRI are collaborating in a project for the Peruvian Amazon. To make substantial progress on such problems inter-Center cooperation will be necessary.

3.7.7.2. CIAT's role

As an institution largely devoted to generation of new agricultural technology through commodity improvement, CIAT must be concerned with the interaction of technology and sustainability. The question is which of the problems involved in sustainability require research and then to select from among them those problems for which CIAT has a comparative advantage or can develop one at reasonable cost. Basically the Center has to convert the many ideas being expressed on the concept of sustainability into a very few operational projects.

CIAT has comparative advantages in creating new technologies that can meet the sustainability criteria. This can be done by conventional as well as non-conventional methods. Conventional methods relate to varieties that grow better in specific environments, including the related improved cultural practices and integrated crop management. Non-conventional methods, for which CIAT is actually developing comparative advantages, relate to work being done on such subjects as biotechnology, microbial associations, and physiological and environmental stresses.

Both sets of methods tend to reduce the "externalities", thus providing means for efficient production growth in the long run. An

important issue is whether the elimination of externalities results in slow-growth or fast-growth agriculture. Application of non-conventional methods and generation of superior technologies would support the latter. However, work with NARDS will be vital. Ways have to be found of marrying the short-term need for food with the long-term goal of sustainability.

3.7.7.3. Low input strategy

CIAT's philosophy is that research should aim to maximize the yields from germplasm at relatively low levels of purchased inputs. The Center emphasizes that low inputs does not mean no inputs. The inputs concerned include fertilizers, lime, herbicides, insecticides and fungicides. No mention is made of low energy inputs through machinery; small farmers generally do not use tractors, but rely mainly on animal draft power.

One reason for CIAT's commitment to a low input strategy is the fact that for many of its farmer clients inputs are physically unavailable or uneconomic. A second reason is that some inputs have a detrimental effect on the environment, mainly herbicides, fungicides and insecticides. Rice in Colombia typifies a high input system with pesticides applied by air on large farms. However, the small farmers of the world are also using pesticides (for example, fungicides on beans in Colombia and bean seed dressings in Rwanda). The IARC answer is to develop varieties that are pest and disease resistant, but some pests and diseases are not amenable to this approach; such resistance also tends to lose its effectiveness over time. Centers have been moving more towards an integrated strategy with agronomic and chemical as well biological approaches. CIAT's rice program is an example of this.

The Panel is concerned about how to reconcile the low input philosophy of CIAT with the concept of sustainability of agricultural production and the protection of fragile areas. Do low input strategies affect sustainability, or do they in some cases simply trade short-term gains for long-term losses? The main reason farmers expand into fragile areas is that they do not obtain enough production from existing areas. In the environmental sense CIAT could distinguish between low input systems that are needed from an economic point of view and those that are desirable from a technical and environmental point of view. Phosphate and lime may not be economic under certain present circumstances but they certainly present no environmental hazards. Intensified production on savannas, where land deterioration is not such a severe problem, would relieve some of the pressures on the fragile forest and hill lands. Apart from rice which is grown on both good and poor soils, on the latter as a pioneer crop, CIAT's mandate crops are often grown on poor soils, particularly in Latin America.

3.7.7.4. Growth in output

The Panel agrees that a research program should be designed to be congruent with the actual or potential resources of its clients, and should develop germplasm that performs better under a given level of

inputs than farmers' existing materials. But this poses the question: can this "nil/low input-modest output" system supply the growing demands?. In Africa population increases of 3% or more will continue for some time. Sustained productivity growth of this order has been achieved in some agricultural systems, using substantial inputs. Well documented studies of long-term trends in agricultural productivity suggest increases of 1% to 1.5% due to plant improvement alone. The Panel has thus strong reservations about the ability of low input/modest output production systems to produce sustained increases at the level needed and would suggest that the programs concerned look at the potentials of their low input strategy to meet the projected demands and to organize data, from their experience and information on the use of their improved varieties, to hypothesize what sustainable productivity increases are likely to be under their low input scenario (in terms of percentage increases per annum).

3.7.7.5. Assessments

The Panel believes that the work of the Agroecological Studies Unit should continue to be aimed at better characterization of agricultural production areas in Latin America. Such refinements would include the collection and analyses of data on climate, land and vegetation. Several international and many national organizations are concerned in the generation of such data. CIAT should aim for excellence in supplying agroecological information as it does for agricultural research information and information on germplasm. However, CIAT should confine its activities to those involved with its commodities. The Panel does not think that CIAT should become involved in the generation of primary data on the effect of land use on soil erosion and run-off or on land clearing technologies. Moreover, the Panel considers that CIAT can make a substantial contribution to the understanding of farmer attitudes to soil resource conservation through its on-farm research activities. Such work would also provide some of the concepts needed for improving predictions about farmer behaviour as land becomes a more and more scarce commodity.

The Panel believes that work could be expanded to include, for one or more of the ecosystems identified in Latin America, information on strategies for intervention including methodologies for characterization, analysis and evaluation of institutional and management approaches and training. The Panel believes that CIAT is in a unique situation in Latin America for organizing this type of work on behalf of, and in cooperation with, other Centers like CIMMYT, CIP, ISNAR and IFPRI. The Center should consider enhancing the capacity of the Agroecological Studies Unit to undertake such activities.

CHAPTER 4 - INTERNATIONAL COOPERATION

4.1. Relations with the Host Government

The agreement to create CIAT was signed in 1967, so that there has been a little over 20 years of interaction between the Center and the Colombian government. In such a familial relationship there are always minor irritations and differences in perception, but relationships have generally been excellent and the Panel commends both the Host Government and the Center for the efforts that have gone into the maintenance of these relations.

CIAT is in a rather different situation from several of the other crop-oriented Centers in that two of its mandate crops form a relatively low percentage of the total value of Colombia's agricultural production (Cassava 5.2%, beans 2.09%) and bean quality requirements for Colombia are rather unique. Even improved tropical pastures, while potentially of great importance, cover a small area at present. Consequently the attention that national agricultural research systems can give to cassava and beans is limited. On the other hand, CIAT's involvement, while of course done with a continental or global perspective, still gives it high profile in these crops compared with the local research effort. ICA, the Colombian research institution, and CIAT have had recently a review of activities and have signed an agreement through which steering committees will be organized for each CIAT commodity. It is hoped that this agreement will bring closer relations between the two institutions.

There is some sensitivity in the national program to the perception that the outside world lacks appreciation of the Colombian research system's role in CIAT's successes. The Panel can only commend the continuing efforts of all concerned to be sensitive to these perceptions.

4.2. CIAT and the National Research Systems.

4.2.1. Status of the national programs

The general perception from discussions in TAC, in the CGIAR and in CIAT's strategy paper indicate that the national research systems are getting stronger in the countries CIAT serves. Figures for expenditures and for numbers of scientists confirm this perception. For example, in tropical South America, investment in agricultural research (in constant 1980 dollars) has grown from $35 million in 1959 to $269 million in 1980, and the number of research scientists has increased from 570 to 4,840. For East Africa the corresponding figures are $13 million to $75 million,

and 220 to 1,600 research scientists 1/. The number of people trained by CIAT and other institutions over the years would also support the perception that national research systems should have grown in strength.

In certain respects, these perceptions are correct. There is certainly a much larger pool of trained scientists. But the development of self-sustaining research institutions has been hampered by shortages or violent year-to-year fluctuations in funding and by a lack of foreign exchange for essential equipment and libraries. Performance of NARS may also be constrained in some countries by poor policy commitment to research, few highly trained research scientists (critical mass), poor research planning and evaluation capacities, and the non-conducive research atmosphere created by lack of incentives and motivation which has almost extinguished creativity.

As a consequence the reality of the situation, confirmed by CIAT scientists working with the national programs and in the visits of the Panel to country programs, is that really strong self-sustaining national programs are the exception. Financial crunches, particularly the debt crises in Latin America and Government financial crises in Africa, have rendered many systems weaker and less effective than they were 10 or 15 years ago. In some countries, indeed, the research systems have stagnated and in a few have become almost inoperative.

4.2.2. Mission and strategy

CIAT continues to focus on strengthening and complementing the activities of collaborating national programs in the areas of its comparative advantage within its on-going programs. It offers collaborative and support activities to strengthen national commodity programs, and it seeks to catalyze and reinforce regional and sub-regional networks with the goal of progressive reduction in the need for CIAT input.

4.2.3. Regional programs and networks.

4.2.3.1. Introduction.

Regional programs directly involve CIAT in a particular region, in cooperation with national programs, to develop research activities and tasks which will strengthen the capacity of national agencies to generate agricultural technologies which will increase productivity and production. They normally provide the means for increased levels of horizontal cooperation and integration and facilitate the building of networks.

1/ Robert E. Evenson. The International Agricultural Research Centers. CGIAR Study Paper 22.

Networks are groupings of participating institutions and scientists interacting with each other around a priority commodity or problem in a way which will encourage horizontal cooperation.

Both regional programs and networks are usually monitored by committees of the participants and by day-to-day bilateral cooperation with NARS.

4.2.3.2. Regional programs

Regional programs are operated through outposted staff.

The Cassava Program has two staff in Bangkok to serve the Asian region, one in Brazil as part of a development project, and another located at IITA serving as CIAT liaison.

The Bean Program has twelve outposted scientist in East, Central and Southern Africa, two outposted scientists based in Guatemala and Costa Rica to serve the Central American and Caribbean region, and two outposted scientists in Peru and Ecuador to serve the Andean region. In addition it has an agronomist in Brazil. The twelve international staff stationed in Ethiopia, Uganda, Tanzania and Rwanda work with the national programs in breeding, agronomy, entomology, pathology, economics, anthropology and on-farm research. Three of these staff, the economist stationed in Uganda, the entomologist in Tanzania and the training officer in Ethiopia, have Pan-African responsibilities.

The regional program model based on outposted staff has been CIAT's mechanism to strengthen the national research systems, to feed in research products from its headquarters program and to feed back local germplasm and information for its headquarter programs. It is expected that such regional programs will phase down with the increasing strength of the national programs, but that networks will grow in strength and usefulness.

4.2.3.3. CIAT networks

CIAT networks (Annex VII) aim at increasing commodity productivity and production by breeding and selection for yield improvement and stability; developing more productive systems of cropping; and strengthening national research programs through training, information, germplasm and technical and material support.

CIAT has so far facilitated the creation of the following networks:

Title	approx. date
Central America and Caribbean Bean Network	1979
RIEPT (Pastures)	1979
Africa Great Lakes Beans	1983
Eastern Africa Beans	1985
Cassava Asia	1983
SADCC (Beans in Southern Africa)	1986
Rice in the Caribbean	1987
Andean Zone Beans	1988
IRRI-CIAT International Network for the Genetic Improvement of Rice (ex-IRTP)	1976

In general these networks have similar structures and governance procedures. They are generally funded through special projects with varying degrees of core budget.

Most have a steering committee composed of coordinators of the commodity program concerned in the national programs in the region. Steering committees are expected to:

- Develop annual work plans.
- Approve regional budgets relating to activities, including collaborative research projects. workshops, training, and equipment for national programs.
- Advise on consultancy visits.

These network structures, based on the steering committee model, appear to be a particularly successful innovation in allowing interaction and decision-making by the countries concerned, the donors and CIAT. In some of these networks (Central America and Eastern Africa) member countries are sharing responsibilities on selected research topics, thus complementing each other. The bean network programs in Africa have supplied germplasm, consultancies, training and equipment, and have organized workshops. Network researchers feel that they are part of the operation and are appreciated by the research staff of the participating national programs.

The Tropical Pastures Program developed RIEPT in 1979 to work *in situ* on pasture technology for the low fertile, acid soils of the tropical American lowlands. An advisory committee of national pasture research leaders was established to define common methodologies and research approaches and to provide general guidance on the development of network activities. The major characteristics of the RIEPT networks were:

- Funding independence; participant NARDS contribute to their own research funding.
- Superior germplasm which was generated by CIAT agronomists in major screening sites.
- Appropriate methodologies and approaches defined by the Advisory Committee.
- A data base at CIAT, freely accessed.
- *Pasturas Tropicales* bulletin that evolved from a newsletter.

The experience gained from RIEPT and the availability of improved grasses and legumes encouraged CIAT to cooperate with ILCA and IEMVT for the development of WAFNET (West Africa Forage Network) with emphasis on crop-livestock systems of the sub-humid savanna. Similarly CIAT has cooperated with national programs and CSIRO to develop the SEAFRAD (South East Asian Forage Research and Development) Network. CIAT plans to outpost two scientists, one in each network, for germplasm screening.

4.2.4. Future trends

4.2.4.1. CIAT's assessment

CIAT expects that the national agricultural research and development systems with which it works will improve in the quality and quantity of the resources at their disposal and that their research and development priorities will change over time. The complexity of conditions in national programs will be considerable; some may be better funded but short of operational support, with well-trained staff but a lack of funding. On-farm research will help close the gap between research and extension. Increased plant breeding capacity in some systems will enable them to take over work previously performed by CIAT. There will be more work on sustainability and export crops and some national programs will move "upstream".

The outcome of this will be a changing pattern of relationships between national programs and IARCs with a movement into a much more collaborative mode.

4.2.4.2. Sharing responsibilities with NARS

CIAT has already developed mechanisms for sharing responsibilities with NARS in the regional programs and in the networks and has established research cooperation with a range of NARS who are not integral parts of regional programs. Increasingly CIAT sees NARS taking up activities which were previously provided as a service by CIAT. The latter is part of the general evolution of NARS. CIAT has also developed mechanisms for NARS partners to participate in decision-making at the regional level.

CIAT has considered three ways in which it could institutionalize the sharing of responsibilities with NARS.

(a) by continuing the trends described above which are already in place;

or

(b) by developing projects with particular countries which are designed to utilize the comparative advantage of those individual country programs to do work which will be of value to other country programs within the overall international effort in a particular commodity. These projects would emphasize research which is of an additive nature to ongoing national activities and would involve

CIAT participation in the transfer of the technology to other regions of the continent and the world;

or,

(c) by transferring the responsibilities for particular groupings of activities to individual national programs, which would then be responsible for developing the normal international cooperation linkages with other countries where such new technologies could be accepted to have application.

In general CIAT sees merit in (a) and (b) above but not (c). The Panel concurs; the latter involves developing another complex of activities essentially duplicating those already available. It would no doubt generate resistance from small countries against a plan that would require them to depend on some other nation's program for assistance when an international and neutral alternative exists in the form of the particular IARC. The model (c) would be almost impossible in Africa given present circumstances and is probably unworkable in Asia and Latin America.

4.2.5. Assessments

4.2.5.1. Perception of CIAT in the national systems

In all countries visited by members of the Panel, CIAT staff have established excellent rapport with their colleagues in the national systems. CIAT is viewed as responsive to the expressed needs of the NARS and an important catalyst in motivating local staff and developing research plans. NARS leaders ascribe particular value to the training offered by the Center to key local researchers. Panel members were impressed by the quality of the CIAT field staff. They appeared especially sensitive to local conditions, relationships, and issues and gave every evidence of personal commitment to development in their regions. Their role in building sustainable research capacity through training and research collaboration, as opposed to conducting independent research, was evident. The Center has selected staff well for these assignments, in which outstanding personal characteristics and qualifications are needed.

Several NARS leaders particularly commended the recent collaboration in training between CIAT and CIMMYT, and urged more such examples. In this way limited resources can be combined to offer workshops that are not commodity-specific.

4.2.5.2. Strengthening systems and programs

Despite the effort that has gone into strengthening their staff and leadership, strong self-sustaining national programs are by no means common in the developing world. This is particularly so in Africa. Many national programs are generally handicapped by severe limitations of operational funds and foreign exchange funds for capital. Furthermore,

the research programming and management capacities are generally weak. These and other constraints limit the productive performance of the NARS.

The Panel believes that CIAT will need to continue its involvement with strengthening national research programs, into the foreseeable future. The nature of this involvement, the time horizon and the appropriate time to withdraw will depend on the individual country strengths.

By the nature of its work CIAT is uniquely equipped to strengthen national research programs in its specific mandate crops. But while there are spin-offs, one strengthened commodity program does not create an effective research institution. Moreover it is possible that the CIAT intervention pushes the national program towards the Center's mandate and priorities possibly creating an imbalance. Several such programs, as for example by a group of centers working in unison, would contribute much more to institutional development. Even more effective in the long run would be a combination of Centers and donors. This is, however, unusual and the Panel has noted that the normal pattern is one of a functioning commodity program operating effectively but below the management level of the national system as a whole. It is doubtful if such a program could survive if CIAT withdrew its technical and financial (usually quite small) support.

4.2.5.3. Research-Extension Linkages

Even when national research systems are strong, there is frequent criticism of the lack of linkages between them and extension systems. The major shortcomings are usually described as a lack of adaptive research and a lack of feedback about farmers' problems.

CIAT's work with farmers in a range of on-farm research programs has developed methodologies whereby these problems can be tackled. However, such programs consist of highly skilled manpower-intensive activities which are irreplicable at this time for most national systems on a system-wide scale. The Panel supports the principle that on-farm research is the vital link for the two-way flow of information to and from the research systems by way of the extension systems. However, its institutionalization raises formidable problems because of cost and lack of trained staff. The Panel believes that CIAT has a role in working with selected national programs to develop least cost on-farm research methodologies that could be widely applied within the level of resources available to national systems.

4.2.5.4. Training in research management for national systems

The relatively poor financial resources and their volatile nature make the management of national research systems extremely difficult. Unfortunately this situation will be the norm for many such systems into the foreseeable future and research managers have to learn to make the best of it. Formal training in research management could help. The Panel recognizes ISNAR's responsibility in this area but considers that CIAT's

knowledge of research systems, its contacts with the scientists involved, its reputation as a research organization and its understanding of the political processes are all advantages which could be utilized by those developing research management training programs.

4.2.5.5. CIAT networks

The steering committees of the African regional bean program appear to be a particularly successful innovation in that they promote information sharing and collaboration by researchers in the countries concerned, the donors, and CIAT. The aim is that the formation of these committees will ensure the sustainability of bean research when and if CIAT involvement ends, and that they will eventually become strong enough to attract and handle directly the donor funds currently channeled to them through CIAT.

CIAT's plan to reduce the number of staff assigned to the African region in five years may be overly optimistic. Indeed, there is some question in the mind of Panel members as to whether the current staffing in this region is sufficient, given the scope of the responsibilities CIAT accepted. For example, CIAT wants to fill one position in the Great Lakes Region with a pathologist with pan-African responsibilities, while the regional steering committee has opted for a breeder, although both are needed, while the single regional economist based in Uganda has a formidable pan-African agenda that is unrealistic.

It is expected that more multi-country regional sub-projects, particularly in Africa, will emerge in order that more than one national program is involved in a particular subject area. This will place more emphasis on increased horizontal cooperation and will increase the need in Africa for a Pan-African Advisory Committee made up of selected members from the other committees of a regional nature.

There will also be increasing pressures on CIAT to become more closely involved in research per se rather than limit their involvement to the institution building/research cooperation which is now evident. This will be stimulated by NARS evolution towards stronger commodity teams. The need for CIAT to be more involved will be dictated by problems still requiring strategic research on solutions; e.g. bean fly, nitrogen fixation in poor soils, cropping systems and soil erosion, etc.

The outcome of these pressures could be further dedication of particular scientists to research while still maintaining some staff in their present institution building activities. The Panel does not see the need for a special facility for the regional programs to carry out research. This increased research emphasis by CIAT staff should be possible through arrangements with national programs in the region.

The future of the three regional programs now in existence in Africa will depend on the donors' negotiations in 1991 and will be conditioned by the decisions taken by TAC with respect to essential/desirable staff categories and the related chances of finding the funds in CIAT core budget.

4.2.5.6. CIAT collaboration with strong NARS

CIAT's collaboration with EMBRAPA in Brazil in building that system's capacity to assist in agricultural development in Africa is worthy of special note. The outreach plans of this highly developed national system seem likely to provide an important model for future agricultural assistance.

Another example of CIAT willingness to share responsibilities with stronger national research systems is the drought resistance studies in beans which are under discussion between CIAT, Brazil and Mexico.

4.2.5.7. Recommendations

The Panel commends CIAT on its effective development of the steering committee model and network activities in Africa and Latin America and recommends that CIAT continue its support for these efforts.

The Panel notes CIAT's success in working out a model for collaboration with EMBRAPA in Brazil, in cooperation with IITA, in relation to the cassava program for the semi-arid parts of Africa. The Panel recommends that CIAT continue to work toward similar outreach plans with other highly developed national systems.

The Panel appreciates the initiative of CIAT staff in Africa for inter-Center collaboration in training and research, and recommends that CIAT headquarters reinforce these efforts.

The Panel recommends that CIAT pool its knowledge and experience with others, including ISNAR, for the training of research managers.

4.3. Relationships with Regional and International Organizations

4.3.1. CIAT activities

National programs of countries collaborating with CIAT are simultaneously associated to regional organizations that carry responsibilities for research and technical cooperation in agriculture. With CATIE (Turrialba, Costa Rica), CIAT maintains relations through the RIEPT, and conversations are under way to develop joint activities around sustainability issues in the humid and sub-humid tropics. CIAT is working with PROCIANDINO and support for CARDI through the PROCICARIBBEAN Network is under discussion. Through the Beans Network of Southern Africa CIAT maintains relationships with SACCAR.

4.3.2. Assessments

Regional organizations, either of research or technical cooperation, have a great deal of experience in working with national programs and could be of help to CIAT in strengthening networking

activities. This is the case for IICA and CARDI; both institutions are actually involved in conversations with IDB for the establishing of networks in Central America and the Caribbean region. CATIE, besides collaborating with CIAT in tropical pastures research and in holding duplicate samples of Center's germplasm collection, offers possibilities for working on issues of sustainability through its recently created Integrated Natural Resources Management Programs. The Panel is aware of talks underway to strengthen CIAT's relations with these regional organizations.

4.4. Collaborative Research with Universities and Other Advanced Institutions

4.4.1. CIAT activities

CIAT has a large number of collaborative research projects with institutions in developed countries. The 1988 list (Annex VIII) included projects with 13 universities (6 USA, 4 FRG, 2 Belgium, 1 Israel), two sister Centers (IRRI, IITA) and a range of research institutions in Italy (5), UK (3), Colombia (1), FRG (1). More projects have come on-stream since the 1988 list was prepared. These projects aim at increasing the understanding required for the solution of production problems, and involve the use of research techniques in which CIAT does not have comparative advantage within its on-going programs.

This collaboration is dynamic and new projects are continually being negotiated. The system is CIAT-driven in the sense that CIAT defines the research needs and project ideas normally come from staff, management and sometimes CIAT collaborators. Considerable flexibility by CIAT is required to cope with differing bureaucratic requirements of the donor agencies in collaborating countries. The funds for these projects come from extra-CIAT sources in most instances.

Some developed countries do not have collaborative research projects, and some in particular are notable absentees from the list of countries contributing to CIAT's collaborative projects. The lack of appropriate funding mechanisms in some developed countries for this type of collaborative research was one of the topics at the inter-Center meeting held to discuss this type of research cooperation at Bad Homburg in FRG in 1987. The issue here is that collaboration with some centers of research excellence is excluded because of current funding procedures. Hopefully, the steady expansion in advanced research networks will provide a stimulus for all donors to develop an interest in these projects.

4.4.2. Assessments

Collaborative research projects between CIAT and developing country institutions and universities are now emerging particularly through the regional programs. Funding for more basic research areas is hard to identify. Projects of a more applied nature are normally funded through the Regional Steering Committees in the category of regional sub-projects.

The Panel supports and encourages increased involvement of the academic staff from universities in research projects as partners with national research programs. In 1989 CIAT has budgeted US $100,000 for such contract research and innovative initiative.

The Panel encourages CIAT in devoting funds to developing country institutions and/or universities. It also applauds the effort CIAT is now making to strengthen the training available to the academic staff of some universities.

CIAT has reinforced contacts with universities in the developing countries through CIAT training programs, sabbatical leave visits to CIAT and CIAT information systems.

To date the expansion of upstream research of this type has not involved CIAT in significant extra costs, but staff visits, project preparation and supervision costs are increasing and need to be carefully budgeted.

4.5. Collaboration with Other International Research Centers

4.5.1. CGIAR centers

An IRRI liaison scientist has been continuously stationed at CIAT with responsibility for the International Rice Testing Program in Latin America. A more general agreement of cooperation for achieving closer collaborations and joint activities has been effective since 1984.

CIAT and IITA have common interests in rice and cassava. Collaborative work in rice has been good and discussions are underway to further increase joint work with WARDA, IITA and IRRI. In cassava research, traditionally a source of some friction between the Centers, things are much better now and CIAT has stationed a liaison scientist at IITA.

A joint collaborative agreement between CIAT and ILCA was signed in March 1983. This made it possible for CIAT to base its East African bean work in Ethiopia, using ILCA as headquarters for support services and as a legal base. The agreement provides for a wide range of joint activities including germplasm and Rhizobium collection transfers and preservation, the interchange of documentation and training materials, joint workshops, the interchange of staff and the establishment of an International Tropical Pastures Evaluation Network.

CIAT also maintains relations with other international centers by hosting scientists and their experiments, when work is of relevance to the region but CIAT has no assignment of responsibilities for it. CIAT provides a base for regional staff of the CIMMYT Maize Program. CIMMYT gives advice on suitable maize cultivars for use in on-farm research, as well as materials for on-station trials. An IBPGR regional coordinator is based at CIAT under a CIAT/IBPGR collaborative agreement by which assistance and support is obtained with germplasm collections.

Regional Staff from the IFDC, INTSORMIL and INTSOY are also based at CIAT. With IFDC in particular, joint research is currently carried out in the context of the phosphorus project and CIAT's commodity research programs. CIP is also getting administrative support from CIAT for its work in Colombia.

4.5.2. Other non-CGIAR international agricultural research centers

Apart from the long-standing interaction with the International Fertilizer Development Center, which has a staff member hosted by the Center to work collaboratively on sources of phosphate, CIAT has few interactions with IARCs outside the CGIAR. It has no agreements or contracts with other international centers. The other limited interactions which exist are on an informal basis.

CIAT has contact with the Asian Vegetable Research & Development Center (AVRDC). AVRDC screens for bean fly for CIAT in Taiwan. If a CIAT Regional Bean Program is set up in Asia, snap beans are likely to be a central component and would encourage closer collaboration with AVRDC. Currently there are contacts on snap beans both with AVRDC and China but for the near future geo-politics may frustrate more formal relationships.

CIAT is also discussing bean fly research with the International Center for Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya. CIAT is interested in help from ICIPE to look at the physiology of the fly. CIAT also has limited contact with the International Council for Research in Agroforestry (ICRAF), also in Nairobi. In both cases only initial discussions on possible areas of mutual interest have been held.

4.5.3. Assessments

The Panel strongly supports the intensifications of collaboration of CIAT with other CGIAR and non-CGIAR Centers. Networks and in-country training offer opportunities for inter-center collaboration in downstream activities that are already underway. Issues in biotechnology and sustainability deserve exploration for inter-center collaboration. Upstream research brings methodologies, training and highly sophisticated equipment and there should be space for mutual consultations and exchange of experiences. Sustainability is another area for which the Panel recommends CIAT contact with other Centers for an integrated approach. Regarding hosting scientists from other Centers whose work is of relevance to the regions, Panel recognizes that many times CIAT facilities offer great help to their research activities. However, it should be kept in mind that NARS appreciate staff posted in their own programs, working with national colleagues on a daily basis through the local research infrastructure.

CHAPTER 5 - TRAINING AND COMMUNICATIONS

5.1. Background

The review of Training and Communications comes at both a difficult and opportune time. Extensive changes in policy and program have occurred or are planned. A fundamental reorganization has resulted in a new Training and Communications Support Program (TCSP) comprising five specialized Units: Training and Conferences, Publications, Information (library and bibliographic), Graphic Arts, and Public Information and Public Relations.

By normal staff attrition, three of these Units and the Program as a whole will have had new leadership over a two-year period. A more comprehensive goal statement has broadened the TCSP role:

- To support CIAT's research and institution-strengthening roles through the training of NARDS staff, provision of scientific and technical information, promotion of cooperation among NARDS and between them and CIAT, and fostering a favourable policy environment for agricultural research through public information.

5.2. Staff and Budgetary Resources

For many reasons the TCSP budget does not give a realistic picture of training and communications expenditures. Direct costs of training (travel, lodging, training materials, etc.) are a major outlay, but more than 40% of those costs are now coming from special projects, home countries and other outside sources. Commodity programs provide an enormous amount of training service without budgeted cost, and also contribute their energies to the preparation of training materials. TCSP units generate some income from sales, and special project funds pay for other aspects of their work.

In 1988 CIAT's core budget provided $2,882,000 for the Training and Communication Support Program, a little less than 11% of the Center's total. About 35% of the TCSP core budget is allocated to documentation and dissemination, 25% to specialized courses, and 20% to individualized training. Conferences and seminars account for about 10%. A modest but desirable allocation is shown for research on making CIAT's communication of technical and scientific information more efficient.

Authorized core staffing for 1989 included four senior staff and 39 scientific and supervisory personnel. The Units are definitely not overstaffed for the work they are expected to do.

5.3. Training: Defining CIAT's Objectives

Since the early 1980s CIAT has sharpened its training priority focus to increase its attention to building national research capacity. Preference for its commodity-specific production courses has been given to research-oriented participants who also take a second phase of individualized disciplinary training to strengthen their role in their commodity research teams at home.

Research strength has also been built by ad hoc group events and individualized training in single disciplines or related to particular problems or techniques.

Although CIAT was never in a position to give fellowship aid to graduate students, it also reaffirmed its interest in supporting their M.Sc. and Ph.D. study by offering opportunities to do thesis research in cooperation with scientists at CIAT.

5.3.1. Activities: training

Training is important in each commodity program. Half of the senior staff and 80% of the support staff spend at least 150 hours a year in support of training goals. Throughout the 1980s the training function grew steadily. There were 80% more rice program trainees at CIAT headquarters in 1986-88 than in 1980-82. Increases were 64% for cassava, 40% for tropical pastures, and 34% for beans, for an overall increase of nearly 50%. One notable expansion has been in training for the emerging field of on-farm research, at headquarters and also in-country.

Relative subject emphasis on training at CIAT and in-country is shown in the following comparative figures:

Number of Participants in CIAT Training, Jan. 1 - Sept. 1, 1989

	at CIAT	in-country
Agronomy/production; utilization/processing	69	113
Seed production, technology	39	56
On-farm research; farming systems	53	132
Disciplinary specialties (entomology, pathology, physiology, soils, soil microbiology, economics)	61	20
Breeding, genetic resources	21	0
Research techniques and methodologies	61	0
Other	4	38
TOTAL	308	359

The Training and Conferences Unit is expected to coordinate all training activities, but to base them on agreement with commodity programs as to "objectives, methods, and responsibilities for input."

Each CIAT commodity group has two training associates who carry much of the load of organizing and managing training events. Another training associate works with the Seed Unit. The Training associates have made an effective and indispensable contribution to CIAT's success in training. Although budgeted through the Training and Conferences Unit, they are physically housed with the commodity scientists of their program. This has promoted good personal relationships, excellent and prompt communication, and reconciling of commodity and training concerns. Although training associates are support staff, they travel widely among cooperating countries and work closely with national program staffs; thus besides implementing training they often also become involved in the design and planning of training efforts.

CIAT continues to be interested in supporting graduate study for young scientists. During the first eight months of 1989 it was host to 23 students doing thesis research, 11 of them at the Ph.D. level. Students from developed countries who bring their own financial support always make up a large share of both totals; regrettably only 5 of this year's Ph.D. research students are from developing countries.

5.3.2. Achievements: training

Between 1980 and 1988 CIAT had provided training at its headquarters station for nearly 2200 professionals. More than 90% were from Latin America and the Caribbean. CIAT's appraisal is that "by and large a satisfactory capacity of human resources for adaptive research has been developed in most countries where CIAT's commodities are important and where the Center is expected to operate." Although Chapter 4 of this report appraises the situation more cautiously, it recognizes that CIAT's training achievements have greatly improved the human resource component of agricultural development.

5.3.3. Future activities: training

5.3.3.1. Training strategies

CIAT's strategic plan for the 1990s deplores the fact that "existing technology transfer professionals have usually received little if any specific training to perform their role effectively, and the NARDS lack the capacity to meet this need." At the same time, the Center questions whether such training is the best investment of the scarce time of CIAT scientific personnel or other Center resources. To deal with this dilemma, CIAT is now committed to the following training strategy:

(1) Training at CIAT headquarters will move increasingly away from multi-disciplinary courses oriented toward crop production and utilization. Stress will be placed, instead, on the disciplinary training or other advanced scientific specialization.

(2) CIAT will give vigorous leadership to the expansion of training capacity at regional and national levels, both for adaptive and on-farm research and for commodity production problem diagnosis and solution (and the seed sector).

(3) As national or regional capacity grows, CIAT will reduce its direct involvement in in-country and regional training. (Provision of training materials is, however, seen as a more or less permanent function compatible with CIAT's obligation to convey its research product to ultimate users).

This three-part strategy is consistent with TAC's advice (CGIAR Priorities and Future Strategies) to "scale down the production and breeding courses at headquarters" and "continue to offer at headquarters the short, highly focused courses in research methods and specialized skills." The training strategy of the future will depend heavily on how well CIAT keeps informed about specific country needs. Senior scientists at CIAT have wide knowledge of country staffing situations. Nevertheless, the frequency of personnel shifts both at CIAT and in national programs make that knowledge vulnerable. The Panel recommends that CIAT systematize its on-going inventory of national program training needs and its schedule for filling them. This will require consultation not just with leaders in commodity research programs but with national research leaders. CIAT commodity scientists will need to pool information with CIAT training personnel (especially the training program leader) and also work with other IARCs to identify deficiencies.

5.3.3.2. Training the trainer

A major change in CIAT training strategy will be to pursue energetically TAC's advice to "concentrate on the training of trainers to work at the national level and on the preparation of training materials". CIAT's primary emphasis in its program of training trainers will be on assisting and encouraging NARDs to "set up or strengthen their own apparatuses to meet the more downstream training requirements of their professional staff." National training capacity is more realistic for large countries than small, and CIAT will be prepared to support regional as well as national efforts.

CIAT's first systematic Train-the-Trainer effort has been in a rice program in the Dominican Republic. Working with national programs in Central America and the Caribbean, CIAT selected participants it was confident would have training responsibilities at home. The course is producing modules and outlines for rice training which the participants expect to offer there. CIAT will continue to provide them with advice, further in-service training, and suitable training materials.

The Bean Program is also at work on plans to strengthen in-country/regional training in Central America and Brazil, and over time the cassava and tropical pastures will move in a similar direction.

The Panel endorses experimentation with the train-the-trainer strategy but sees a danger in relying too heavily on it. The stragegy will succeed only to the degree that national partners have both the will and the resources to build training programs of their own or make a durable commitment to regional cooperation. It depends on countries choosing good potential trainers, keeping them in that function, and providing them with facilities and support -- giving them a job to do and the tools to do it. In many countries those are unrealistic expectations at this time. The Panel endorses the goal of relieving CIAT of responsibility, as soon as possible, for training either in adaptive research and production or in the "downstream" functions of technology transfer. The Panel expects that a mixed and changing strategy will be used, depending on the CIAT commodity and also on the relative size and strength of the national programs with which it works.

5.3.3.3. Individual and specialized training

For a long time CIAT scientists have been increasingly involved in individual, as contrasted with group, training activities. This trend is expected to continue, at least for headquarters training. Individualized training is expensive, labor-intensive, and time-consuming. Considerable vigilance will be needed to insure that it is well-planned, well-supervised, and carefully evaluated.

In 1988 the Biotechnology Research Unit offered "second generation" training to established commodity scientists who wanted up-dating on tissue culture. This year the Bean Program plans a more general refresher course for mid-career scientists. Need for this kind of up-dating will grow, and CIAT is to be commended for taking the initiative in offering it.

5.3.3.4. Support for M.Sc. and Ph.D. study

CIAT program leaders do not consider thesis research students a burden, and report unused capacity to cooperate in thesis research. It is becoming increasingly clear that the problem is much more one of money than of structure. Additional funds are desperately needed to support graduate study for agricultural scientists in the developing world. If they were available, the other problems of CIAT support to M.Sc. and Ph.D. study would not be insuperable.

The Panel renews the urging of previous reviews that CIAT seek funding for full fellowship support for graduate study, including thesis research with CIAT, for present or prospective collaborators in country programs.

There is a wider pool of graduate students from developing countries who are not now involved with CIAT commodities or cooperating

country programs. CIAT does not consider it efficient to use its scarce thesis research facilities to support them, because their commitment and future employment are uncertain. However, the Panel believes the Center could benefit by offering a limited number each year of "thesis assistance grants" (international travel, meals, lodging, and the normal research costs) to persons from developing countries who are not now in national programs but who are interested in doing research at headquarters on CIAT commodities. The probable flood of applicants for such awards could be turned to good use if highly competitive awards attracted more of the best young scientists to CIAT commodities.

5.3.3.5. New demands from evolving programs

The 1980-87 total of 131 headquarters trainees from Asia and Africa is expected to increase sharply as CIAT gets deeper into its Asian cassava and African bean programs. In the first eight months of 1989 alone, CIAT's headquarters station was host to 36 Asian and African trainees.

CIAT's programs have developed impressive and well-regarded in-country and regional training activities in their regions. These include courses, workshops and monitoring tours and are often inter-center in nature. The Panel commends CIAT's willingness to go some extra steps to serve these distant clients, and urges a continued effort to do so.

5.3.3.6. Staffing for training

As CIAT shifts its training emphasis, the expanded program of specialized "up-stream" training will necessarily continue to be firmly the domain of the scientific staff. But program scientists cannot relinquish their ultimate responsibility for the content of in-country programs, nor should training associates withdraw from support of individualized training at headquarters.

The Panel suggests that responsibilities of commodity program staff and Training Associates may need clarification as CIAT takes on new leadership in promoting in-country training. It strongly urges CIAT to:

(1) More formally define the duties of training associates.

(2) If those duties are likely to grow, make sure associates have the necessary in-service training opportunities to equip them to do the work expected of them.

(3) Even with the present scope of duties, recognize that persons in such a key training role need greater opportunities for continued professional growth. This growth could be in training skills and computer competence as well as in their disciplines.

5.3.3.7. Coordination and cooperation

Proposed changes in CIAT training strategy will require increased cooperation and coordination with other regional and international agencies. CIAT has already initiated such efforts in the 1987 agronomy trials training course in Ethiopia (with CIMMYT) and the forthcoming Central American regional training in on-farm research (again with CIMMYT). CIAT has also run joint training courses with IITA in Africa on field methods for grain legume research. The Panel commends CIAT's awareness of this need for inter-agency cooperation in training, and particularly encourages CIAT efforts to offer training in cooperation with other IARCs.

5.3.4. Assessments: training

The achievements of CIAT in training are impressive. CIAT alumni are in key scientific and administrative positions in most countries of Latin America. Users uniformly applaud CIAT's attention to training materials. Training manuals are described as helpful and comprehensive. Good progress is being made in translating a number of CIAT's key Spanish-language materials on beans and cassava into English and French to meet CIAT's new training needs on other continents.

There is also appreciation of and considerable demand for CIAT's widely acclaimed audio-tutorial materials, although the prices necessarily charged to cover production costs are high enough to raise the question of how realistically available these materials are to poor countries and to institutions facing fiscal and exchange problems. The Panel concurs in CIAT's view that the 1984 EPR recommendation (to assign a permanent staff position to leadership of the Audiotutorial Materials Section) is too narrow considering the changes that are occurring in training needs and technology.

Facilities for training at CIAT are in general excellent. No obvious deficiencies exist in the quality and equipment of classrooms, provision of teaching aids and training materials, outdoor recreation facilities, lodging, and meal service. Facilities for study and group social/cultural appear to be less satisfactory.

The Panel suggests that CIAT use trainee evaluations and its own planning devices to find out how much the lack of these study and social facilities reduces satisfaction with training and how the deficiencies can be remedied.

5.4. Information Services

5.4.1. Objectives: information services

The Information Unit is primarily a library and documentation enterprise. It maintains a comprehensive collection of the printed references likely to be required by CIAT scientists, a computerized

bibliographic database on CIAT commodities, and access (on-line or otherwise) to similar databases elsewhere.

CIAT has also accepted the goal of making its materials and bibliographic service easily accessible to scientists elsewhere.

5.4.2. Activities and achievements: information services

The library's book collection now comprises about 43,000 volumes, and 10,000 more are available on microfiche. A Bibliographic Bulletin listing all new non-serial library acquisitions goes regularly without charge to CIAT's own scientists and to 160 institutions worldwide with whom it has exchange relationships. The library also maintains files of 2,800 serials or journals. Many of the library's materials are not yet covered by a computer-accessible catalog and abstracts, but a budget allocation has already been made for that purpose.

Three commodity information centers (Scientific Information Centers, or SINFOCs) also maintain comprehensive collections, emphasizing the kind of materials not usually held in libraries. The 10,000 documents on cassava and a similar number on field beans are the largest collections of their kind in the world. About 6,000 items have been collected on tropical pastures. All three collections are computerized and regular bibliographic publications or the results of searches are generated as printouts. CIAT's bibliographic services are principally made available to scientists elsewhere through commodity Abstract Reviews issued two to four times a year for cassava, beans, and tropical pastures. Current technology has made it relatively easy to produce items like the recent special bibliography on Beans in Africa and a similar one in process on cassava in Southeast Asia. The Pages of Contents of 900 scientific journals are assembled and published for distribution at regular intervals to 700 subscribers in all parts of the world. CIAT then offers photocopy service to provide any subscriber with a full copy of any article whose title proves of interest.

5.4.3. Future activities: information services

Those responsible for library and SINFOC collections are exploring distribution of compact disks instead of printed bibliographies and printouts, so that users can search at their own convenience in their own institutions. Whatever ultimate choices are made, this alertness to opportunity for change is commendable.

The Panel urges CIAT management to assist the Unit in following, evaluating, and making efficient use of the new and emerging technologies for providing bibliographic service.

5.4.4. Assessments: information services

Users of CIAT's bibliographic services are unanimous in their enthusiasm for it. The library is valued by CIAT staff, who also use the copying service extensively. The published bibliographies it distributes have a valued place in libraries where CIAT commodities are important.

Non-users are perhaps more of a problem. For example, in 1988 there were only 65 cassava abstract and 23 bean abstract subscribers in all of Southeast Asia and Australia-New Zealand. Only 4% of 345 bibliographic searches requested from the SINFOCs came from all of Africa and Asia, while 40% came from Colombians not directly associated with CIAT. Less than 5% of the requests for photocopies of reference materials from the CIAT collection in 1988 came from outside Colombia and only 23 requests from all of Asia and Africa.

Cost is no doubt a factor, but CIAT is not unwilling to subsidize target users if it can find reasonable ways to do so. What is striking is the enormously greater use of all of these services by Colombian scientists and students than by those from other countries. This is not a cause for complaint; it is mentioned only as evidence that a service highly valued in the immediate region ought to be attracting a similar level of use in other countries where CIAT's mandated commodities are important.

The Panel recommends that CIAT explore ways to get wider awareness and greater use of its SINFOC commodity collections and other bibliographic resources. It suggests that photocopying charges be reviewed to see whether any revision in rates is feasible, justified, and likely to promote use of the service by CIAT's intended users. It also notes that other IARCs are developing bibliographic database capacity like CIAT's, and endorses CIAT interest in shared effort and cooperation.

5.5. The Publication Function

5.5.1. Activities and achievements: publications

The Publications Unit produces or cooperates in producing CIAT annual and program reports, network newsletters and publications, books and technical reports, seminar and conference proceedings, and training materials. An innovation in the past 18 months, the introduction of ENGSPAN (computer translation from English to Spanish), has given CIAT interesting new capacity to provide English language scientific reports to Spanish-language users.

5.5.2. Future activities: publications

Most CIAT publications now are addressed to researchers working with its mandated commodities. But CIAT feels it has unique capacity to serve "technology transfer intermediaries" as well, because of the expertise and experience of its staff in diagnosing production problems

and offering technological solutions for a wide range of ecologies and farming systems. CIAT hopes to be able, over time, to have some of its "publication editors" take on new duties as "writers" to help scientists convert their material into usable popular form.

5.5.3. Assessments: publications

CIAT publications have an enviable reputation for the accuracy of their contents and the care with which they are edited and produced.

Demands on the Publications and Graphic Arts Units have increased greatly in recent years, and the trend will continue. Up-dating of older materials, service to networks, and growing demands of the CIAT public information effort will add to the normal workload. In addition, the strategic plan commits CIAT to the new task of making available "specialized materials to the whole spectrum of upstream to downstream oriented audiences, including technology intermediaries."

The proposed budget and staffing pattern for 1993, which show no significant increase, raises questions as to whether the workload issue is being squarely faced. There has been considerable unhappiness throughout CIAT about slowness in production of publication, and the blame is properly put on limited resources to keep up with the load.

One problem may be the lack of a systematic way to prioritize publication requests and needs. If resources are scarce, careful choices must be made about publication length, urgency, format and distribution. The Panel recommends attention to the balance between demand for services from the publication program and resources available for it. It also urges that the expected audience and intended use for each publication be taken into account in setting priorities.

The Panel believes that commitment to publications in aid of technology transfer should be approached with caution, limiting them to materials that are general (i.e. not location-specific) in nature, that emerge from CIAT's own research, and that do not reduce its capacity to produce needed publications or deliver other services to the scientific community. An already overloaded unit must not be assigned new duties without either new resources or relief from some current obligations.

Where publications go and how they are used is the ultimate measure of their value. The Panel welcomes CIAT's decision to review its mailing lists and target more carefully its publication announcements and distribution. In light of budgetary and exchange problems in many national programs, the Panel recommends careful analysis of policies for pricing publications and other CIAT materials to make sure they accomplish the desired distribution.

5.6. Program Activities in Transition

5.6.1. Conferences, visitors

The Center has a good conference facility that offers a favourable setting for productive exchanges among technical and scientific people. Fifteen to 20 conferences are held a year, and total attendance is at least 600 or more. The conference program is managed, with no apparent serious conflicts or problems, within the framework of the training structure.

Much conference activity is commodity related. Typically, two to four times a year there are meetings of bean, cassava, tropical pasture or rice groups. Interaction among institutions is encouraged; within the past year CIAT was able to co-sponsor a useful conference with IITA and CIP on questions of root/tuber production.

Two changes in operation are planned: without reducing service to commodity programs, the array of conferences each year will become more varied, involve new partners, and include more cross-disciplinary or center-wide issues. Conference management will also go beyond logistical questions to include advice and help on how to structure conferences to make them more productive.

5.6.2. Public information

Besides press releases and media contacts, CIAT relies on two major public information tools: CIAT International and CIAT Report (Informe CIAT). Both publications have been very well received, are of good professional quality, and merit continued support.

CIAT International is a magazine-type publication which is scheduled to appear twice a year with reports in popular language on CIAT program changes and research achievements.

CIAT Report, issued annually in English and Spanish for general distribution, gives a brief but systematic overview of the year's program, highlighting activities of special importance. Money has been saved and reader needs better served by issuing the detailed annual reports for each programming unit as separate publications for a more limited circle.

CIAT's strategic plan stresses that in coming years a more aggressive policy will be followed "to make the importance of CIAT's activities as widely known as possible." The industrialized countries are mentioned as well as the developing nations in which CIAT commodities are important. The Panel agrees that continued effort along these lines is desirable, with particular attention to CIAT efforts to carry out a research program that is fully consistent with sustainability goals.

5.7. Recommendations

The Panel recommends that CIAT systematize its on-going of national program training needs and its schedule for fillir This will require consultation not just with leaders in commodity resea... programs but with national research leaders.

The Panel recommends that CIAT explore ways to get wider awareness and greater use of its SINFOC commodity collections and other bibliographic resources.

In light of budgetary and exchange problems in many national programs, the Panel recommends careful analysis of policies for pricing publications and other CIAT materials to make sure they accomplish the desired distribution.

The Panel recommends attention to the balance between demand for services from the publication program and resources available for it.

CHAPTER 6. ORGANIZATIONAL STRUCTURE AND PROCESS 1/

6.1. Introduction

CIAT's management, like that of the other IARCs, faces a continuing challenge of balancing requirements for greater efficiency and accountability with the need to create an environment that fosters innovation and scientific progress. Increasing size and growing pressure from donors seeking reassurance for their treasuries that their money is being used effectively impose the demand for accountability, and the need to respond to donor pressure is a fact of life for the centers. If anything, it is likely to grow if the rate of funding increase declines and more activities are added to the CGIAR System. On the other hand, scientists worry that more and more of their time is taken up in responding to these pressures.

CIAT's scientific staff are already extremely busy. The reasons are obvious: a heavy travel schedule, a huge number of visitors, many reviews and meetings, and no "closed" season for field work. They have a large cadre of excellent support staff who must be kept busy on the essential routine work. Time for analysis and reflection on the progress of research is limited.

There are other pressures upon CIAT as well. The Center must decide how to incorporate the issue of sustainability, how best to respond to the pressing but disparate needs of the NARS and how far and how fast to move some of its work upstream. Most of this will require increasing collaborative work: collaboration among CGIAR and non-CGIAR Centers as they work with national programs and regional networks and organize training; collaboration with other centers, multilateral organizations, and national programs on sustainability issues; and collaboration with advanced laboratories in upstream work. The elements of all these have existed in previous decades, but they will certainly grow stronger in the 1990s.

These pressures are also certain to lead to changes in research thinking. For example, upstream research may well be more speculative than the research that is currently the norm; the probabilities of success are less, while the possibility of a high payoff from such isolated successes is greater. It is relatively easy to predict that a plant breeding program, given time and resources, will come up with an improved plant and to measure progress accordingly. Progress in upstream research will be much more difficult to measure; its management will require a lighter rein and its impact is likely to have a different time perspective.

1/ This Chapter was written jointly by the EMR and EPR Panels and appears in both reports.

This chapter, prepared jointly by the EMR and EPR Panels, reflects upon these concerns, upon past achievements of the Center, and upon its future goals. Here the Panels suggest some directions CIAT might follow as it enters the next decade, when demands will inevitably change, and new challenges will come to the fore.

6.2. Structure and Process at CIAT Today

6.2.1. Overall organizational structure

The current CIAT organizational structure is charted in Figure 1. Below the Director General (DG), responsibility for the programmatic work of the Center is divided between two Deputy Directors General (DDGs). One handles Tropical Pastures, Rice, and Training and Communications Support, plus several of the research support units, and is responsible for NARS relations in Latin America and the Caribbean. The second oversees the Bean and Cassava Programs, three of the advanced biology units, and station operations, and is responsible for NARS relations in Africa and Asia.

A Director of Finance and Administration (DFA), on the same level, supervises an Executive Officer who, in turn, manages human resources (for locally recruited staff) and other administrative functions, and a Controller, responsible for financial management. Several small units report directly to the DFA: a Projects Office to coordinate reporting to donors, a Personnel Office for internationally recruited staff, an Office handling administrative systems and procedures, and the CIAT Miami Office.

An Office of Internal Auditing has an administrative relationship to the DFA but a direct reporting line to the Director General. The DG also has an internationally recruited Assistant, who, among other functions, serves as Secretary to the Board of Trustees.

6.2.2. Organization of CIAT's programmatic work

CIAT was founded with and has maintained a commodity focus, although the orientation of the units, and thus their names, has changed over time. Currently, there are four commodity programs: Beans, Cassava, Rice, and Tropical Pastures. Each has responsibility for both research and institution-building via training and collaborative research with national programs. In addition, a Training and Communications Support Program has been placed recently on the same organizational level.

The Bean Program is CIAT's largest in terms of the number of internationally recruited staff, a substantial number of whom are outposted in Brazil, Costa Rica, Ethiopia, Rwanda, Tanzania, and Uganda. All report to the program leader, although there is also a coordinator for East and southern Africa and the Great Lakes Region, resident in Ethiopia.

The Cassava Program has scientists in Brazil, Ecuador, and Thailand as well as at Palmira; all report to the program leader.

CIAT ORGANIZATION CHART

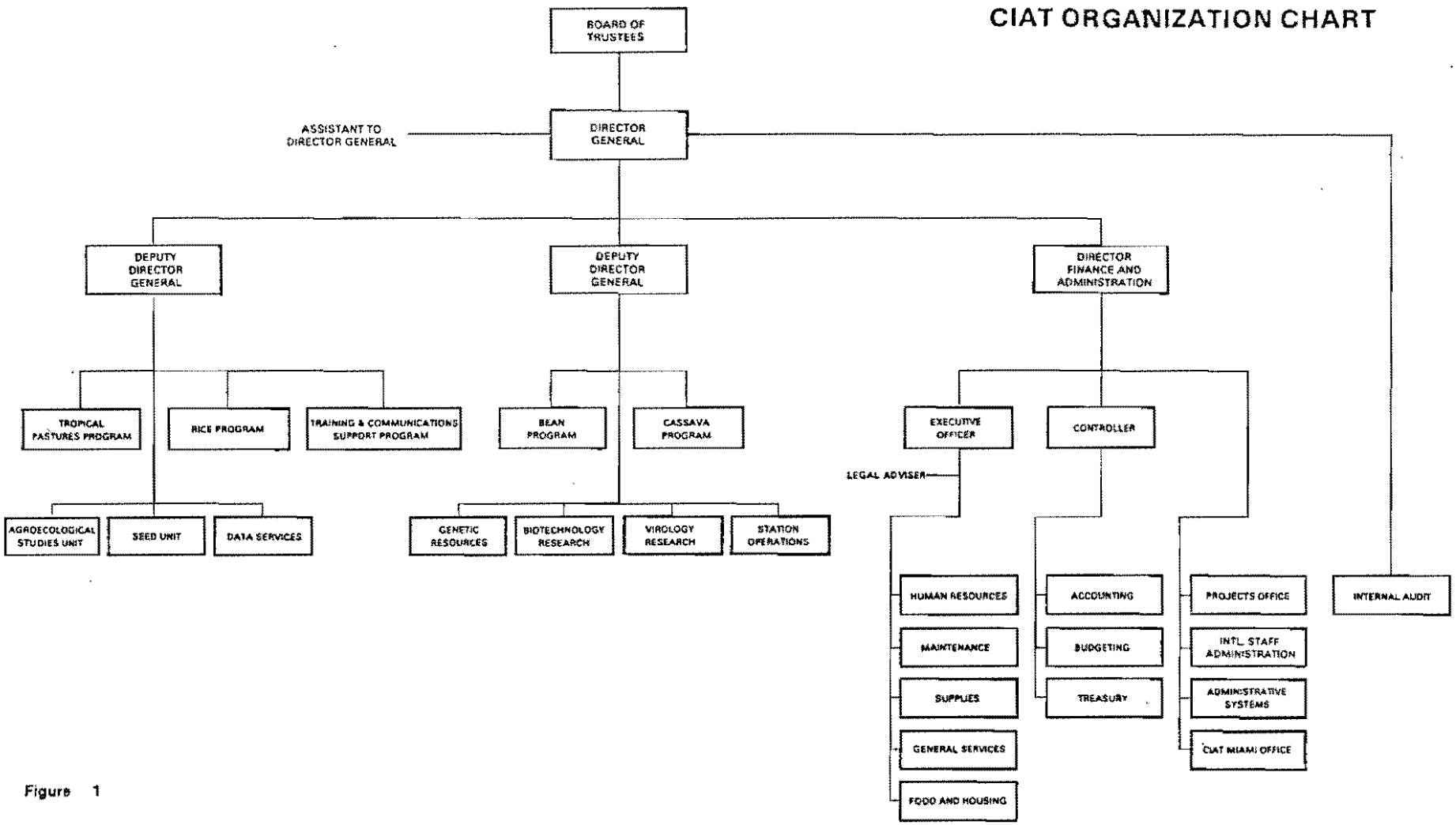

Figure 1

The Rice Program is CIAT's smallest, and its program leader is thus able to participate in research as well as management. It has staff outposted in the Caribbean region and strong ties to IRRI including collaboration with an IRRI liaison scientist posted at CIAT and responsible for international rice testing.

The Tropical Pastures Program, with outposted staff in Brazil and Costa Rica, is the only commodity program organized into three functional units (Germplasm Evaluation, Pasture Evaluation, and Production Systems), whose heads report to the program leader while they, in turn, supervise the units' scientists.

The Training and Communications Support Program is also comprised of specialized units, five in number: Training and Conferences, Publications, Information (library and bibliographic), Graphic Arts, and Public Information and Public Relations. Again, it is headed by a program leader to whom the unit heads report. Two staff members of this Program are actually housed within each of the commodity programs in order to organize training events focusing on the commodity.

The Genetic Resources and the Seed Units were established prior to the second EPR; the other three units are relatively new. The Agroecological Studies Unit was made independent of Data Services in 1984; the Biotechnology Research Unit was set up in 1985, the Virology Research Unit in 1987. Four of the units (Genetic Resources, Biotechnology, Virology, and Agroecological Studies) are upstream, feeding into and, in the case of the Agroecological Studies Unit, helping to focus research of the commodity programs. The Seed Unit works downstream, seeking methods, processes, and organizational forms to move research products to the small-farmer clients of the commodity programs.

The Units are managed by their respective heads under a DDG. Research projects are formulated by an ongoing, informal dialogue among unit heads, program scientists, and program leaders to identify thrusts important to the programs. The DDG arbitrates on priorities. With respect to the Genetic Resources Unit, the program leaders make up an informal committee to negotiate priorities among themselves. To the best of the Panels' knowledge, this mechanism has not yet been extended to the newer Units.

The Units themselves may identify opportunities they see as having potential and bring these to the programs to gain support for their initiatives.

The main research service is Station Operations, with responsibility for the upkeep and operation of the CIAT experimental stations at Palmira, Santa Rosa, Quilichao, and Popayán. The Data Services Unit provides computer services, maintains the databases, and gives advice on experimental design and analysis through its Biometry Section. The centrally organized Analytical Services Laboratory (ASL) supplements laboratory services within each Program. Its main function is the analysis of soil and plant tissue.

All three of these services respond to demands from the Programs and the Research Support Units. Scientists put forward their needs independently. Problems in resolving demands are negotiated with program leaders. In the cases of Station Operations and the ASL, in the last resort there is arbitration by small committees: for Station Operations this is composed of the program leaders and the superintendent of the service; for the ASL it is the Research Services Committee, made up of a scientist from each program. Again, final arbitration is with the DDG.

6.2.3. Leadership style and practices

For the past fifteen years, CIAT has had a forceful leader who has imparted to the Center his own strongly held values regarding the critical importance of CIAT's mission and the need to uphold high standards of both research and management in pursuing it. His own commitment and confidence have generated the same among the staff, and the Panels are very pleased to note the widespread pride in CIAT's achievements.

CIAT's senior management also benefits from the combination of skills, experience, and knowledge brought to the Center by its two Deputy Directors General, who share with the Director General a strong commitment to CIAT's mission and fundamental values.

CIAT defines its "management team" as made up of the DG, the two DDGs, and the DFA, whom it currently refers to as the "Directors." They meet frequently but irregularly, perhaps three times a week for varying periods of time averaging an hour per meeting. There are also countless one-on-one meetings among these persons to discuss issues as they arise, and they circulate their chronological files of correspondence to keep abreast of each other's concerns. Since all four travel frequently, it often occurs that one must make a decision in an area normally the responsibility of another.

The Director General holds monthly staff meetings: one month with all so-called principal staff--Senior Staff, Postdoctoral Fellows, Senior Research Fellows, Visiting Scientists, and the top rank (GAS) of the locally recruited administrative staff; the second month with Senior Staff only. Biennually, he has a private meeting with each member of the Senior Staff.

In pursuit of his goal of participatory management, the Director General has appointed staff to a number of cross-unit standing committees:

The Administrative Policy Committee, chaired by the DG, meets as needed--every two to three months--to advise the DG on matters related to personnel policies, management procedures, and key administrative issues, and is a sounding board for staff concerns on these matters. The management team, the Executive Officer, and two elected Senior Staff representatives comprise the membership.

The Leadership Group is composed of all members of the management team except the DG, plus all Program Leaders. Chaired by one of the DDGs, it was established to discuss various inter-program and Center-wide

research and cooperation issues and recommend action to the DG. Of late, it has met only every three to four months.

There are also committees to discuss/coordinate research services, sustainable production systems, field operations, electronic data processing, personnel classification, space planning, Palmira landscaping, and ARCOS (CIAT's staff newsletter).

The third important layer of management on the scientific side includes the Program Leaders. These are all senior and well-recognized scientists, most of whom have spent a number of years at CIAT and seem to have imbibed what may be called the "CIAT Culture." Although their individual styles differ, the Panels have the impression that they believe in, and practice, participatory management within their respective programs. The senior scientists participate in research program planning and program implementation through constant, though informal, interaction. Most of the units also organize weekly staff meetings to share information and raise substantive research-related issues. From all the evidence, the Program Leaders provide strong and supportive leadership while, at the same time, they have succeeded in creating a collegial atmosphere.

The Program Leaders must depend on the two DDGs for coordination of their research and outreach activities and for resolution of any conflicts of interest.

6.2.4. Planning and review processes

CIAT began work on its earlier strategic plan in 1979, culminating in the publication of "CIAT in the 1980s: A Long-range Plan for the Centro Internacional de Agricultura Tropical" in 1981. This plan was developed through a consultative process involving CIAT staff, the Board of Trustees, and representatives from collaborating NARS and advanced research institutions. In 1985, the Center prepared a rolling five-year version of the original plan, "CIAT in the 1980s Revisited: A Medium-term Plan for 1986 to 1990." This was drafted following the 1984 External Program Review and was designed to address the key strategic issues raised by the Review.

Planning for the subsequent strategy--"CIAT in the 1990s"-- started in October 1987 with discussion by the Board's Executive Committee on the planning process. The process thereafter consisted of Center staff dialogue, interactions with Board members, and meetings with research leaders from Asia, Africa, and Latin America. Regional meetings and the Annual Program Reviews that occurred during the period provided additional opportunities to discuss ideas and review progress.

In April 1989, the Program Committee and the full Board considered a completed draft. The refinement of this document has been used by the Panels as a framework against which to review the Center's programs and management. Panel members were impressed by the care devoted to the process and by the wide-ranging consultation involved. Nonetheless, they believe that, while the strategy properly charts a path for CIAT's future,

it should not form a straitjacket to constrain the creativity of the Center's scientists.

In 1988, after the start but well before the completion of the strategic planning process, CIAT responded to requests from TAC and the CGIAR to prepare a five-year program and funding plan. In spite of the timing vis-à-vis the long-term planning underway, this "operational" document reflected many of the ideas being considered in the long-term plan. CIAT expects to develop a revised five-year plan on the completion of the strategic plan.

On an annual basis, CIAT prepares a program and budget plan in accordance with the requirements and timetable established by the CGIAR. This document is reviewed by the CGIAR Secretariat and TAC, submitted to the donors for funding, and finally approved to become the operating plan for the fiscal (calendar) year.

There are three other planning and review mechanisms at CIAT designed to uphold scientific standards and ensure relevance to the Center's objectives:

- Internal Program Review, held program-by-program and including all headquarters and outposted staff, usually scheduled just prior to the Annual Program Review, to examine on going activities in considerable depth;

- Annual Program Review, a one-week event held at the end of each calendar year and attended by all staff (including outposted) and involving an intensive evaluation of one program each year with brief reports on the activities of the other three. Members of the Program Committee, new Board members, and, of late, some external scientists have been co-opted to participate in these proceedings;

- Program Committee of the Board of Trustees meets twice annually, once in conjunction with the Annual Program Review, to assess and report to the full Board on the Center's program plans.

The Report of the External Management Review contains additional discussion on the planning process, particularly on its relation to budgeting, and makes several recommendations to better integrate planning at all levels.

6.3. Organizational Issues and Recommendations

Panel members are unanimous in their judgment that CIAT is a skillfully managed institution. Management problems that have arisen have been attacked vigorously, with the result that none of the issues raised below represent matters of critical concern, although they deserve attention.

6.3.1. Decision-making

As demonstrated by the establishment of standing committees and the other lines of communication, top management seeks to encourage broad participation in decision-making. Management's philosophy is to delegate whenever possible to the level closest to the action and to make policy and resource allocation decisions that are Center-wide or that involve more than one unit on the basis of appropriate consultation with those involved, but without abrogating the authority of the responsible officer.

It is extremely difficult in a short visit to any institution to determine whether or not an expressed management philosophy is actualized. Certainly the Panels observed general, and in many cases high, satisfaction with the work environment, a finding that would be unlikely if staff perceived they were not listened to. The recent culture audit also evidenced widespread agreement that "frequent internal consultation facilitates work." On the other hand, the Panels believe that the principle of participatory management could be strengthened to the benefit of CIAT as a whole if closer communication between the second and third layers of the organization could be achieved and if there were a clearer delegation of authority to the Program Leaders.

The commodity programs are the heart of CIAT's research system, and commodity Program Leaders have a good deal of autonomy, although some claim that management occasionally makes decisions on both staffing and programmatic matters without consultation. The Panels have every belief that the Program Leaders manage their programs well. The scientific staff appear to have great loyalty to their leaders and generally feel that they receive solid support for their research. However, Program Leaders are strongly defensive of their programs, concerned about whether they will get the kind of service they need from research support units, and somewhat apprehensive of inter-disciplinary collaboration across programs, lest it diminish the main thrust of the programs, where their first loyalty lies. The Panels did not find this surprising, but believe that, while it will not stop changes in direction--CIAT's past record emphasizes this--it does make it harder for the Center to respond to new situations.

As noted, the DG, the two DDGs, and the DFA comprise top management. They meet frequently, share their chronological files, and otherwise communicate so as to be able to serve as alter egos for one another during their recurrent travel absences. The Panels sense, despite the existence of the Administrative Policy Committee (chaired by the DG) and the Leadership Group (chaired by one of the DDGs), that staff perceive this to be a somewhat closed group that does not adequately "touch base" vertically. However, the management thinks that informal communication does take place on a day to day basis.

The Panels believe that decision-making and intra-center cooperation would be enhanced if the next layer of authority were incorporated into the top management team. This does not imply any change in hierarchical authority; rather it promotes CIAT's accepted principle of participatory management. The Program Leaders are in close touch with the scientific staff and with conditions and concerns of the NARS, and they would bring a valuable perspective to management

deliberations. In addition, and perhaps more importantly, their participation would stimulate a broader view of overall CIAT strategic issues on their part, help break down the "four-centers-in-one" mentality, and foster greater inter-program collaboration. Thus the Leadership Group should be superseded by a formal Management Committee constituted by the DG, the two DDGs, the DFA, the four commodity Program Leaders, and the Program Leader for Training and Communications Support. The inclusion of the last-named leader is necessary because of the increasing role of training as an input into NARS development. When appropriate to the agenda, the Executive Officer and/or the Controller should also join the group, and the Assistant to the DG should serve as secretary.

The Committee's meetings should be sufficiently regular and frequent. It should be chaired by the Director General whenever he is available, with an agenda planned in advance and minutes prepared and distributed. The agenda might include: mechanisms for joint ventures between/among programs, strategies to relate to NARS, new initiatives for the Center, and administrative issues. In fact, the Administrative Policy Committee should probably be abolished with its issues brought before this group.

The Panels recommend that top management at CIAT be redefined to incorporate the third level in the hierarchy (the Program Leaders) and that a Management Committee be established, to be chaired by the Director General and to meet regularly and frequently, with an advance agenda and formal minutes recorded.

In addition, the Panels would like to see steps taken to ensure that the Program Leaders' authority is in accord with the responsibility expected of them. While they should be held accountable for the outcome of program work and for the management of program resources, they should also be delegated concomitant authority. For example, they should direct recruitment and selection of staff--to be sure, with adequate consultation and the right of final approval reserved to the DG and the respective DDG; they should be their scientists' first line of contact in decisions related to work plans, sabbatical leaves, performance evaluation, and other personnel matters; they should be involved more directly in resource planning; and they should design the special projects for their programs. The image of authority would be effectively strengthened, in the Panels' view, if the title of Program Leader were upgraded to Director. (If this were done, the DFA might be titled Associate Director General for Finance and Administration, thus placing the function above program leadership while still below the DDGs and emphasizing the preeminence of CIAT's programmatic work.)

The Panels recognize that an increase in delegated authority may absorb more of the Leader's time and divert them from personal research. The fact is, however, that program staffs are large, and someone close to the front line must attend to management of research within the program and coordination with other units, oversee relations with national programs, manage the program's resources, and deal with inevitable personnel issues.

6.3.2. Organizational structure

Organizational structures invariably evolve over time based on historical circumstance as well as the talents and abilities of existing personnel. From time to time, therefore, it is appropriate to reconsider whether or not there would be a more efficient and effective way to allocate authority and responsibility. The Panels feel that CIAT should carefully assess its present organizational structure in terms of the following criteria:

a) appropriateness of the structure to accomplish the Center's strategic goals;

b) simplicity of reporting relationships (for example, at the moment most of the Program Leaders report to both DDGs on research and international cooperation matters);

c) reduction to a minimum of complex coordination processes at all levels of the organization;

d) effective delegation of authority to the lowest level in which responsibility for a given activity is placed, and especially reduction to a minimum of the number of decisions that must be made by the Director General;

e) sharing of personnel, facilities, and other resources whenever practicable;

f) coordination of the research support units and the research services with the research of the commodity programs, while "leaving the door open" for leadership in upstream research;

g) demonstration of the preeminence of CIAT's programmatic work vis-à-vis its administrative side.

The Panels recognize that there are several structural models that could achieve these objectives, each with some advantages and some disadvantages, but have not carried out a detailed analysis of all the alternatives.

The Panels recommend that the incoming Director General, in consultation with the Board of Trustees, evaluate the current structure in the light of the criteria listed above.

6.3.3. Coordination of the research support units

The successful identification of upstream opportunities, particularly in both biotechnology and virology, signals that the units--while still support units in that their efforts must further the commodity improvement goals of CIAT to be relevant and acceptable--will be a growing source of research initiatives.

Given the strategic move upstream, it is important that the organization and structure of CIAT encourage such moves and, if management finds it appropriate in pursuit of Center goals, further development of the units. While the Panels see no reason for their amalgamation, a course that has been contemplated, these considerations suggest that coordination and collaboration will allow cost-effective use of facilities and will generate synergy among unit staff in the search for new ideas and research opportunities.

In support of these objectives, the Panels believe management should appoint a new internationally recruited staff member on the level of the Program Leaders to oversee and coordinate the three advanced biology units (Genetic Resources, Biotechnology, Virology), the Agroecological Studies Unit, and the Seed Unit. At the outset, the holder of this position should concentrate on coordinating the work of the advanced units with the research plans of the commodity programs, which themselves would be responsible for commissioning any other upstream work needed from advanced institutions. Overall coordination of university contacts would then rest with the DDGs. Initially the new leader might also be responsible for supervision of Data Services, the Analytical Services Laboratory, and Stations Operations, ensuring that they serve the research needs of the commodity programs efficiently and effectively. Therefore,

The Panels recommend the appointment of a Coordinator of Research Support to supervise the work of CIAT's advanced biology units as well as all the other research services in the interim.

At some later point when programs in these areas are mature, it may prove desirable to give these activities the status and increased autonomy of a "Program" and designate the person involved as Program Leader (or Director).

To promote coordination with the more immediate problem-solving work of the programs, the Panels suggest that informal committees involving the Program Leaders be established with respect to biotechnology, virology, and seed production, similar to the one already in place for genetic resources.

6.3.4. Strengthening competence in disciplines

CIAT's strategic plan asserts the intention to continue management of its research on the basis of multidisciplinary teams organized around single commodities and supported by specialized research units. However, the Center does raise the question as to how researchers in individual disciplines can maintain scientific excellence.

One way it suggests is through publication in high-quality refereed journals as was also recommended by the second EPR. The Panels noted that CIAT scientists turn out large numbers of publications--about 300 in 1987--with 12% published in international journals and most of the remainder in CIAT-sponsored publications.

CIAT argues rightly that its mandate is to produce improved technology. Nonetheless, its task is also to contribute to scientific leadership in tropical agricultural science and to scientific thinking that has global applicability. Thus, the Panels endorse the encouragement of increased publication in refereed journals included in the CIAT "Policies and Procedures Manual" (No. 1.08 of 15 July 1985) and inclusion of this item in the personal evaluation form and suggest that management devise other specific means for accomplishing this objective.

Another way the Center could strengthen competence in disciplines would be to provide opportunities for intra-disciplinary interaction. This occurs naturally in the advanced biology units; more effort will be required to bring it about with respect to scientists attached to the commodity programs. Measures might include: encouraging scientists to set aside some research time for collaboration on an opportunity or a problem area with potential benefit to more than one program, encouraging regular attendance at disciplinary meetings, and informal workshops to focus on new findings or new methodologies in a given discipline.

There is another side to the coin, however. Some program staff see a danger that scientists in the highly specialized research units will develop their own disciplinary agendas that might not be relevant to the perceived research needs of the programs. The challenge will likely increase as the Center moves into more upstream research, where breadth versus depth of knowledge in a particular segment of science will have to be determined. In the final analysis, however, the personality and ambitions of the individual scientist will probably be a decisive factor in settling this issue.

6.3.5. Management of outposted scientists

Various members of the two Panels had the opportunity to meet many of the scientists in CIAT's outreach operations. There are 32 currently stationed outside Colombia, projected to increase to 37 in 1993. Unlike some of the IARCs where outposted staff report to a Director for Outreach, CIAT's outposted scientists are an integral part of their respective commodity programs. The Panels confirmed that this is a satisfactory arrangement as far as the individual scientists are concerned.

However, the problems facing outposted staff are very different from those facing staff at Palmira, and it is difficult for managers from headquarters visiting for short periods to appreciate fully the petty frustrations that are the hallmark of their day-to-day operations. Among them are seemingly irrelevant financial reporting requirements, delays and misunderstandings in decisions, problematical research infrastructure, and the need to spend considerable time on administrative matters that would be dealt with by support units at headquarters. For example, scientists must themselves recruit assistants and manage them in accordance with local laws and customs, sometimes involving several countries. The Panels want to emphasize, however, that these problems do not affect the high quality of the work done by CIAT's outposted scientists. They are recorded as perceptions that deserve management attention.

Clearly, the independence demanded of outposted staff as well as the nature of their work with national programs suggests that special personal characteristics must be among the qualifications sought. These include cultural sensitivity, adaptability, competence in negotiation, and pedagogic skills as well as substantial research experience. The CIAT scientists met by the Panels seemed especially well suited to their assignments.

The Panels would also consider it valuable for staff to spend more time at headquarters before being posted elsewhere than appears to be the case presently. There is probably no better way to understand CIAT's culture and purposes or to build a commitment to the Center's strategic goals and operational objectives.

The Panels strongly endorse the placement of CIAT's outposted scientists in the NARS facilities in most countries in which they are posted, while retaining a regional brief. This close association has certainly strengthened CIAT's responsiveness to its clients' needs and could be practiced by other CGIAR Centers. The development of Steering Committees in the African Bean Program has been very successful in giving the national scientists a major role in determining program direction. On occasion, however, there may be conflicts within the Steering Committees about priorities. It is essential that the members themselves resolve these before the Center becomes involved. The Steering Committees should be encouraged in their independence and the Center and donors should be very sensitive to imposing their views on the Committees. This is likely to be counterproductive.

6.3.6. Increasing NARS participation in operational planning

An important element of CIAT's mandate is assistance in building research capacity within national programs. As Center staff have so clearly demonstrated, a long-term impact is most effectively pursued through a collegial approach. In order to ensure, therefore, that the Center's operational plans are in harmony with the current needs and interests of the NARS, the Panels suggest that management consider inviting a few selected leaders of the appropriate commodity research programs of the relevant NARS to take part in the Annual Program Review.

CHAPTER 7 - GENERAL ASSESSMENT AND FUTURE DIRECTIONS

CIAT is one of the older Centers of the system; it started with a very broad brief which has been gradually narrowed over the years by cutting some programs while expanding or redirecting others. The Center operates on a mix of global, regional and commodity mandates. It is relatively easy to define the program and focus of a commodity program but regional mandates are subject to political pressures as well as technical considerations. The deteriorating food situation in Africa, the levels of poverty and hunger, the rapid population increase and the lack of growth in its economy will demand increasing attention from every aspect, including research, of the international donor community. However, several national research programs must be at and/or near the limit of their capacity to effectively absorb CG System network projects. Even more crucial is their likely ability to operate and maintain these projects when a Center withdraws.

Though it has made great strides in developing food production, Asia's food supply remains precarious and it faces major problems in expanding incomes, so that cash crops, both traditional and non-traditional, have a major role in the future.

In Latin America the regional and national disparities in land distribution mean a large number of resource-poor farmers are dependent on a few crops for food and income. The larger farmers will continue to dominate the supply of food for urban areas, and also for agricultural exports so desperately needed for foreign exchange.

Overarching all of these is the question of natural resource degradation. World attention has been focused on the Amazon but this is only a part, though a very visible one, of a global problem which is not confined to the tropical lowlands.

CIAT's strategic plan has addressed these issues and has attempted to find a balance between these competing and sometimes conflicting demands. Operationalizing this plan to allocate enough resources i.e. a critical mass of research resources to address the underlying technical components of these issues will be a continuing challenge to the Center.

The Panel found that the strategic plan was useful in fulfilling its terms of references to address the question "the appropriateness and effectiveness of the Center policy and strategy for the development of its program". The Panel believes that, apart from the visible output of this planning exercise, the intangible output, the experience gained by all those involved in the process, is invaluable. It would be useful if this experience could be captured for the benefit of other IARCs and national programs. Very substantial efforts and resources are going into strategic planning in agricultural research systems. The benefits may not be known for several years, but CIAT's experience would be very useful in guiding others as to the usefulness of both the process and the outcome.

7.1. Achievements

The achievements of the research programs have been noted in Chapter 3. For rice the impact of the research continues to enhance agricultural production in Latin America and the Center has had an important role in maintenance research on the crop. Because of the nature of the sub-sector in Colombia farmer yields in both irrigated and favoured upland areas are quite close to those on experimental farms. However, production costs are very high and CIAT's research is contributing to cost reduction by lowering the amount of inputs, particularly pesticides. This is a contribution to both lowered production costs and decreased environmental contamination.

CIAT's role in cassava work includes both the conventional research activities on improving productivity and work on post-harvest conservation and consumption. While cassava has been a major cash crop in parts of Asia for many years (for starch and more recently for animal feed) its development in Colombia and Ecuador as a cash crop for both feed and food opens up some useful possibilities for increasing rural incomes.

The Center's work on beans has secured widespread recognition and the example of the rapid spread in Guatemala of CIAT national program bean varieties, illustrates the major role to be played by a combination of an effective national program and a variety that was markedly superior in yield to the local variety, because of its resistance to virus.

Varieties of grasses emanating from the collection and breeding program at Carimagua have spread widely. However, the development of grass legume mixtures promises to open up new prospects of development for the Llanos. Grass legume pastures, as part of a rotation with cash crops like rice or soybean, present an unequalled opportunity for development of large areas of poor lands.

CIAT has had an important impact in other areas of agricultural development. The training programs have made a substantial contribution to the growth of scientific capacity within national research systems and the information system has been used by scientists throughout the tropics. Users of the bibliographic service strongly support it but its circle of influence needs to be much wider. Lack of scientific information of any sort is a chronic problem throughout most of Africa. This is perhaps even more important in the universities than in national programs. Students graduating from these universities have little familiarity with up-to-date literature, particularly the commodity oriented materials for which CIAT can be rightly proud.

CIAT's efforts in seed production research are tackling a long standing and difficult problem facing agricultural development particularly for small farmers growing mainly subsistence crops. Small farmers are always prepared to pay commercial prices for hybrid maize, for example. The increased yields resulting from the combination of hybrid seed and fertilizers make it worthwhile for them to do so. If farmers do not use inputs, other than improved seed, the question then becomes one of estimating whether increased yield will induce the farmer to buy new seeds from large or small seed producers. If it is, then there are likely to be

opportunities for the artisanal seed producers that are being encouraged by CIAT.

7.2. Research

The Panel was impressed with the quality and quantity of research in the Programs of CIAT, particularly in regard to work on adaptation to stress and in the extent of the release of new varieties with multi-resistance to a spectrum of biotic and environmental stresses. Genetic improvement in these materials has been associated with an increase in the understanding of the physiological basis of this resistance and of agronomic practices which help reduce the stress. There is a solid flow of research results, and of germplasm, to the national programs CIAT is serving and to international agriculture. New persistent legumes and grasses for tropical pastures, upland rice varieties tolerant of acid soils with high Al levels, beans with broad resistance to disease plus increased yield potential and cassava free of viral pathogens are specific examples.

In producing this material CIAT is aware it is not sufficient to screen merely for tolerance. New ideas about the intensity of the challenge, infection levels, the dynamics of pest and pathogen populations, and the nature of durable and partial resistance are being integrated into the breeding programs.

A notable feature of CIAT's approach to its extensive inter-country collaboration is the incorporation of its outposted staff within national services, another is the multi-disciplinary approach it takes to its commodity programs in which the interplay of economists and biological scientists has been most productive. A significant move to upstream research is also taking place with the establishment of specialized units in biotechnology and virology. CIAT is sensitive to the need to ensure the work of these units remains problem-oriented and that they serve the needs of its commodity programs. A significant number of collaborative research projects with other institutions are in place thereby widening the pool of expertise that CIAT can draw upon and enlarging its research base in a cost-effective manner.

The low input philosophy proclaimed by CIAT has its origins in a distribution objective, of seeking to help the poor sectors of the farming community. Its significance in operational terms lies in the emphasis given to producing lateral resistance to various stresses, and not to the negligible use of purchased inputs, particularly fertilizer. It is a philosophy open to misinterpretation on two counts, its restricted meaning at CIAT, and its utility in a region where there is an urgent need to increase the productivity of agricultural land.

A major challenge is how to improve production gains in its mandate area without compromising the orientation to resource-poor farmers. Steady incremental advances in the genetic yield potential of its target-crops are likely to accrue which, when screened over a decade and so, will make a significant overall contribution to food production, but these advances would be increased by exploiting to a greater degree the

potentials available in better agronomic and pest control practices, larger fertilizer inputs in reducing harvest and post-harvest losses, and by giving greater explicit recognition to the large quantity of market supplies which originate from larger farms.

Land degradation in Latin America arises through deforestation and cultivation of fragile, often upland soils. Tax incentives and policies that encourage exploitation of new lands, particularly forest areas, and low productivity in existing farm areas lead to these expansions. New agricultural technology can influence unsatisfactory policies and increase productivity and thus encourage sustainable systems.

Sustainability of production is a principle that CIAT embraces with enthusiasm. Its staff are well aware that both resource-rich and resource-poor farmers may sacrifice ecological stability for short-term gains but only the latter are driven by the imperative of survival. The concepts of sustainability and a low input philosophy are compatible when food supplies are adequate, but as the deficits projected for the next decade increase prices, and hence poverty, the conflict between these approaches will become more pressing and the need for CIAT to broaden its approach that much greater.

Other areas of activity of the research programs where the Panel has some concern focus on the need to ensure adequate resources for collecting and screening of germplasm, for the collation of information on the occurrence and distribution of major production constraints, in increasing the statistical precision with which some yield trials have been conducted and in examining the balance of resources provided to each program.

7.3. Relations with NARDS; Developing their Research Capacity

Relations with NARDS is a theme that permeates most of the discussions on international agricultural research. To the IARCs it means the development of national research capacity. CIAT, as Chapter 4 points out, is deeply involved not only through its commodities research, but also through its training programs and its regional networks; it plans to increase this involvement in the coming decade.

However CIAT, in common with other IARCs, faces some formidable problems in helping the development of NARDS. Weaknesses in national research and development programs are a reflection of the weaknesses in the public sector generally. All segments of the public sector suffer from the same kinds of problems, though they may differ in degree. Indeed research systems may suffer even more from lack of resources than other public sector enterprises because the visible impact takes time and the value of research output depends so much more on quality rather than quantity. In a few countries weak public sector research is compensated for by strong private research institutions.

The strength of CIAT's client NARDS varies within and among regions and among commodities; these strengths and weaknesses have many causes. In Latin America even the best institutions are suffering severe financial

difficulties. It is difficult to predict the impact of these on scientists' morale or how long it takes before a research institution losses its scientific momentum. Institutional decay can be very rapid, institutional development very slow.

In Africa research institutes suffer from lack of well-trained and experienced staff and lack of financial resources. While the former can be improved fairly quickly the latter may take years to overcome taking into account the slow growth of the economies. So the outlook for developing self-sustaining research institutions in Africa is rather bleak and, as there seem to be few examples of self-sustaining research programs within weak institutions (without donor intervention), Center collaboration with national programs should be viewed as a long-term understanding.

Another area of challenge to CIAT is the fact that CIAT's mandate commodities have a dominant role in agricultural production in only a few areas, unlike wheat, rice and maize. The Center does not of course, work with national programs without their invitation; nevertheless the presence of CIAT may influence national programs in various ways; it may unbalance the priorities; it may lead the national institution to decide that its limited resources could be used better on other important crops. On the other hand the national institutions might regard the presence of a vigorous and successful research program as a demonstration of what research can do, thus confirming to the national policy makers that research is worthwhile.

The network system has the capability of counter-acting some of these pressures. It helps to give the research a broader base over several countries, where a particular commodity is collectively important, but less important on a country basis. It imparts a degree of stability to the research systems. Perhaps more important, it imbues the scientists involved with a sense of motivation. In East Africa the Panel was very pleased to note that the national scientists appeared to have a good morale, in spite of the many and serious logistic and financial problems which were part of their daily lives.

The Panel thinks that it would be a mistake to have too many Center staff in a particular network. It recognizes that there are urgent problems but numbers alone will not solve them. Over a 5-10 year period it may be possible to build a network that is intellectually self-sustaining. Whether it will be financially self-sustaining is another matter. In theory CIAT should withdraw when the former is attained, but then its withdrawal would likely lead to the collapse of the network for financial reasons.

Training is one of the crucial areas in developing national research capacity and this has received very strong support from scientists and program leaders at CIAT. CIAT's strategic plan for the 1990s deplores the fact that many NARDS are not yet in a position to provide training for the technology transfer professionals who help move research findings into farm practice. Yet it doubts the wisdom of investing scarce time of CIAT scientific personnel or other Center resources in such training. To deal with this dilemma, CIAT is now

committed to a strategy consistent with TAC's advice (CGIAR Priorities and Future Strategies) to "scale-down the production and breeding courses at headquarters" and concentrate on "short, highly-focused courses in research methods and specialized skills." This will include courses to familiarize mid-career scientists with new research developments and techniques. The second part of the new training strategy is more difficult -- to build national or regional training strength in the areas of production, adaptive research, and technology transfer. Although time-consuming now, CIAT's commitment to helping build this strength should, in the long run, release rather than absorb its staff strength and energies.

There is a further question about CIAT's role in training at the level which links research and extension. Many reports deplore the weaknesses of these linkages and most suggest that on-farm testing has a major role in stimulating the linkages and providing the feed back that research needs. All too often, unfortunately, this is rhetoric and there is little meeting of minds in the two separated institutions. Training in on-farm testing is more than the provision of techniques and methodology. It is the changing of attitudes, particularly of researchers that is an important part of the technology development process. If the Center's withdraws from this particular area it is difficult to see who is going to fill the resulting vacuum. Few other institutions can match the IARC's record in changing attitudes to agricultural research.

7.4. Management

The EMR and EPR Panels have written a joint chapter on the management of the Center. The Panels have been unanimous in their view that the Center has been well managed. Scientists are also unanimous in saying management has been fully supportive of their efforts. The concern of the Panel has been with the future, the new challenges to the Center as it moves more of its research upstream, the development of the NARDS, the issues of sustainability and the generally increasing complexity of inter-Center collaboration, as the System takes on new tasks. In suggesting ways in which CIAT could change to meet these challenges, the Panels have been well aware of the complexity of managing these tasks.

ACKNOWLEDGEMENTS

The External Review Panel thank the management and staff of CIAT for the support they have given to us at all stages of the review. The open nature of the discussions, the prompt and positive responses to requests for time, the helpful attention of the Assistant to the Director General and the support staff and the hospitality of the Director General and the Board have enhanced the productivity of the Panel and made its task an enjoyable one.

The Panel appreciated the opportunity for the Chairman to attend the meeting of the Board in March and have informal discussions with the Trustees. Also the opportunity to present its findings to the Board and the scientific staff at the end of the review.

The EPR is grateful for the reception of its members by ICA officials in Bogota and in ICA Stations in Colombia. It is also grateful for the reception accorded its members by officials of the national research services in Thailand, Brazil, Ecuador, Costa Rica, Ethiopia, Tanzania and Rwanda. The willingness of busy officials to discuss CIAT is a reflection of its standing with its partners.

The Panel wish to extend its grateful thanks to Ms Marioara Lantini of the TAC Secretariat, together with Maria del Socorro Lasso and Maruja Rubiano of CIAT for their continually pleasant demeanour in the face of long hours worked and their unfailing helpfulness in the preparation of the report.

It has been a pleasure and a privilege to Panel Members to spend a short time within the CIAT community.

CONCLUSIONS AND RECOMMENDATIONS

OF THE

EXTERNAL MANAGEMENT REVIEW

OF THE

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

(CIAT)

Panel Members:

Vijay S. Vyas (Chairperson)
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CGIAR Secretariat
September 1989

EXECUTIVE SUMMARY OF THE EXTERNAL MANAGEMENT REVIEW

CIAT is a well-managed institution. This was the main conclusion of the first External Management Review, which took place in 1984, and it is very much the impression of this Panel.

CIAT Today. Since 1984, many changes have taken place in CIAT's internal and external environment. It is a much larger institution; its research programs are more complex; infrastructure and facilities are more developed; and outreach activities are much more extensive. As a result of changes in the external environment, the Center has had to go beyond its primary objective of rapid increase in food production. The issues of sustainability, environmental protection, equity, and gender have had to be accommodated in its plans and programs. The funding position is becoming increasingly difficult; hence, CIAT must be more proactive in the management of its finances. Finally, there is a growing tension between the need and the desire for upstream research and institution-building tasks. In general, CIAT has responded to these changes judiciously and well.

Legal Status and Governance. In the past year, CIAT attained international organization status. Although the process was lengthy and difficult, the Center handled it successfully. With this new status, CIAT is now able to operate with greater confidence, both within its host country and in other parts of the world.

CIAT's relationship with Colombian institutions is cordial and constructive. It also has agreements with and staff posted in 12 countries in Latin America, Africa, and Asia; there are less formal arrangements with a number of other countries that permit the Center to work collaboratively with local scientists, distribute nurseries, collect germplasm, etc. In the Panel's view, these relationships are generally excellent.

The Panel reviewed the Board's performance in the areas of policy-making, oversight, management of Board operations, and relationship with management as well as the process of the selection of the new Director General. Overall, the Panel considers the performance of the CIAT Board to be satisfactory. Its committees appear to operate effectively, although the Panel recommends that the terms of reference of the Executive Committee and the Audit and Operations Review Committee be defined more clearly.

Organizational Structure and Process. The External Management and Program Review Panels have jointly examined the organizational structure and process of CIAT. Panel members are unanimous in their judgment that CIAT is skillfully managed and its leadership is well qualified and resourceful. As a

recently conducted cultural audit suggests, the management and the staff at all levels widely share the norm to uphold high standards of both research and management in pursuing CIAT's mission.

The Panels believe that the principle of participatory management could be strengthened to the benefit of CIAT as a whole and recommend that top management be redefined to incorporate the third level in the hierarchy (the Program Leaders) and that a Management Committee be established, to be chaired by the Director General and to meet regularly and frequently, with an advance agenda and formal recorded minutes.

Organizational structures invariably evolve over time, based on historical circumstances as well as the talents and abilities of existing personnel. The two Panels recommend that the incoming Director General, in consultation with the Board of Trustees, evaluate the current structure in the light of the criteria listed in Chapter 3 of this report.

The successful identification of upstream research opportunities, particularly in biotechnology and virology, is a strategic goal of CIAT. To promote this, the Panels recommend the appointment of a Coordinator of Research Support to supervise the work of CIAT's advanced biology units as well as all other research services.

CIAT's strategic plan asserts the intention to continue management of its research on the basis of multidisciplinary teams organized around single commodities and supported by specialized research units. It does recognize, however, the importance of maintaining excellence in relevant scientific disciplines. The Panels suggest that the Center design mechanisms to promote intradisciplinary interaction.

The Panels endorse the close integration of CIAT's outposted scientists in the four commodity programs and commend the collegial relationships they have developed with the national agricultural research services with which they work. There is a need, however, for CIAT headquarters to help them reduce time spent on financial management and administrative chores.

Planning, Budgeting, and Review. Over the past two years, CIAT has engaged in an elaborate process of strategic planning and, at the time of this review, has a plan in final draft. The next step is to revise its medium-term and annual operational plans to better reflect these strategic objectives.

CIAT's budgeting and reporting system has been improved since the last EMR, and the final budget for each cost center serves as a firm plan against which expenses can be controlled. However, participation in the budgeting process has not been as broad as it might be, and the Panel recommends that the process

be revised to include consultation on all aspects of the budget, including staffing patterns and costs, with those who will have the responsibility for budget implementation, down to the level of each cost center. This revision, by building staff commitment, should enhance budget compliance.

Management of Human Resources. CIAT has an extremely well-qualified local staff, many of whom have been employed by the Center for an unusually long period. The personnel function is highly professional and uses careful analyses of the local employment market to set salaries and benefits. The fact that CIAT has shown great sensitivity to the concerns of the local staff is reflected in the positive results of the recently completed cultural audit. Partly in response to strongly felt interest, a training needs assessment is now underway. We recommend that management pursue vigorously the assessment of needs in the area of staff training and career development, design a more systematic set of policies to respond to the identified needs, and commit adequate resources to assure their realization. Communications with this staff group is another area that needs attention.

There are currently 86 Senior Staff positions at CIAT, in addition to 18 Postdoctoral Fellowships and 16 Senior Research Fellowships. Management pays considerable attention to recruitment for these positions, each of which represents a substantial investment by the Center and an important element in its ability to reach strategic goals. It needs to investigate remedies to recruitment constraints. To assist members of the Senior Staff to better fulfill their management responsibilities, we recommend that all first-line supervisors be trained in financial management as is relevant to their assignments, as well as in supervisory skills. To meet the career development interests of staff, CIAT has recently instituted a policy of short-term study leaves. As another measure, that could as well help scientists translate their substantial data into scientific publications, we recommend that CIAT seek or help identify funding for and recruit well-qualified Masters and Ph.D. candidates to conduct their dissertation research under the supervision of CIAT Senior Staff scientists.

CIAT has shown itself to be committed to planning at every level. We believe that preparation of an annual workplan by each individual scientist is a rung on the planning continuum that will ultimately ensure fulfillment of the strategic goals. In addition, such workplans become the basis for an equitable and objective performance evaluation and a means of course correction for the subsequent year. Therefore, we recommend that CIAT design and implement a system of individual performance planning and evaluation.

Financial Management. Financial management at CIAT has improved substantially since the last EMR and is one of CIAT's

areas of strength. The development and implementation of an improved management information system has led to important improvements in financial control and reporting, especially at the Palmira headquarters. We recommend that efforts be continued to extend these improvements to CIAT's outposted staff.

Changes in the international economy have affected CIAT by both altering its usual cash flow pattern and by causing changes in its expected income due to fluctuations in currency exchange rates. We recommend that CIAT increase its working capital reserves to protect itself against delays in the receipt of contributions from donors, and that it pursue, with the CGIAR and other centers, the development of innovative funding mechanisms so as to improve its long-term financial stability. We also recommend that the CGIAR Secretariat and the centers jointly establish procedures so as to take advantage of opportunities for debt conversion operations.

General Administration. CIAT's general administration was commended by the Panel not only for its service and efficiency but also for its deep commitment to improving its own capabilities in providing the necessary support for the Center's research operations.

The CIAT of tomorrow may differ significantly from the CIAT of today programmatically and in terms of its mandate, yet we believe its administrative structure and managerial processes have imparted a resilience to the institution to cope with the uncertainties of the future.

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CGIAR Secretariat

Dr. Michael Collinson
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1818 H Street N.W.
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B. External Management Review Panel

Chairman

Dr. Vijay S. Vyas
Director, Institute of Development Studies
B-124 A. Mangal Marg
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Jaipur 302 015
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Dr. Kenneth Hoadley
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INTERIM TERMS OF REFERENCE FOR EXTERNAL PROGRAM REVIEWS OF THE INTERNATIONAL AGRICULTURAL RESEARCH CENTRES

The Consultative Group on International Agricultural Research (CGIAR) has charged its Technical Advisory Committee (TAC) to conduct External Programme Reviews (EPRs) of the CGIAR-supported International Agricultural Research Centres (IARCs) [1] to determine their efficiency and effectiveness in reaching the CGIAR goal:

> "Through international agricultural research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well-being of low income people are improved."

The Objectives of EPRs are:

1. - to evaluate for the CGIAR the programme of the Centre, in particular with respect to:

   (a) the current and future relevance to the CGIAR goal of the centre's mandated activities;

   (b) the appropriateness for support by the CGIAR of the Centre's research and other activities, and the amount and scope of the Centre's efforts devoted to them;

   (c) the past achievements of the Centre and the probable dimensions of the return to further efforts in research and related activities or, where appropriate, the introduction of new activities;

2. - to assess for the CGIAR, in the context of its goal:

   (a) the appropriateness and effectiveness of the Centre's policy and strategy for the development of its programme;

   (b) the standing in the world of the Centre's programme and staff in research, training, and related activities, and its relationships with other IARCs, national and international organisations, and private interests concerned with the research;

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[1] "Centre" for the purpose of this document comprises the Board, the Director and staff of all CGIAR institutions, whether designated as Association, Board, Centre, Institute, Laboratory or Services.

(c) the priorities for research, training and related activities of the Centre and the means to address them;

(d) the progress of the Centre's efforts to assist appropriate institutions in developing countries to assume responsibility for location-specific research, training and related activities, including networks or wider research where feasible;

3. - in light of 1 and 2 above, to review and comment on the he effectiveness of the Centre's provisions for:

(a) developing and updating its objectives and the strategies to reach them (operational mandate, long-term plan, medium-term projections);

(b) measuring results and impact of past efforts and, as a consequence, adjusting priorities by dropping, adding or modifying activities as required;

(c) ensuring appropriate allocation of resources to: research programmes; training; assistance to national programmes; networks; genetic resources conservation, if appropriate; data processing and other forms of research support; information and documentation, etc;

(d) ensuring staff competence and quality;

(e) ensuring operational efficiency and effectiveness;

4. - to advise the CGIAR on:

(a) the Centre's actions on the recommendations of the previous reviews as approved by the Group;

(b) constraints to achievement of stated objectives at the Centre, programme, and activity levels, and means to overcome them;

(c) the need for any monitoring, interim, or supplementary review, and on the objectives, dates and schedule of such review;

(d) specific questions or issues raised by TAC, CGIAR Members, the Centre, and others, which follow:

List of Specific Questions

Priorities and Strategies

1. Within the framework of the CGIAR priorities and future strategies, are the recommendations as defined in CIAT's draft strategic plan approved by the Board, sound, relevant and useful for the determination of CIAT's strategies and research priorities? Does the focus of CIAT's work need narrowing or widening?

2. What role have interested and collaborating national programmes had in the preparation of the Centre's draft strategy? What are their views on the future planned by CIAT?

3. Is the relative importance given by CIAT to its mandated crops, beans, rice, cassava and tropical pastures in accordance with changing global needs? In the light of overall CGIAR priorities with respect to these commodities, what are the planned size and scope of CIAT's activities for the next 5-10 years? How should the allocation of resources to these activities be prioritised if the budget were to be reduced?

4. What is CIAT's strategy for strengthening NARS of different countries, at varying stages of development, in different regions? Has the mode of operation via its outreach teams yielded the expected results? Has the technical assistance approach been effective? What is the demarkation of responsibilities between Headquarters and regional programmes? What is the role of CIAT's networks?

5. How is CIAT planning greater orientation towards sustainability of production, usefulness of research results for resource-poor farmers, and improving production under difficult environmental conditions? What is the role of national programmes in determining the needs in these areas and the order of priority with which they are addressed by CIAT?

6. How does CIAT intend to adapt its training strategy to the evolving research capacity of national programmes? Is more in-country training needed?

7. In view of the location specificity of research conducted for or in particular farming systems, what emphasis is there on development of methodology for use by the Centre and by national programmes?

8. Is CIAT giving sufficient consideration in planning research and related activities to the needs of women and to the implications of the application of research results for women?

9. Has CIAT undertaken an adequate ex-ante analysis of the likely impact of its research and related activities?

10. Is CIAT's strategy of incorporating economics research within each of its commodity programmes effective? What areas could benefit from cooperation with IFPRI, ISNAR and non-CGIAR institutes?

11. As national systems and cooperative networks assume more responsibility for research on beans, rice, cassava and tropical pastures, which research and related activities are likely to remain with CIAT's comparative advantage?

Research

12. What is the scope for a better identification of research needs for beans, rice, cassava and tropical pastures? What is the role of disciplinary research at CIAT? Does CIAT have the appropriate balance of specialized disciplinary staff at Headquarters to support its research programme?

13. What is the nature and magnitude of strategic research undertaken at CIAT on contract research, and what are the plans for the future? Are these plans appropriate for the needs of CIAT's clients and partners, and for the overall balance of CIAT's programme?

14. What are the effects of improved CIAT technologies on human nutrition? Which research does CIAT undertake into food and feed quality and the prevention of harvest and post-harvest losses?

15. How does CIAT monitor the effectiveness of technology transfer and the impact of its research and related activities on its target groups?

16. Which mechanisms and processes does CIAT have in place to ensure the quality and relevance of its programmes?

17. What contribution has the breeding strategy of dual emphasis on both yield potential and performance under low inputs made towards CIAT's goal and research objectives?

18. What has been the role of crop management research (e.g. intercropping techniques) and has there been any collaborative programmes with IITA, CIMMYT and national programmes?

19. Has the rapid expansion of the bean programme for Africa been sufficiently focused? What is the strategy for a coordinated long-term effort? Is sufficient attention been given to institution building?

20. Is the future demand for cassava sufficiently strong to justify a major international research programme?

21. Are the needs of small farmers sufficiently reflected in the research programme on tropical pastures? Is the programme in the Amazon Basin environmentally positive or negative? Has consideration been given to agroforestry or silvopastoral systems?

Research Support

22. Is biotechnology research sufficiently problem-oriented and what are CIAT's areas of comparative advantage?

23. How does CIAT see its responsibilities and comparative advantage in seed production?

24. Does CIAT have adequate biometrics support?

25. Do CIAT's information services fulfill the most important needs of national programmes with respect to both content and language?

ANNEX III

DOCUMENTATION FOR REVIEW PANEL

A. Documentation provided by TAC Secretariat

1. CGIAR Priorities and Future Strategies, 1987
2. Interim Terms of Reference for External Program Review of the International Agricultural Research Centers
3. Guidelines for External Program Review Panels
4. List of Specific Questions Related to CIAT
5. Report of the Second External Program Review of the Centro Internacional de Agricultura Tropical (CIAT), 1985.
6. Extracts from the Reports of the 34th, 40th, 43rd, 45th and 46th Meetings of TAC
7. Review Process in the CGIAR System. August 1988.

B. Documentation Provided by CIAT

1. CIAT Report, 1989
2. CIAT in the 1990s: A Strategic Plan, Revised Draft, Sep. 1989
3. CIAT in the 1980s, Nov. 1981
4. CIAT in the 1980s, Revisited
5. Summary of Actions Taken by CIAT on Recommendations of last EPR
6. Summary of Achievements since the last EPR
7. List of Contracted Projects
8. List of Agreements with other IARCs on Cooperative Activities
9. CIAT 1988 Program and Budget
10. 1985 Report of the Program Committee
11. CIAT Program Committee Report, May 1986
12. Addendum to CIAT Program Committee Report, June 1987
13. Addendum to CIAT Program Committee, May, 1988
14. Report of the Program Committee, April 3, 1989

15. Comments by the CIAT Program Committee Regarding the First Draft of the Interim Plan, January 28, 1988

16. Organigram and Staff List

17. List of CIAT Staff Publications

18. CIAT Charter and Documents of Establishment

19. A Proposal for Creating an International Institute for Agricultural Research and Training to Serve the Lowland Tropical Regions of the Americas, October, 1966.

20. Evolutions of CIAT's Mandate Over Time

21. Program Plans and Funding Requirements: 1989-93

22. Board of Trustees Handbook

23. The Decision-Making Process at CIAT, June, 1989

24. Internal Review Process at CIAT, June, 1989

PROGRAM OF EPR PANEL COUNTRY VISITS AND PEOPLE MET

A. CIAT Headquarters, 31 March - 4 April 1989

J. Coulter, EPR Panel Chairman, visited CIAT, attended the CIAT Board Meeting and met the Members of the Board.

B. Visit to Thailand, 20-24 April 1989

J. Coulter and R. L. Villareal, accompanied by two CIAT scientists posted in Bangkok, (R. Howeler, Soil Scientist and K. Kawano, Plant Breeder) visited CIAT Activities in Thailand

20 April

Arrival in Bangkok

21 April

- Meeting with Amphol Senanarong, Deputy Director General, Department of Agriculture
- Meeting with Sophon Sinthuprama, Cassava Coordinator, Field Crop Research Institute
- Meeting with Vichitr Benjasil, Director, Field Crop Research Institute
- Visit to Rayong Field Crops Research Center - discussions with:
  - Charn Thiraporn, Head of Station and Breeding Group
  - Anuchit Tongglum, Head of Agronomy Group
  - Reinhardt Howeler, CIAT Soil Scientist, Asian Regional Cassava Program
  - Kazuo Kawano, CIAT Plant Breeder, Asian Regional Cassava Program
- Visit of field experiments at the station

22 April

- Visit of factories involved in producing cassava chips and pellets and manufacture of starch
- Visit of cassava field experiment at Dok Pai Reservoir Station
- Return to Bangkok

23 April

- Visit of Kasetsart University. Discussions with:
  - Vangnai Somsak, Dean, Faculty of Agriculture
  - Kaseam Piluek, Plant Breeder, Dep. of Horticulture
- Sanan Chantkam, Head of Agronomy
  - Ed Sarabol, Agronomist, Department of Agronomy
  - Vichan Vichukit, Agronomist, Department of Agronomy
  - Chaireg Maneephong, Plant Breeder, Dep. of Agronomy

C. Visit to CIAT, Colombia, Brazil and Ecuador, 11-24 June 1989

11 June

The whole Panel assembly at CIAT.

12-13 June

Meetings at CIAT Headquarters and Program Presentations

14-16 June

Field trip to the Colombian Llanos (Carimagua, Santa Rosa)

14 June - with CIAT plane to Carimagua

Carimagua Station:
Meetings with:
H.O. Jimenez, Director CNI Carimagua
Carlos Lascano, Animal Nutritionist
Derrick Thomas, Agronomist
Miles Fisher, Ecophysiologist

Panel visits to experimental sites on ranches in Llanos and on farms in the Piedmont, accompanied by; Jose M. Toledo, Carlos Lascano, Carlos Serie, John E. Ferguson and Silvio Guzman.

Evening: Return to Villavicencio

15 June - from Villavicencio:

am. Panel visits to rice/pasture experimental sites in Piamonte and Matazul, with R. S. Zeigler, S. Sarkarung and J. I. Sanz of CIAT.

pm. Panel visits to ICA 'La Libertad" and CIAT Sta. Rosa Experimental Stations, with Dario Leal, ICA, P. Vargas, FEDEARROZ, and R. S. Zeigler, Alfonso Dias, E. Guimaraes and F. Correa, CIAT.

Evening; return to Villavicencio and, with CIAT plane to CIAT Palmira.

16 - 17 June - From CIAT Palmira, the Panel splits;

Drs. Abdalla, Moscardi and Villareal to Ecuador to see cassava cooperatives and rice experimentation.

Drs. Brumby, Coulter and Kearl to CIAT Popayan Experimental Station with Drs. D. Pachico, S. Singh, J. Lynch and other Bean Programme staff. Visits to farms in the Popayan area, and a cooperative with Dr. J. Ashby and staff of the Farmer Participatory Research Project. Visits to CIAT Quilichao Experimental Stations with Bean and Pasture Programme staff.

Evening 17th: Panel reassembles at CIAT Palmira.

18-24 June - Visit to Brazil

18 June
P. Brumby, B. Kearl, R. Villareal
Travel to Brasilia

19 June
Visit to Planaltine CPAC Station

A.M. Meetings with:
Carlos Magnos, President, EMBRAPA
Jose Roberto Perez, Director, EMBRAPA
Jim Spain, Soil Scientist Pasture Development, CIAT
Esteban Pizarro, Agronomist, CIAT
Roberto Saez, Economist, CIAT

P.M. Visit to CPAC/CIAT Pasture
Meeting with Jose Roberto R. Perez, Director CPAC

20-22 June - Visit to Goiania, to the Bean and Rice Station of EMBRAPA

Meetings with:
Emilio de Maia de Castro - Station Chief
Francisco Zimmermann - Rice
Maria Jose de O. Zimmermann - Beans
Michael Thung - Agronomist, CIAT

23 June
Travel to Costa Rica to visit the Bean Program

Meetings with:
Jesus Hernandez L., Director General, MAG
Michael Dessert, CIAT

Carlos Mario Garcia, Coordinator in Central America Regional Bean Program
Adrian Morales G., Head Grain Legumes

Visit to MAG-CIAT Pasture Program

Meetings with:
J. Toledo, CIAT
Stephano , CIAT
Danilo A. Pezo, CATIE
Jose Pedro Sanchez Gomez, DG ECAG, CIAT Pasture Agronomist
Pedro Angel, CIAT Costa Rica
Victor Prado, MAG
Rodolfo Acaya, UCR
Olman Diaz, Director of Production MAG

24 June
Visit to Guapiles and Atenas

D. Visit to East African Bean Program (Ethiopia, Tanzania and Rwanda), 20-28 July 1989

J. Coulter, A. Abdalla, E. Moscardi, E. Paterniani, and Ms. J. Joshi (EMR) visited CIAT activities in East Africa

Ethiopia (19-22 July)

19 July - Arrival in Addis Ababa

20 July - Briefing at Debra Zeit
- Africa-wide situation; East Africa Project

21 July - Visit National program (IAR) at Nazreth
- station tour; regional program/NARS/base location administration; IAR program (influence of regional program on it); training program (influence on national program development)

22 July - Meeting with S. Debela, General Manager, IAR
- CIAT/IAR relations; importance of beans in Ethiopia; role of regional program in assisting national program.

Meetings with:
Roger Kirkby, Regional Coordinator
Bill Grisley, Regional Economist
Jeff Mutimba, Regional Training Officer
Girma Zawde, Office Manager

National Program Staff

Yilma Kebeda, Station Manager
Amare Abebe, Bean Coordinator
Teshome Girma, Bean Breeder
Kidane Georgis, Agronomist
Etag. Mariam, Weed Scientist
Ferede Negasi, Entomologist
Telehun Mulatu, Economist
Senayit Yetnebesk, Food Scientist
Meteferia Habtehyemer, Research/Extension Liaison

Seme Debela, General Manager, Institute for Agricultural Research

Tanzania (23-24 July)

23 July - All-day meeting at CIAT/Arusha with CIAT staff
- SADCC Project introduction; production constraints; genetic improvement; cropping systems

24 July - Depart for Lyamungu

Meetings with:
C. Mushi, National Director of Bean Research Program
- host country/CIAT arrangements

Meetings with:
David Allen, Regional Coordinator SADCC
James Ampofo, Entomologist SADCC
Todo Edge, Agronomist SADCC
Barry Smithson, Breeder SADCC
William Grisley, Economist Regional Bean Program for Eastern Africa

National Program Staff

Clemence Mushi, Bean Coordinator
Bette Gondwe, Plant Protection
Ruth Kamal, Bean Breeding
Patrick Ndakidemi, Agronomist

Rwanda (25-28 July)

25 July - Travel to Kigali (Rwanda)
- introduction to Great Lakes Bean Program

26 July - AM transfer Kigali-CIAT/Rubona
- brief on history/progress with ISAR
- PM meetings with:
B. Ukiliho, Bean Breeder and other national program scientist

28 July - Day in Kigali writing up Africa notes

Meetings with:
Pierre Nyabyenda, Coordinator - Great Lakes Bean Program (Rubona Station)
Bone Ukiliho, Bean Breeder and Station Director, Riverere
Jim Butler, Pathologist, USAID
J. Voss, Former Anthropologist

ANNEX V

MAIN PHASE OF THE EPR

(10-29 September 1989)

A. PROGRAM

Sunday, 10 September 1989

A.M. - Arrival of Panel Members at CIAT
P.M. - Panel meeting

Monday, 11 September

A. M. - Meetings to discuss issues and arrange staff meetings
P. M. - Orientation meeting for all Panel and CIAT Directors
- 18:00 h. Panel meeting

Tuesday, 12 September

- Meetings between Panel Members and individual staff
- 18:00 h. Panel meeting

Wednesday, 13 September

Meetings between Panel Members and individual staff
- 17:00 h. - Meeting with EMR Panel
- 18:00 h. - Panel meeting

Thursday, 14 September

AM - Panel Members' meetings with:

- Biological Research Unit/Virology Research Unit/Breeders
- Post harvest/Seed Supply/IPRA
- Training Associate
- Social scientists/on-farm Research/IPRA
- Pathologists/Virology Research Unit/Physiologists
- Agronomists and Soil Scientists

- 18:00 h. - Panel meeting

Friday, 15 September

Report writing

- 17:00 h. Informal cocktail with CIAT Principal Staff

Saturday, 16 September

- Report writing
- 11:00 - 16:00 h. - Panel meeting

Sunday, 17 September

- Report writing

Monday, 18 September

- 8:00 - Panel meeting with CIAT Directors Staff - initial discussion of issues
- 14:00 - Panel meeting: discussion of first drafts
- Report writing

Tuesday, 19 September

- Report writing
- 17:00 - Meeting with EMR Panel
- Evening - Panel's discussion of drafts
  Early drafts of report may available to CIAT management.

Wednesday, 20 September

- Report writing
- Dr. Coulter, Dr. Moscardi, Dr. Abdalla, Dr. Vyas (Chairman of EMR): visit to Bogota:
  8:30 - 10:30 Meeting with Dr. Gabriel Montes, Director General, ICA
  11:00 - 12:00 Meeting with Dr. Ricardo Vargas, Director, DRI
  Dr. Pablo Curtica, Assistant Director for Research
  Dr. Hernán Chaverra, Assistant Director for Planning
  13:00 - 14:30 Meeting with Dr. Augusto Urrea, Subdirector, FEDEARROZ
  Dr. Nestor Gutierrez, Economic Section
- Evening - Panel's discussion of drafts

Thursday, 21 September

- Report writing
- Evening discussion of drafts

Friday, 22 September

- Report writing
- Evening discussion of drafts

Saturday, 23 September

- Report writing
- Meeting with EMR
- Evening discussion of drafts

Sunday, 24 September

- Report writing
- Meeting with EMR
- Evening discussion of drafts

Monday, 25 September

Morning - Draft report made available to CIAT's management
Evening - Panel's discussion of drafts and of CIAT's commentaries

Tuesday, 26 September

- Finalization of draft report

Wednesday, 27 September

- Morning - Preparation of final version of report
- Evening - Report sent to printing

Thursday, 28 September

Morning - Presentation of report to CIAT Staff
Duplication and distribution of report

Friday, 29 September

Morning - Presentation of report to the board
Evening - Reception

B. CIAT STAFF MET BY PANEL

Office of the Director General

J. L. Nickel, Director General
D. R. Laing, Deputy Director General
F. Torres, Deputy Director General

Bean Program

D. Pachico, Leader
J. L. Kornegay, Plant Breeder
C. Cardona, Entomologist
W. Janssen, Economist
M. A. Pastor-Corrales, Plant Pathologist
J. Lynch, Physiologist
J. White, Physiologist
S. P. Sing, Plant Breeder

Tropical Pasture Program

J. M. Toledo, Leader
J. W. Miles, Plant Breeder, Agronomy/Forage Breeding
F. E. Ferguson, Agronomist, Seed Protection

C. Sere, Agricultural Economist
R. Vera, Animal Scientist, Cattle Production Systems
C. Lascano, Animal Scientist, Pasture Quality and Nutrition
M. Fisher, Ecophysiology
R. Schultze-Kraft, Agronomist, Germplasm
D. Thomas, Agronomist

Cassava Program

A. C. Belloti, Leader
C. Hershey, Plant Breeder
R. Best, Chemical Engineer, Utilization
R. Moreno, Agronomist
J. C. Lozano, Pathologist
M. El-Sharkawy, Physiologist
C. Wheatley, Physiologist, Senior Research Fellow

Rice Program

R. Zeigler, Leader
S. Sarkarung, Plant Breeder
L. R. Sanint, Economist
A. Fisher, Agronomist

TRAINING COMMUNICATIONS SUPPORT PROGRAM

G. E. Habich, Leader

General Administrative Services Staff

W. Correa, Head, Graphics Arts/Production
S. Amaya, Head, Publication Unit
J. Reeves, Senior Writer, Public Information Unit

Training and Conferences Unit

C. Connolly, Training materials, Senior Research Fellow
V. Zapata, Trainer of Trainers, Senior Research Fellow
A. Caldas, Admissions

RESEARCH SUPPORT

Agroecological Studies Unit

P. Jones, Head
S. Carter, Agricultural Geographer

Seed Unit

S. Pachico Camargo, Head
A. Garay, Seed Specialist
A. Monares, Economist
L. Field, Anthropologist

Biotechnology Research Unit

W. M. Roca, Physiologist, Head
R. Chavez, Plant Breeder
M. Kounade, Biologist
M. Luisa Mann, Biologist

Data Services

Maria Cristina Amezquita, Biometrics Head

Virology Research Unit

F. Morales, Virologist

Farmer's Participation Research Project (W. K. Kellogg Foundation)

J. Ashby, Rural Sociologist

Experiment Stations Operations

A. Diaz-Duran, M. S., Superintendent

Genetic Resources Unit

R. Hidalgo, Physiologist

FINANCE AND ADMINISTRATION

F. Kramer, Director

CIMMYT STAFF HOSTED AT CIAT-PALMIRA

S. Pandey, Plant Breeder
E. B. Knapp, Production Specialist

C. NATIONAL INSTITUTIONS

Gabriel Montes, Director ICA (Instituto Colombiano Agropecuario)
Ricardo Vargas, Gerente DRI (Desarrollo Rural Integrado)
Augusto Urrea, Subdirector FEDEARROZ (Federacion de Arroceros)
Nestor Gutierrez, DRI

THE RESOURCE BASE AND FOOD ECONOMY OF CIAT's MANDATE AREA

Resource Base

Major Latin American ecosystems are the Tropical Forests, the South American Savannas and the Andean Hillsides. These main regions have to be expanded with other zones where important production systems including rice, beans and cassava are found. Africa and Asia also have large areas where CIAT is actually working.

Latin America

The Tropical Forests ecosystem is comprised of two large areas: (a) a semi-evergreen seasonal forest region, characterized by a short but defined dry period (3-4 months), occupying vast areas of the Amazon and Orinoco basins of Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru and Venezuela, as well as sizeable areas in Central America and the Caribbean; and, (b) the tropical rain forests, with higher total rainfall and no defined dry period, occurring in the Andean Piedmont of the Amazon in Colombia, Ecuador and Peru as well as in the west central lowlands of the Amazon basin, including southeastern Colombia, northeastern Peru and northwestern Brazil.

Farmers poor in land and resources are drawn to this fragile environment by land availability and the opportunity to produce crops using nutrients released by the burning of the forest cover. This fertility depletes rapidly and the colonists move on. The challenge is to halt deforestation by means of an appropriate system that will ensure sustainable use of land and water resources. New acid-tolerant pastures developed by CIAT hold great potential, particularly for reclamation of already degraded areas.

Within the ecosystem of the South American Savannas, two sub-ecosystems can be considered: (a) well-drained tropical savannas or the lowland areas (Llanos) close to the equator, and areas of higher elevation represented primarily by the Cerrados of Brazil; and (b) poorly-drained tropical savannas occurring primarily in the lowlands of Bolivia (Beni), Brazil (Pantanal de Mato Grosso), Colombia (Casanare), and Venezuela (Apure).

Savanna regions can support extensive livestock systems on native pastures even though the acidity and low fertility of the soils have produced only poor quality native grassland vegetation. Carimagua, the ICA/CIAT experimental station located in the eastern plains of Colombia, is the major forage screening site for the well drained savannas. CIAT has collected and evaluated there many grasses and legumes that are acid tolerant and perform well under natural soil conditions. Integrated "ley farming" schemes which combine crops (acid tolerant rice lines and cassava) and improved pastures are being developed for the Llanos of Colombia.

The ecosystem of the Andean Hillsides encompasses mid-elevation areas of Colombia, Ecuador, Peru and Bolivia. Small farms and dual-purpose systems are very important in this ecosystem. Cropping of hillsides has been exacerbated by high population pressure.

Similar characteristics appear in the hillside mid-elevation areas of Central America and Mexico. Bean production tends to be concentrated at intermediate and high altitudes in areas with high rural population densities within this ecosystem. Particularly important are systems of bush, semiclimbing and climbing beans in different associations with maize.

These major ecosystems certainly take a great part of the CIAT's mandate area. However, scattered across tropical and subtropical South America and in large regions of Mexico and Central America, are other areas with rainfall patterns ranging from subhumid to humid types: low to medium altitude tropics, cool highlands and sub-tropical areas, and irrigated and non-irrigated coastal regions. In all of these, important production systems for rice, cassava and beans occur.

Africa and Asia

Humid and sub-humid ecosystems with low fertility soils and fragile and eroding tropical hills and mountain slopes, are not restricted to Latin America and the Caribbean. Eastern and Southern Africa as well as West Asia and North Africa, have important areas where beans are a significant source of both calories and protein. In Southeast Asia, with vast areas ranging from acid to moderately acid soils, national pasture research programs are successfully testing CIAT germplasm. Southern and Eastern Asia are also important cassava production areas covered by CIAT's mandate.

The food economy of the tropics

CIAT's actual mandate then, is concerned with vast areas in the three regions of the world: Latin America, Africa and Asia. They share a common need for improved agricultural technologies, but the differences in their resource base, cultural values and patterns of development call for different macro-economic and agricultural policies and require that CIAT and other IARCs working there have regionally-differentiated program research thrusts.

The following sections briefly describe the food economy in each region.

Latin America

Rates of growth in production of major food crops have been consistently better for Latin America over the last 25 years than for other regions ang developing countries. From 1962 to 1972 total food production grew at a rate of 4.2% in Latin American, compared to 3% over all developing countries. In the following decade the Latin American growth rate was equal to the overall average. In the 1960s growth in

yields per hectare accounted for 35% of Latin America's increased food output, while in the 1970s this contribution had risen to over 60%.

Urbanization has been a driving force in last two decades. In the early 1960s, 51.2% of Latin America was rural compared to 30.7% in 1986. This transformation has had a dramatic impact on the food system, consumer preferences, and the development of agro-industry.

Growing incomes, greater urbanization, increased labour force, and population growth (2.6% in 1961/70 to 2.4% in 1981/86) all combined to continually increased demand for food. Overall, growth of food consumption in Latin America has exceeded the growth of production since 1970. In the 1960s the region was a net food exporter; in the years 1961-65 nearly four million tons per year were exported. By 1978-80, this trade had become almost four million tons of net imports. Cereals and vegetable oils account for a very significant part of the rise in food imports of Latin America.

What has happened in Latin America? Both non-economic and economic factors enter into its poor agricultural performance in recent years. Civil and political upheavals have helped to create a discouraging environment for investment and production opportunities. Changes in world production and financial markets have worsened the terms of trade for traditional agricultural exports. Finally, and perhaps most important, early industrialization policies of import substitution and overvalued exchange rates discriminated strongly against agriculture in many Latin American countries.

A long period of industrialization disequilibrium and rapid debt accumulation, plus other unfavourable internal and external factors, have created in Latin America problems with no precedent in history. Probably no other region has been as hard hit by the international debt crisis, although toward the end of the decade this crisis has caused a realignment of exchange rates, improved domestic competitiveness of the agricultural sector and stimulated exports.

With significant comparative advantages in a number of agricultural products, stabilization and adjustment policies are being implemented with the goal of creating foreign exchange savings or generating foreign exchange earnings to act as a major source of economic reactivation.

Rapid incorporation of new technologies into production systems is also needed, both to help reconquer the domestic market lost to imports and to improve trade competitiveness for exports to the world markets. In addition Latin America will need help in facilitating agricultural trade adjustment.

Africa

Economic performance of sub-Saharan Africa has been consistently weak for more than a generation. By the 1980s per capita incomes had fallen to about three-quarters of the level reached by the late 1970s. In most sub-Saharan countries aggregate per capita caloric availability is below the minimum nutritional standard. Serious malnutrition is the

result, with some 60% of the population estimated to suffer from insufficient protein-energy intake.

This region has had the slowest expansion of food production, not only per capita but also in total, among the world's regions. Poor performance has been due to external factors as well as weak economic domestic policies and unusually high population growth.

Yields of major food crops have been stagnant for two decades, and production increases in the 1960s were achieved solely through area expansion. As the rate of growth in area cultivated slowed in the 1970s, the annual production growth rate fell to 1.2%, well below the population growth rate of 2.9% to 3.3%.

Recently, many African countries have adopted structural adjustment programs, improving export and domestic commodity pricing policies and government economic management. However, these measures are not likely to produce immediate responses given the wide gap between production and population growth rates and other structural constraints.

Unlike the situation in other developing regions, increases in production of agricultural nontradables in sub-Saharan Africa are not market driven. Close to 70% of the people in Africa live in rural areas, consuming most of what they produce. Raising the real income of these people is a prerequisite of any policy aimed at improving the African standard of living, and that calls for immediate emphasis on increasing food supplies. Cassava and beans offer excellent opportunities for increasing such supplies through productivity gains. Contribution of cassava and beans to caloric intake and protein intake respectively, are of paramount importance in Equatorial and East-Southern Africa.

Developing agricultural technology that is adoptable within such an economic environment is a challenge. Suitable technology must meet the standards of low cost with minimal risk. Nevertheless it is likely that growth in productivity of food to match growth of population will require substantial inputs into the agricultural producing economies.

Given the urgency of increasing food supplies in sub-Saharan Africa, "intelligent borrowing" has been pointed out as an important source of acquiring new agricultural technology.

Asia

Asia is the largest and most heavily populated of the developing regions of the world. In the first years of the post-war period, the combination of the bulk of the population residing in the rural sector, high population densities, extremely limited farm size, and a rate of growth in food production that barely kept pace with population, created a sense of despair about Asia's ability to feed itself. Over the past two decades, the Green Revolution has stirred optimism by allowing growth in the agricultural sector to proceed at a relatively high rate.

The rice economy is about the only homogeneous element that runs through the different agricultural sectors of tropical Asia. Rice is the

major calorie source in the diet as well as the major source of farm income. Cassava is the second most important carbohydrate staple, followed by maize.

Unlike other regions a large portion of Asia's rural populations is landless, making much of the rural population dependent upon wage income for their food. As a result, despite progress in food production it is estimated that more than 60% of Asia's people are undernourished. A considerable share of the hungry are in countries that have attained food self-sufficiency.

Rapid structural change through export-oriented industrialization is occurring in many of the economies of Southeast Asia. The urbanization and income changes inherent in this process are inducing rapid diversification in food demand and in turn creating new opportunities for the agricultural sector. An example is the rapidly rising demand for livestock products and in turn for feed grains.

Diversification will be demand-led under these circumstances, and will be best-stimulated by policies that do the most to increase rural income and employment.

CURRENT RESEARCH NETWORKS

PROGRAM/NAME	COUNTRIES	OBJECTIVES	CIAT
BEANS			
REGIONAL NETWORK ON BEANS: EASTERN AFRICA **Coordinator and Steering Committee**	Kenya, Tanzania, Sudan, Uganda, Ethiopia, Somalia, Madagascar	o Strengthen the national research capacity of participating countries from the region; o to jointly develop adapted and improved bean production technology components for traditional and improved cropping systems; o to stimulate increases in the production of beans, and consequently; o to contribute to the necessary food security of this high density population region of the world.	Executor
REGIONAL NETWORK ON BEANS: SOUTHERN AFRICA (SADCC) **Coordinator and Steering Committee**	Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, Zimbabwe, Kenya.	" "	Executor
REGIONAL NETWORK ON BEANS: GREAT LAKES (Central Africa) **Coordinator and Steering Committee**	Rwanda, Burundi, Zaire	" "	Executor
BEAN PRODUCTION IN THE CENTRAL AMERICA AND CARIBBEAN REGION **Coordinator and Steering Committee**	Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, Mexico and Panama	To continue the production and dissemination of improved bean (*Phaseolus vulgaris* L.) technology to meet production constraints which are specific to the Central American and Caribbean region.	Executor

NAME	COUNTRIES	OBJECTIVES	CIAT
REGIONAL BEAN RESEARCH PROJECT IN THE ANDEAN REGION **Coordinator**	Peru, Paraguay, Bolivia, Ecuador, Colombia, Venezuela	To strengthen regional research and technology transfer capacity while increasing productivity of common beans among highland resource-poor producers in the Andean Region.	Executor
ADVANCED BEAN RESEARCH NETWORK	(To be initiated in October, 1989)	Very similar to those enunciated below for the advanced cassava research network.	
RICE			
CARIBBEAN RICE IMPROVEMENT NETWORK **Coordinator guided by a Project Advisory Committee**	Belice, Guyana, Jamaica, Haiti, Dominican Republic, Trinidad, Surinam.	The overall goal of this project is to support the objective of self-sufficiency in rice production in the Caribbean Region and to reduce the large outflow of foreign exchange presently demanded by the region's needs to import this staple.	Executor
ROCKEFELLER FOUNDATION NETWORK ON RICE BIOTECHNOLOGY **Steering Committee**	Global	Objectives are to develop and improve advanced biotechnology for rice improvement. Specific features include the demonstration of rice anther culture as a viable strategy in breeding programs and RFLP mapping.	Collaborator
INTERNATIONAL RICE TESTING PROGRAM (IRTP) **Steering Committee**	South America, Central America and the Caribbean	International network for the genetic enhancement of rice.	CIAT hosts regional coordinator

NAME	COUNTRIES	OBJECTIVES	CIAT
PASTURES			
TROPICAL PASTURES NETWORK (RIEPT) **Coordinator**	Amazonian Region of Peru, Ecuador, Colombia, Brazil, Bolivia	Goals are to promote seed multiplication in selected countries of the region; to expand methodology development for on-farm pasture evaluation; to continue the support to local pasture networks and promote their interaction; and to stimulate linkages between research and development related to tropical pastures.	Executor
SOUTH EAST ASIAN FORAGE AND PASTURE R & D (SEAFRAD) **Advisory Committee**	PRC, Malaysia, Sri Lanka, Thailand, Philippines	Activities include training, development of R & D methodology germplasm collection, introduction and evaluation, and information exchange.	Coordinator
COLLABORATIVE FORAGE RESEARCH NETWORK FOR WEST AFRICA **Steering Committee**	The West African region (Burkina, Faso, Benin, Cameroon, Chad, Congo, Cote D'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Niger, Nigeria, Senegal, Sierra Leone, Togo and Zaire)	On the networking process there was a quick agreement on the bottom-up approach proposed by ILCA, which includes an introductory workshop to define specific objectives, strategy, structure and operational mode.	Coordinator Collaborating Center ILCA
CASSAVA			
CASSAVA STARCH IN LATIN AMERICA **Steering Committee**	Argentina, Bolivia, Brazil, Colombia, Ecuador, Paraguay	Goals are to facilitate free communication between researchers and to promote the interchange of experiences for the development of a cassava starch industry.	Catalyst
CASSAVA GERMPLASM EVALUATION IN LATIN AMERICA **Steering Committee**	Brazil, Colombia, Ecuador, Mexico, Panama, Paraguay	Goals are to provide interested countries with high possibilities for solving production/utilization problems and to promote the interchange of experiences in varietal selection so as to improve the efficiency of breeding.	Convenor

NAME	COUNTRIES	OBJECTIVES	CIAT
ADVANCED CASSAVA RESEARCH NETWORK **Steering Committee**	Argentina, Belgium, Brazil, Canada, China, Colombia, Italy, Japan, Nigeria, UK, USA, West Germany	The objectives of this network are to identify key constraints in production and processing which are considered difficult to solve through traditional research, to strengthen the link between basic research in advanced institutions and the more applied work done by the IARCs and NARDS, and to seek and make efficient use of resources.	Collaborator
HUMAN RESOURCES DEVELOPMENT FOR GENERATION AND TRANSFER OF ROOT AND TUBER CROPS TECHNOLOGY **Steering Committee**	(Global)	The main purpose of the project is to facilitate the expanded development of human resources in root and tuber crop improvement programmes of selected developing countries in Africa, Asia, the Middle East, Latin America and the Caribbean in order to enable farmers to adapt new technologies designed to increase their own food supply and income as well as to augment the availability of low-cost food to urban populations.	CIAT Collaborating Centers CIP & IITA

Five Projects with Research Institutions Around the World 1988

CIAT collaborates with many advanced research institutions on a range of projects which will further the state of knowledge in prioritized research areas in which the Center does not have an immediate comparative advantage within its on-going programs. Many of these projects are funded by the national donor agencies in the countries where the collaborating institutions are located. The current projects are alphabetically listed with their respective institutions and, if applicable, the funding source.

Institution	Description	Funding Agency
Faculte des Sciences Agronomiques de Gembloux, Département de Phytotechnologie Tropicale. Belgium	Legume germplasm research	Administration Générale de la Coopération au Développment (AGDO)
Fondo de Desarrollo Rural Integrado. Colombia	Agroindustrial development of cassava in Colombia	Fondo de Desarrollo Rural Integrado (DRI)
Institute of Horticultural Research. United Kingdom	Pathogenic variation of *Pseudomonas syringae* pv. *phaseolicola*, the halo blight pathogen of *Phaseolus* beans	Overseas Development Administration (ODA). United Kingdom
Institute of Horticultural Research. United Kingdom	Third-country quarantine of African beans	CIAT
Istituto d'Agronomia e Coltivazione Erbacea. Rome, Italy	Evaluation of existing and creation of new variability in *Phaseolus vulgaris* germplasm	Italian Government
Istituto di Biologia Agraria. Viterbo, Italy	Development of a tissue culture cycle in common beans (*Phaseolus vulgaris*)	Italian Government
Istituto di Fitovirologia Applicata (IFVA). Rome, Italy	Characterization of the main bean yellow mosaic virus isolates in North Africa, West Asia, and China	Italian Government
Istituto Nazionale della Nutrizione (INN). Rome, Italy	Research on antinutritional factors in common beans (*Phaseolus vulgaris*)	Italian Government

ANNEX VIII

Institution	Description	Funding Agency
Istituto Sperimentale per L'Orticoltora. Milan, Italy	Development of a protocol for agrobacterium-based transformation in bean (*Phaseolus* spp.)	Italian Government
Institut für Viruskrankheiten der Pflanzen (IVPB). Braunschweigh. Federal Republic of Germany	Distribution and importance of viruses naturally infecting *Phaseolus vulgaris* and its relatives in Africa	Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ)
International Institute for Tropical Agriculture (IITA). Nigeria	Exploration and evaluation of cassava mite predators	IITA
International Rice Research Institute (IRRI). Philippines	IRRI-CIAT collaborative project	IRRI
Louisiana State University, Department of Biochemistry. USA	Development of gene-transfer techniques in cassava	United States Agency for International Development (USAID)
Ministry of Agriculture. Iran.	Scientific and technical cooperation in research and training on *Phaseolus* bean improvement	Government of Iran
Mississippi State University, Office of International Programs. USA	Sorghum research in Latin America (INTSORMIL)	USAID
Overseas Development and Natural Resources Institute (ODNRI). United Kingdom	Organoleptic and biochemical evaluation of storage life of cassava	ODA.
Technical University, Bonn, Federal Republic of Germany	Plant regeneration of *P. vulgaris* in tissue culture (Ph.D. thesis)	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). West Germany
Technische Universitat Berlin. Federal Republic of Germany	Research on dual-purpose systems and the role of improved grass-legume pastures for milk and beef production in acid soils of tropical America	GTZ

Institution	Description	Funding Agency
Tel Aviv University. Israel	Identification and characterization of genetic strains in *Bemisia*	USAID
Universitat Marburg. Federal Republic of Germany	Competition and survival of *Rhizobium* bv. *phaseoli* strains	BMZ
University of California. Davis, USA	Molecular markers for evolutionary studies in *P. vulgaris*	
University of Florida. Gainesville, USA	Development of genetic molecular markers in *Phaseolus vulgaris*	USAID
University of Munich, Institute for Economic and Social Sciences. Federal Republic of Germany	Social benefits and costs of rice research in Brazil	BMZ
University of Wisconsin, Department of Horticulture. USA	Interspecific hybridization in *Phaseolus* spp. through embryo culture	USAID
Vrijes University. Brussels, Belgium	Transformation of cassava tissues	
Washington University, St. Louis, Missouri. USA	Conferring virus resistance in cassava by introduction and expression of virus coat protein gene	Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM)-Rockefeller Foundation

ANNEX IX

GLOSSARY OF ACRONYMS

AESU	Agroecological Studies Unit
ASL	Analytical Services Laboratory
AVRDC	Asian Vegetables Research and Development Center
BRU	Biotechnology Research Unit
CATIE	Centro Agronomico Tropical de Investigacion y Enseñanza
CENARGEN	Centro Nacional de Recursos Genéticos
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CNPAF	Centro Nacional de Pesquisa em Arroz e Feijao
CPAC	Centro de Pesquisa Agropecuaria dos Cerrados
CSIRO	Commonwealth Scientific and Industrial Research Organization
DRI	Desarrollo Rural Integrado
DSU	Data Services Unit
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria
EMR	External Management Review
EPR	External Program Review
FAO	Food and Agriculture Organization of the United Nations
GRU	Genetic Resources Unit
IARC	International Agricultural Research Center
IBPGR	International Board for Plant Genetic Resources

ICA	Instituto Colombiano Agropecuario
ICM	Integrated Crop Management
IDB	Interamerican Development Bank
IEMVT	Institut d'Elevage et de Medicine Vétérinaire des Pays Tropicaux
IFDC	International Fertilizer Development Center
IICA	Instituto Interamericano de Cooperacion para la Agricultura
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Center for Africa
INTSOY	International Soybean Program
INTSORMLL	International Sorghum and Millet Program
IPM	Integrated Pest Management IPRA Investigacion Participativa para la Agricultura
IRAT	Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
MRB	Minimum Research Budget
NARDS	National Agricultural Research and Development Systems
NARIs	National Agricultural Research Institutes
NARS	National Agricultural Research Systems
OECD	Organization for Economic Cooperation and Development
R&D	Research and Development
RIEPT	International Tropical Pastures Evaluation Network
SACCAR	Southern African Center for Cooperation in Agricultural Research
SEAFRAD	South East Asian Forage Research and Development

SINFOC	Scientific Information Center
TAC	Technical Advisory Committee
TCSP	Training and Communications Support Program
TPP	Tropical Pastures Program
VRU	Virology Research Unit
WAFNET	West Africa Forage Network