CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE AND CGIAR SECRETARIAT

REPORT OF THE

FIFTH EXTERNAL PROGRAMME AND MANAGEMENT REVIEW

OF THE

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

(CIAT)

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

April 2000

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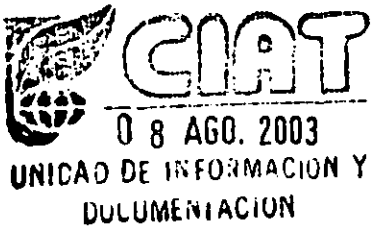

REPORT OF THE

FIFTH EXTERNAL PROGRAMME AND MANAGEMENT REVIEW

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CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

(CIAT)

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FOREWORD

This is the Report of the 5th External Review Panel appointed to evaluate the research programme and management of the International Centre for Tropical Agriculture (CIAT). The composition of the Panel is given in Appendix I, along with brief biodata. The Terms of Reference for the Fifth External Programme and Management Review (EPMR) of CIAT are provided in Appendix II, and the itinerary of the Panel is described in Appendix III.

In conducting the review the Panel was guided by the Terms of Reference with the aim to: a) provide CGIAR members with an independent and rigorous assessment of the institutional health and contribution of the Centre, and b) provide the Centre and its collaborators with assessment information that complements or validates their own evaluation efforts. CCERs commissioned by CIAT during the evaluation period, and relevant Systemwide evaluations were also used by the panel.

The Panel worked in an open, participatory and transparent manner aiming at a strategic and forward looking orientation while assessing the past. Strategic issues were identified on the basis of a list requested from the Centre, discussion with the Board prior to the First Phase, and after a careful consideration among the Panel members. The Panel based its assessments on information that was gathered during presentations and discussions with the Centre staff, both at headquarters and outposted, and with Centre Board members, interviews of government officials, partner organisations, collaborators and farmers. The Panel had access to a vast number of documents and publications that were provided by the Centre and the TAC and CGIAR Secretariats (Appendix IV), including a Review of CIAT Financial Management System (Appendix VI). CIAT Direct Research Allocation 1999 is shown in Appendix VII.

The Panel sought for opportunities for the staff to raise any concerns or issues to discuss, also confidentially. Impressions and information on CIAT's partnerships with NARS were gathered during the field visits. Other CGIAR centres and members were invited to bring any issues to the Panel's attention, but none were received, except some references to successful co-operation with CIAT.

The Panel hopes that this report is useful for TAC, for the CGIAR and for CIAT itself.

SUMMARY AND RECOMMENDATIONS

Mission and Mandate

CIAT was founded in 1967 following an agreement by the Colombian government and the Rockefeller Foundation. In 1988 it obtained international status. Its mandate activities include global responsibility for research on germplasm enhancement of beans, cassava and forages; regional responsibility for research on rice in Latin America and the Caribbean (LAC); research on natural resource management (NRM) in tropical America; and institutional development through support activities at national and regional levels. Over the years the Centre has increased its focus on sustainable production and natural resource management, and has developed a strong ecoregional approach in its NRM research. Characteristic features of CIAT's research philosophy have included collaboration with partners through many different arrangements, and the utilisation of participatory methods.

CIATS's mission today is to "To reduce hunger and poverty in the tropics through collaborative research that improves agricultural productivity and natural resource management".

CIAT's Strategic Plan for the 1990s called for integrated germplasm development and NRM, a mix of global and regional programmes, and a substantial reduction in commodity programmes to be offset by an increased role for NARS. Production systems research with no bearing on sustainability was phased out.

The Centre strives to integrate commodity oriented research and resource management oriented research within and among projects to achieve sustainable increased productivity. Commodity research at CIAT has moved upstream, in keeping with TAC recommendations, and NARS are assumed to be more engaged in applied crop improvement and other adaptive research.

Strategic Research Issues

Quality and Relevance of Science. CIAT has continued its excellence in science with exemplary programs in areas such as integrated pest management, forage improvement, participatory research, land use, GIS tools and biotechnology. The Centre has productive collaborative relationships with advanced research institutes, NARS and other partners. In the view of the Panel the Centre's position in the research spectrum in relation to alternative suppliers of the research should be reviewed on a continuing basis.

Research Park. In an attempt to use best its scientific capacity and facilities to help others, and to augment synergistic scientific capacity at the Centre, CIAT has ventured into the implementation of a research park concept with some 18 scientific organisations now operating on the campus. The Panel encourages further exploration and formalisation of this approach and believes that it should be expanded to field as well as laboratory-based research. Currently, the CIAT field facilities are underutilised with a large area being planted to sugar cane.

Gene Bank. One of CIAT's most important public goods continues to be its gene bank with major collection of beans, tropical forages and cassava and their wild relatives. While the Panel recognises the dedicated and professional work done to store and manage these

collections, it is concerned about the considerable backlogs in most operations. The Panel sees at CIAT an immediate need to implement the investment plan to upgrade the CGIAR's gene banks to better meet their international responsibilities. Furthermore, the Panel emphasises the importance of the current negotiations for an International Undertaking and urges CIAT to engage in a dialogue among its Board members and with its national partners to assure that a favourable agreement for agricultural and food genetic resources is reached.

Commodity Research. CIAT's commodity research builds on the long history of crop improvement of rice, beans, forages and cassava. The Panel is convinced that the crop improvement projects remain relevant and productive. Recent impact studies show extensive adoption of varieties derived from CIAT materials in all four crops. The impact of current research inputs from modern biotechnology, IPM, participatory methods and other such tools can only be gauged in the future, but the Panel is optimistic that many of the research achievements during the period under review will contribute significantly toward improving the sustainable productivity of CIAT's mandate crops. In the current trend to move upstream, the Panel cautions that CIAT must be attentive to the variability in capacity among its NARS partners.

The period since the last review has seen the establishment of the Fund for Latin American and Caribbean Irrigated Rice (FLAR), a consortium involving both the public and private sector dedicated to the support of rice research in the region. The growing demand for rice in Latin America and the Caribbean is being met by increased investment in adaptive research through FLAR while CIAT is focussing on new biotechnological tools for germplasm enhancement. Cassava improvement at CIAT has been redirected mostly toward meeting industrial needs in Latin America and Asia. Improved forages have been developed with major potential to enhance topsoil quality in large areas of LAC.

Impact assessment studies indicate increasing adoption of bean varieties developed by or with CIAT. No ready replacement exists for beans in the diets of the poor in both LAC and Africa. For both beans and forages, no significant alternative suppliers of technology exist. The Panel urges CIAT to guarantee adequate resource allocation for its commodity research, the results of which continue to serve the poor, and sees important opportunities for CIAT in new technologies allowing the modification of nutritional characteristics of food crops.

Biotechnology. The CIAT biotechnology group is impressive, with the capacity and contacts to keep abreast of new developments in their field of science. The work currently done at CIAT is relevant and productive, taking a problem solving approach while employing and developing suitable new methodological tools for crop enhancement. Through numerous partnerships, some of which are being implemented at the campus in a research park setting, CIAT is assuming a regional role in developing biotechnology. The Panel encourages this approach and supports CIAT's initiative to establish a regional biotechnology laboratory.

Natural Resource Management. CIAT has a significant capacity in NRM research built around competencies such as social science, IPM, soil science and GIS. Based on the watershed as the unit of analysis, participatory methods have been developed and are being disseminated for use by CIAT and its partners, to create a more effective mechanism for problem identification and to increase the relevance of research results and the likelihood of their adoption.

The African Bean Project has been exemplary in fostering interdisciplinarity and integrating NRM with commodity research. Based on this successful experience in implementing NRM research, the Panel sees the need to identify a technological or social process entry point, be it a commodity, a soils or pest problem or other well defined constraint where CIAT has the competency to respond.

In IPM, soil, and land use research the Centre has succeeded in creating an interdisciplinary research culture, and a level of integration that is leading to tangible research outputs with a high probability of adoption. The land use research has been able to address important biophysical and socio-economic issues related to NRM on a broad scale. The IPM project has organised and is leading a global project on white flies that may prove exemplary to the CG System. It represents a "task force" or "thrust" approach that has mobilised global scientific resources to address a worldwide problem.

CIAT is also applying its resource management and commodity research in developing technology options for smallholder systems in a research process that is based on a holistic and rigorous description of the landscape. The Panel notes, however, that the comparative strategic research in the CIAT NRM reference sites has not live up to its promise. The Panel encourages CIAT to synthesise the wealth of experience and knowledge gained from its systems research into an appropriate research framework and methodologies that allow for successful integration.

Governance and Management

Governance. CIAT's Board of Trustees has 16 members, who represent both the regional distribution of the Centre's activities, with strong emphasis in Latin America, and the variability among its partners. During the past five years the Board has confronted a number of demanding situations, such as funding difficulties, new research structure, and searching for a new Director General. The Panel commends the determination of the Board to provide maximum stability in institutional structure and research management over the past three years. This has minimised the destabilising impact of the external conditions in which CIAT operated. The Panel urges the Board now to refocus its attention on strategic issues of resource allocation and the monitoring of implementation.

Improved Management. The recently departed Director General and his stable Management Team developed and modelled a strong corporate culture which permeates the entire organisation and which is reflected in a set of core values: participatory management, transparency, fairness, service orientation, cost-consciousness, and output-based performance evaluation. These guiding principles allowed CIAT to re-build its financial integrity, implement a major downsizing without labour problems, remodel its performance appraisal system, significantly improve staff participation, increase training and development opportunities for all it staff, foster harmonious relations between staff and between units, re-engineer a number of its support services, and reduce the operational cost of both research projects and support units. The Panel commends CIAT for the major improvements in leadership, administration, and finance and only wishes to underline the need to elevate the priority assigned to the redesign of CIAT's financial information systems, processes and procedures which should facilitate project budget monitoring and reporting.

Project Based Management. During the period of this review, CIAT completed the migration to project based management begun in the late 1980s. In 1996 the structure shifted

from programmes to 16 projects (plus leadership of 3 systemwide projects) administered by two directorates, Genetic Resources and Resource Management. The outcome was a flatter management structure with increased administrative duties for all project leaders.

Other Strategic Issues

Focus and Integration. CIAT has a constituency with almost infinite needs and it operates in some very complex and challenging research environments. When this situation is combined with the current global funding environment, it is not easy to maintain focus and to achieve integration among activities with diverse financial support. The Panel commends Management for its achievements in this regard, notes significant exceptions, and urges continuing vigilance to ensure that the essential focus and integration are achieved and maintained.

Security. Security is an underlying issue at CIAT, because of the well-known internal situation in Colombia. All reasonable precautions have been taken by CIAT to minimise the risk to staff and their families. The lack of complete security imposes some limitations on the conduct of fieldwork, as certain locations in Colombia must be avoided, but given the vast geographical area and many countries served by CIAT, there are many suitable alternative sites for research. The security issue must be kept under constant watch and review, but up to the present it is not of a magnitude that requires action beyond the precautionary measures already in place.

Virtual Reality. Nothing in economic history has moved as fast as the information revolution. It is changing the paradigm of research as ever more powerful computers have the ability to deal simultaneously with numerous complex databases. Reductionist research is giving way to complex modelling of biological, physical, and chemical systems in an increasingly integral manner, providing insights to researchers that were beyond the imagination just a few years ago. If CIAT is to maintain a credible research presence, renewal of staff capacity, additional bandwidth in connection to the Internet, and continuing modernisation of equipment are essential.

Donor Driven Research. CIAT's current research program is financed both by unrestricted contributions, and by 140 restricted research grants of varying size and type. These restricted research grants are funded from 40 different sources, and together they account for approximately 70 percent of CIAT's budget. There is no more challenging task for CIAT management than to interact with its many donors in such a way that each individual grant contributes to the overarching goals of CIAT's mission. Donor-led research investment may compromise CIAT's focus on its central goals, or encourage overinvestment in favoured areas.

Intellectual Property. Intellectual property is an important concern that will have profound implications in the operations of CIAT and other CGIAR centres in the near future. The CGIAR has historically operated and made its major achievements in the milieu of free exchange of scientific information and technologies. That environment has changed dramatically within the past decade. The major inputs to and outputs of CIAT's research – germplasm, varieties, information, scientific tools, and others that used to be in the public domain and readily accessible and available to CIAT and its partners, have become subject to significant IP concerns. IP issues will become even more pervasive in the future. Thus,

management of intellectual property to ensure that they are able to pursue their mission with success will be a major challenge for CIAT and the CGIAR.

Vision and Strategy

Principles of Engagement. The Panel identified (1) poverty alleviation, (2) international public goods, (3) comparative advantage, and (4) probability of success as principles that should guide CIAT's scientists in deciding among the many and varied opportunities (that must always be distinguished from needs) that will confront CIAT in the modern world order of research.

A New CG Model. The Panel considers that CIAT is making the transition to a new model among the CG Centres. It is working to implement an effective model for blending NRM and germplasm research. It has become a more open centre and the hub of the research establishment for the region, while maintaining international presence and impact. It has combined a core long-term agenda consistent with its mission and mandate with a realistic involvement in the current research market as represented by its research park. The panel **commends** the Centre for the effective management of this evolution

Reconciling Core Competencies. The Panel recognises that achieving the current objectives of the Centre requires core competencies based on different research paradigms. To succeed, CIAT must reconcile those paradigms at the operational level and live with the healthy tension that will always be associated with productive interdisciplinary research.

LIST OF RECOMMENDATIONS

Chapter 2 – Saving Biodiversity

1. Because of the global responsibility assumed by CIAT for its germplasm collections held in trust, and the urgent need to upgrade the gene bank and its operation, the Panel **recommends** that CIAT give urgent priority to obtaining necessary funds to comply fully with the Systemwide Genetic resources Program on upgrading CGIAR gene banks; that a timetable of 5 years be set to complete the upgrade effort; and that Board and Management examine needs – staffing, special equipment, etc. – to ensure that upgrading is carried out successfully.

2. Because CIAT holds in trust the largest global collection of cassava among its total collections of over 50,000 accessions; because the storage and management of this vegetatively propagated crop is costly due to high labour inputs, and because storage in tissue culture, even with slow-growth methods, poses some risks to the genetic stability and safety of the germplasm, the Panel **recommends** that CIAT direct major effort to develop a reliable cryopreservation method to cut costs and to guarantee the long-term safety of these collections.

3. Because biotechnology research at CIAT generates a new class of genetic resources; e.g. clones, sequences, probes, transgenic organisms, and associated information; because these new genetic resources are as valuable as "traditional" genetic resources; and because they will become increasingly more important for research and technology development, the Panel **recommends** that CIAT adopts the broader concept of

agrobiodiversity to include the new class of genetic resources, and develop appropriate policies and protocols to manage their conservation, exchange and use.

4. Because agrobiodiversity conservation, enhancement and use is central to the mission and international research responsibilities of the CGIAR and CIAT; and because the emergence of the private sector as a major technology provider within the new global regimes of intellectual property and biosafety has profound and pervasive implications on the generation of international public goods, the Panel **recommends** that CIAT, within the framework of the CGIAR, develop at the earliest possible time a *comprehensive* policy, operational strategy and capacity to manage its research and development efforts on agrobiodiversity to ensure maximum access to and freedom-to-operate in the use of genetic resources, biotechnology applications and information, and the safe deployment and use of products derived from them.

Chapter 3 – *Improving Productivity*

5. Because of the strategic importance of CIAT's mandate commodities to the well-being of the world's poor; because CIAT is a major if not the only nucleus of international research on these commodities; and because research and development on commodity improvement requires consistent, long-term and adequate efforts, the Panel **recommends** that the Centre Board and Management commit, secure and provide sustained and adequate support to the Centre's global and regional commodity research responsibilities.

6. Because of the vulnerability of the highly successful African Bean Project to changes in donor funding and the impression of African NARS partners that CIAT has no long term commitment to the continent, the Panel **recommends** that CIAT assure the project of long term sustained funding to safeguard continuity and the ability to expand into promising areas such as forages.

7. Because of advances in technology that allow the modification of the nutritional characteristics of staple food crops, such as the production of vitamin A precursors in rice, and because improved human nutrition would be a major contribution to the welfare of poor consumers in LAC; the Panel **recommends** that CIAT monitor closely the advances in this technology as well as the surrounding intellectual property issues, and take all appropriate steps to utilise these technologies in appropriate germplasm improvement programs.

Chapter 4 – Protecting the Environment

8. Because the approach of CIAT's Natural Resource Management research at the farm, community, watershed, and ecoregion levels, is not always clear, the Panel **recommends** that CIAT develop a rigorous overall research approach with greater integration among projects, define their specific objectives (including the role of reference sites and related activities) more clearly, and establish a clear framework of their hierarchical and functional relations and responsibilities.

9. Because the Hillsides Project work developed in Colombia has not yet lived up to its promise in Central America, the Panel **recommends** that CIAT develop a rigorous and coherent research plan for the Hillsides Project including clear and consistent definitions.

Chapter 6 – Better Policies

10. Because the integration of research on germplasm, natural resources and social science lies at the heart of CIAT's strategy and because CIAT has had a lengthy experience in bringing about such integration, the Panel **recommends** that CIAT document its experience by assessing the impact of its past integration efforts on its target areas and populations.

Chapter 7 - Partnerships

11. Because CIAT has had extensive and varied experiences with different forms of research partnerships (e.g., networks, consortia, joint ventures, collaborative projects), the Panel **recommends** that CIAT carry out an analytical review of this experience to derive lessons for itself and other CGIAR institutions.

Chapter 9 – Organisation and Management

12. Because integration of research efforts is a cross-cutting issue for the Centre, the Panel **recommends** that CIAT include in its next strategic planning exercise an in-depth examination of the composition of its project portfolio and the mechanisms used to foster intra-project and inter-project integration.

13. Because the present information systems do not provide the project leaders with relevant, timely and accurate financial information, the Panel **recommends** that CIAT elevate the priority assigned to the redesign of its financial information systems, processes and procedures.

Chapter 10 – General Assessment and Strategic Issues

14. Because all successful research endeavours at the Centre, such as participatory management research, are characterised by the maintenance of core competencies and institutional memory, the Panel **recommends** that CIAT ensure that its research strategy for NRM be explicitly cumulative in nature.

15. Because CIAT has used effectively the products and processes of its participatory germplasm improvement research as an effective entry point to gain the confidence of farmers and facilitate the more complex but equally essential NRM research, as exemplified by the African Bean Program, and because technology and social process are recognised as potentially effective entry points into communities, the Panel **recommends** that CIAT further develops its "entry point" model to help identify optimal entry points for its NRM research projects.

CHAPTER 1 – EVOLUTION AND STRATEGY

1.1 Origin and Evolution of CIAT

The International Centre for Tropical Agriculture (CIAT) is an autonomous non-profit organisation, which was founded in 1967 following an agreement signed by the Colombian government and the Rockefeller Foundation. CIAT has been part of Consultative Group on International Agricultural Research (CGIAR) since 1971. It was one of the four "founding" centres that were established in response to the food crisis of the 1960s. CIAT's initial mandate was 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." In 1977, at the CGIAR's request, the Board recognised global responsibilities going beyond initially emphasised regional responsibilities. The centre In 1988 CIAT was recognised by Colombia as an international organisation under specific act of legislation and it operates under a World Bank-UNDP agreement.

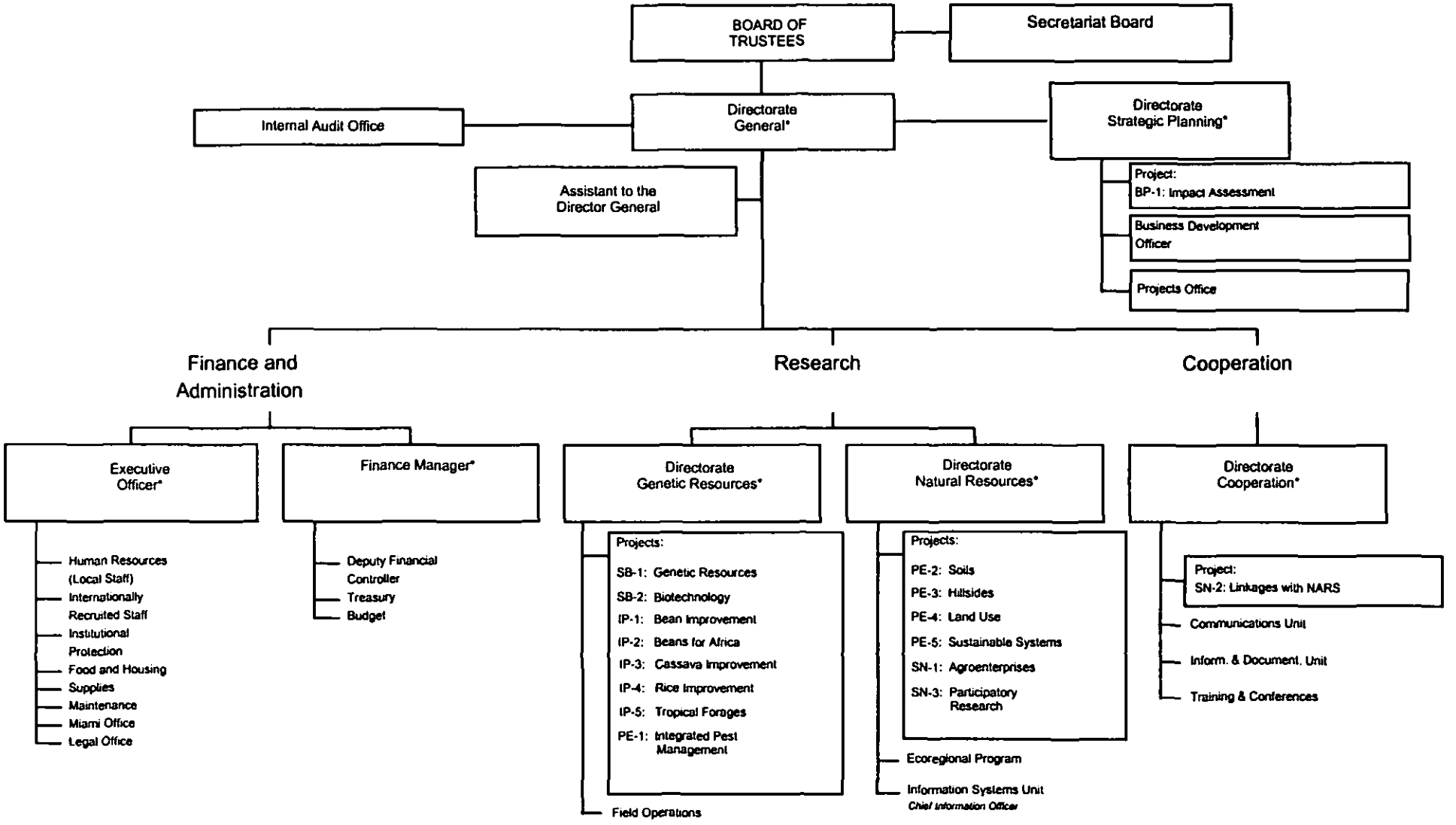
CIAT has undergone more changes over the years than perhaps any other CGIAR Centre. This may have been due to its mixed and broad responsibilities for commodity improvement and for production systems of crops and, in the earlier years, livestock for the tropical regions in which it operates. CIAT's early programs were Production Systems Programs in Cassava, Beans, Beef, Swine, Animal Health, and Small Farm Systems and crop improvement programs in Rice (co-operative with IRRI) and Maize (the Andean Regional Maize Unit, co-operative with CIMMYT). In the 1970s CIAT developed its facilities and programmes during a period of rapid expansion. By the time of the First External Review, large changes were already underway. The Centre was moving from a broad initial base to a smaller number of research programs with narrower geographical and ecological foci. The research on livestock was phased out and the research programs were built around three major food staples of the Latin American region: rice, beans, and cassava. A fourth program, replacing the previous Beef Program, was structured toward the end of the decade for research on forage pastures in the acid soils of the Latin American lowland tropics. Organisational procedures for program review and modification were established. The end of the decade was characterised by rapid expansion of collaborative networks for testing and adoption of CIAT's technologies and by emerging attention on managing natural resources, which was reflected by the establishment of the tropical forages programme.

In the beginning of the 1980s CIAT expanded its operations outside Latin America for the commodities, beans, cassava and tropical forages, for which it had a global mandate. The regional programme for cassava in Asia started in the late 1970s and one for beans in Africa began in 1983. For rice CIAT had a regional mandate, and the focus was broadened to include upland environments, in addition to irrigated rice.

CIMMYT replaced the regional maize research programme at CIAT. CIAT increased ties with national agricultural research programs to decentralise a share of its operations. Regional programs were built with staff posted to key regions (from 26 % of the total in 1984 to 43 % in 1989), and regional networks developed. Specialisation was another feature of the 1980s as several specialised units were established to support the commodity teams. These included Genetic Resources, The Agroecological Studies, Biotechnology Research, Virology Research, and the Seed Unit. The training, communications and information units were consolidated into the new Training and Communications Support Programme. Farmer Participatory Research began as a project in 1987.

By the end of the 1980s the Centre had strategically placed itself to cover the whole spectrum from strategic to applied research. The requirement for sustainability was further emphasised as reflected in the environmental sensitivity in the research themes, such as biological control, reduction of soil erosion and water stress. CIAT's decision to complement germplasm development with the management of natural resources was reflected in Strategic Plan for the 1990s. Serious financial cuts, felt across the CGIAR, affected CIAT in particular, due to inflation and exchange rates, and forced the Centre to downsize its operations and reduce the number of staff considerably. The areas of biotechnology, genetic resources, soils and participatory research were, however, largely protected. Despite financial difficulties the Centre went ahead with very large changes outlined in its new Strategic Plan. A new mandate was drafted and a new program structure devised. Research allocation for the four germplasm improvement programmes and training was cut, and a new set of ecoregional activities started. New NRM programmes were initiated on tropical lowlands and on hillsides, and to study policy effects on land use systems. CIAT also became involved in CGIAR Systemwide initiatives. In response to the 4th EPMR in 1995 and implemented by the new Director General nominated at that time, CIAT changed its organisational structure in 1996. The senior management team was built around the elements that CIAT considered essential in its new strategy: "improving productivity, managing natural resources and doing research together". Directors for Genetic Research, Natural Resource Management Research and Regional Co-operation are principally responsible for leading CIAT's strategy along each of those lines. In addition to these Directors and the DG, the Management Team includes the Director of Strategic Planning, the Executive Officer for Administration and the Financial Manager. From the previous Research Structure based on programmes and units, CIAT changed into a structure of 16 projects, which include 2 in Germplasm Collection (including Biotechnology), 5 in Germplasm Improvement, 5 in Sustainable Production, 3 in Enhancing NARS and 1 in Policy, according to the log-frame output categories endorsed by the CGIAR. There are 3 projects related to CGIAR Systemwide Initiatives.

Figure 1. Organizational Chart



* Member of the Management Team.

1.2 Mandate of CIAT

CIAT's operational mandate, as stated in the Strategic Plan for 1991-2001, "CIAT in the 1990s and Beyond", is: "CIAT will contribute to technology development that will lead to long-term improvement in productivity of agricultural resources; to the development of innovative, more cost-effective agricultural research approaches and methods; to the strengthening of agricultural research institutions in participating countries; and to the development of interinstitutional linkages." CIAT's mandate activities are in the following areas: i) Germplasm development research of beans, cassava and forages with a global responsibility and of rice with a regional responsibility for Latin America and the Caribbean; 2) Resource management research in tropical America through land use research and agroecosystems-oriented research in cleared forest margins, hillsides and savannahs, and 3) Institutional development through support activities at national and regional levels.

Increasingly CIAT seeks to apply its expertise also to solve distinct production problems encountered with other than the mandate crops for the private sector, farmer organisations and others, who contribute to the research costs. CIAT deploys specific scientific expertise such as IPM, soils, biotechnology, germplasm conservation etc. to address single and major production problems of other high value crops, such as tropical fruits, where no research support exists in NARS.

1.3 Role of CIAT

CIAT's mission, as approved 1999 by its Board, is: "To reduce hunger and poverty in the tropics through collaborative research that improves agricultural productivity and natural resource management". CIAT aims to contribute to overcoming some of the technological constraints to productivity through sustainable management of the natural resources and to overcoming institutional constraints. CIAT presents a system's approach that links improvement of germplasm with better management of natural resources. The overriding themes in the 1990s have been greater prominence to poverty reduction, reaching beyond Latin America and the Caribbean to Africa and Asia, increased focus on new upstream scientific tools, working beyond the specific mandate food commodities and making the natural resource effort more explicit.

CIAT sees itself as part of an emerging global system of agricultural research and development and as complementary in relation to other institutions involved in the partnerships. CIAT assumes a key role in supporting national research systems, while considering its interaction with universities and other specialised instituted important, and it is involved in systemwide programmes and other types of inter-centre collaboration. The non-traditional partners, including NGOs and the private sector, are considered increasingly important.

1.4 CIAT's Strategic Plan and Medium Term Plan

In the Strategic Plan for the last ten years ("CIAT in the 1990s and Beyond"), CIAT's research paradigm changed from having been based on a supply-driven reductionist approach to one designed to promote sustainable systems and to address factors that link a farm's ecological, economic and environmental performance. This strategic plan was based on an analysis of CIAT's external and internal environments within a long-term perspective, which showed that the environment was changing rapidly and continuously requiring a radical change of CIAT to guarantee its relevance. This Strategic Plan is characterised by integrated germplasm development and NRM, in which new programmes were initiated, a mix of global and regional programmes, a considerable reduction in commodity programmes of CIAT with an increased role of NARS in crop improvement. The Strategic Plan emphasises four interrelated guiding principles to be followed: relevance/goal orientation, systems perspective, multi-institutional approach and comparative advantage. As stated in the Plan:

"Germplasm development research will be directed at characterising and broadening the genetic base of selected commodities, and at understanding gene-governed mechanisms determining plant adaptation and productivity in major production areas, including the ecosystems of tropical America selected for intensive agroecological research. The aim is to develop the potential of germplasm resources for increasing output and efficiency of input use."

"Resource management research will focus on important tropical American agroecosystems which are threatened by increasing land use intensity or natural resource degradation, as well as on those which may have the potential for relieving such pressure. The aim of research will be to understand the basic processes within the agroecosystems for the purpose of making agricultural production more sustainable."

"This integrated approach will be pursued within a framework of interinstitutional co-operation aimed at enhancing complementarity and increasing cost-effectiveness of research at the national, regional and international levels."

During the implementation of the 1991-2001 Strategic Plan, there have been elements which have not materialised, such as increases in total resources by 20%, allocations to sorghum and soybean improvement, and reaching self contained germplasm and agroecosystems programmes. Additional, unanticipated new areas of activities include: agroenterprises activities, community resource management, farmer participatory research, integrated pest management, and Systemwide programmes.

The Medium Term Plans have been the tools to carry forward the implementation of the CIAT Strategic Plan for 1991-2001. There have been three successive ones applying to the period under assessment in this EMPR: 1992-1996, 1993-1998 and 1998-2000, which is entitled Doing Research Together. In the last of these, implemented 1997,

the Research Programme was reorganised to a project structure. Genetic resources, biotechnology, pre-breeding and resource dynamics achieved increased emphasis while the allocation for classical breeding and production systems was decreased. The emphasis on impact assessment and strengthening NARS remained at a previous level. Two principles became central: Integration of germplasm improvement with natural resource management and collaboration with partners to make this integrated approach successful. Research work was organised around teams, and projects became autonomous with responsibilities for research plan development, resource management, human resources, relations with partners and fund raising. CIAT has fully implemented the logical framework model for managing its research planning, monitoring and evaluation process and for all administrative activities.

Since the implementation of the 1998-2000 MTP, there have been rolling MTPs for three year periods, as required by the CGIAR, but there have been no changes in the allocation of core funds, nor reorganisation. Any variations from the implementation of the planned MTP research programmes since 1997 have been due solely to changes in donor decisions about unrestricted and targeted funding. CIAT has, however, had a number of pilot initiatives, including activities on non-mandate crops, enhanced involvement of private sector in cassava research, consortium on spatial information and initiation of Business Development Office.

Towards the end of 1990s CIAT initiated the process to reformulate its Strategic Plan for 2001-2010 with the aim to develop strategies that meet stakeholders objectives and mobilise support. The process, now under way, has included documentation of past impacts and estimation of new ones, analysis of the external and internal environments, and consultation with stakeholders. The process is expected to communicate new vision in a dynamic environment for stakeholder support and internal cohesion. The issues considered in the Plan will include changes in the organisation of the CGIAR, alternative funding options, including public investors in the South and the private sector, new types of partnerships, the changing role of public research, new culture for scientists and new organisational model of CIAT.

1.5 Strategic Issues

This Review follows the revised approach to External Programme and Management Reviews (EPMRs) which draws, to the extent possible, on Internally Commissioned External Reviews (CCERs). The merits of this approach are discussed in a document entitled "Improving the Quality and Consistency of the CGIAR's External Centre Reviews," a discussion note prepared by the CGIAR and TAC Secretariats for International Centres Week 1995. In preparation for the Review, members of the Panel attempted to identify major strategic issues to be considered. This was accomplished through extensive consultation with the CIAT Board, management and staff and through reference to the CCERs. Other reviews and consultant reports were utilised, and collaborating institutes in the CGIAR System and outside were contacted to identify their concerns.

These strategic issues are grouped into five broad categories: (a) CIAT's strategic niche within the global system for agricultural research; (b) the research strategy and programme thrusts; (c) the overall governance and management of the Institute; (d) other key issues facing the Institute and (e) issues identified by the institute management.

(a) Strategic Niche of CIAT

❖ Since the last review, CIAT has undergone major restructuring. Mandate crops are no longer the primary organising principle. Is the present structure of two research directorates, one for Genetic Resources Management (GRM) and one for Natural Resources Management (NRM), appropriate and is there proper balance and integration between the two?

❖ All Centres, including CIAT, struggle with the balance between regional and global research programs. CIAT has the added complexity of security issues in the region. What is the appropriate balance between regional and global programs.

❖ CIAT is now emphasising the use of its scientific capacity to help other institutions. It has become a research park of sorts, hosting some 18 institutions, including CIMMYT, IPGRI, IRD, Von Humbolt, CORPOICA and BIOTCH. Activities include such items as the improvement of Mora (the Andean Blackberry) and contract work for the cut flower industry. Does this approach represent CIAT's comparative advantage in contributing to international public goods? What is the rationale for the establishment of a research park?

❖ CIAT is an enthusiastic participant in many systemwide projects. While additional resources were available for start up, funding in the longer term is competitive with other opportunities and transaction costs are significant. How, in the future, will this work be integrated into the core activities of the Centre and funding secured, while maintaining the Systemwide nature of the research and high degree of collaboration with partners?

(b) Research Programme Issues

❖ What is the appropriate disciplinary balance among the internationally recruited staff of CIAT?

❖ As a considered strategy, and in response to suggestions from TAC as well as some donors, CIAT has positioned itself well upstream in the spectrum of research in several programmatic areas including (1) GIS, (2) genetic resources, (3) participatory research, (4) IPM, (5) soils and (6) biotechnology. Unless comparative advantages are considered, this could place the Institute in competition with advanced research laboratories in the developed world. Critical mass is also a serious problem. Finally, upstream research will inevitably result in 'intermediate' products and practices, making

it more difficult to demonstrate farm level impact, which is a preoccupation of some donors. Positioning the Institute in the research continuum is an important question to consider.

❖ Donor influence on the research activities of the Institute is an important issue. Has the current funding situation pushed CIAT into an opportunistic approach to research? Do the "essential" programme thrusts need to be better defined, for which continuing long-term funding could be sought?

❖ Which themes and outputs of CIAT correspond to:

✓ Public goods for which CIAT will keep responsibility in the long term?

✓ Public goods for which in the medium term (5-10 years) NARS or other institutions should take full responsibility?

✓ Private goods which the private sector has a comparative advantage to provide?

❖ Crop improvement programmes still account for a significant portion of CIAT's research activity and represent long term commitments by the Centre. The strategies employed need to be evaluated. Prospects for continuity of these programs also need to be considered, the bean breeding program in Africa being of immediate concern.

❖ Advances in biology have implications for many of CIAT's programmes, and relationships exist with a number of laboratories in developed countries. Whether these relationships are appropriate and productive needs to be considered.

❖ The participatory approach to research has been embraced fully at CIAT. Whether this approach has been effective in producing desired outcomes and impacts needs to be assessed.

❖ The impact of CIAT since the last External Review and the mechanisms that are in place for monitoring impact should be considered.

❖ CIAT was among the first Centres to place a major emphasis on natural resources management research. Whether current efforts are appropriate needs to be reviewed in the light of different biophysical and socio-economic conditions and the differential state of the NARS.

❖ The revolution in information technology is one of the transforming features of modern society, and critical to the future of CIAT. The current status and strategy for information management needs to be considered.

❖ Should forage research be expanded in Africa? Is this a niche that is not currently being filled?

(c) Governance and Management

❖ The composition of the Board and its committee structure is an important issue. There is a question of whether the existing structure and articulation of committees allows the Board to make the most effective use of its time in maintaining proper oversight of Centre activities. This will include a look at:

✓ The level and quality of interaction with management on budget and financial issues.

✓ The quantity and type of information about CIAT research activities available to the Board.

✓ The Board's exposure to CIAT program activities in the field.

❖ The four CCERs commissioned by the Board form the basis of the EPMR. The EPMR will examine the scope and comprehensiveness of these reviews in clarifying strategic program issues, and comment on their utility as a management tool.

❖ A significant change during the period under review is the move to a more participatory management environment. The reorganisation of the research programs and the flattening of the management hierarchy have prompted changes in many areas of the centre's work. CIAT's scientific program is currently organised in 16 projects, overseen by two research directors. Of 60 senior scientists, a large proportion (25?) has management responsibilities. The EPMR will review the strengths and weaknesses of this arrangement.

(d) Other Key Issues

❖ Training efforts have been affected by downsizing in the CGIAR System. The impact of these changes and the future direction of training efforts in CIAT are important questions.

❖ Relationships with NARS are a key issue. CIAT has a lot of influence and it is important to work with NARS to create capacity.

❖ The management of intellectual property will be an increasingly important issue.

❖ Gender is a major issue for CIAT in terms of the orientation of CIAT's research and the composition of its scientific staff. This issue needs to be examined specifically and within the context of the research projects.

❖ Security is presently a pervasive issue at CIAT. Does it affect the recruitment and retention of staff and the implementation of all programs in Colombia? This issue needs to be considered from the standpoint of governance and management as well as the structure and implementation of research programmes.

(e) Issues Identified by CIAT Management

❖ **Partnerships:** In recent years CIAT has entered into a variety of new partnerships. These include closer alliances with CGIAR members from tropical countries; producers associations and other private organisations including NGOs; strategic alliances with research organisations hosted at CIAT. In addition, CIAT's traditional partnerships with NARS has been evolving as the public sector NARIs have downsized in many countries and regional networks have become increasingly autonomous or imperilled as their donor funding has been withdrawn. The management of this changing array of partnerships is a critical issue for CIAT.

❖ **Operational Mandates:** CIAT's operational mandates have evolved significantly over time, including at one time, animal health, maize, small farm systems and swine. In the early 1990's new elements were added. It is natural, therefore, that CIAT's operational mandates are revised periodically to adjust or include new elements in light of changing circumstances.

❖ **Scientific Integration:** Effective integration of interdisciplinary research is essential to the implementation of CIAT's central mission of improving agricultural productivity and natural resource management. Because integrating research across a wide variety of disciplines has been a priority of research management, an appraisal of whether CIAT is maximising interdisciplinarity in its research when opportune and appropriate would be useful.

❖ **Organisational Flexibility:** Due to the need to deploy interdisciplinary teams to tackle changing challenges, organisational flexibility is essential. It would be useful for the EPMR to consider whether CIAT has put in place policies and organisational structures to facilitate flexible response to emerging demands.

❖ **Security:** In the last decade CIAT scientists and their families have been victims of violent acts in a number of countries, both in Africa and Latin America. Scientific research has had to cease in some countries with resident CIAT staff (e.g. Ethiopia, Rwanda) and in other cases (e.g. Colombia, Peru) some ongoing research has been impeded at times. The management of research programs in the face of a variety of threats and risks of violence is clearly an important issue CIAT that the EPMR is asked to comment upon.

1.6 CIAT's Response to the Recommendations of the 1995 External Review

The 4th EPMR, conducted in 1995, found CIAT on recovery from serious organisational and financial problems, which weren't over yet. The Panel made several recommendations to assist the centre in improving its Research and Resource Management. CIAT generally agreed with the analysis and recommendations of the 4th EPMR. Many of the recommendations dealing with scientific approach related to institutional and management questions, which became the immediate task of the 1995 nominated new DG leading to the organisational restructure in 1996. The 4th EMPR

recommendations, the Centre's response to them and the status of the implementation of the suggested changes, with revision by this EPMR Panel, are presented in Appendix V.

CHAPTER 2 – SAVING BIODIVERSITY

2.1 Introduction

Genetic resource conservation and utilisation can be considered the most international of all CGIAR activities, and such work produces significant international public goods. Because most countries cannot afford to hold all of the germplasm resources needed, an international system of genebanks has developed, in which CGIAR centres hold extensive global or continental collections. Other genebanks hold duplicate collections to guard against catastrophic loss of valuable collections by war, fire, earthquake or other natural forces.

Central and South America comprises one of the world's great areas of diversity of plant genetic resources (PGR). When CIAT was established, it was given responsibility to collect, evaluate, conserve, characterise, document and distribute germplasm of cassava (*Manihot)*, common beans (*Phaseolus*) and tropical forages. With the founding of the CGIAR, CIAT received a global mandate – including germplasm responsibilities – for cassava, common beans and tropical forages. Since 1982, because of the importance of endemic PGR in Latin America, the International Plant Genetic Resources Institute (IPGRI) – and its predecessor institution, International Board on Plant Genetic Resources (BPGR – has stationed a Regional Co-ordinator at CIAT to strengthen collaboration in genetic resources work in the Americas.

Developments in biotechnology, information technology, remote sensing and participatory research have provided new tools and approaches that could help improve genetic resources conservation and utilisation. Molecular tools are now available to dissect, analyse and direct the nature and pattern of genetic variations in plant species and their associated organisms. GIS enables better understanding of the spatial distribution of genetic resources as well as bio-physical factors contributing to their distribution. Computer technology and bio-informatics have also rapidly evolved, allowing development of fast, accurate and user-friendly databases. Such developments are bringing profound changes in genetic resources conservation and utilisation. CIAT selectively develops and uses these new tools to understand, conserve, and utilise genetic diversity of its mandate crops.

2.2 Plant Genetic Resources (SB-1)

2.2.1 Evolution

Genetic resources work began at CIAT in 1978 with the establishment of the Genetic Resources Unit (GRU). Early work focused on collecting *Phaseolus* beans, cassava and tropical forages and distributing germplasm to national programs on request or through international nurseries. Early on, seed health and tissue culture were added to

the GRU, and because cassava is vegetatively propagated, emphasis was given to ways of storing cassava as tissue cultures and later, in cryopreservation.

In 1994, CIAT's bean, cassava, and tropical forage collections were placed *'under FAO...in trust for the benefit of the international community, in particular the developing countries, in accordance with the International Undertaking on Plant Genetic Resources'.*

Before 1978, germplasm activities were integrated with breeders in the Bean, Cassava and Tropical Pastures Programs. Since 1996, when the new project framework was introduced, the GRU became, virtually unchanged, project SB-1: *"Integrated Conservation of Neotropical Genetic Resources"*, with three objectives: 1) to assemble germplasm collections that are available to users, meet international standards, and are relevant to conservation; 2) through training, to help build regional capacity in conservation sciences and techniques; and 3) to develop *in situ* conservation methodologies for farmer landraces and wild relatives. Related objectives include:

- To improve or develop conservation techniques integrating conventional and modern biological technologies and focusing on *ex situ* collections of mandate germplasm, with linkages to *in situ* conservation on-farm or in protected areas.
- To assess and characterise the structure and diversity of genetic resources of wild and cultivated mandate species, selected non-mandate species, and associated organisms through use of analytical genomic technologies and agroecological information.
- To make genetic resources, databases, and genetic stocks and pertinent information available to users at CIAT and partner institutions.

During the period under review the responsibilities of the GRU were expanded to include *in situ* conservation, and native biodiversity areas not covered previously.

2.2.2 Achievements and Impact

The GRU continues efforts to conserve and distribute germplasm of CIAT's three mandated crops: beans, cassava and tropical forages. Related to those efforts are modest advances in methodologies and procedures to assure seed health in storage, long-term storage of seed materials (mostly beans and tropical forages) and vegetative materials (cassava) as tissue cultures or in cryopreservation. Such advances are operational in nature but science-based. SB-1 operates both as a service unit and a research unit for specific problems, usually in close collaboration with SB-2, with which it shares staff.

From its beginning CIAT has actively collected *Phaseolus*, *Manihot spp.* (cassava and its wild relatives) and tropical forage legumes and grasses. Today CIAT holds about 10 percent of the total accessions held in trust by the CGIAR, and the collections are as follows:

Phaseolus beans	
Accessions of *P. vulgaris*	25,454
Other cultivated species	3,002
Wild species	167
Tropical forages	
Legumes – total accessions	18,559
Grasses – total accessions	1,916
Manihot (cassava)	
M. esculenta (cassava) total accessions	5,537
Wild species	330
Total	54,965

Seeds of beans and forage species are stored in long-term storage facilities at Palmira, and cassava is stored *in vitro* and in field genebanks. Core collections have been developed for cassava and beans. Using molecular markers, the genetic structure of wild and cultivated beans and cassava collections have been characterised, thereby helping to define genepools and provide insights into domestication and genetic distances.

The entire cassava field collection is duplicated *in vitro*, has been screened for viruses and viroids, and is sub-cultured every 12-14 months. A cryopreservation method was developed, but the technique still needs improvement, as recovery rates are highly variable between genotypes, and the method is not yet reliable for all clones.

During the review period, the GRU distributed some 10,000 samples per year to different users. Such samples are covered by Material Transfer Agreements, in accordance with the FAO trusteeship agreement.

Some progress was made in characterising and evaluating collections and in developing new conservation and enhancement strategies and/or methods. Major backlogs still exist in characterisation, evaluation, duplication, and regeneration of the collections.

GRU is contributing to the Systemwide Information Network for Genetic Resources (SINGER), which links independent Centre databases. CIAT databases are being unified under the same format.

Following restructuring of CIAT, the GRU budget also absorbed the costs of various training activities.

Project scientists produced a total of 42 publications during 1995-1999, including 17 in refereed journals, 11 in conference proceedings, and 8 book chapters.

2.2.3 Future Strategy

Over the next several years, upgrading the genebank will be a main task. The Systemwide Genetic Resources Programme (SGRP) study of genebank upgrading in the CGIAR lists the following necessary tasks for CIAT:

1. Processing - removal of backlogs for bean, cassava and forages, with initial viability testing of regenerated materials.
2. Storage - For long-term storage; incorporate upgraded multiplication of 24,000 beans and forages, plus a further backlog of 18,000 samples. Entire designated cassava collection (5,728 clones) to be placed in cryopreservation.
3. Regeneration. Regenerate 32,000 beans and forages. Rationalise heavy distribution of samples that depletes stocks and requires more regeneration.
4. Safety back-up storage. Work in association with CATIE (Costa Rica) and CENARGEN (Brazil); some 42% of the collection is duplicated now; 24,000 new accessions will be duplicated, and samples sent earlier for duplication will be replaced with materials of good viability.
5. Characterisation. 61% of the overall collection needs characterisation. Morphological screening should be complete and specific molecular markers used (phaseolin for 18,000 beans); allozymes will be used for 4,000 selected forages of *Stylosanthes* and *Brachiaria*.
6. Information. Information management needs upgrading. Bar coding will be introduced in the *in vitro* collection and the seed collection.
7. Germplasm health. 35,000 seed accessions and 2,400 clones of cassava to be checked. Equipment is needed for disease indexing of cassava.
8. Germplasm Supply. Rationalisation and better planning as an integral part of genebank management.

While genebank upgrading will receive highest priority, other important activities will also be pursued. Exploration is still needed in some areas e.g., cassava in the Caribbean, to sample completely its genetic variability.

Continuing research on priority areas includes:

- Slow growth *in vitro* and reliable methods of cryopreservation of cassava.
- Diagnostic techniques for detection and identification of seed-borne pathogens.
- Relationships between landraces and wild relatives, and the relative importance of each.
- Structure of gene pools.
- Spatial distribution of genetic diversity.
- Geneflow between wild relatives and landraces of rice and beans, comparative mapping of all populations of wild relatives.
- Biodiversity at the farm level (see Section 4.6).

2.2.4 Overview and Assessment

The GRU work is very important and has good leadership with lots of drive and enthusiasm. The genebank faces many demanding operational and collaborative tasks and is seriously understaffed, especially because of added tasks to which it must also respond. Operating a genebank to meet global needs as well as international standards is complex and demanding. The Panel commends the GRU staff for its dedication, enthusiasm and the professional way it handles its tasks.

CIAT holds in trust the largest global collections of cassava and *Phaseolus* beans[1], which constitutes a major responsibility for the Centre. Current annual costs of CIAT's genebank activities averaged US$ 926,500 for 1998 and 1999, with 70% going to meet personnel costs and 20% for supplies and services[2]. CIAT ranks second in the CGIAR to CIP in current average annual costs of its genebank operations. After upgrading is completed, CIAT's genebank costs are estimated at US$ 950,000 per year, highest in the CGIAR.

The 1997 Centre Commissioned External Review (CCER) of SB-1 concluded that CIAT germplasm scientists were dedicated, of high quality and worked hard. The CCER commended SB-1 for keeping abreast of latest scientific issues, incorporating new scientific developments into its work, networking with others, and connecting strongly with project groups in CIAT and other institutions.

The 1997 CCER considered that CIAT's special assets in germplasm work were: extensive collections, vast field and greenhouse space, and dedicated support staff. Further, the CCER pointed out that germplasm resources held by CIAT can be directly accessible to development, "*...assuring CIAT a singular niche in tropical agriculture*". However, the CCER feared that CIAT's niche in germplasm work is threatened by too broad responsibilities; that changing from programs to projects has resulted in short-term scientific objectives tied to specific restricted funding; that budget cuts have resulted in decreased staff; and that together these issues are beginning to blur the focus of research activities. The CCER concluded the staff is trying to fulfil the multiple tasks and "*is simply spread too thin, both in human resources and expertise...*" and that it is "*...imperative for the maintenance of CIAT's central position in international agriculture that this situation be remedied*". The Panel agrees with this assessment.

The 1997 CCER stated that CIAT's objectives for the genebank must be very carefully defined and managed, so that existing research staff can produce outstanding research that will not only meet international standards, but also will maintain the Centre's central role. Funding changes may have serious effects well beyond the level of support. Tightly linking of special funds to specific objectives would broaden the range of research, thereby narrowing the flexibility and discretion of potential work to be done

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[1] Source: FAO, 1996. Report on the State of the World's Plant Genetic Resources for Food and Agriculture, FAO, Rome.

[2] Source: CGIAR System-wide Genetic Resources Programme (SGRP, 2000, A Funding Plan to Upgrade CGIAR Centre Genebanks).

within CIAT and outside. Commitment of support would also be shortened, "*making long-term research almost impossible*".

The CCER concluded that many aspects of work in SB1 and SB2 do not fit in a project mode, and stated in regard to the project system: *"The clearest example is the germplasm conservation activities, which are a basic, mandated function of CIAT, independent of projects"*. The CCER pointed out that a project format does not preclude adequate support and flexibility, because portions of the core budget could be set aside to support germplasm conservation and core SB-1 activities. This would provide security and flexibility, while maintaining accountability.

The Panel was concerned to learn that new CIAT initiatives in non-mandate crops may add to the workload of an already-overextended genebank. For example, conservation of tropical fruits endemic or indigenous to Latin America is in itself a difficult task, but the possible future involvement in introduction and conservation of exotic fruit crops from other regions, e.g. citrus and mango from Asia, could present essentially open-ended operational and research-related problems for the GRU.

The Panel wishes to focus attention to the ongoing negotiations on the International Undertaking (IU), the implications of which could have far-reaching consequences on CIAT's, and the CGIAR's, genetic resources activities. Extended negotiations on the International Undertaking (IU) are complicating CIAT's ability to undertake explorations, as agreements must be negotiated before hand about management of the collections. Partly because of the lack of an agreement, no new explorations have been made since 1998, and little novel germplasm has been added to the collections. The IU negotiations are also affecting the exchange of germplasm, traditionally the GRU's key global service. A failure of the IU negotiations will likely pose a threat to the status of the collections. Possible demands and claims for repatriation could be a major burden for all CGIAR centres. Germplasm exchange could be severely impeded, and all crop improvement activities could be jeopardised.

The Panel considers the genebank operations to be of global importance, particularly if, under a favourable IU, the CGIAR centres will be given a special role in benefit sharing mechanisms in accordance with the Convention on Biological Diversity. This may have implications for the need but also for the availability of funding. An IU, placing the genetic resources of agricultural and food crops under a multinational agreement system, would be imperative for the functioning of the CGIAR genebanks. Thus, the Panel urges CIAT to put emphasis on this issue through its Board and national partners and, together with the other Centres in the CGIAR system, engage in collective and constructive efforts to ensure that the interests of their purported beneficiaries, especially the poor, are always served.

The Panel notes that the collective efforts through the SGRP seek to secure funding to upgrade the genebank. This excellent opportunity requires constant attention by the Centre's Management and Board, in concert with other IARCs, to ensure that the proposed funding will come through.

Because of the global responsibility assumed by CIAT for its germplasm collections held in trust, and the urgent need to upgrade the gene bank and its operation, the Panel **recommends** that CIAT give urgent priority to obtaining necessary funds to comply with the Systemwide Genetic resources Program on upgrading CGIAR gene banks; that a timetable of 5 years be set to complete the upgrade effort; and that Board and Management examine needs – staffing, special equipment, etc. – to ensure that upgrading is carried out successfully.

Because CIAT holds in trust the largest global collection of cassava among its total collections of over 50,000 accessions; because the storage and management of this vegetatively propagated crop is costly due to high labour inputs, and because storage in tissue culture, even with slow-growth methods, poses some risks to the genetic stability and safety of the germplasm, the Panel **recommends** that CIAT direct major effort to develop a reliable cryopreservation method to cut costs and to guarantee the long-term safety of these collections.

2.3 Understanding and Using Agrobiodiversity (SB-2)

2.3.1 Evolution

In 1978-79, CIAT's genetic resources unit initiated research to apply cellular physiology/tissue culture to cassava germplasm conservation and pathogen eradication. Following the recommendation of the 1984 EPMR, the Biotechnology Research Unit (BRU) was created in 1985, with responsibilities to: 1) conduct centre-wide research to support the four mandate commodities; 2) bridge advances in basic research that applied to constraints related to CIAT programs and 3) build biotechnology capacity in developing countries.

By 1992, the BRU had established three lines of research: tissue culture and genetic transformation, molecular biochemistry, and application of molecular markers to conservation and breeding. About the same time an Agrobiodiversity Team, an informal scientific resource group, was formed to apply biotechnology to genetic resources characterisation and utilisation.

Following the 1995 reorganisation, the BRU and the Agrobiodiversity Team merged to form Project SB-2: *"Assessing and utilising agrobiodiversity through biotechnology"*, which integrated the work of BRU with related activities of the four commodity programs. Some activities were also decentralised, e.g. *in vitro* preservation of cassava and protein electrophoresis in SB-1, and anther culture of rice in IP-4. In this manner, biotechnology research in SB-2 explores and develops new areas, while developed and mature biotechnologies are devolved to, and used by, the "applied projects".

The objective of SB-2 is to apply modern biotechnology to identify and use genetic diversity to broaden the genetic base and increase the productivity of mandated and selected non-mandated crops. Main expected outputs are: improved genetic diversity characterisation of wild and cultivated species and associated organisms; genes and gene combinations to broaden the genetic base; and enhanced collaboration with public and private sector partners.

2.3.2 Achievements and Impact

Since its initiation in 1995, the project has achieved significant results in various areas, as follows (see also Systemwide Report on plant Breeding Methods, 2000[3])

- *DNA-based genome analysis*
  - Characterisation of the genetic structure of cassava, bean, cassava bacterial blight and rice blast using molecular markers.
  - Development of new microsatellite markers in cassava, bean and *Brachiaria.*
  - Mapping the genome, including producing the first molecular map for cassava, and locating genes for resistance to cassava bacterial blight, cassava whitefly, African Cassava Mosaic Disease virus (ACMD), Bean Golden Mosaic Virus (BGMV), bean anthracnose, as well as genes for phosphorus uptake in bean, apomixis in *Brachiaria*, and others.

- *Genome modification and/or enhanced utilisation*
  - Useful gene introgressions from wild relatives for yield in rice, associated with 10-20% yield increase.
  - Introgression of genes from tepary bean for resistance to bacterial blight in common bean
  - Development of genetic transformation method for *Brachiaria.*
  - Rice transformation with rice *hoja blanca* virus (RHBV) coat protein gene.
  - Genetic engineering in view to genetic transformation, with a Cry IA (b) gene and a cassava bacterial blight pathogenicity gene.
  - Efficient micropropagation (RITA) in cassava.

- *Research and other collaborations*
  - Production of a cassava BAC library.
  - Assembling DNA clone collections, libraries, strains, others.
  - Cassava Biotechnology Network.
  - Various workshops on molecular diversity, tissue culture, genetic transformation.
  - Contribution to development of biosafety regulation and public information.

Many of the above outputs and achievements are already in use or are close to field application. For instance, tagging of the bgm-1 gene for BGMV resistance has

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[3] Glaszman, J.C., R. Visser and R. Hautea. Preliminary Report for the CIAT PBM Review, March 27-31, 2000. [Systemwide Report on Plant Breeding Methods, TAC Secretariat 2000]

demonstrated the feasibility of effective marker-assisted selection using a SCAR marker. Marker assisted selection (MAS) for the apomixis gene in *Brachiaria* is being initiated. Similarly, MAS is planned for blast resistance genes in rice. Cassava micropropagation is being adapted for farm-level commercial operations.

Efficient transformation techniques for *indica* rice were developed. Rice lines genetically transformed for RHBV resistance are now available and will be field- tested soon after approval by Colombian biosafety authorities.

New lines of work are being explored in bioinformatics (CGIAR links with NCGR; USAID/USDA support with Cornell University) and functional genomics (EST development for cassava with IRD-Agropolis).

Project scientists produced a total of 153 publications during 1995-99, including 61 in refereed journals, 48 in conference proceedings, and 6 book chapters.

2.3.3 Future Strategy

The project will continue to develop and apply modern biotechnology concepts and techniques to characterise genetic variability of mandate and non-mandate commodities and associated organisms, and to improve genetic conservation and enhancement.

Molecular markers will be developed and used in MAS in beans, cassava, rice and *Brachiaria*). High-throughput assay capacity for PCR-based markers will be developed to move them to application in genetic resources management and commodity improvement.

Initial products from genetic transformation will be evaluated. New, selective applications of genetic transformation techniques will be sought for mandate crops, e.g. starch modification in cassava.

Strategic partnerships with advanced research institutes and the private sector will be pursued. Partnerships with NARS in collaborative research and capacity building will be strengthened. A regional genome research and service facility is being considered.

2.3.4 Overview and Assessment

The Panel is impressed with the quality of the science in biotechnology research and its high level of integration into the genetic resources and commodity improvement projects. The integration is apparent in several aspects, such as:

- Established, operational interdisciplinary teams that bring together different expertise, including biotechnology, into genetic resources and commodity improvement projects.

- Identification and prioritisation of biotechnology activities consistent with genetic resources and commodity improvement objectives.
- Selective, focused applications of biotechnology techniques combined with more traditional techniques in genetic resources conservation and enhancement.
- Adoption of biotechnology techniques for routine application by the genetic resources and commodity improvement projects (e.g. anther culture in rice breeding, micropropagation of cassava in genetic resources conservation).

The Panel is pleased with the balance between exploratory research and new methodology development, and deliberate efforts to use new applications in genetic resources conservation and germplasm enhancement. The most relevant techniques for immediate or short to mid term impact are in place or in progress. Several matured technologies have been passed to application groups, while arrangements are being made to accommodate pioneer applications of the most recent advances. Strategic partnerships have been established to develop future resources in structural and functional genomics.

Biotechnology research activities and requirements are expanding because of high demand for biotechnology applications by the genetic resources and commodity improvement projects. There is also an increasing demand from NARS for training and capacity building in biotechnology applications, collaborative research, and biotechnology-related policy issues (e.g. biosafety).

The CIAT biotechnology facilities are now close to saturation. The full implementation of MAS will require additional space and high-throughput capacity, to ensure that a routine/service laboratory is accessible to all users, without constraining new technology development research. Further adaptive research will be required to reduce operational costs.

CIAT hosts external research groups working on common research themes, e.g. the National University of Colombia and the Von Humboldt Institute in regard to biodiversity analyses. This indicates a trend toward integration of CIAT's comparative advantages in biotechnology with that of the host country and LAC, with local and regional programmes in biodiversity conservation, enhancement and utilisation.

The above strategy to build a critical mass of scientists quickly and to attract further investments will ultimately enable CIAT to have access to a full range of technologies. Similarly, this approach can also attract graduate students, visiting scientists, and research interns and trainees to work on joint projects. Also, CIAT's mandate for building human resource capacity would be served and kept relevant.

Because of the potential benefits from biotechnology applications to CIAT's mandate and priority non-mandate crops; because of the needs of its partner NARS for effective applications of new technologies to address important research areas, and because of the limited capacity of most NARS in the region to undertake agri-biotechnology research and development, the Panel enjoins CIAT to take the opportunity (and responsibility) to serve as a bridge for the "new sciences" with its partner NARS.

The Panel suggests that CIAT should establish a regional biotechnology research centre, in concurrence with 1997 CCER, principally to serve the collaborative research and training needs of its partner NARS.

2.4 Overall Assessment

CIAT has a major global responsibility – to collect, conserve, document and make available useful materials from its world collections of cassava, beans, and tropical forages. CIAT holds these germplasm "in trust", on behalf of the global community and the present and future generations, to contribute to improved agricultural productivity and reduce poverty and natural resource degradation.

The Panel commends the CIAT staff for their dedication, enthusiasm and hard work in assembling and managing the large germplasm collections of CIAT's mandate crops. Their task is huge, and particularly difficult when resources are scarce. Some bottlenecks in the genebank and its operations are not easy to overcome under any circumstances. Even with immediate infusion of adequate resources, the genebank "cannot buy time", and it will take several years just to catch up to meet and satisfy fully its responsibilities.

The Panel notes that less than half of the collections are characterised, and suggests that characterisation and regeneration of collections be accelerated. The Panel became aware of the wealth of evaluation data, accumulated over the years, that reside in other CIAT projects and or scientists. Such information is a valuable link between germplasm conservation and use; however it could be unintentionally dispersed and lost. The Panel strongly suggests that CIAT make an immediate effort to assemble all existing evaluation data about its germplasm accessions and collections, and in concert with SINGER (see Section 7.4), organise these data in an appropriate database. The Panel stresses that any further diminution in the capacity to evaluate the germplasm collection will effectively erode the value of one of CIAT's key resources – its germplasm.

The Panel is pleased to note that CIAT at the beginning of the review period recognised that the genebank and its operations needed major upgrading, and that modest improvements were made in physical infrastructure, seed health and viability testing, drying, and storage. Despite those improvements, the Panel emphasises that upgrading must be accelerated and cannot be further delayed. As of 1999, a huge backlog existed in several key areas. The Panel understands the backlog is due in part to limited resources, despite the fact that the GRU was largely exempted from budget cuts when CIAT had to scale down its operations in 1995/96.

Because of the global responsibility assumed by CIAT for its germplasm collections held in trust, and the urgent need to upgrade the gene bank and its operation, the Panel **recommends** that CIAT give urgent priority to obtaining necessary funds to comply with the Systemwide Genetic resources Program on upgrading CGIAR gene banks; that a timetable of 5 years be set to complete the upgrade effort; and that Board

and Management examine needs – staffing, special equipment, etc. – to ensure that upgrading is carried out successfully.

Because CIAT holds in trust the largest global collection of cassava among its total collections of over 50,000 accessions; because the storage and management of this vegetatively propagated crop is costly due to high labour inputs, and because storage in tissue culture, even with slow-growth methods, poses some risks to the genetic stability and safety of the germplasm, the Panel **recommends** that CIAT direct major effort to develop a reliable cryopreservation method to cut costs and to guarantee the long-term safety of these collections.

The Panel is concerned that the International Undertaking on Genetic Resources (IU) could have far-reaching implications for CIAT and CGIAR genetic resources activities. Failure of the IU poses a threat to the status of collections. Possible demands and claims for repatriation could be a major burden for the Centre. Germplasm exchange could be severely impeded, and all crop improvement activities could be jeopardised. The Panel urges the Board to give this matter priority attention, together with other IARCs and partner NARS.

The Panel was impressed with the quality of the science and biotechnology research at CIAT and its targeted applications to genetic resources conservation and enhancement. The use of new tools for targeted "mining" for important genes is already demonstrating potentially huge payoffs, such as the identification of quantitative trait loci (QTL) from wild relatives of rice. Other examples of potentially major finds are new resistance genes against important diseases and insect pests. The Panel enjoins CIAT to pursue these efforts vigorously and bring them to application as early as possible.

Because biotechnology research at CIAT generates a new class of genetic resources; e.g. clones, sequences, probes, transgenic organisms, and associated information; because these new genetic resources are as valuable as "traditional" genetic resources; and because they will become increasingly more important for research and technology development, the Panel **recommends** that CIAT adopts the broader concept of agrobiodiversity to include the new class of genetic resources, and develop appropriate policies and protocols to manage their conservation, exchange and use.

Biotechnology moves at a very rapid pace. It is essential that CIAT maintains and/or strengthens integration of biotech research with genetic resources and commodity improvement, and the capacity to keep abreast with pertinent scientific developments.

Managing biotechnology research goes well beyond the scientific and technical aspects. Equally or perhaps even more important are broader issues of intellectual property, biosafety, food safety, and public acceptance, particularly of transgenic products. The Panel notes that CIAT recently developed a policy on intellectual property and is also aware of similar systemwide activities.

Because agrobiodiversity conservation, enhancement and use is central to the mission and international research responsibilities of the CGIAR and CIAT; and because the emergence of the private sector as a major technology provider within the new global regimes of intellectual property and biosafety has profound and pervasive implications on the generation of international public goods, the Panel **recommends** that CIAT, within the framework of the CGIAR, develop at the earliest possible time a comprehensive policy, operational strategy and capacity to manage its research and development efforts on agrobiodiversity to ensure maximum access to and freedom-to-operate in the use of genetic resources, biotechnology applications and information, and the safe deployment and use of products derived from them.

CHAPTER 3 - IMPROVING PRODUCTIVITY

3.1 Introduction

In the CGIAR system, CIAT has the global mandate for beans, cassava and tropical forages, and the regional mandate for rice in Latin America and the Caribbean. These commodities have always been considered important to the poor, and their importance to global food security and poverty alleviation has not diminished.

In vast areas of the tropics, degraded lands, drought, acidic and low fertility soils and erosion are severe constraints to sustainable crop and animal production. If only some of this tremendous area could be rehabilitated and made more productive, it could help millions of the world's poor who live there. The CIAT mandate commodities are often among the only crops that can grow and sustain people under these harsh conditions.

3.1.1 The Common Bean

The common bean (*Phaseolus vulgaris*) is the most important grain legume for human consumption. Some 60 percent of world production comes from Latin America and Africa. Most production is on small farms that are often dispersed and located on hillsides and in fragile environments.

Most beans are consumed in or near their production areas. Consumption remains high in countries where they are traditionally eaten, and is increasing in others. Analysis of consumption according to economic strata, shows as much as 20% higher figures for the lower strata than average. Important sources of protein and minerals, beans are indeed "the meat of the poor".

3.1.2 Cassava

Cassava is grown in some 90 tropical and subtropical countries and provides food for 500 million people - mostly the poor, and provides livelihood for many millions of poor farmers and countless processors and traders, many of them women. A hardy crop, cassava can be grown in difficult conditions by resource-poor farmers.

There are great differences between continents in cassava use: human food is its dominant use in Africa, while small-scale processing for industrial use dominates in Asia and Latin America. With the exception of some Asian countries, more than 80% of cassava is consumed in the country of production, and it constitutes an important food for the poor, especially in Africa.

3.1.3 Tropical Forages

Tropical forages are the basis of most animal production in the tropics. In extensive pasture systems and intensive cut-and-carry forage systems, feed for livestock is often the most limiting input.

Demand for meat, milk and other livestock-derived products has been increasing globally and in developing countries. Livestock is important not only as a source of meat and milk, but is equally so for draft in small-scale farming.

3.1.4 Rice

Rice production area in Latin America and the Caribbean is about 6.1M ha, representing about 4.1% of the world rice area and about 3.6% of world production. Irrigated rice accounts for more than 80% of production, while the area and production of upland rice continue to decline. Average yields in the region rose from 3.3 t/ha in the 1960s to 4.6 t/ha in 1995. During the 1990's, production expanded at a rate of 3.8% annually, reported by CIAT to be the highest expansion rate for any region in the world. Today, rice supplies LAC consumers with more calories than either wheat, maize, cassava, or potatoes.

Increased world rice production, including LAC, contributes significantly to social welfare, particularly in reducing the real price of rice over the last 30 years. As a majority of the poor, both urban and rural, spend a high proportion of their income on food, benefits from improved rice production are shared among farmers and consumers.

International research and development on beans, cassava, tropical forages and rice remain consistent with CGIAR and CIAT missions to ensure sustainable food security and alleviate poverty. During the review period, CIAT has conducted research in five projects devoted to Improving Productivity (IP). Discussion of each project follows.

3.2 Beans for Latin America (IP-1)

3.2.1 Evolution

CIAT began bean research in 1973 under the Food Legume Production System Program. In 1974, when an international conference recommended that CIAT should concentrate on beans, a Bean Production Program was created, with a global mandate responsibility for the crop. In 1977, the name was changed to Bean Program. The Bean Africa Project was created in 1983/84. In the early 1990s, CIAT initiated changes in its commodity programs in accordance with strategic plan. CGIAR funding cutbacks in the mid-1990s accelerated the changes. In 1994, the Bean Program was re-organised into two projects: IP-1 (Beans for Latin America) and IP-2 (Beans for Africa).

3.2.2 Achievements and Impact

Over the years, CIAT bean breeding resulted in numerous variety releases for LAC, Africa and Asia. Looking at cumulative, overall CIAT variety releases since 1970, over half of all variety releases were beans – a total of 354 varieties released (243 in Latin America; 111 in Africa and Asia). For the period under review the project achieved the following:

- 45 varieties that trace back to CIAT germplasm were released by 15 NARS in Latin America.
- Adoption of improved bean varieties in the LAC varied. As of 1997, areas planted to varieties with CIAT-material-content ranged from a low of 9 % in Colombia to a high of 95 % in Bolivia. Other countries with adoption rates above 50% of "CIAT materials" are Brazil, Costa Rica and Argentina. Many countries benefited economically from the adoption of varieties derived from CIAT germplasm, with Brazil, Argentina and Guatemala among the largest beneficiaries.
- The bean core collection has been fully characterised, which has proved very valuable to bean researchers world wide.
- In addition to improved germplasm and varieties, the project identified new and potentially important sources of resistance to major diseases and insect pests, and sources of tolerance to low phosphorus (P), drought and Al toxicity conditions.
- New promising lines with multiple resistances to diseases, insect pests and abiotic stresses were developed.
- New knowledge and understanding were generated of the genetics of important traits; mechanisms of bean adaptation to edaphic stresses; biology of important pests and pathogens; and the development and use of molecular markers for.
- MAS was developed for bean golden mosaic virus resistance, an advance that could decrease breeding efforts by about 60% (see Section 2.2).
- Research backstopping was provided to the bean project in Africa and NARS, e.g. populations and breeding methodologies.

During the period under review, the project scientists published 9 book chapters, 51 articles in referred journals, 21 articles in non-referred journals, 104 papers presented in congresses, and 9 manuals and other publications.

3.2.3 Future Strategy

Bean breeding at CIAT focuses on distinct production systems. CIAT will continue to emphasise genetic enhancement and release of improved populations to NARS, and will design improved gene pools for specific production systems, incorporating multiple resistance/tolerance to various stresses, with good adaptation and yield, and of preferred type.

CIAT now leads in using MAS for bean improvement. The initial target trait is resistance to BGMV – the most important bean disease in LAC. A study is underway to

confirm and assess the relative efficiency of MAS and to guide its use for bean improvement.

Saturation of the molecular map of bean will be pursued using additional classes of markers such as simple sequence repeats (SSRs). The objective is to develop PCR (polymerase-chain reaction)-based markers and tag other important genes and traits such as QTLs for BGMV resistance, yield and yield components, and P use efficiency. Such new markers should facilitate and enhance the manipulation of complex genetic traits.

More activities are envisaged in participatory plant breeding and integration with the natural resource management (NRM) projects, particularly in Central America.

3.2.4 Overview and Assessment

CIAT bean improvement is organised according to major production systems, *viz.* mono-cropped beans, associated beans as a primary crop, associated beans as a secondary crop, and beans in highly unfavourable or fragile environments. This allows a holistic view of constraints and priorities relevant to diverse users, identifies opportunities for integration of technology interventions, e.g. improved genetics, agronomy and/or resource management, and allows a focus in areas of CIAT's comparative advantage.

While breeding objectives expectedly vary according to production systems, some common ones do exist; e.g. resistance to principal diseases – viruses such as BGMV and BCMV, common bacterial blight, anthracnose, and angular leaf spot. In some systems, resistance/tolerance to edaphic constraints such as low P and high Al are important. For preferred types, higher yield potential is a priority objective.

The Panel endorses the strategy to serve needs in specific production environments and considers it important in achieving potentially higher adoption and impact. Such an approach logically can be extended to the micro level, i.e. farm/community level, with adoption of appropriate participatory plant breeding (PPB) approaches (see Section 5.4). The Panel emphasises that the success of participatory approach requires strong inputs from systems agronomists and social scientists (see Chapter 4), competencies that at the moment are inadequate or do not exist in the project. The Panel suggests that the competencies of agronomy and socio-economics be made available to the project.

The Panel noted the marked decline in the number of bean variety releases since 1995[4], as well as an accompanying decline in the number of varieties per CIAT breeder during the same period. Various factors could have contributed to the decline, including the shift in emphasis from release of finished varieties to release of improved germplasm; severe cutbacks in operational support, and erosion in capacity of partner NARS – and the bean networks – to carry out variety development. These possible reasons are not mutually exclusive. The Panel endorses the view of the recent impact study[4] that this

[4] Johnson, Nancy. 2000. Global Impacts of CIAT Germplasm Improvement Programs, 1967-1997: Progress Report on the IAEG Study

matter deserves careful attention and further study because of its potentially broad implications in commodity research and development strategies.

The Panel is pleased to note that applied genomics are now being integrated into CIAT bean improvement research. MAS in beans will probably be the first successful use of applied genomics in breeding CIAT mandate crops, and may serve as model for other grain legumes. The Panel endorses CIAT's efforts to use MAS in beans, and suggests that CIAT pursue institutional partnerships with ARI's and other Centres in an intensified effort to saturate the molecular genetic map of beans and other grain legumes.

Considering the diversity of bean production environments and user preferences, as well as relatively weak seed support systems in dispersed small farm production, PPB may assume a higher importance in LAC. Thus the non-formal sector may assume closer roles than CIAT partners and NARS in improving and disseminating beans. The Panel suggests that CIAT continue to explore, establish and strengthen this partnership.

The Panel commends CIAT for pursuing innovative approaches for improving beans, including the use of biotechnology tools and PPB, and encourages the development and evaluation of these approaches. In this way, the Centre can advance its own efforts, while making a distinct contribution to the body of knowledge on research methodologies.

3.3 Beans in Africa (IP-2)

3.3.1 Evolution

CIAT's bean research in Africa started in 1983-84 with the Great Lakes regional project. Using special funds, bean research was extended into Eastern Africa in 1986-87 and into Southern Africa in 1987-88. During 1992-94, these projects were merged under the Pan-African Bean Research Alliance (PABRA). PABRA was to facilitate greater efficiency of technical collaboration through complementary cross-regional use of donor funds. Its specific objectives were: 1) to deployment a smaller number of CIAT staff across sub-regions, 2) to use diminishing funds to support research by strengthened NARS, 3) to gain a more equal and independent footing for the bean networks and CIAT, and 4) to facilitate wider collaboration among bean networks and NARS scientists.

After CIAT's reorganisation in 1996, the Bean Program was split and Project IP-2 (Meeting Demand for Beans in Sub-Saharan Africa in Sustainable Ways) was formed. This move was part of an emerging strategy to diversify CIAT activities beyond beans, and to provide greater administrative autonomy to Africa-based activities because of their physical distance from CIAT headquarters. Extensive inter-project links became possible during 1999 as other CIAT projects evolved and became more involved in Africa.

3.3.2 Achievements and Impact

The following are the main achievements and impact of the project:

- *Development and release of improved bean varieties in the region.*
  - Variety releases in Africa increased over the period from 1991-95 to 1996-97.
  - Tremendous progress in developing materials with multiple-constraints resistance, particularly against the stem maggot, root rots, tolerance to low soil nitrogen and P, angular leaf spot, common bacterial blight, and the main viral diseases.

- *Adoption of CIAT bean varieties.*
  - Impact assessment studies indicate increasing adoption of bean varieties developed by or with CIAT, with positive economic impacts.
  - In Rwanda, farmers and the national bean industry have gained significant economic benefits from adopting high-yielding climbing bean varieties.
  - Some breeders assert that PPB has increased adoption rates of their varieties (see Section 5.4.2).
  - In Uganda 74% of the area in a study site was planted to two bush bean varieties four years after their introduction. One of these varieties accounts for 90% of bean earnings. A substantial proportion of low-income adopters reported increased food security.

- *Strengthening Local Seed Supply Systems.*
  - Farmer groups, including women's groups, have begun to multiply and sell seed from bean varieties they helped to select. Some farmers see ongoing co-operation with scientists in PPB as a means of sustaining the market for their seeds (see Section 5.4.2).

- *Institutionalising Participatory Research Methods.*
  - Farmers in Uganda and western Kenya have, on their own initiative, begun to disseminate PPB and train other farmers to produce seed. (see Section 5.4.2)
  - Some NARS have incorporated PPB into their breeding program.
  - CIAT scientists have included farmers as co-authors of CIAT publications.

- *Network Facilitation.*
  - Two regional bean networks (ECABREN for Eastern and Central Africa and SABREN for Southern Africa).
  - Pan-Africa network.
  - Development of strategic research plans for the region, formulation of national research strategies, identification of specialised research inputs from CIAT through networks.

- *Integrative research on sustainable crop and soil management.*
  - Identification of best options for managing field productivity constraints (see Chapter 4).

- *Scaling up innovations.*
  - Distribution of 3000 mini-kits (decision guide and leguminous green manure species seed), training farmers and extension staff, producing posters, and providing local institutions with compact disks to facilitate translation into local languages.
  - Research findings demonstrate that understanding how farmers learn about management should not be limited to group interviews but should use a combination of methods.

3.3.3 Future Strategy

Bean productivity and commercialisation through ongoing close collaboration with farmers, networks and NARSs and thus enhancing sustainable production technologies and practices.

Bean improvement activities will continue to focus on multiple constraints. In some niches, improved varieties of climbing beans for use both as dry bean and snap bean, will be introduced, tested and disseminated.

Participatory and integrated research approaches will continue to be employed, and options for crop/pest/soil management will be developed.

3.3.4 Overview and Assessment

The African Bean Project has been exemplary in fostering interdisciplinarity. Bio-physical and social scientists work and publish together and clearly understand and respect each other's work.

PPB is an integral part of the African Bean Project. The Panel conversed with CIAT and NARS breeders who, despite their own initial opposition and scepticism, now are emphatic that PPB has increased their effectiveness as breeders by shortening the time to the release of a new variety and enabling them to produce varieties compatible with heterogeneous local conditions and local preferences. (see Section 5.4.2) The project has been very effective in implementing and institutionalising participatory methods in arenas ranging from local communities to scientific reports. Other CIAT participatory initiatives may find a strengthened interaction with the African bean project beneficial. (see Section 5.4.4). CIAT scientists and their partners have been very effective in working with women farmers. This should be continued.

The project has effectively facilitated the development of regional scientific networks, and other CIAT networks may find it beneficial to strengthen interaction with the African bean project.

The Panel notes that the Africa bean project appears to have been successful in integrating commodity improvement and NRM activities. Focus on the bean production

system appeared to have provided the setting for integration. The Panel was struck by the effectiveness of the bean "hook" in providing CIAT scientists with an entry point for working with farmers on NRM research. A closer study of the Africa bean project appears warranted, as a potential working model of integration that may be considered in project implementation strategies in Latin America and elsewhere.

While recognising the commendable work of the project staff in Africa, the Panel also recognises that the Africa bean project has benefited much from other headquarter-based research projects and activities in terms of breeding materials, back-up research and methodologies.

The Panel notes that the bean activities in Africa have been exclusively dependent on special project funding support. As recently as 1999, for instance, it has not received core-funding support from the Centre, although one position became core funded in 2000. This renders the project highly vulnerable to cuts or termination of donor funding. The lack of core funding support is also taken by African NARS partners as a lack of long-term commitment by the Centre to the continent. The Panel was persuaded by the Project's assessment of the need for additional funds for professional education (including social science) for local staff.

Because of the vulnerability of the highly successful African Bean Project to changes in donor funding and the impression of African NARS partners that CIAT has no long term commitment to the continent, the Panel **recommends** that CIAT assure the project of long term sustained funding to safeguard continuity and the ability to expand into promising areas such as forages.

3.4 Cassava Improvement (IP-3)

3.4.1 Evolution

When the CIAT Cassava Program was established in the late 1960s, there was little knowledge about cassava as a crop or plant— including its biology and problems and strengths as a crop. Genetics and genetic improvement were essential elements of the learning process. A strategic research program, undertaken for some 20 years, helped build a broader core of knowledge about cassava and its relatives, its pests and diseases, and major constraints and opportunities relating to its improvement.

Early priorities emphasised dual-purpose cassava – for direct use as food and for industrial uses – including a search for high protein lines. Building on earlier national collections in Latin America, an extensive germplasm collection was assembled. Many developing country scientists received training in cassava research, and many have continued as key collaborators in research and development.

A strong emphasis on pathology and entomology provided a solid underpinning for crop protection, and knowledge gained of pest and disease biology and damages provided critical information for breeders.

Breeding was done mostly at headquarters, and for reasons of quarantine and plant health, true seeds were sent to collaborators in Asia and Africa to be planted and grown out. There selections were made of individual plants that could be termed proto-clones that were then subjected to field and screenhouse testing to identify useful characteristics, particularly levels of resistance to major pests and diseases. In most cases, final selections of candidate varieties were made by NARS. Emphasis in Asia was selection for industrial uses, mainly animal feed or starch. An outposted breeder provided a strategic locus for germplasm transfers to Asia, from which new materials systematically were made available to NARS.

When the project structure was adopted in 1996 the Project was named "Roots and Development: Genetic Enhancement of Cassava in Sustainable Ways", and the pathology and entomology capabilities in cassava at headquarters were distributed to other projects, mainly PE-1.

3.4.2 Achievements and Impact

Partly because of the Cassava Biotechnology Network (CBN), started by CIAT, some 50 laboratories – some third of them in developing countries – now use molecular markers, gene cloning, genetic transformation and disease diagnostics in cassava research. Many laboratories in developing countries use tissue culture to conserve and manage cassava genetic resources. CIAT developed the molecular genetic map of cassava – the first done solely by a CGIAR centre. CIAT has used the map to tag important traits and genes.

Broadening the genetic base has been a major achievement, requiring collaboration with scientists at headquarters, the GRU, BRU, outposted staff, and national collaborators. As a result, cassava breeding in Asia had tremendous impact on production in the region, by making germplasm available to NARS in a form useful in breeding and selection.

Without doubt, the greatest impact of CIAT's cassava work has been its collaborative efforts – with IITA playing the leading role – in the biocontrol of cassava mealybug in Africa (see Section 4.2, IPM). Economic benefits of that work over the years are estimated in the billions of US dollars, and its benefits are continuing. Work on cassava mealybug continues in this regard.

Varietal releases in cassava total 61: Brazil-11, China-6, Colombia-7, Cuba-2, Dominican Republic-2, Ecuador-2, Honduras-2, Malaysia-2, Mexico-2, Panama-1, Philippines-8, Thailand-7, and Vietnam-7. The value of increased production attributed to CIAT varieties is estimated at US$ 513 million, of which US$ 391 million was gained in Thailand, where CIAT-related germplasm has had its greatest impact and where 52%

of the cassava area is planted to CIAT-related varieties. The greatest beneficiaries in Latin America have been Haiti (US$ 33 million), Brazil (US$ 33 million) and Cuba (US$ 11 million)[5]. In Asia, cassava is a commercial crop, whereas in Latin America most of the cassava is marketed as fresh roots. Rates of return on CIAT research in cassava are estimated to be 24%. Relatively higher rates of returns for regional programs suggest CIAT cassava materials may have higher benefits in new areas.

Scientist-led PPB has been used in cassava to help identify high starch content varieties for industrial processing.

In 1995-1999, project scientists had 31 referred journal articles, 6 book chapters, and 60 conference publications.

3.4.3 Future Strategy

Because of increasing interest in growing cassava in Latin America as a commercial crop, breeding objectives will include high yielding processing varieties for starch and other products. Dual-purpose cassava will no longer be emphasised, but dry matter productivity will receive more attention. To that end, a public/private consortium, CLAYUCA, was formed to establish new models to finance and support cassava research and development, and to attend to needs of different groups of end-user users, both public and private. CIAT sees two advantages in working with CLAYUCA, developing strong relationships with the private sector (animal feed and starch industries in particular) and helping to set priorities and increase financial support.

In addition to finding varieties suited for industrial processing, breeding objectives include: continuing search for disease and pest resistance, root quality, improved plant architecture, reduced production costs and plants suited to mechanical planting and harvesting. CIAT will maintain a modest effort on developing "cassava". It will also embark on biotechnology research for herbicide tolerances and starch modification in cassava.

Because there is no longer a CIAT breeder in Asia, improved true seeds and virus-indexed materials will be sent from Colombia to be tested by Asian NARS as proto-clones and/or candidate varieties. CIAT plans to establish a Cassava Biotechnology Network for Asia, if external funding is obtained.

3.4.4 Overview and Assessment

Within the CGIAR, CIAT has the global mandate for cassava. In practice, this responsibility appears to relate mostly to making germplasm available to Asia and Africa. Most new cassava germplasm is made available to NARS through either CIAT or IITA, and there are no alternate suppliers of such research and research-related services. In the past germplasm was made available in Asia through an outposted CIAT breeder in

[5] Johnson, Nancy. 2000. Global Impacts of CIAT Germplasm Improvement Programs, 1967-1997: Progress Report on the IAEG Study.

Thailand who then made materials available to NARS. CIAT plans to continue that work through a part-time national scientist. The Panel has reservations about this arrangement, given that the presence of the CIAT breeder in Asia in the past appears to have produced the greatest impact of CIAT cassava germplasm anywhere in the world.

In Africa, CIAT has made endemic Latin American germplasm available by systematic introductions through IITA. This work has proved very successful, despite the lack of resistance in Latin American germplasm to African Cassava Mosaic Virus (ACMD). Thus IITA must protect Latin American lines from infection by the virus. A related important matter is the need for CIAT to introduce ACMD resistance into Latin American germplasm as a pre-emptive measure in case the virus should eventually reach Latin America and devastate the crop.

The global situation for cassava may be changing. Latin America is showing more interest in industrial uses, but still will want 'sweet cassavas' that are low in prussic acid (HCN) and that can be marketed as fresh roots. In Asia, industrial cassava seems to attract more interest outside Thailand, especially in China where new starch factories are being built or planned. In Africa, cassava remains mostly a locally processed and marketed village product, or the fresh leaves and roots are used as staple food. The Panel suggests that in view of the wide differences in interest in cassava between the continents, CIAT must consider the needs of each continent in setting its germplasm enhancement priorities, in order to meet its global mandate responsibilities. The project emphasis for industrial cassava is appropriate for LAC and Asia but may have little relevance in Africa.

Cassava is one of the few crops for which a global research and development strategy has been prepared and which is in the process of being implemented[6]. That strategic document calls for long-range research that includes research related to crop management (e.g., pests and diseases, improved planting materials), genetic resources (exploiting the large genetic pool in LAC, tissue culture, rapid propagation) and varietal development (use of diverse landraces to develop cultivars for small-scale farmers, value added traits, starch quality, etc.). CIAT has participated in developing the global strategy and stands to play a leading role in providing germplasm resources on demand to NARS.

The CCER in 1998 for the IP projects made six recommendations concerning IP-3, that may be summarised as follows: 1) concerns about minimum critical mass to develop scientific capacity and impact, including concern about the small size of the cassava project; 2) need for CIAT to be in touch with market developments; 3) need for upstream research "to develop scientific and technological products, targeted at a wider array of consumer needs and more favourable growing regions"; 4) two positions were recommended, an eco-physiologist to work on adaptation in different environments, and a chemist or biochemist to work on nutrition, root quality, post-harvest deterioration, and starch uses; 5) continued and expanded support for research on root rots and whiteflies

[6] Plucknett, Donald L., Truman P. Phillips, and Robert B. Kagbo. 1998. A Global Development Strategy for Cassava: Transforming a Traditional Tropical Root Crop. A report prepared for the International Fund for Agricultural Development (IFAD), Rome. 27 pp.

because of the threats they pose; and 6) a focus on pre-breeding rather than conventional breeding, and to reduce breeding sites from 6 to 2 distinct environments – semi-arid and sub-humid – which are seen as most important zones for future expansion and impact. The Panel finds the CCER to be well written and useful. The Panel notes that the Centre has responded positively to some of these recommendations. But the panel also agrees that the size of the cassava improvement effort is small and probably below critical mass.

At the operational level, the current project apparently lacks the critical mass that the global research responsibilities require. The Panel saw little evidence – beyond individual scientist's interests – of strong links between the genetic enhancement program and key scientists from other disciplines.

CIAT needs to consider carefully how it plans to meet its global responsibilities in cassava. Core funding levels available for cassava also do not present convincing evidence to the Panel that CIAT's global cassava mandate, especially as it relates to needs outside LAC, is given high priority by the Centre.

The Panel believes that a global cassava development strategy is important to the crop's future in the world; that CIAT's mandate and research responsibilities are essential to the global development strategy; and that CIAT's location near the centre of origin of cassava makes vital its global role in germplasm conservation and enhancement, especially in view of the difficult problems of safe international movement of cassava germplasm.

The Panel concludes that CIAT's global research responsibilities on cassava require sufficient support and staffing; and that CIAT should assert and re-establish its international research leadership on cassava.

3.5 Improved Rice for LAC (IP-4)

3.5.1 Evolution

The evolution of the rice project (Improved Rice Germplasm for Latin America and the Caribbean) can be traced back to the late 1960's when high yielding rice varieties were introduced into the region by the Rockefeller Foundation program, which evolved into CIAT. During the 1970's, commercial varieties were developed exhibiting high yield potential, improved grain quality and resistance to important diseases and insects. The International Rice Testing Program (IRTP) was established and it facilitated the distribution of improved germplasm throughout Latin America and the Caribbean. This germplasm has been generated through the use of conventional breeding, recurrent selection, interspecific crosses, anther culture, and more recently (especially in the period under review) through the use of molecular markers (plant and pathogen), and genetic transformation.

The period since the last review has seen the establishment of the Fund for Latin American and Caribbean Irrigated Rice (FLAR), a consortium involving both the public and private sector dedicated to the support of rice research in Latin America and the Caribbean. The founding members were the Instituto Rio Grandense do Arroz (IRGA) of Brazil, the Federación Nacional de Arroceros (FEDEARROZ) of Colombia, the Oficina Nacional de Semillas of Costa Rica, the Fundación Nacional de Arroz (FUNDARROZ) of Venezuela, CIAT, IRRI, and CIRAD. FLAR's mission is the sustainable development of irrigated rice production in Latin America and the Caribbean by making it competitive, profitable, and efficient while lowering the relative price of rice to the consumer.

3.5.2 Achievements and Impact

The Centre lists the following achievements during the past five years:

- Identification and utilisation of genes from wild relatives (*Oryza rufipogum, O. glaberrima, and O. barthii*) of rice for the improvement of yield and stress resistance and broadening the genetic base of cultivated rice.
- Improvement of gene pools using a recessive male sterile gene and recurrent selection.
- Improvement of breeding lines for upland savannahs.
- Improvement of breeding lines of upland rice for the highlands of Colombia.
- Enhancement of gene pools through anther culture and embryo rescue.
- Incorporation of the "new plant type" from IRRI into breeding populations.
- Characterisation of rice pests and genetics of resistance for rice blast.
- Use of molecular markers in breeding for blast durable resistance.
- Evaluation of transgenic rice plants for the control of Rice *Hoja Blanca*
- Virus (RHBV).
- Evaluation of rice germplasm for resistance to RHBV and *Tagosodes oryzicolus.*
- Isolation and characterisation of the causal agent and vector of the new virus disease *entorchamiento.*

As with any crop breeding effort, the impact must be evaluated over the long-term. The CIAT rice program has been fully integrated and collaborative with NARS rice programs in the region, so discrete achievements (CIAT vs. NARS) are difficult to document. This is a very positive indicator of the approach and effectiveness of the project. It is an undisputed fact that CIAT has been, and remains, the heart of rice research in Latin America and the Caribbean, so achievements and impact in the region as a whole relate directly to the Centre.

Since 1967 nearly 300 new varieties, originating mostly from CIAT improved germplasm, were released in Latin America and the Caribbean. Forty percent of the crosses for these varieties were actually made at CIAT and nearly all the crosses involved a parent from CIAT or IRRI. The outcome of this is that modern semidwarf varieties account for 93% percent of all flooded rice production, representing more than 80% of total rice production in the region. Average yields in irrigated rice areas have risen from

3.3 t/ha in the mid-1960's to 4.6 t/ha in 1995. The important impact has been on consumers, for whom the real price of rice is less than half of what it was in the 1960's. The impact on producers has been mixed. Relatively large-scale producers with irrigated land have prospered. Relatively small-scale producers on marginal land (particularly upland) have been forced out of rice due to the reduced real prices. For small-scale producers on irrigated land, the impact probably has been neutral – production has gone up dramatically but lower prices have offset prices in the long run. On balance, the program/project has made an exceptionally beneficial contribution to the consumers in Latin America and the Caribbean for whom rice is an increasingly important food.

3.5.3 Future Strategy

The goal of the CIAT rice project continues to be the improvement of the nutritional and economic well being of rice growers and low-income consumers in Latin America and the Caribbean through sustainable increases in rice production and productivity. Three major overlapping areas of endeavour are expected to continue: (1) enhancing gene pools, (2) understanding the physiological basis of important rice traits and (3) characterising host-pest interactions.

CIAT rice scientists believe that yield enhancement beyond the present level will require the identification of alternative approaches that allow broadening of the genetic base of cultivated rice. They plan to focus on pre-breeding activities with the aid of molecular tools. This will be combined with conventional pedigree breeding in close collaboration with national rice programs and FLAR. Promising lines will be made available to NARS through the INGER network to serve as parents for further regional breeding.

In the near term (2001) CIAT expects to be providing near-isogenic lines with QTLs associated with yield for use in LAC breeding programs. Molecular markers associated with important traits such as blast resistance and submergence tolerance will be identified and used in MAS. Improved sources of blast resistance will be made available to national breeding programs. Improved upland rice cultivars are anticipated for the highlands and other relevant ecosystems such as Pucallpa, Peru. CIAT expects to complete epidemiological studies for the control of rice (RHBV) and its vector, *Tagosodes orizicolus*, and evaluate in the field the potential for the use of transgenic plants with resistance to RHBV.

In the next five years, improved yield potential of LAC cultivars is expected through the use of genes from wild rice. The introgression of the "new plant type" from IRRI into LAC gene pools will be completed. This and other material hopefully will broaden the genetic base of national rice breeding programs. Rice blast populations in LAC will be characterised, identifying relevant blast resistance genes, and "partial resistance" to blast for use in breeding programs aimed at durable resistance. IPM strategies will be pursued for controlling RBHV and its vector. This strategy will include

virus resistance genes from transgenic plants. Submergence tolerant cultivars will be utilised to pursue an improved weed control strategy.

3.5.4 Overview and Assessment

The CIAT/FLAR arrangement likely represents the future for commodity improvement programs throughout the world. CIAT is to be commended for its role in furthering this model of participatory research that encourages the engagement of many (but not all) of the major stakeholders. This model has the added advantage of effective use of resources for the common good throughout the region.

During the last five years, and over the longer term, output of the program has been exceptional. Based on the comments of the 1998 CCER, and our own observations, it appears that the quality and relevance of the science in this project are excellent.

Despite the favourable comments above, the publication rate does not reflect this assessment. The CCER recommended that more attention should be given to publications, and the project has now established a goal for its scientists of at least two refereed publications per year. The Panel commends the scientists involved for setting this goal and striving to reach it. It is expected to help in the communication of findings to other scientists in the region and will also provide the necessary foundation to apply for external grants. Few donors will be willing to provide financial support to scientists who do not have a credible list of refereed publications.

CIAT continues to meet its responsibilities toward the upland rice ecosystem in close collaboration with EMBRAPA and CIRAD. Though it is declining steadily in area, this rice ecosystem is still important in LAC. As the area continues to ratchet downward, research investment may need to be adjusted accordingly.

While improved human nutrition is mentioned as goal of the project, it has been addressed mostly, if not exclusively, through increased production resulting in a reduced real price and increased availability to consumers. Now on the horizon is the prospect to manipulate specifically the nutritional characteristics of food staples such as rice. Rice has been successfully transformed to induce the production of vitamin A precursors. If this technology can be moved to the production stage, it could represent an enormous contribution to improved human nutrition. CIAT has done a preliminary assessment to determine the acceptability of "Golden Rice" in LAC. Great enthusiasm seems to exist as LAC consumers are accustomed to yellow rice and place a high value on it. CIAT should position itself to utilise this technology in an expeditious manner, but, at this point, it may be a bit early to become involved. The intellectual property issues surrounding this technology are complex and CIAT should not become involved until the freedom to operate is clearly established.

3.6 Tropical Grasses and Legumes (IP-5)

3.6.1 Evolution

CIAT has been involved in research in livestock or forages since the late 1960s. Early work centred on beef cattle and animal health for extensive cow-calf operations in the savannahs (The Beef Program 1968-1976). When inadequate feed resources were identified as the major problem in ruminant livestock in Latin America, a new effort was undertaken in tropical pastures and forages for the vast acid-soil regions of LAC. The Tropical Pastures Program (1977-1991) aimed to develop grasses and legumes for extensive grazing systems with minimal inputs. Emphasis was placed on collecting African grasses and Latin American legumes adapted to forest margins and savannahs. Networks were used to advance efforts with collaborators in LAC and West Africa. More than 20,000 legumes and grasses adapted to acid soils were collected. Grasses and legumes were identified for pasture/livestock systems in acid soil areas. Methods for forage and pasture evaluation were developed.

In 1992, a new Tropical Forages Program (1992-1996) was formed from the Germplasm and Utilisation components of the previous Tropical Pastures Program, and - in the same reorganisation - some former TPP components (Nutrient Cycling, Ecophysiology, Farming Systems and Economics) were transferred to the new Savannah Program. Other work (e.g., seed production) was eliminated. The mandate of the Tropical Forages Program was to develop and deliver selected forage ecotypes to NARS and CIAT's NRM Programs. A strategy to exploit natural variability in forage plant germplasm was adopted to identify key traits that would overcome specific constraints (acid soils, pests and diseases, and drought in target ecosystems: savannahs, forest margins, hillsides). Also, forages were to be evaluated for NRM purposes (green manure, erosion barriers, cover, and fallow improvement). During its 4 years, the Tropical Forages Program increased the collections - and the range of genetic variability - of legumes and grasses. Selected grasses (*Brachiaria*) and legumes (*Stylosanthes*) were bred to overcome pest/disease problems and new forage species were released by NARS for multipurpose use in humid and subhumid environments.

The 1996 restructuring resulted in severe staff reductions at all levels. In 1997, again as a result of Centre-wide structural changes, the existing project (Tropical Grasses and Legumes: Optimising Genetic Diversity for Multipurpose End Uses; IP-5) was formed.

3.6.2 Achievements and Impact

Building on the work of its predecessors, the Tropical Forages Project has made significant progress in selecting and deploying grass and legume species in LAC and SE Asia, and in identifying plant traits associated with higher quality and improved adaptation to biotic and abiotic factors. Progress has also been made in developing methodologies to screen forage germplasm more efficiently for quality, spittlebug resistance, diseases, and adaptation to low fertility soils. The work involved is world-

class, well focused and of high quality. The team involved is small in number, 5.5 fulltime-equivalent international scientists, but their work is focused, strategic, integrated and well led.

Some of the research highlights include:

- *Superior lines of Brachiaria developed*
  - Screening procedures developed for Al tolerance, rhizoctonia, and digestibility.
  - Three hybrids are being evaluated under grazing.

- *Identification of anti-nutritional factors*
  - Tropical forage legumes show high levels of condensed tannins (CT) that negatively affect voluntary intake, digestion and N utilisation.
  - Legumes differ in CT types and forms, including extractable and insoluble CT, molecular weights, types in tissues, and in tropical legumes, differential nutritional effects.
  - Using the work above, new protocols and laboratory techniques have been developed to measure legume forage quality.

- *On-farm work (TROPILECHE) in subhumid hillsides*
  - improved forage legume (*Cratylia argentea*) in cut-and-carry systems can substitute for expensive protein supplements in the dry season.
  - shrub legumes with improved grass/legume pastures help to intensify livestock farms on subhumid hillsides in Costa Rica.
  - under grazing, legumes (*Arachis pintoi, Centrosema sp.*) in association with *Brachiaria* produce 30-70% more liveweight gain and 15-30% more milk than grass only pastures.

- *Spittlebug damage can be very serious in Brachiaria*
  - New screening methodologies developed for spittlebug resistance, both in the glasshouse and field.
  - Using the new methods, new sources of resistance were identified and used in breeding to produce new hybrids.
  - Selected hybrid-derived clones show a greater degree of antibiotic resistance than the standard resistant check (*B. brizantha* CIAT 6294 cv. Marandu).
  - Armed with good screening methodology, crossing elite apomictic genotypes produces new superior apomictic segregants that can be tested for commercial release.

- *Spittlebug ecology and control*
  - Eleven species identified from 5 genera in Colombia, 3 being new reports; four species found in Ecuador.
  - For IPM strategies, study of entomopathogens considered the most promising natural enemies for biological control.

- *Endophytes in tropical grasses (Brachiaria)*
  - Might cause losses of productivity in grazing livestock.
  - Their presence increased tolerance to drought of infected plants more than of uninfected plants.

The economic importance of *Brachiaria* in tropical America is well established. In Brazil, estimates of the current area under *Brachiaria* pastures range from 30 to 70 million hectares. *Brachiaria decumbens* is especially important due to its excellent adaptation to vast areas of acid infertile soils in places where livestock production is the main land use. Introduction of *B. decumbens* in savannahs has resulted in a 2- to 3-fold increase in individual animal liveweight gain and a ten- to fifteen-fold increase in production per ha.

The Panel members visiting Central America observed keen interest in *Brachiaria* by farmers in or near reference sites or SOLs where the new materials had been introduced.

The Project publishes the Journal *Pasturas Tropicales*, which has over 500 subscribers, and serves as a vehicle for publishing original research results on tropical forages. Also, a series of publications has been prepared that deal with the agronomy, biology and improvement of grasses (*Andropogon gayanus, Brachiaria*) and legumes (*Centrosema, Arachis, Cratylia*).

In 1995-1999 project scientists had 84 referred journal articles published or accepted for publication; 13 invited book chapters; and 22 workshop and conference papers.

3.6.3 Future Strategy

CIAT plans to characterise the full extent of variability for important traits in key forage species, but has not been able to do so due to limited resources. To deal with this, it intends to: 1) use MAS to identify QTLs for spittlebug resistance, Al tolerance and forage digestibility in *Brachiaria*; 2) obtain greater precision in genotype evaluation and selection based on known biochemical and physiological attributes associated with insect resistance and with adaptation to abiotic stresses such as low soil fertility, drought and poor drainage; 3) give greater emphasis to selection for forage quality; 4) apply recent knowledge on endophytes to improve grasses for environmental adaptation, yield and persistence; 5) develop expert systems to target forage germplasm in its multiple uses; 6) use its new greenhouse screening technique to identify Al tolerant *Brachiaria* recombinant materials coming from the breeding program and 7) identify and isolate genes that contribute to adaptation/performance of selected grasses in infertile acid soils.

Research on grass-legume systems in degraded pastures will also be pursued by linking closely with the soils project.

3.6.4 Overview and Assessment

The Tropical Forages Project has gone through many changes during the review period, but has not lost its sense of priority, focus and mission. Small in size, the multidisciplinary team handles an astounding array of problems and challenges, with skill, ingenuity and dedication. This small group represents the world's only international team involved in tropical forage grass and legume improvement, providing a significant global resource for tropical germplasm fitting production needs, while at the same time offering opportunities for use in niches and larger uses relating to NRM. While the resources available do limit the Project mostly to work in Latin America, its forage materials should arouse keen interest in Asia and Africa. In Asia, CIAT operates another tropical forage project introducing forages to smallholders in a farmer participatory approach. The shrubby forage legumes have potential use in Asia and Africa for smallholder cut-and-carry systems. The Panel urges CIAT to extend or strengthen its tropical forage work in Africa.

The quality of the science is high and the work is outstanding. The work on apomictic breeding in *Brachiaria* is simple but elegant in design and is almost certain to have a high impact. The work on endophytes in tropical grasses is exciting and important. Some of the work might be enhanced by closer relationships with Project SB-1.

Brachiaria is probably the most widely planted tropical forage grass in the tropics. The new materials coming from the project are vigorous, with resistance to spittlebug, tolerant of high soil Al, and more drought tolerant than other grasses that might be used. Their vigour and hardiness in acid, less fertile soils where seasonal drought may occur make them a strong candidate for planting in pasture rehabilitation, to help restore degraded pastures to a productive state, allowing more intensive use of higher producing pastures, freeing some lands for crops, and in the end helping to save tropical forests that otherwise might be cleared. Another land-saving factor is drought tolerance in *Brachiaria*, which would help balance feed resources over the whole year, thereby freeing some land for cropping or for specialised pasture use.

The Panel notes that the level of core support for Tropical Forages Project is low. Its work is both rare and valuable, its performance has been outstanding, and its products are valued by farmers and producers. Also, its global research responsibility is singularly important, because it is the only such international tropical forages program in the world. The project today barely meets critical mass levels, and does so only because of outstanding leadership, sharp and clear focus on priorities and strategies, and brilliant science.

3.7 General Assessment

The various reviews of CIAT's work stress the importance of the Centre's commodity improvement projects. The Panel reaffirms the importance of the projects in CIATs role and niche in international agricultural research and development.

It is the Panel's considered opinion that the Centre's commodity improvement projects remain relevant and productive. Given the available resources, the projects continue to be outstanding, with good focus, always innovative, using the best available science – both conventional and new technologies, tools and approaches. Innovations are the core of research, and the Panel is very pleased to find many of these in the Centre's commodity improvement projects. The Panel commends Centre management and staff for continuing the tradition of excellence at CIAT and for their dedication and hard work.

Commodity improvement is by its very nature long-term. While the Panel gives due recognition to the outstanding accomplishments of the Centre during the period under review, it is fair to conclude that these achievements and impacts were built on solid research undertaken by the Centre during earlier periods. Most of the research achievements during the last five years are still in gestation and have yet to produce tangible products, in terms of improved varieties released by national programs and adopted by farmers. Thus the real impact of these products, and the research that went into them, can only be gauged in the future. Nonetheless, the Panel is optimistic that many of the research achievements during the period under review will contribute significantly toward improving the sustainable productivity of CIAT's mandate commodities.

A significant change in research orientation at CIAT and other Centres is the shift away from commodity focus into a broader and integrated natural resource management approach. The Panel is pleased to note that most of the Centre's commodity improvement projects have moved toward higher integration with NRM (See Section 4). The Panel found evidence in this regard, especially in the Africa-based projects. The Panel encourages CIAT to strengthen this integration further in all of its commodity improvement projects, and suggests that all requisite competencies are provided to the projects.

It is, however, also the Panel's responsibility to point out potential threats and weaknesses in the Centre's commodity improvement projects, some of which have become apparent during the period under review.

The Panel stresses that for most of the Centre's mandate commodities, there is no alternative supplier of knowledge and technologies at the international level. Tropical forages and beans are the foremost examples. But the same is true for several important aspects of cassava and rice research. The commodity improvement projects are operating on minimal, even sub-minimal, level of support to discharge their respective global or

regional research responsibilities effectively. The Panel finds this to be a serious matter of concern that needs careful and urgent attention by the Centre Board and management.

The Panel recognises that resource limitations and the pressure to "move upstream" are major determinants of the shift toward more strategic research. While the Panel concurs with the positioning the Centres upstream in the research and development continuum where it has comparative advantage, it is worth noting that this framework assumes that effective alternative suppliers exist and that NARS are able to pick up research responsibilities that the Centre once assumed. The Panel is convinced that this is not necessarily the case with some, if not all, of CIAT's mandate commodities and most of its developing country partners. The Panel also wishes to bring to the Centre's attention the ever present possibility and danger of indirectly contributing to widening the rift between the "haves" and "have-nots" among its partner NARS.

Because of the strategic importance of CIAT's mandate commodities to the well-being of the world's poor; because CIAT is a major if not the only nucleus of international research on these commodities; and because research and development on commodity improvement requires consistent, long-term and adequate efforts, the Panel **recommends** that the Centre Board and Management commit, secure and provide sustained and adequate support to the Centre's global and regional commodity research responsibilities.

Because of the vulnerability of the highly successful African Bean Project to changes in donor funding and the impression of African NARS partners that CIAT has no long term commitment to the continent, the Panel **recommends** that CIAT assure the project of long term sustained funding to safeguard continuity and the ability to expand into promising areas such as forages.

Because of advances in technology that allow the modification of the nutritional characteristics of staple food crops, such as the production of vitamin A precursors in rice, and because improved human nutrition would be a major contribution to the welfare of poor consumers in LAC; the Panel **recommends** that CIAT monitor closely the advances in this technology as well as the surrounding intellectual property issues, and take all appropriate steps to utilise these technologies in appropriate germplasm improvement programs.

CHAPTER 4 - PROTECTING THE ENVIRONMENT

4.1 Introduction

In 1991 "preserving the natural resource base" became one of CIAT's guiding principles. This natural resource management focus, which was consistent with CIAT's long-standing systems approach, had the goal of contributing to the "generation and use of environmentally sound and economically viable options for improved land management and productivity increase by stakeholders".

The new principle reflected growing understanding of the interconnection of the well being of an agroecosystem with the well being of the human community that utilises it. This led to methods of research to increase agricultural production sustainably, which assessed more explicitly crop improvement techniques in the context of the ecosystems and socio-economic systems in which they would be applied, and in a more interdisciplinary manner than in traditional crop research. Necessary in any agricultural production system, CIAT considered it to be particularly crucial in the fragile, high stress environments on which CIAT focused. Thus, research at CIAT integrated the CGIAR pillar of crop productivity into an interdisciplinary three-legged stool of interactions among germplasm-based technologies, environmental systems and processes, and socio-economic systems and processes. Such research, of necessity, involved social scientists, economists and bio-physical scientists and in many instances, as a matter of efficiency and effectiveness, utilised participatory research methods (see Section 5.4).

4.1.1 Analytical Framework

The Panel agrees with the basic NRM principle that the relationship among strategic, applied and adaptive research must be iterative and non-linear. Given its complexity, a basic challenge of NRM research is the development of an appropriate framework. To aid the Panel in its work, a four element framework was devised, including examples of research activities for each element. Therefore, the Panel assessed CIAT's NRM research using the following four-element framework:

- *Assessment of the status of natural resources and their management at a given site.*
  - Interactive Assessment: project planning by objectives by scientists and stakeholders. Science-led Assessment: existing data sets, GIS, standard scientific assessment techniques.

- *Identification of the key factors linked to the sustainable use of the natural resource.*
  - Interactive identification: observations by local residents and scientists. Science-led identification: literature, experiments based on formal hypotheses.

- *Research the key processes, principles and structures that determine the ecological and socio-economic outcomes of NRM.*
  - Interactive research: farmer research committees and scientists do experiments and refine questions. Science- led research: hypothesis testing in field and/or laboratory research.

- *Propose solutions and test their validity.*
  - Interactive testing: scientists and farmers suggest solutions and test in formal experiments and/or through farmer research committees. Science-led research: field studies or experiments for validation

Reference sites: Based on the expected magnitude of effects of changes in natural resource management, CIAT chose three priority Latin American ecoregions for NRM research: *forest margins* and *hillsides* which are typically characterised by fragile ecosystems and poor smallholders, and *savannahs* which are generally underexploited areas with marginal soils but productive potential. To study typical problems in these ecoregions, CIAT designated at least one reference site in each. Watersheds were chosen as the research unit for reference sites because they were considered to be clearly bounded geographically, complex, hierarchical, dynamic, and adaptive systems. CIAT considers reference sites as field laboratories at local scales where cross-scale research can be undertaken, and where options for smallholder farmers can be tested early on, in collaboration with potential local users and other stakeholders. CIAT reference sites are not intended to constitute a sample representative of the ecoregion, but rather are intended to provide a sample of the problems.

Three ecoregional reference sites serve as research *loci* for a number of CIAT projects. The forest margin reference site in Pucallpa, Peru is managed with CIFOR and ICRAF; and is benchmark site of the ASB (Alternatives to Slash-and-Burn) Systemwide Program. The savannahs reference site is at Puerto Lopez, Colombia where research has been limited by security problems. The hillsides reference site in Central America is comprised of two locations, San Dionisio, Nicaragua, and Yorito, Honduras, which represent different rainfall patterns.

At the time of the review, five CIAT projects devote a majority of their effort to work in differing aspects of agroecosystem sustainability: integrated pest management, soil degradation, community-based watershed management, land use, and sustainable systems for smallholders. Each project uses participatory research methods. The Panel assesses each project in terms of the analytical framework presented above.

4.2 Pest and Disease Management (PE-1)

4.2.1 Evolution

This project (IPM for a Safer Environment: Integrated Pest Management in Major Agro-Ecosystems of the Americas; hereinafter referred to as the IPM Project), which

began in 1996, grew out of the former Cassava Program's early 1990s project, Integrated Cassava Management in Major Agroecosystems of Latin America and Asia, which emphasised both IPM and integrated crop management, and included strategic research in pest management. With the change to the project system, an IPM Scientific Resource Group (SRG) assembled to design subprojects for the IPM project, PE-1. About 8 scientists, most of whom also have responsibilities in other projects, now work in the IPM Project.

The IPM project probably represents less than half of CIAT's total IPM work, which is also conducted for rice (IP-4 and FLAR), beans (IP-1 and IP-2) and tropical grasses and legumes (IP-5) projects. A scientist from IP-5, tropical forages, also works in the IPM project. The only core funding for the project is for work on cassava. The IPM project also supports NARS research on non-mandate crops including oil palm, asparagus, grasses, potatoes, fruits, citrus, vegetables, flowers, roses, and legumes.

The objective of the IPM project is "to develop and transfer improved pest and disease management components for major agricultural production systems and reduce environmental damage due to excessive pesticide use".

Major project research activities include: finding and evaluating natural enemies of major pests and diseases; testing and verifying IPM and its components on farms; studying the biology, ecology, behaviour and damage of pests and diseases; molecular characterisation of major pathogens and providing diagnostic kits; and characterisation of whitefly biodiversity. The project has 3.8 senior scientists.

4.2.2 Achievements and Impact

Building on the earlier Cassava IPM Project research, PE-1 works on an impressive array of strategic research problems to understand the biology of pests and diseases and the nature of their damage to crop plants. Current achievements include:

- *Global Whitefly IPM Research Network* (see Box 4.2.2).
  - Initial work in 22 countries in Africa and LAC has become global in scope.

- *Biological control for cassava mealybugs.*
  - Identifying natural enemies and parasitoids of the 2 most damaging mealybugs, *Phenacoccus manihoti* and *P. herreni.*
  - Volatile compounds in cassava and parasitoid behaviour.

- *Biological control of cassava whiteflies*
  - Identifying parasitoids of *Bemisia tabaci* as biocontrol agents.
  - Eleven species of whiteflies identified in the Neotropics.
  - *B. tabaci,* a ACMD virus vector, found on cassava in Latin America where cassava has no resistance to the African virus, a new threat.
  - Cassava varieties resistant to whiteflies identified, the first host plant resistance to whiteflies ever found.

- *Biological control of cassava hornworm*
  - Entomopathogenic fungi, *Beauveria* and *Metarhizium*, are potential biocontrol agents.

- *Biocontrol of cassava green mite (CGM)*
  - Studies of the mite predator, *Typhlodromalus manihoti.*
  - Entomopathogenic fungus, *Neozygites, and viral CGM* pathogens as biocontrol agents.

- *Integrated control of cassava root rot diseases* (Phytophthora)
  - Participatory diagnostic survey of farmer practices and on-farm trials.
  - Identification and molecular characterisations of causal organisms.
  - Molecular detection method for *Phytophthora* on vegetative tissues.
  - Heat treatment methods to help control the disease.

- *Virus diseases of cassava*
  - Mapping the spread of cassava frogskin virus in Latin America.
  - Three potexviruses infect cassava.

- *Participatory research with farmers (CIALs)*

Project staff have published 30 refereed journal articles, 5 book chapters, 30 conference proceedings, 5 manuals and conducted 54 workshops.

Box 4.2.2 The Global Whitefly IPM Project – An example of rapid global response capability to a transnational problem.

The Global Whitefly IPM Project, which CIAT co-ordinates, is one of twelve projects of the Systemwide Program on Integrated Pest Management (SP-IPM) which is convened by IITA. The Project is formally known as "Sustainable Integrated Pest Management of Whiteflies as Pests and Vectors of Plant Viruses in the Tropics". The Project has a Steering Committee that evaluates new research proposals, allocates funds for a Task Force for each new activity, and reviews the progress of on-going initiatives. In early 1996, the Whitefly IPM Task Force met to define priorities, which fell within three categories of whitefly importance: (i) as vectors of plant viruses in mixed cropping in the low- to mid-altitude Tropics and (ii) as direct pests in LAC, and (iii) as vectors of cassava mosaic disease in cassava across sub-Saharan Africa.

Six sub-projects were identified:

- in highlands
- as virus vectors in mixed cropping in Mexico, Central America and the Caribbean,
- as virus vectors in mixed cropping in Eastern Africa,
- as vectors of plant viruses in mixed cropping in Southeast Asia,
- as vectors of cassava mosaic virus in sub-Saharan Africa
- as direct pests in South America

The Project Work Plan covers six major themes:

- a tropical network of professionals
- integrated diagnosis and characterisation of the problems in each area,
- a phase of basic research to understand better the underlying pest and disease dynamics,
- development of improved IPM packages, based on improved scientific understanding
- training
- evaluation of impact

Phase I – developing the network of professionals and diagnosing problems – began in 1997 in Latin America and Africa, with funding from the Danish International Development Agency (Danida). Since then the Project has evolved to include seven donors, five IARCs, 10 advanced research organisations, and 30 NARS (12 in Latin America, 10 in Africa and 8 in Southeast Asia).

All formal partners use standardised methodologies so that data sets from across the Tropics can be compared. In this way critical areas ('hot spots') were identified where basic research can be conducted – 5 hot spots in Latin America and 5 in Africa. Extensive, standardised diagnostic surveys quickly yielded practical information used in guiding initial IPM. For example, extensive surveys quickly defined the moving front of the cassava mosaic disease (CMD) in the Eastern Africa Lakes Region, as well as zones at highest risk. Such knowledge allowed the multiplication and deployment of elite, CMD-resistance cassava varieties from IITA in front of the epidemic to try to slow its spread and protect the most vulnerable zones.

Basic research is about to begin in the 'hot spots' identified in the diagnostic phase and to gain more information on the whitefly and its biotypes and the viruses for which it is a vector. The Project has enlisted the interest and support of advanced research institutions, IARCs, NARS scientists and donors to support and carry out a timely, well-designed and implemented, global research effort on a highly adaptable pest/virus complex that has raced around the world. With the help of NARS, and CIAT's GIS staff, mapping studies have shown where, how far and how quickly whiteflies can move in the Tropics. The Panel considers the Project to be a global partnership model that has enlisted and mobilised the best scientists in a global effort to meet the threat of emerging, invasive pests. The Panel commends CIAT and the IPM project staff for this work.

4.2.3 Future Strategy

CIAT's work in IPM is mostly strategic in nature. CIAT intends to continue to identify parasitoids, entomopathogens or predators to control important pests. Biology studies of important diseases and pests will continue, using conventional and molecular methods. Pest behaviour will continue to receive attention as a way to improve and speed the biocontrol processes, including work on volatile materials from plants that may serve as attractants, pre-release conditioning of biocontrol agents to enhance their activity, feeding behaviour of predators and parasitoids, pathogenicity of entomopathogenic fungi and viruses, and evaluation of biocontrol agents in the field. Continuing studies will determine the principal entomological problems affecting asparagus production and to identify arthropods that may be present on produce entering export markets.

Studies will continue on cassava frogskin virus including host plant resistance, incorporation of resistance to the African cassava mosaic disease into Latin American germplasm, a molecular detection method for potexviruses, and determining the possible incorporation of a virus into the cassava genome. Phase II research is about to begin in the Global Whitefly Research network, including interpreting, synthesising and publishing information and in establishing a website.

4.2.4 Overview and Assessment

This project is clearly producing results and is active in the four criteria in the analytical framework used by the Panel. IPM research being carried out under PE-1 is of high scientific quality, strategic in nature, and essential for developing IPM components. The quality of the work and the scientists involved make the project a kind of magnet for collaboration, both within and outside Colombia. The work owes much of its strength of staff and breadth of knowledge and experience to its origins in the Cassava Program. The long-range research emphasis of the Cassava Program on major and emerging pests and diseases positioned the Centre well for moving into IPM.

The IPM project is international in scope, with the Global Whitefly IPM Network being perhaps the best example. The Panel commends the work of the IPM project in identifying key problems, in undertaking strategic research to understand and solve them, and in attracting and recruiting partners for the necessary collaboration to deliver the results to resource-poor farmers.

The Panel noted that PE-1 increasingly is called on to work on problems of non-mandate crops in Colombia, on a case-by-case basis. The Panel recognises that this development is in part a response to funding shortfalls. However, this does raise the question of whether this work might draw the attention of CIAT's IPM scientists away from work on mandate crops and longer-range global needs.

The Panel suggests that CIAT give special attention where possible to limiting staff fragmentation (which may be a particular risk under the project system), while securing long-term strategic research and effective integration.

4.3 Overcoming Soil Degradation (PE-2)

4.3.1 Evolution

The goal of the Soil Degradation project (Confronting Soil Degradation: Developing Strategies for Productivity Enhancement and Resource Conservation; PE-2) is to overcome soil degradation through productivity enhancement and natural resource conservation. The project, created in 1997, evolved from the Soil and Plant Nutrition Unit (1996) which in turn developed from CIAT's Savannahs (1992-93) and Tropical Lowlands (1994-95) Programmes. The project contributes to achieving a sustainable level of agricultural production by developing and implementing resource-conserving

practices, such as Integrated Nutrient Management (INM), integrated soil pest management, minimal or no tillage, crop rotations and better crop-livestock integration.

The Project's objective has become more basic (separated from production) and more specific (focusing on soil quality) with time. Its goal is: "identifying strategic principles, concepts and methods for protecting and improving soil quality through the efficient and sustainable use of soil, water and nutrient resources in crop-livestock systems" (1999).

At present, a multi-disciplinary team of scientists addresses issues of soil degradation mainly in the savannahs and hillsides of Latin America. The group convenes the Systemwide Program on Soil, Water and Nutrient Management (SP-SWNM, designated as CIAT Project SW-2), relating to similar problems of soil erosion and nutrient depletion in Sub-Saharan Africa and Southeast-Asia, and its work in PE-2 constitutes CIAT's contribution to the Systemwide Program (see Section 7.4). Senior staff cover the areas of soil physics, soil chemistry, soil biology and microbiology, plant nutrition and production systems.

The project outputs provide information and decision support tools for national program scientists and extension agents, with a focus to improve production systems and prevent and/or reverse land degradation. These are intermediary products in terms of overall development goals of CIAT and partners. The project provides the following outputs:

- Assessment of soil, water and nutrient management constraints, and characterisation of plant components for improved production and resource conservation.
- Development of strategies to protect and improve soil quality.
- Improvement of decision making for combating soil degradation and reaching greater agricultural productivity.
- Enhancement of institutional capacity for soil water and nutrient management (SWNM) through the dissemination of concepts, methods, tools and training.

The project has 4.15 senior scientists.

4.3.2 Achievements and Impact

The results of PE-2's savannah ecosystem work have been recently reported in two CIAT publications: "Sustainable Land Management for the Oxisols of the Latin American Savannahs " (1999) and " *Sistemas Agropastoriles en Sabanas Tropicales de América Latina* " (1999). Part of the results on soil quality and soil quality indicators has been published and is being applied through the guide " *Método Participativo para Identificar y Clasificar Indicadores Locales de Calidad del Suelo a Nivel de Microcuenca. Guia 1.*" Some achievements according to project output include:

- *Soil, water and nutrient management constraints assessed*
  - Crop monocultures and crop rotations with green manures result in an accumulation of large quantities (100 kg N/ha) soil nitrate-N in savannah Oxisols. Strategies to recover this soil nitrogen should include deep rooting forages in agropastoral systems and/or deep rooting crops such as sorghum and millet in crop rotations.
  - Main biophysical constraints for savannahs, hillsides and forest margins identified.
  - Savannah oxisols are more susceptible to degradation than previously thought, with large decreases in total porosity (40 to 60 %) and macroporosity (5 to 20 %) occurring during 20 years of cultivation.
  - Rainfall infiltration rates in savannah soils are unexpectedly low as a result of rapid surface sealing after tillage (harrowing).
  - Upland rice yields decline by over 50 % after 3 years of cultivation, which is related to the number of passes of a harrow and subsequent loss of soil structure.
  - Intra-specific variation in nutrient release patterns of *Mucuna spp.* legumes have been demonstrated, providing feedback for germplasm improvement programs.
  - Grass/legume mixtures can enhance the acquisition of N, P, K and Ca on low fertility soils compared to grass only pastures.

- *Strategies developed to protect and improve soil quality*
  - Pastures sown to improved forage germplasm have been shown to accumulate significant amounts of carbon as soil organic matter at depth in Oxisols.
  - Improved grass/legume pastures result in a larger overall sink for all greenhouse gases (carbon dioxide, nitrous oxides and methane) compared with other land use systems currently present in the Colombian llanos.
  - Studies on P cycling in long term pastures indicate that legume- based pastures stimulate/maintain higher organic and available P levels than grass alone or native savannah pastures.
  - Residue decomposition rates and nutrient release patterns have been determined for rice, maize, cowpea, soybeans and the major grass and forage legume germplasm used in the savannahs.
  - Savannah soils are very susceptible to compaction with rapid loss of pasture productivity. The avoidance of surface sealing and compaction is a key strategy for sustainable production of savannah soils. Options to achieve this include better ground covers, conservation tillage systems and terracing.

- *Improved decision making for combating soil degradation*
  - Guidelines for better management of soil organic matter in savannah Oxisols have been established.
  - Soil quality indicators have been identified for the savannahs and hillsides, and a guide for measuring soil quality has been produced.
  - Data from organic material decomposition trials have been incorporated into an Organic Resource Database.

- A decision tree for the use of organic materials as biofertilizers is being developed and tested.
- Maps of erosion risk in the Rio Cabayul watershed in Colombia are available.

- *Institutional capacity for soil water and nutrient management enhanced*
  - The use of a guide for soil quality has been demonstrated to groups of NARES.
  - Over 50 students have been trained and/or participated in research projects.

Project staff have published 47 refereed journal articles, 49 book chapters, 87 conference publications or conference proceedings, 1 manual and conducted 3 workshops.

4.3.3 Future Strategy

The Soil Degradation Project will develop strategic knowledge on the evolution of soil properties, mainly organic matter and physical factors associated with cropping systems of the savannahs and hillsides. Soil constraints and agricultural practices affecting the sustainability of the savannahs and hillsides cropping systems continue to be studied in agropastoral systems with a grass-legume pasture phase, sequential crop rotations with cereal-legumes, conservation tillage and construction of an "arable layer" (productive layer) in the savannahs, dual purpose live barriers along contour lines and around lower edges of fields, improved fallow systems, and crop rotations in the hillsides.

4.3.4 Overview and Assessment

This project is active in all four elements of the Panel's analytical framework. Outputs 1 and 4 (see Section 4.3.1) dominated the work of the last 5 years of the Soil Degradation project. Today it is clearly understood that the sustainability problem can be stopped and reversed with an appropriate management of soil organic matter and minimum tillage practices. The Panel believes a shift in emphasis to outputs 2 and 3 is now appropriate. In the near future, CIAT should implement its findings at the cropping system level, emphasising the commodities for which it has major responsibility: beans, rice, cassava and tropical pastures. The Panel visualises a close association of the Soil Degradation staff with the commodity programs working with a cropping systems perspective. Furthermore, since a meaningful application by CIAT of the knowledge developed so far has to be done at the cropping system level, and these systems are mostly location specific, the Panel suggests that much of this work should be done in conjunction with NARS at the sites of interest – e.g. beans in Africa, IPM, Tropileche Consortium, and agropastoral systems work in the Cerrados of Brazil.

The link of Soil Degradation with the Smallholder Systems project (PE-5) is essential, because at the cropping system level the results of soil degradation have direct relevance to CIAT's mandate.

In spite of substantial efforts to develop soil quality indicators, this work is still at the level of methodology development. The Spanish guide mentioned above (see Section 4.3.2) is a participatory effort to identify and class local soil quality indicators; however, it is not ready for use in agricultural management, decision making, and monitoring agricultural systems sustainability. Thus, the usefulness of soil quality indicators is still to come.

The Panel considers that the work of the Systemwide Soil, Water and Nutrient Management Program (CIAT project SW2) is of high value. Also, the Panel is particularly impressed by the results and relevance of the research contributed to the Systemwide Africa Highlands Initiative (see Section 7.4). The outputs on Resource Management Domains related to the Organic Resources Database, guidelines for re-capitalisation of nitrogen and phosphorous in degraded soils, and the recommendations for optimising combinations of organic-inorganic inputs and their management are of particular importance.

The Panel endorses the CCER 1999 conclusion that the organisational arrangement of research into projects at CIAT has had some negative effects on research efficiency. There is need to rationalise and organise activities in a more integrative manner in a problem solving type of approach.

The Panel wishes to quote from good advice given by the 1995 CCER on Resource Management Research: "Rather than thinking of two research approaches – one on commodities and one on natural resources – CIAT needs to see itself as having one research policy contributing to commodity development in a sustainable fashion, and developing sustainable agriculture within a commodity strategy."

4.4 Hillsides Project (PE-3)

4.4.1 Evolution

Hillsides are the major agro-ecosystem farmed by the poor in Tropical America and are subject to severe environmental degradation. In contrast to the forest margins and the savannahs, CIAT retained a designated hillsides project, "Community Management of Watershed Resources" in order to address the specific issues involved in multi-stakeholder management of natural resources. In 1992, CIAT created an eco-regional Program "to improve the welfare of the hillside farming community through development of sustainable and commercially viable production systems." From its initiation in 1992 to 2000, the Program/Project has undergone constant and complete turnover of principal staff.

In 1992, the Program had an agronomist in Central America and, at headquarters, a soil scientist and a rural sociologist who acted as program leader. In early 1993, a logical framework and work plan were developed based on projected program staffing. Research activities were focused on soil management, cropping systems, farmer

participatory research, and decision support systems. Management activities were organised within a "Program" framework. In 1996, financial cuts led to devolving to NARS virtually all the soils and cropping systems activities while retaining the decision support and farmer participatory research work. As a result, a new logical framework and work plan were developed with the goal "To institutionalise community-led management of watershed resources for more productive, sustainable and healthy hillside agroecosystems". From 1996-99, (when organised as "Community Management of Natural Resources") the project worked only on decision support tools and organisational approaches and ceased research on experimental production systems. This was the result of strategic prioritisation in consultation with key stakeholders and donors at a time when overall resources were being reduced. In 1999, new leadership re-appraised this decision, and decided to introduce cross-project research between PE-3 and the Soils Project (PE-2) on experimental production systems, rather than restricting research only to decision support tools and organisational approaches. A revised logical framework and work plan were adopted "To improve the standard of living and food security of hillside farmers of Tropical America and make their interaction with the environment more sustainable". The current revised logical framework and work plan is similar in scope to the original 1993 plan although some outputs and activities have been assumed by other CIAT Projects.

CIAT plans to carry out strategic research at the field, system and landscape level, and to focus on identifying principles and processes to intensify, stabilise and diversify small farmer production systems, in ways that are ecologically sound and economically viable for at least one generation. Hillsides research products were originally conceived in the Hillsides Program as intended to produce:

- GIS linked decision-support tools for participatory land use planning, bio-economic evaluation of new production systems in alternative land management scenarios, soil and water resource monitoring tools and decision support tools.
- Experimental production systems combining improved germplasm, with integrated crop, nutrient and pest management components.
- Organisational approaches and principles for collective resource management to support improved production and conservation in hillsides. Hillsides project research is carried out in Colombia, Honduras and Nicaragua.

The CIAT SOL Concept: As part of the Hillsides Project in Central America, in late 1999 after a change in leadership, CIAT began testing an innovation for technology development for production systems in complex, highly variable tropical environments. Termed SOL— the Spanish acronym for "supermarket of technologies for hillsides" – the idea is defined as: a network of actors and activities taking place at various sites within a reference site. The approach is intended to:

- Maximise interaction between scientists and end users.
- Promote rapid feedback between the strategic and adaptive ends of the technology development continuum.

- Derive strategic principles for designing menus of technology options for hillsides production systems (i.e. the plan for supplying the supermarket).
- Test principles based on strategic research results in specific circumstances, with end users and obtain their reactions (i.e. demand from shoppers in the supermarket).
- Produce empirical data from strategic research experiments only now being established, and experience in organising the network as an input to DSS, market options, sustainable production systems, crop rotations, NRM decision support tools, soil quality indicators, participatory methods and organisational models.

CIAT and its partners expect that SOLs will strengthen existing social infrastructure to facilitate effective watershed management research. The Centre anticipates the demand-driven SOL approach will encourage farmers and their communities to interact more closely with NARS, NGO's and research institutions, experiment and adapt existing or new technologies, and improve their capacity to solve some of their own problems. Farmers are expected to be able to express their needs for new technologies much more directly and with greater clarity than in the past. At the same time, research institutions are expected to become more receptive to solving the problems of resource poor farmers in a more timely and focused fashion.

CIAT's priorities for research on community based management of watershed resources from 1996-1999 were to produce: 1) an interactive digital database for decision support with PE-4 (*The Atlas of Honduras*), and 2) A multiple-goal decision support tool for community land use planning, a suite of models for evaluating scenarios of land use, and the software applications for the DS Tool. CIAT's priorities for research in SOL were first formulated in spring, 1999 as:

- What are current uses of organic material/ crop residues at reference sites?
- What are the main biotic and abiotic factors limiting crop productivity?
- What is the potential of local flora as nutrient sinks and biofertilizers?
- Can local indicators of soil quality be related to formal soil quality indicators and used by farmers for monitoring changes in soil quality?

The research priorities for on-farm and on-station research in SOL sites in Central America are:

- What is the potential of contrasting combinations of plant types (short season, shallow rooted, perennial, deep-rooted etc.) to solve or minimise limiting factors, in particular soil-borne pathogens?
- What are the rates of decomposition and nutrient release of most relevant local and introduced sources of organic residues in the watershed, in particular potential biofertilizers?

CIAT's hillside research in Africa is undertaken through the African Highlands Initiative, which is convened by ICRAF. CIAT staff were involved in the initial planning, serve on the steering committee and are responsible for two working groups: IPM and Intensification and Participatory Research (see Section 7.4).

The project has 1.4 senior scientists and 2 senior research fellows.

4.4.2 Achievements and Impact

The Hillsides project works on a wide array of socio-economic and biophysical factors. Current achievements include:

- *Methodology Development*
  - Improved measures of poverty for spatial analysis developed for the Atlas of Honduras, a joint product with PE-4.
  - SOLs in the very early stages of being established in two Central American sites.
  - Model for *ex ante* analysis of change in small watersheds resulting from small irrigation projects.
  - The well-being index, a measure of poverty developed for combining GIS with data from participatory research.
  - Two models for Honduras and Colombia to do bio-economic simulation.
  - Nine tools for watershed resource management decision support published in Spanish; 3 in English.

- *Methodology Dissemination*
  - Joint training workshop carried out with the African Highlands Initiative using research products developed in PE-3.

- *Participatory Research*
  - Project Planning by Objectives around watershed resource management with 15 organisations (NGOs, farmer organisations, universities, CORPOICA and other government agencies, CIAT) in the Cauca Valley, Colombia led to the formation of CIPASLA which developed a 5 year plan (updated annually) and developed projects to meet objectives, with different institutions implementing different parts of the plan. CIPASLA won the *Planeta Azul* prize for its work.

- *Integration of scientific and traditional knowledge:*
  - Method for linking local and regional perceptions of well-being linked to georeferenced databases.
  - Soil quality score card developed with glossary of local taxonomy.

- *Database Development*:
  - Baseline data collected on soil quality, soil microfauna properties (Colombia), household level agriculture and population censuses (Honduras)
  - Agricultural Atlases of socio-economic and biophysical data for Honduras available and sold through partners' outlets.
  - 22 internal working documents and databases for baseline studies of the site in Honduras and 8 for the site in Nicaragua.

- 3 Georeferenced digital elevation models for the sites in Colombia, Nicaragua and Honduras as a baseline to guide the location of strategic research experiments and extrapolation of results.

- *Technology Dissemination*
  - Stakeholders experimenting with improved land management in Colombia.

Project staff have published: 10 peer reviewed articles, 9 book chapters, 25 conference papers, 10 manuals, and conducted 16 workshops from 1996-9.

4.4.3 Future Strategy

CIAT's Community Management of Watershed resources project plans to validate the multiple-goal DS tool in Central America for community-based watershed resource management. The GIS-linked watershed models, site digital elevation models, and bioeconomic simulation models built by the project will be applied in Central American sites for:

- Land use scenario assessments
- *Ex ante* and *ex post* evaluation of conservation and production technologies
- Simulations for experimental production systems research
- Monitor and evaluate landscape changes in sites
- Training

These models will be used as components for a policy-level DSS being assembled with Kings College, London and other ARIs.

The project will promote cross-project research with other CIAT projects in Central America, in particular forages and soils for research on experimental production systems in Central America through the SOL approach. In 3-5 years CIAT expects its research partners to take over facilitating joint training, planning, monitoring and evaluation for the SOL network in a watershed. Training in the use of the Nine Tools for watershed management decision support has been extended to the African Hillsides, the Andean region, and Vietnam and will continue in Africa and Asia.

4.4.4 Overview and Assessment

With reference to its analytical framework, the Panel found that the research in Colombia involves all four elements, while research in Central America is concentrated in the first element. Natural resource management at the watershed level is complex and difficult to research, but such work – if well designed and implemented – could prove valuable. The Panel visited two hillside sites in Central America; Yorito in Honduras (started in 1994) and San Dionisio in Nicaragua (started in 1996). There were demonstration plots at both sites of NARS partners, alongside CIAT's plots being prepared for initiating strategic research trials in May 2000. No CIAT experimental treatments have yet been established in these sites. Research to establish priorities through Participatory Planning by

Objectives is in preliminary phases in Yorito. The Panel found the quality of biophysical and social science research in the two sites it visited to be unsatisfactory. The Panel was not able to visit the Cauca hillsides research site for security reasons.

The hillsides work in Colombia has made important contributions to social and biophysical methods for watershed management, but the Panel did not find this to be replicated in Central America. The Panel was unable to discern a systematic and coherent program of biophysical or social science research being undertaken at either of the reference sites visited in Central America. The Panel noted a lack of appropriate baseline data from which to assess changes in sites where CIAT has been working for over four years. The 1999 COSUDE/IDRC evaluation of the hillsides project similarly noted a lack of clear goals for the reference sites, and recommended the collection of baseline data on which comparisons could be based, to increase focus, and to define clearly strategies to achieve results.

The Panel insists that a rigorous and coherent research plan consistent with CIAT's NRM approach be developed for each reference site. To accomplish this, the program needs a framework and methodology structure that ensures integration of social scientists and biophysical scientists, and builds on their special skills and talents.

The Panel shares the view of the 1999 COSUDE/IDRC project evaluation and the previous EPMR that the limited PE-3 staff should be concentrated. To make continuous and systematic fieldwork, and necessary methodology development possible, the Panel urges that serious consideration be given to stationing more project staff in Central America. Given the importance of the reference sites in the Hillsides Project, the Panel suggests that scientists should deepen their relationship with farmers by living near the reference sites in Central America instead of in capital cities.

CIAT needs to develop a strategy for dealing with the diverse capabilities and commitments of its partners in the SOLs. The Panel proposes that farmers' involvement in SOLs be monitored to determine the effectiveness of the SOLs in reaching farmers of varying socio-economic status and gender.

The Panel observed a lack of consistent operational definitions at CIAT of its key concepts such as reference site, SOL, and SOLcito, leading to considerable confusion, and hampering interdisciplinary efforts. Work that cannot be defined or explained is not likely to be implemented well.

The Panel remarks that farmers' ability to express their needs for new technologies with greater clarity and more directly will have little effect in the absence of substantial research capacity in the NARS or NGOs. Attention should be paid to strengthening the network of researchers to whom farmers will be making their requests. (see Section 5.4.4).

Because the Hillsides Project work developed in Colombia has not yet lived up to its promise in Central America, the Panel **recommends** that CIAT develop a rigorous and coherent research plan for the Hillsides Project including clear and consistent definitions.

4.5 Land Use Studies (PE-4)

4.5.1 Evolution

The objective of this project (Environmental Sustainability and Land Use Dynamics in Latin America; PE-4) is to "improve policy and decision making for sustainable land and environmental management in Latin America through the scientific analysis of land and environmental patterns, anticipated dynamics and policy indicators." The process started in 1982 when an Agroecological Studies Unit was created at CIAT, staffed by geographers working in different plant breeding programs with the goal of meeting their needs for mapping and spatial analysis.

In 1992, when Natural Resources Management became a work area for CIAT, the Unit was transformed into the Land Use Programme. This Program continued to provide services to the plant breeding programs, but also began to develop a research agenda within a NRM frame. In 1994 it was thought that separating the services and research components would serve the Centre better. Therefore, a GIS Unit was created to provide services, while Land Use was kept as a research Program. Under the 1996 change to a project structure, the Land Use Program was renamed the Land Use Project. By 1998, the decision of 1994 was reassessed, and the GIS Unit was integrated within the Land Use Project. The Land Use and GIS work together in various activities, including serving other CIAT Projects (NRM and Plant Breeding) to address research needs in several fields.

Project outputs include identification of environmental opportunities and constraints; land use patterns; spatial distribution and correlation with socio-economic data; determinants, dynamics and impacts of land use in Latin America; and the development of socio-economic indicators. Other products of the project are Rural Sustainability indicators, environmental indicators, land use characterisation, interpolated climate surfaces, land use and soil erosion maps. The project has 6.0 senior scientists.

4.5.2 Achievements and Impact

The Land Use Project has made important contributions to the tropics in general and to Latin America and the Caribbean in particular. Contributions include climate surfaces for the tropics (supported by data from 20,000 climate stations) and development of a model to estimate climatic characteristics of any point in the tropics based on available meteorological data. The project has also developed *FloraMap*™, a software to define possible distribution of living species, and site similarity analysis using a comprehensive database.

The Land Use project supports CIAT scientists such as breeders and epidemiologists who work with spatial distribution of organisms. Such efforts include; combining agroecological and characterisation data for bean and forage accessions; the ecology and dissemination of whitefly-transmitted viruses; and helping to define CIAT's reference sites through basic characterisation, mapping, and decision support systems for land use planning

- *Development of Analytical and Decision Making Tools*
  - Decision support tools for land use planning.
  - Contributes to World Bank Sustainability Indicators Program, GEO 2000, the State of the World Resources Program, the Soil and Terrain Database (FAO) and others.

- *Development of GIS tools*
  - Accessibility algorithm for accessibility analysis to markets, harbours and remote areas.
  - Spanish version of the *MapMaker* model for land use planning.
  - Use of radar images to generate elevation models (important in the tropics due to persistent cloudiness).

- *Data sets for Latin America*
  - *Atlas on Environmental and Sustainable Indicators*: indicators and indices for multi-level decision makers providing the basis for land use dynamics studies.
  - *Atlas of Honduras*: biophysical and socio-economic characteristics at municipality and community levels before and after Hurricane Mitch.
  - *Data set for Africa:* support to IP-2 in producing the Atlas of Common Bean Production in Africa.

In 1995-1999, project staff have published 46 refereed journal articles, 24 book chapters, 47 conference publications, 12 conference proceedings, 2 manuals, 11 web publications and 10 CD Roms.

4.5.3 Future Strategy

To capitalise on its unique position in land planning and GIS expertise and infrastructure, CIAT desires to become a leading Latin American institution in environmental monitoring (NRM indicators, land use dynamics) and impact assessment. The area of environmental sustainability will continue to be central to Land Use activities.

CIAT plans to use climatic databases and site similarity analysis along with GIS modelling and regional trials data to develop tools (e. g. refinements of the *FloraMap* model) for germplasm improvement, targeting and distribution; for development of bioinformatics (the combination of GIS and genomic analysis allowing the study of

geographic flow and distribution of genes); and for the study of the distribution and epidemiology of pests and diseases.

4.5.4 Overview and Assessment

The Land Use Project works in elements 1 and 2 of the Panel's evaluation framework – which is quite appropriate in the Panel's view – and is fully meeting its objectives. The Project on Environmental Sustainability and Land Use Dynamics in Latin America plays an important role in addressing biophysical and socio-economic issues related to NRM at a broad scale. Through participation in multidisciplinary groups, modelling efforts and the combination of physical, social and economical information, this group has proven capacity to generalise and develop information at the regional level in Latin America. It has shown the feasibility of identifying areas of growing potential for given species and varieties (*FloraMap*), of monitoring changes in land use *(Atlas of Environmental Indicators for Latin America*) of developing maps of environmental vulnerability (hurricane Mitch, *El Niño*) and of participating in the land planning process using GIS technology and participatory techniques (e.g. Puerto Lopez pilot land planning study, Colombia) with high accuracy, cost efficiency – at a cost 50 percent lower than traditional approaches.

The Land Use project is one of CIAT's major NRM activities, and provides a focus on the broader NRM issues of the Tropics including lowland and hillsides ecosystems. At the same time, it provides the NRM research with the means to scale-up resource management knowledge generated at lower levels. The Panel considers the continued development of this project to be of high value to the sustainable use of natural resources in Latin America and the tropics at large, and one of CIAT's major contributions to its mandate.

4.6 Smallholder Systems (PE-5)

4.6.1 Evolution

The Smallholder Systems Project (Sustainable Systems for Smallholders: Integrating Improved Germplasm and Resource Management for Enhanced Crop and Livestock Production Systems) was established in 1997 to integrate farmer adoption of improved germplasm with more sustainable management practices to ensure sustainable production systems. The mandate of Smallholder Systems is to study production systems development; integrate crop management-oriented research in commodity programs; and evaluate and integrate factors affecting rural production systems such as soils, agro-industry, and socio-economic structures and processes. It has worked with commodity-based special projects, introducing a whole-farm approach to the research agenda and an NRM approach to land use. Research priorities are set annually in collaboration with other CIAT projects and international and national partners. Special projects in cassava and forages in South East Asia were folded into this project. The project co-ordinates CIAT's contributions to the forest margin reference sites in Peru.

Systems research is carried out at the Forest Margins reference site at Pucallpa, Peru, and in a mountainous area in Hue Province, Vietnam and in Thailand. Some Soil Degradation research is now integrated into the Smallholder Systems work plans. Research on developing more sustainable cropping systems that include forages and cassava is carried out in Latin America (forages, much of it through the TROPILECHE consortium) and Southeast Asia (forages and cassava).

CIAT systems research in Colombia and Central America is now led by project PE-3, "Community Management of Hillside Resources". (see Section 4.4) PE-5 has contributed through simulation modelling of smallholder cropping systems and development of forage-based technologies. There is little smallholder agriculture in the Savannahs, though PE-5 contributes in diagnosis of problems and opportunities and on-farm development of forage technologies.

The Smallholder Systems Project collaborates in Latin America with CIFOR, ICRAF and ILRI (Forest Margins, TROPILECHE); and IRRI and ILRI in Latin America and Asia on forages and cassava. TROPILECHE also works in Central America and is one of three consortia of the systemwide Livestock Initiative (see Box 4.6.1).

The project has 3.3 senior scientists and 2 postdoctoral fellows.

Box 4.6.1 The TROPILECHE Consortium in Latin America

TROPILECHE is one of three consortia of the Systemwide Livestock Programme. CIAT is the convenor of TROPILECHE, and its Co-ordinator – who holds a joint appointment with the International Livestock Research Institute (ILRI) – is stationed at CIAT.

The objective of TROPILECHE is "to increase milk and beef production of dual-purpose livestock in smallholder farms through the development of improved forage-based feeding systems". Study sites include the dry hillsides of Central America (Costa Rica, Nicaragua and Honduras) and the forest margins of the Amazon (Colombia and Peru), where livestock production is important in land use and the livelihoods of resource-poor farmers. In the forest margins, low quality feed from degraded pastures limits milk production. In the seasonally dry hillsides, the major feed constraint to improving milk production is lack of high quality forage from native pastures during the dry season. The strategy to solve feed constraints includes: evaluating new feed resources to match animal nutritional requirements, on-farm participatory evaluation of new forages, characterisation of benchmark sites – including economic analysis and acceptability/adoption studies.

CIAT Projects working in TROPILECHE include Tropical Grasses and Legumes (IP-5, which plays the major role, Sustainable Smallholder Systems (PE-5), and Hillsides (PE-3).

4.6.2 Achievements and Impact

The Smallholder Systems project works mostly on applied research with partners to integrate strategic research results into production systems. Current achievements include:

- *System components assessed to provide alternative land use options*
  - Studies in Forest Margins: characterisation, problem diagnosis, and land use dynamics; poverty and environment, indicators of human nutrition and health, intensification and livestock development.
  - New forage options for smallholders in Asia.
  - Green manure in East Africa (see Section 3.3.3).
  - Interactions between social groups and changes in land use and biodiversity.
  - Vietnam watershed: characterisation, problem definition (see Section 4.4).

- *Generic agricultural technologies for sustainable production developed through PRM* (see Sections 3.6, 5.4)
  - Partners initiated participatory projects (LAC).
  - Varieties and agronomic practices identified/developed/evaluated (LAC, Asia).
  - PRM crop and technology development and evaluation (LAC, Asia).
  - Datasets: rainfall and erosion linked to GIS (LAC).
  - Acceptance of technologies: NGOs: cassava conservation strategies; farmers: *Arachis pintoi-Brachiaria* associations (LAC) (see Section 3.6).
  - Manuals published, video produced: new forage varieties, guide to grasslands, PRM, farmer success story (Asia, LAC).
  - Relations developed between crop response and soil and plant nutrient levels.

- *Models/frameworks developed*
  - DSSAT model: linked with organic matter module, *Brachiaria* model added, adapted for smallholder systems simulation modelling – GIS model developed integrating germplasm and environment.
  - Linear models of interventions: forage in dual-purpose cattle production, economic evaluation in smallholder systems (see Section 7.4).
  - Framework for participatory monitoring and evaluation.

- *Increased effectiveness of CIAT and partners for research for developing productive and sustainable land use practices*
  - Networks and partnerships to increase collaboration
  - Books and manuals produced: CIAT systems research, PRM in agronomic research, PRM.
  - Introduce new approaches to targeting and developing technologies with farmers
  - Partners trained in PRM (Africa, Asia, LAC)

In 1995-1999, project staff have published 59 refereed journal articles, 30 book chapters, and 162 conference publications or conference proceedings.

4.6.3 Future Strategy

CIAT will focus on improving pasture systems for forest margins, developing new smallholder crop and livestock technologies, developing methodologies for farm-level socio-economic and environmental impact and for model for multi-institutional PRM, developing a model for community-based natural resource management in Southeast Asia, and developing new approaches to scaling up technologies developed through PRM.

4.6.4 Overview and Assessment

The Smallholder Systems Project has the explicit objective of integrating germplasm and natural resource management to develop sustainable systems. This higher system level of integration is more challenging and complex, but amenable to assessment under the Panel's framework. The Panel is pleased to note that project objectives and activities always start with, and are based on, a holistic and rigorous description of the landscape.

The Panel commends the project for its success in integrating NRM and commodity research. The Panel notes in particular the work in South East Asia that has been very successful in developing and introducing technology options, principally forages, for resource-poor smallholder systems. Similar successes were achieved in developing sustainable cassava-based systems in Asia. Both of these activities have undergone external reviews recently, and the Panel concurs with their findings and very positive assessments.

Participatory methods have proved effective and valuable in the project's approach. The Panel saw evidence that the approach is enthusiastically endorsed and adopted by CIAT's partners in the communities where the activities are undertaken. The Panel encourages the Centre to ensure that it does not work exclusively with the top strata of smallholders.

The Panel notes that a suitable "entry point" appears to have been useful in catalysing the interest and participation of local partners, and providing a locus on which the integration of germplasm and NRM can be built. Cassava and forage, together with soil erosion, appear to have provided these points for integration in Asia. Co-ordinating research on common issues/scientific problems across different sites (especially reference sites) would be valuable in the Centre's systems research. The Panel encourages CIAT to synthesise the wealth of experience and knowledge gained from the systems research into its overall NRM framework, as it develop strategies for replication and/or scaling up.

4.7 Overall Assessment

The Panel concurs with the finding of the First Review of Systemwide Programmes with an Ecoregional Approach that "the principles underlying the ecoregional approach are valid and of continuing high priority for pursuing the sustainable improvement of agricultural productivity".

The development of sustainable livelihoods and production systems in heterogeneous ecological and social systems is a complex undertaking. There is no magic bullet. In its NRM research, CIAT has fostered the incorporation of participatory methods into the culture of biophysical scientific research (see Section 5.4). Although it has taken time, progress has been made in embedding the NRM scientific research in local ecological and social realities. However, the opportunity for comparative strategic research inherent in the reference sites has been significantly under-utilised. The Panel encourages CIAT to develop a comparative research strategy and methodology for these sites. The effectiveness of the Hillsides projects in Central America is hampered by the lack of consistent definitions and of a framework to allow biophysical and social scientists to work in an integrated way at the agro-ecosystem level. The NRM research needs to bring all of its components to an equal level of excellence and a higher degree of scientific integration. Careful attention must be paid to ensuring that this diverse set of research projects has a cumulative effect and that the framework and methodologies can be replicated elsewhere. That will be the overall test of success of this work.

CIAT's NRM research appears to be more successful when it has a explicit entry point that provides a rapid pay-off for the farmer and an initial focus for research. CIAT projects currently use two methods for creating an entry point into a community: technology and social process. For example, the Africa Bean Project uses bean technology (often following participatory methods) as an entry point and then widens its focus to research other farmer-identified problems including NRM. The Hillsides Project uses a social process, Participatory Planning by Objectives, elicit farmers' problems and

then narrows its focus to research questions within CIAT's commodities or natural resource management research areas. The Panel encourages CIAT to ensure that all field projects have clear entry points.

Given the possible fragmenting effects of the project structure, the Panel advocates that attention be given to encouraging scientists to work together across project boundaries. Most scientists in CIAT are part of more than one project.

The Panel concurs with the Systemwide Review of Ecoregional Research recommendation that collaboration with strong partners in strategic research on biophysical and social science and policy aspects of NRM should be strengthened. We also concur that the imbalance between biophysical and social science research must be redressed. Because CIAT is developing and testing innovative ways of doing science, the Panel suggests that CIAT consider investigating the research process itself. This might include analyses of the processes and factors affecting the effectiveness of interdisciplinary research, participatory research methods and multi-scale research.

Because the approach of CIAT's Natural Resource Management research at the farm, community, watershed, and ecoregion levels, is not always clear, the Panel **recommends** that CIAT develop a rigorous overall research approach with greater integration among projects, define their specific objectives (including the role of reference sites and related activities) more clearly, and establish a clear framework of their hierarchical and functional relations and responsibilities.

Because the Hillsides Project work developed in Colombia has not yet lived up to its promise in Central America, the Panel **recommends** that CIAT develop a rigorous and coherent research plan for the Hillsides Project including clear and consistent definitions.

The Panel commends CIAT for its strong commitment to Natural Resource Management Research, shown by the research efforts of various projects (P-1 – P-5) at various levels of integration: region, ecoregion, watershed, village and farm. The Panel urges CIAT to make the necessary efforts to integrate more fully the work among projects, define their specific objectives more clearly and establish a framework showing their hierarchical and functional relations and responsibilities.

CIAT is in a unique position to develop the principles and practices related to low input, sustainable agronomy and is making a major contribution in this area. We urge the Centre to stimulate the implementation of field demonstrations of these findings at headquarters and at the reference sites.

CHAPTER 5 - STRENGTHENING NARS

5.1 Introduction

The international centres have always been concerned with the development and strengthening of the agricultural research capacity of the countries they serve, and especially of the country where a given centre is located. This responds fundamentally to the need to have sound research partners at the country level, to ensure that jointly generated technologies effectively reach local farmers and achieve the expected impacts on food production and rural community improvement.

Given the Centres' mandates and their limited funding, the approach taken towards strengthening the national agricultural research systems (NARS) has typically emphasised the following: making available superior genetic materials produced by the centres; training of national agricultural research scientists and technicians; collaboration and assistance in carrying out research, often involving the direct participation of Centres' scientists; and distribution of information and publications. These activities have been selective, directed towards the program areas of concern of each International Centre. An important way of reaching out broadly to the NARS of many countries simultaneously has been through the formation of research networks.

CIAT has followed this general pattern in its relations with the NARS, evolving over time in accordance with the needs and priorities of its own research programs, and local realities. Thus, in the early years, the training program was very large, diverse and intensive and mostly concentrated in the Latin American region. Subsequently it was reduced but broadened to include more trainees from other regions, and more recently its has become much more limited and selective to provide training in key or innovative areas of research. Similarly, CIAT has emphasised crop improvement research with national research institutes (like ICA-Colombia, or generally the INIA's, in their Latin acronym) with which extensive agreements where established, including for joint use of field facilities. The initial concentration of CIAT efforts in Latin America was later broadened to Africa, where now CIAT has most of its out posted staff, and to some extent to Asia.

As CIAT changed the focus and organisation of its research programs starting in the late 1980's, the nature of its relations to the NARS also was progressively modified. For instance, at the country level certain institutions, other than the INIAs, have sometimes become more important as components of the NARS (agricultural universities, state level research centres, NGOs), becoming attractive as collaborators in some research areas. This situation is especially true in Brazil, despite the overwhelming presence of EMBRAPA; and also in smaller countries like in Central America, where the INIAs often are too small or weak, and other agencies are better equipped for some kinds of research, such as in applied rural social sciences.

The foregoing trend in CIAT - NARS relations has been prompted also by the significant move by CIAT towards NRM research, with its ancillary features of focusing on less-favoured agricultural areas, poor small farmers, participatory research methodologies, and rural agroenterprise development. These are all topics in which the traditional INIAs do not have strong capacity, and in fact they frequently find themselves excluded from them by their mandates or current policies. Under these circumstances, strengthening the NARS means finding institutional partners different from the INIAs, and this is visible in the CIAT associations during the 1990's.

Another factor affecting CIAT's activities in support of NARS' improvement concerns the CG decision to devolve the more applied crop research, like creation of finished varieties, to the NARS and restrict the international centres to upstream research. This strategy is introducing an important change in the traditional forms of CIAT-INIA co-operation in plant breeding research, and can be expected to lead to new schemes and partners for this research, including associations with the private sector.

Under the current project-based organisation of CIAT's research, its activities for strengthening the NARS are grouped under three projects: Agroenterprises (SN-1), Linkages with NARS (SN-2) and Participatory Research (SN-3). These projects are reviewed in detail in the following sections. Two caveats should be raised beforehand, though: 1) there are many formal and informal activities, contacts and exchanges that take place at the level of all CIAT projects, which have an impact on improving the NARS' research capacities, but which may not be explicitly captured under the three projects mentioned above. 2) The "NARS-strengthening" objective of CIAT at present is not as strong or as important a goal as it was 15 or 20 years ago. In fact, since collaboration with NARS is indispensable now to carry out most of CIAT's research projects, the choice of partner institutions is principally dictated by shared interests, potential synergy, or relative resource contributions. Local institutional strengthening and human resource development occur naturally as part of the primary research co-operation.

5.2 Agroenterprises (SN-1)

5.2.1 Evolution

The Rural Agroenterprise Development Project (Rural Agroenterprise: Linking Smallholders to Growth Markets for Improved Resource Management; SN-1) has its origin in the 1970's, when the Cassava Program initiated research on root processing and consumption characteristics, as these aspects were crucial for the crop breeding part of CIAT's research. The Centre contributed significantly to the development of postharvest and processing technologies for cassava, along with marketing and consumer research. Also starting in the 1980's, the Utilisation Section of this Program led the efforts to formulate and implement "integrated cassava research and development projects", which sought, in partnership with local and national institutions, to establish small rural agroenterprises for cassava processing and marketing. The first such project was set up in

1981 in the Colombian North Coast region, to process dried cassava chips for the animal industry as a way to expand the market for small farmers' produce and raise their income levels. A similar one was established in Northeast Brazil in 1989, in a collaborative project between CIAT and various Brazilian governmental institutions (see reviews of these two projects in Chapter 6). This general approach has been adopted in some countries in Latin America, and is now being used also in Africa.

As CIAT's programs were reformulated in the early 1990's and the Hillsides Program and subsequently the Tropical Lowlands Program were established with an emphasis on poverty alleviation, the need was perceived within these programs for postharvest and consumer market technologies, as components of a research strategy aiming to help and motivate farmers to achieve the sustainable use of natural resources. Thus, when CIAT restructured in 1996, the Rural Agroenterprise Project: Linking Small holders to growth markets for improved Resource Management was created.

The objectives of the project are: "to develop..... methods, tools, and institutional models for the design and execution of successful rural agroenterprise projects that integrate market opportunities and postharvest technologies with environmentally sound production and processing practices".

This project takes an area-based, rather than a single commodity approach, to identifying agroenterprise opportunities with market potential for small farmer communities. For this reason, it works in close collaboration especially with other projects in the natural resource management sphere (see Sections 4.4 and 4.5). It focuses on fragile hillsides and tropical lowland ecosystems, but also includes work in the Colombian *llanos* in the savannah ecoregion, on small farmer groups, and on ways to improve women's roles and family incomes.

5.2.2 Achievements and Impact

Although Project SN-1 has long roots in CIAT's research, its current 1996 formulation is quite new. It has already performed an impressive array of activities but final outputs and impact on target areas and populations will take longer to assess. So far, the project is capitalising on the successful implementation and positive evaluation of the two earlier projects in Colombia and Brazil, mentioned above.

The first important achievement is the elaboration of a conceptual approach for the development of rural agroenterprises, grounded in CIAT's past experience and current research. This approach sets forth the major steps to be followed in the process (i.e., identification of market opportunities; appropriate postharvest technologies; needs for effective organisational schemes; institutional models for support systems; and building capacity to develop such projects) and describes the tools, methods and information required for each step to be successfully executed. This conceptualisation provides the logical organisation and ordering of all the project's activities.

The "research materials" of the project are local agroindustry organisations, methods and institutional arrangements developed, tested and validated with partners. Data are generated through field case studies in different countries for documenting lessons learned and best practises. The project has been very successful in bringing together a variety of institutional partners and special funding to implement several field case studies, mostly in Latin American countries and a few in Asia.

Following the above-mentioned component steps of the rural Agroenterprise Development Project, some highlights of its output and achievements are as follows:

- Market opportunity identification. A participatory method for selecting crops with good market potential, developed at CIAT, was tested in reference sites in Peru and Honduras, with good results. These show that fruits, vegetables and dairy products rank high in the preferences of small farmers. An Internet-based information system on alternative trade (ATIS) of special interest for small farmers has been developed and placed in the project's web page.

- Postharvest technology. Data and information systems to assist in postharvest technology selection have been developed, and participatory research methods have been adopted for postharvest technology research in geographical areas of project concern. These methods are being field tested on topics such as sour cassava processing and lemon grass drying in Colombia, and cheese processing in Peru. Also, in collaboration with CIRAD studies have been made for the adaptation of advanced technology for adding value to selected crops with good potential markets. One example is the production of passion fruit juice.

- Agroenterprise organisation. A review study was completed and a method defined to identify research needs with regard to internal organisation of small agroindustries. This method was applied in 8 case studies of the Andean region of South America, 3 in Central America and 2 in Asia, thereby identifying factors and characteristics associated with the performance of small rural industries. Also, an analytical study was done on enterprise linkages in the agribusiness chain, focussed on a case in Colombia.

- Integrating rural agroindustry and local support systems. A methodology was developed and tested for the design of models and policies to facilitate the integration of small agroindustries. This methodology was applied in the study of six integrated agroindustry projects in Colombia, organised around the processing of six crop and livestock products. Also, a scheme has been formulated for setting up rural agroindustry committees, and applied in reference sites in Colombia, Honduras and Peru.

- Enhanced capacity for executing agroenterprise projects. Over 150 national personnel have been trained through CIAT-sponsored workshops and other events, using training materials produced by the project. These have been in Latin America and Africa. The project has also published and broadly distributed technical and awareness

documents, and is active in the formulation and support of networks and other linkages of partner organisations.

While this is a good indication of the productivity of the agroenterprises project, it does not provide sufficient data to analyse its cumulative impact. Most of the achievements constitute intermediate research outputs, or results that can only have impact if adopted by newly emerging (or improving) rural agroindustries, located in ecoregions like those defined by the project. However, considering the vast number of field studies conducted, the many national and regional collaborating institutions involved, and the large number of technical personnel participating, the CIAT project most likely has already contributed to raise the local capacity to analyse, design and implement small agroindustry projects of this nature. The evidence will be the actual development of such industries in the right rural context in developing countries. CIAT should set up a monitoring system to track such development and implement impact assessment studies in due time.

5.2.3 Future Strategy

This project is still at an early stage of implementation and many of its current activities are in full development or at mid stream. It can be expected therefore that the present strategy will continue for the next few years. Continued focus on poverty alleviation should sharpen the targeting of small farm crops in fragile environments, female employment in post harvest activities, and small enterprises. Similarly, expected impact on the environment will require continued emphasis on adding value to crops, as an incentive to better resource conservation, and on processing techniques that reduce pollution.

5.2.4 Overview and Assessment

The project has made remarkable progress in the four years since it was created. It has produced information, methods and empirical results on a variety of topics, and it has attracted local partners and substantial funding support to carry out its activities. However, the breadth and diversity of topics covered, the geographic dispersion of its "research fields", and the multiple and varying objectives of the project, make it difficult to figure out how it will all eventually come together, in the form of tested and replicable conclusions and recommendations. In fact, a big question is to what extent this project is "research", versus a combination of activities that rather belong in the "rural development" project area. The project follows the case study method and proceeds in a trial and error scheme progressively adjusting its results and subsequent strategies until reaching the desired objectives. Although this maybe an appropriate method for advancing knowledge given the complexity of the problems present in the rural environments covered by the project, it may take a long time to arrive at satisfactory results, and it may still be doubtful whether such results can be extrapolated to other non-observed situations.

The Panel recognises that the project seeks to develop methodologies and contributes to research partnerships in support of improving the livelihoods of the rural poor. However, the Panel suggests that project staff and CIAT research leaders revisit the approach followed by the project in order to sharpen its research techniques, and do an *ex ante* appraisal of its probable outcomes in regard to the overall purposes of NRM research at the Centre.

5.3 Linkages with NARS (SN-2)

5.3.1 Evolution

The project to strengthen links with NARS (SN-2) was set up at the time of CIAT's reorganisation in 1996, by putting under a single co-ordination officer various units that dealt with external relations, training and the provision of information. These activities were of long standing at CIAT and in the 1970's and 80's were known as "outreach", correctly conveying the fact that relations with the NARS were mainly one-way, from CIAT to them. The deep changes occurred in the 1990's in CIAT's programs and administrative organisation had many implications for the intensity and nature of its linkages to the NARS and to the international agricultural research establishment. In essence, this meant shifting to a multilateral co-operation approach, reducing the training function and emphasising arrangements such as networks and consortia with NARS and other collaborating institutions, seeking funding from host and participating countries for the CG centres (i.e., CIAT), and obtaining special project funding from any donors. To perform better this set of tasks under the new scenario, CIAT created a Regional Co-operation Directorship, putting under its authority also the Communication Unit, the Information and Documentation Unit, and the Training and Conferences Unit. All four of these, were subsequently labelled project SN-2 "Strengthening Private and Public Linkage for Agricultural Research and Development". This therefore is not a research project, but a service project whose objective is defined as: "To help increase the effectiveness of national, regional and global agricultural research systems by building partnerships, sharing information, developing human resources, and promoting collaboration between countries and institutions". One of its functions is to centralise the administration of resources received under contract from NARS to finance joint research, training and co-operation activities.

5.3.2 Achievements and Impact

Achievements of this project will be reviewed according to the objectives and activities of each of the four components of the project. The Directorate for Co-operation, which co-ordinates the project, has as its major function to maintain relations with NARS and Agricultural Ministries at high administrative levels, and to monitor the needs and demands of NARS in Latin America, Africa and Asia. Principal achievements in the past years include:

- Establishment of a new "co-operation policy", approved by the BOT, that provides the guidelines for all collaborative projects underwritten by CIAT. It lays out standard procedures for establishing agreements and contracts for research ventures funded by specific donors. The Directorate has taken active part in negotiations and contacts to formalise many of these research agreements.
- Improved relations with national governments. Close rapport has been achieved principally with the Colombian Government, which has become an important contributor to the CG (US$ 1.7 million per year), largely for support of CIAT's work. With Brazil, close co-operation has been resumed through EMBRAPA, which allocates its annual US$ 0.5 million contribution in cash to CG centres through CIAT. Training agreements were signed with the Government of Ecuador, funded by the World Bank.
- Strengthened ties with LAC regional organisations/programs. CIAT participated in joint project proposals and bids with PROCIANDINO and PROCITROPICOS; and it established agreements with IICA for activities in Central America.
- Expanded collaboration with universities. Several agreements were signed with universities of Latin America and Europe, for student research and training in CIAT projects.
- Contractual arrangement with the Spanish Agency for Technical Co-operation, to administer agricultural projects funds.

Several specific research partnerships have been arranged through CIAT project staff, which are housed within the respective projects. These are discussed in Section 7.3, since the Directorate of Project SN-1 is only marginally involved in these, mainly in centralised record keeping.

Achievements and impact of the Communications Unit and the Information and Documentation Unit are reported in Sections 7.6 and 7.7 respectively. These Units have had an excellent performance, despite CIAT's budgetary stringency of the past years.

The Training and Conferences Unit, notwithstanding the drastic reduction in its staff and budget, has continued to provide excellent support for the planning and execution of courses, seminars and workshops held at CIAT and elsewhere. Achievements in this area are discussed in Section 7.5.

5.3.3 Future Strategy

The organisation and functions of Project SN-2 are expected to be maintained in the coming years. Increased efforts will be made to further improve relations with national Governments in CIAT's regions of concern, raising CIAT's profile, and seeking co-operative ventures and project funding. Contacts will be expanded with countries and NARS of Africa and Asia.

5.3.4 Overview and Assessment

This project is essentially a conglomerate of administrative and service units, that provide specific outputs and support of an institution-wide nature. It is not really one "project", and assessment must be related to each of the functions involved. In this respect, the Directorate of Co-operation appears to have been very successful in improving relations and collaborative links with governments, NARS, and selected regional and national agencies in Latin America. This was made evident, for instance during the visit by some members of the Panel to EMBRAPA and other research institutions in Brazil. Contacts with the equivalent institutions in Africa and Asia are decentralised to CIAT regional co-ordinators. The Panel suggests that CIAT should make special efforts to establish closer ties in these regions, particularly with those countries and NARS where CIAT technologies and services would be of greatest value.

The role of the Communications, Information and Documentation, and Training Units in effectively linking CIAT with the NARS is crucial for the Centre's continued effectiveness in strengthening these systems. These Units have performed in an outstanding manner. The Panel suggests that CIAT should consider doing a review of its experience with partnerships (see Section 7.3).

5.4 Participatory Research (SN-3)

5.4.1 Evolution

While the very best plant breeders have had strong relationships with farmers, the necessity of and methods for consulting farmers (especially poor and women farmers) has not been a part of the formal training or mainstream scientific culture of plant breeders. CIAT has been one of the leaders in developing participatory plant breeding (PPB), a method plant breeders can use to create and systematically incorporate collegial relations with farmers into their way of doing research.

Strategic research on participatory research methods (PRM) began at CIAT in the 1980s with a focus on participatory evaluation of advanced lines by farmers and other users. CIAT breeders began to realise in the late 80s that there were potential gains to be made by using participatory methods with segregating materials in beans and cassava. Strategic research further developing PPB has been undertaken in the African Bean programme and the Systemwide Program on Participatory Research and Gender Analysis. In 1990 the W. K. Kellogg Foundation funded a special project based at CIAT called IPRA (Investigación Participativa con Agricultores (Farmer Participatory Research). During the 1990's the focus moved beyond research methods linking individual researchers with individual farmers to methods to develop a long-term community level capacity for technology evaluation and adaptive research by creating farmer research committees (CIALs). In the mid 1990's CIAT's Board of Trustees established the Hillsides program and IPRA became a project within it. In 1997 with the

shift to projects, the Hillsides program evolved into two projects: Community Management of Hillsides Resources (PE-3) and Approaches to Participatory Research (Methods of Farmer Participation in Research and Gender Analysis for Technology Development and Natural Resource Management; SN-3). The current focus in Latin America is on the institutionalisation and scaling up of CIALS. A variant of the model of participatory research is being implemented by FLAR (see Section 3.2).

Inattention to the gendered division of knowledge, responsibility, labour, property, technology and power can adversely affect research. CIAT is the convenor for the Systemwide Program on Participatory Research and Gender Analysis (SW-3) (see Section 7.4). The programme assesses and develops methodologies and organisational innovations for gender-sensitive participatory research, and operationalises their use in plant breeding and crop and natural resource management

5.4.2 Achievements and Impact

- *Participatory Research Methods (see Sections 4.3. 4.4, 4.5. 4.6, 5.2)*
  - In an area of Colombia where live contour barriers had been adopted only by farmers required to do so to get credit or extension services, the adoption of live barriers by farmers who were introduced to live contour barriers with participatory methods was compared over two years with adoption by farmers who were required to plant them to get credit. Only 20 of the 40 farmers who signed up for credit, actually planted barriers. In contrast all 115 farmers approached through participatory methods had planted and 146 farmers to whom they had recommended barriers had also adopted them.
  - Diffusion of PRM to CIAT projects: IP-2: green manures and AHI, SN-1: market opportunity identification (Africa, LAC), PE-3, PE-4: land use planning (LAC), PE-5: forage evaluation (Asia, LAC), technology development (Asia, LAC, ASB).
  - Three Latin American universities can teach PRM.
  - PRM institutionalised: workshops include both farmers and scientists, farmers as co-authors with CIAT scientists of CIAT publications and reports to government.

- *Gender Analysis*
  - Workshops on skill building in gender analysis and stakeholder involvement for participatory research in LAC, South Asia, South East Asia and Africa.
  - Production of written, electronic and visual materials on PRM and gender analysis for use by practitioners, scientists and scholars.
  - Twenty-one small grants have been awarded for empirical studies of gender sensitivity in PPB and NRM.
  - Websites for programme information and recommended PR & GA tools.

- *Participatory Plant Breeding* (see Sections 3.2, 3.3, 3.4, 3.6, 4.2,)
  - CIAT and some (but by no means all) NARS breeders in East Africa told the panel that, despite their initial opposition and scepticism, they now think that

PPB makes them more effective as breeders. They said PPB shortens the time to the release of a new variety and enables them to produce varieties compatible with heterogeneous local conditions and local preferences. Similar opinions have been reported from West Africa, Syria, Jordan, India and other countries where IARCs and the PRGA work.

- Diffusion of PPB to CIAT breeders (beans in Africa and LAC and cassava in LAC). (see Sections 3.3.2, 3.3.3, 3.3.4, 4.6.2)
- Diffusion of PPB to some international crop networks and national programs in Asia, Africa and Latin America.
- PPB research initiated by NARS breeders in Brazil, Honduras, Bolivia, Ethiopia, and Yemen, other IARCS and northern universities on the advantages and disadvantages of farmer involvement in the early stages of plant breeding. (see Section 4.6.2)

- *CIALs*
  - Preliminary data show that research by a CIAL can increase adoption rates and that there is a spillover affect to other communities with CIALs. For example, 8 years after a new bean variety had been tested by a local CIAL, it had been tried and adopted by 80% of the farmers in the originating village, 50% in three nearby villages with CIALS, and 20% in four communities without CIALs.
  - Adoption and diffusion of the CIAL approach in Latin America to over 40 NGOs, government organisations and universities in 8 countries.
  - Training of 400 facilitators (including 100 trained by other institutions) and (in 1999) 18 trainers of facilitators.
  - Nationalisation of the CIAL program in Colombia.
  - Formation of CIAL Associations in Colombia and Honduras.
  - CIALS now helping to form other CIALS and undertaking community service projects.

5.4.3 Future Strategy

CIAT plans to continue to develop PRM for eventual empirical study. It will develop new and modify existing PRM, in particular, expand the scope of the CIAL approach to include the capacity for discovering and learning about ecological principles and key biological processes related to crop health management and integrating them with existing local knowledge, and determining when collective action is needed to increase effectiveness. It will institutionalise PRM through organising participatory research under the direction of farmers in Latin America and supporting the application of PRM in CIAT and the NARS. The systemwide programme will focus on mainstreaming programme outputs in CG centres, facilitating empirical PPB/NRM studies, including decentralised partnerships among IARCs, NARS, NGOs, and GROs, integrating gender/stakeholder analysis into all PBB and NRM empirical studies. The Participatory Plant Breeding and Intellectual Property Rights, Ethical Values and Best Practices Program initiated in 2000 will research the IPR implications of PPB to which farmers make an intellectual contribution.

5.4.4 Overview and Assessment

CIAT's agroecosystem approach depends on successfully grappling with complexity. Since the farmer works with complexity on a daily basis and must, of necessity, be an integrator, her/his active participation is essential to the success of this approach. The Panel lauds CIAT for innovative work on PRM which both enables breeders to incorporate user preferences in complex agroecological and socio-economic systems and enables farmers to become more effective in their interactions with NARS and NGOs. This set of methodologies is an important international public good.

The Panel concurs with the previous EPMR's recognition of the promise of CIAT's innovative methods for achieving farmer and community participation in "benefiting the sites, the ecoregion and the overall development of effective approaches to research in natural resource management in the small farm sector". CIAT has played a crucial role in putting PRM on the intellectual map.

Having seen the results of variety trials presented by CIAT farmer-researchers, the Panel applauds the use of participatory research methods to facilitate, research and adapt the integration of germplasm-based technologies with more sustainable natural resource management practices to specific socio-economic-ecological systems.

Dynamic and effective work on PRM is being done in the Africa Program. The program focus has been on Latin America, while the PRGA Systemwide Program works with most of the IARCs and a large number of NARS in Africa and Asia as well. Increased interaction and exchange between Headquarters and field programs working on PRM would be mutually beneficial.

FLAR provides an interesting partnership model. The Panel encourages CIAT to consider establishing a similar innovative partnership for PRM training and dissemination, CIAL support, and network facilitation. This partnership should be designed to relieve CIAT scientists the burden of training and organisation maintenance in order that they might concentrate on research.

Empirical research on the long-term effectiveness of many participatory methods is still in preliminary stages. Therefore, CIAT must systematically investigate the effectiveness of these methods. The project has invested sufficient resources in developing and disseminating PRM and organisational innovations to create an adequate number of cases for study. The Panel believes that now the project should concentrate its efforts on rigorous comparative research on the formation, effects and evolution of PRM and traditional methods under varying conditions; the process of organisational innovation and its effects on sustainability and livelihoods; the factors affecting the diffusion of PRM; and the effect of PRM on the practice of science. World class social scientists must undertake this research (see Sections 4.4.4 and 4.7). The Panel is very impressed by the potential of participatory plant breeding and the manner in which CIAT has linked it to the issue of intellectual property rights in the aforementioned IDRC-

funded project on Participatory Plant Breeding and Intellectual Property Rights, Ethical Values and Best Practices.

CHAPTER 6 - BETTER POLICIES

6.1 Introduction

The international centres, including CIAT, established a significant capacity in agricultural economics research from the initiation of the system in the 1960's. Economics research was required to assess the viability of the farm technology developed by the Centres, but also to provide more macroeconomic analysis about the mandate commodities and on general developments in agriculture, to provide a contextual framework within which agricultural research had to be designed and executed. This capability was subsequently expanded to include social sciences more generally, especially as the CG strategy directed more effort towards small farmers, the rural poor and women's roles.

The socio-economic research at the IARCs played an important role in helping shape policies within the CGIAR system and at each centre, and also it contributed to the policy discussion and formulation at the country level, particularly with respect to the NARS' organisation and programs.

In the last decade, socio-economic research at the IARCs has changed away from a macro policy focus. At CIAT in particular, this activity has been reorganised so as to concentrate mainly in the assessment of impact of Centre's research. Some of the major problems being dealt with, like NRM in less favoured areas, gender issues, poverty alleviation and sustainability are quite complex and often site-specific. Hence it will take time until new reliable strategies and models become available and may affect policies. Within CIAT and the CG system impact assessment analysis may play a significant role in policy design and resource allocation, even before "finished products" are released.

6.2 Impact Assessment (BP-1)

6.2.1 Evolution

Assessment of CIAT's research impact has been conducted since the 1970s, initially focusing on estimating the returns to investment in crop research.

As the mission, objectives and work programs of CIAT were changed in response to expectations and requests of donors, it became necessary to address more directly and thoroughly the question of impact assessment. Thus, in 1993 the Impact Assessment Unit was formed, which was subsequently converted to the Impact Assessment Project (Assessment of Past and Expected Impact of Research; BP-1) at the time of CIAT's restructuring in 1996. This decision has correctly given higher priority to this task within CIAT, and is insuring the continuity of a well focussed effort, with a high level of professionalism. CIAT is one of the seven centres participating in the former IAEG (now SPIA) study on the impact of CGIAR germplasm improvement research.

The purposes of the impact assessment project are to generate and disseminate information and methodological tools aimed at: 1) improving the capacity of CIAT and partner organisations to allocate research resources more efficiently, and 2) helping demonstrate to donors and other stakeholders the productivity and social value of the Centre's research.

It should be stressed that the current view of impact assessment in the CG system, one that CIAT is implementing, is that it must be an integral part of the entire research process: planning, priority setting, execution and monitoring, and evaluation of results. Impact assessment feedback into this process helps to modify strategies, as well as earlier *ex ante* assessments and projected outcomes.

The methods of neo-classical economics have been used extensively to estimate economic returns to agricultural research. Based on the concepts of consumer and producer surplus they have been used particularly to assess the effect of research outputs on individual commodities and/or aggregate production. Since the 1970's several studies of this nature have been done at CIAT for its mandate commodities. As CIAT's mission and program were redefined and modified, particularly during the 1990's, the problem of assessing impact became more difficult. Measuring the effects of the adoption of research outputs on small farmers' livelihoods and rural communities was critical to evaluating CIAT's research.

Evaluating the effects of NRM research was further complicated by the long time frame (raising inter-generational issues), the frequency of market failures in the natural resource sector, and structural factors such as land tenure systems, state-local relations, and local culture. In addition, cost-benefit analysis was unsuited for assessing impacts in terms of improvements in sustainability of agro-ecosystems, sustainability of livelihoods, community and individual well being and empowerment, and equity. Many standard social science methods, while appropriate, also have limitations. Thus, CIAT has devoted considerable effort to generating and adapting methodologies appropriate for socio-economic NRM assessment.

CIAT's impact assessment effort has evolved to cover two major lines of work: 1) Empirical evaluation of effects of its research, both ex-post (i.e., of actions already conducted and results achieved) and *ex ante* (i.e., estimating likely results of projects yet to be implemented); and 2) developing or improving methodologies for adequate impact assessment of CIAT's NRM activities and research projects with high social content. In addition, the BP-1 has continued to devote substantial effort to set up computerised databases and conduct agricultural sector and commodity trend studies.

6.2.2 Achievements and Impact

In this section, the contents, significance and main conclusions of the above impact assessment work since 1996 are reviewed. Before, though, mention should be made of the particular achievements and "impacts" of CIAT projects discussed in other chapters of this report. These represent enumeration of research products, releases of

technological innovations, intermediate-level utilisation of these, and occasionally simple quantification of farmer adoption of better plant materials. Although quite valuable to provide indications of CIAT's research productivity and degree of outreach to farmers, they are not good measures of impact, in the sense that they cannot determine quantitatively how the final target population of farmers and consumers (including sub-categories by gender, income, etc.) are actually affected by the new technology. The impact assessment studies conducted by the BP-1, reviewed below, aim basically at measuring this latter definition of impact.

6.2.2.1 Empirical Assessment of Past Research Impact

There are 15 different studies reported for the period under consideration, some of which have been completed and others are ongoing. Some show a progressive sophistication in the analytical tools and models used, which is important because the data used for these studies come mostly from field sample surveys. These surveys are expensive to carry out, and the BP-1 has taken care in the statistical sampling and field gathering of the information, which insures good quality data. Subsequent socio-economic analysis, however, is uneven with respect to model specification, techniques and rigor – with the noted tendency to improve in the last years.

The majority of these studies focus on the adoption of new technology (particularly new varieties of beans and cassava), using indicators such as percentage of farmers who have adopted the technology as a measure of achievement. The analysis tries to identify the factors affecting adoption and their relative importance under different local circumstances. The impact in each case is measured in different ways, from full estimation of Benefit/Cost ratios or internal rates of return, to some estimate of added value of total production or gross benefits, to calculation of various indicators such as change in yields, production, cost savings, cropping patterns, etc. Some studies include qualitative questions to help assess the impact of the new technology on women, on nutrition at the family level, and on changes in the quality of life in the communities, in general.

The four studies on bean adoption, in areas of Peru, Bolivia, Honduras and Tanzania, show very different results, because of the time periods covered and other factors, but all report high rates of adoption, over 90%, except in Tanzania which shows 9 to 27% rates of adoption. The study for Honduras is particularly interesting, since it estimates benefits of virus resistant varieties that help avoid yield losses; it then relates bean production area with poverty incidence maps and it concludes that bean research helps significantly to improve the situation of poor farmers. This, both through increasing yields and farmer income, and reducing income variability and improving the people's capacity to cope with economic crisis. This study does a fine job of relating agricultural research with poverty analysis, and represents also one of CIAT's methodological contributions to impact assessment studies.

Adoption studies on cassava and on IPM in beans in Colombia show rates of adoption that fall after an initial higher level. These are interesting because they identify

characteristics of the technologies that made them unattractive to farmers, e.g., high moisture cassava not well suited for processing, and beans IPM, rendered uneconomical by high risk of crop loss versus low cost of chemical spraying. These results can provide feedback information to the researchers, for the further design of their programs.

As rural agroindustry development has gained importance in CIAT's research strategy under the NRM area, it seems appropriate to evaluate the impact of past efforts aimed at generating market opportunities through processing of traditional crops, and gain insights helpful for new projects of this kind. The BP-1 has conducted two such studies, one on small cassava processing rural industrial projects in Northeast Brazil and one in Colombia. These are still being further analysed with new methodological approaches. The projects were similar in their conception and form of implementation, essentially involving the introduction of new cassava varieties and small-scale industrial equipment and processing technologies, embedded in participatory community programs, with public support and CIAT playing a leading role. The BP-1 evaluation studies reach positive results and conclusions about the value of such projects. In the Colombia case, they estimate an internal rate of return of 80%, with benefits evenly distributed among producers, processors and consumers. The rate of adoption of new cassava varieties is 52%. Several other qualitative positive impacts on the community are identified. Although the rate of return seems overestimated due to the assumptions and procedures used in the study, the conclusions reached appear quite reasonable: 1) agricultural research should not restrict itself to crop improvement, but must also consider the marketing problem; and 2) that co-operatives and other local community organisations are very important to reach the poor with the new technologies, and for the correct design of these technologies. The Brazil study only estimates gross benefits of the project, which look meagre because of the small increase in production achieved over the study period, but it reaches similar conclusions as to positive impact on the rural area involved.

In South East Asia, an impact assessment was based on the principle that quality of life is best defined by the person who lives it. Thus, in this participatory research method, the measures of quality of life were defined together with the farmers. These methods are increasing the validity of impact assessment.

Another innovative BP-1 study seeks to assess the value of CIALs (community level participating research committees) for the adoption and impact of CIAT technology in the Cauca department of Colombia. This is an important study, which should provide much needed evidence about the contribution of CIALs towards the better fulfilment of CIAT's purposes. While still in process, preliminary results indicate that the existence of farmer research committees has raised the adoption rate of an improved bean variety, and otherwise stimulates farmers awareness and activities for their own technological improvement. Another recent study on CIALs, based on a small sample of organisations that support them, has arrived at a preliminary estimate of 78% returns on the investment by these organisations.

Two aggregate studies by BP-1 refer to global impacts of CIAT Germplasm Improvement Programs 1967-97, and to Evaluation of Rice and Forages Research in

Latin America. The first of these is of special interest, because of its long-term and broad spectrum analysis of CIAT's research impact over three decades. Data problems are severe for a study of this nature, and therefore many criticisms or objections could be made as to certain assumptions and figures used in the study to overcome the data deficiencies. Nevertheless, it is a very valuable effort, ingenious and skilful, based on reasonable assumptions and analytical methods, which yields satisfactory rough approximations of economic returns to CIAT's crop improvement research. These results show world average internal rates of return as follows: In rice 57%, forages 35%, beans 27% and cassava 24%. Even under high error margins, these are high rates when compared with those obtained in most other investments in developing countries. The study also found high marginal rates of return to bean research in Africa and cassava research in Asia, encouraging a global projection for CIAT outputs originally produced in Latin America.

In sum, the foregoing BP-1 impact studies, however different in content and rigor of analysis, point overall to a quite positive result with respect to the impact of past research activities of CIAT. Indeed, the selection of studies with the purpose of assessing the acceptability of certain innovations to farmers is biased towards this result, but the aggregate studies cited above add confidence to the overall view expressed here.

6.2.2.2 Assessment of Future Impact of Research

Five of BP-1's studies fall under this category, in which the objective is to estimate possible returns to research efforts, under alternative assumptions or scenarios as may prevail over the periods of time considered. This information is useful for prioritisation, allocation of research resources, and research program design.

Studies on forages, cassava, savannahs and forest margins crops, and savannah soils research estimate the projected benefits, following conventional cost-benefit analysis techniques and employing software packages developed at CIAT and IFPRI.

In the case of planned forage CIAT research in Latin America, an internal rate of return of 76% is calculated – higher than that found in a previous study – confirming the high payoff to this research activity. Simulation of alternative scenarios shows the advantage of opening the international market, and the disadvantages of protective policies in other countries. The study of expected returns to CIAT cassava research is important because it assesses consequences of budgetary reductions in this program, and the effect of spillovers of LAC research into Asia and Africa. It estimates net benefits ranging from 0.5 to 1.5 billion dollars for each of the three world regions. The distribution of benefits is slightly in favour of producers, with a 60% share on average.

The study on Savannahs and Forest Margins crops refers to Colombia's Llanos and Amazonia, and estimates the benefits over 15 years accruing to 16 crop and livestock activities researched by CIAT and the Ministry of Agriculture. It concludes that net present value of social benefits would range from 0.5 to 23 million dollars per year for each activity, with livestock meat at the top. Noteworthy is the finding that the returns to

new high value crops like fruits can be higher than for traditional staples like beans and cassava. Benefits would accrue mainly to consumers. Again, the study concludes that investment in agricultural research for this ecoregion is highly profitable.

The evaluation of soil management technology and agropastoral systems for the Latin America Savannahs developed by CIAT's NRM program is still in progress, but it is innovative insofar as it will incorporate GIS maps to define and analyse impact according to areas of homogeneous impact.

Finally, a study to assess the efficiency of communal water management (for drinking purposes) in a Nicaraguan village represents an effort to study the institutional and technological options available to poor people, in the resource management areas. This is a case study, the main value of which will be as input for the development of analytical methodologies for assessing strategies and impact of social capital, at the rural community level, as reviewed below.

6.2.2.3 Development of Analytical Methodologies

BP-1 has been working on four methodological issues that impinge upon its evaluation responsibilities in CIAT:

- The creation and improvement of computer software for application of economic surplus models. The basic output has been the MODEXC program, which CIAT is using extensively and has made available to any users. It has also collaborated with IFPRI in development of the DREAM software, which incorporates GIS data and techniques to assess spatial consequences of new technology, and is useful for the estimation of spillover effects.
- Assessment of NRM activities and of agricultural technologies having impacts on natural resources. Development of methods and tools in this area is still at the initial stages and so far there are only partial applications, as reviewed under 6.2.2.1. Also, a scheme has been developed to assess impact over time at the NRM reference sites. Collection of baseline data for this monitoring system is starting in 2000.
- Design of new methodology to assess impact of agro-enterprise projects for small farmers is still at the proposal stage.
- Methods to analyse the impact of projects designed to increase social capital. This is a very important effort, given the increased emphasis on organisational innovation (CIALs, SOLs). The study is drawing on the literature on economics of information to design a conceptual framework for analysing the relations between social capital, decision making and social welfare, which can then be applied to community level problems in areas of rural poverty.

With the exception of the economic surplus methodology, the other studies represent a rather new thrust at CIAT, with no operational results yet. The Panel supports the development of multiple methodologies appropriate for assessing the full gamut of socio-economic impacts of CIAT's research.

6.2.3 Future Strategy

CIAT intends to maintain the general direction of its Impact Assessment Project, aimed at providing information and methods. More effort will be devoted to appraise the anticipated returns to research in different areas, while also providing feedback on the effects of past investments in research. This information will help CIAT in the design of future research strategies and project selection. In the short term, CIAT will strive to improve targeting of research benefits to the poor rural people and to environmental problems.

6.2.4 Overview and Assessment

Impact assessment at CIAT is a well organised, ongoing activity with broad coverage of subjects and geographical areas. There does not appear, however, to be a planned pattern or priority order with respect to the topics studied. It looks that the availability of special funding dictates which impact assessment studies are carried out; but unfortunately the particular interests of specific donors do not always coincide with the priority needs of CIAT.

For instance, as argued elsewhere in this report, tropical forages is a very important area of CIAT's work, with enormous actual or potential impact in many developing countries. Yet, there is only one recent CIAT study to document this assertion, and it is limited to the Latin American Region. Most of what has been done or is planned on this topic is concerned with farmer adoption of CIAT plant materials – which is a restricted view of impact and hence only partially useful from the standpoint of assisting in research re-design and resource allocation.

In general, the impact assessment studies reviewed are focussed on small rural areas and/or specific projects – commodity or other – and place major emphasis on documenting and understanding adoption of the CIAT provided technologies. Such is the case with most of the impact assessment studies on beans, cassava and rural agroindustry. This is appropriate and valuable for many purposes, but it does not easily allow aggregation into indicators to measure the overall impact CIAT research has. It may be appropriate for CIAT to put more resources into impact assessment at the macro level. It may also be appropriate for CIAT to include standard methods in the social sciences such as meta analysis and qualitative analysis. Analysis of factors such as land tenure systems and culture would also strengthen some impact assessments.

The Centre allocates a significant portion of its budget to NRM. Its NRM research is complex because it involves farmer participatory research methods, small rural and institutional development activities, and poverty alleviation. Impact evaluation in this case is not only about the effects of the new technology, but also of the effects of the research strategies or methods used on the communities. Some studies, such as the one on CIALs in Colombia and on cassava processing schemes aim at assessing these new methods. However, these few studies do not yet provide conclusive evidence. CIAT ought to implement a more intensive program of research in this area (see section 5.4).

The incipient work on developing impact assessment methodologies for NRM is fine, but it does not show the urgency of this subject. Perhaps one way to approach the problem would be for CIAT to contract out the development of the required impact assessment methodologies for NRM in tropical areas with advanced institutions/universities of the North. CIAT could then devote its effort to empirical testing in the field.

Because the integration of research on germplasm, natural resources and social science lies at the heart of CIAT's strategy and because CIAT has had a lengthy experience in bringing about such integration, the Panel **recommends** that CIAT document its experience by assessing the impact of its past integration efforts on its target areas and populations.

6.3 Gender Analysis

The last EPMR commended CIAT's efforts to incorporate gender analysis into all aspects of the research program. This relatively strong performance has continued throughout the period under review.

During field visits as well as Headquarters discussions, the Panel observed that gender analysis plays a part in determining research strategy and objectives for both biophysical and social science planning. The presence of women farmers in focus groups and in CIAT's field level interactions indicated to the Panel that CIAT staff and partners in the field have made significant progress in integrating knowledge of gender issues in agriculture and NRM. Economic analysis of trends in rural and urban poverty examines gender implication of changing conditions. Crop improvement in beans, cassava, and grasses recognises the importance of women in the farming systems in question and includes women in PRM. In CIAT's research on participatory approaches, gender questions are studied explicitly. Through its convenor role in the Systemwide Program on Participatory Research and Gender Analysis, CIAT both fosters and benefits from the development of new analytical methods and tools applied to gender questions.

The Panel noted that the implication of differential impact by gender of technology uptake has not always been integrated as a standard part of CIAT's *ex ante* or *ex post* analysis of impact, and encourages CIAT to examine this issue systematically.

It will be important to keep up the flow of information about gender analysis into the other research projects, so that new knowledge can be integrated at planning and implementation stages. The Panel encourages CIAT to identify explicit mechanisms to ensure that this will happen.

CHAPTER 7 – PARTNERSHIPS

7.1 Doing Research Together

During the period under review, partnership has been stressed as a central feature of CIAT's philosophy. "Doing Research Together" is the subtitle of CIAT's current Medium Term Plan. Positioning itself appropriately will allow CIAT's modest human and physical resources to leverage significant contributions to poverty reduction and natural resource conservation in the world. In taking this approach, CIAT has moved with the times in recognising that the practice of science has changed significantly in recent decades. The quality of CIAT's working relationships with other institutions - national and international, public and private, profit and non-profit - will be the critical determinant of the centre's effectiveness.

The role of the Directorate of Co-operation reflects the increased emphasis CIAT places on its many partnership arrangements. The objectives of the Directorate are to identify and monitor the demands and needs of CIAT's partners, to represent CIAT as a stakeholder in various collaborative networks, and systems of co-operation, and to co-ordinate the internal policy framework and procedures for managing various partnerships. The Directorate houses project SN-2 Strengthening National Systems, as well as the Information and Documentation Unit (the Library), the Training Unit, and the Communications Unit (see Section 5.3).

The key concept of partnership plays out in CIAT's approach to its host country, to its donors, to other CGIAR centres, to the research and development institutions of developing countries, to advanced research institutes, and to NGOs. The following sections consider the various partnerships that compose the Centre's network of alliances and affiliations, and which provide the framework for optimising its contribution.

7.2 Host Country

From the beginning, CIAT's relationship with the Government of Colombia has been positive, productive, and mutually supportive. The presence on the Board of Trustees of three very senior ex officio Colombian members reinforces the links that are in place at an operational level.

During the period under review, this relationship has been strengthened on both sides by a number of factors. The Government of Colombia has become an active member of the CGIAR and has provided international leadership in the Global Forum as well as the Oversight Committee of the CGIAR. At the same time, Colombia's contribution to CIAT in the form of restricted core financing has increased to a level of US$ 1.9 million. The additional in-kind contribution to CIAT provided through tax and duty exemptions is currently of the order of US$ 100,000.

The Government of Colombia describes its relationship to CIAT as that of "investor" rather than "donor". In this spirit, CIAT and national system representatives participate in planning and implementing a shared program of work, established by joint committee. CIAT provides significant training and interaction with the Colombian national research system, in particular in the areas of biotechnology and participatory research techniques. The CIAL framework developed collaboratively at CIAT has been adopted as a key methodology for the delivery of research/extension by the national system. (See 5.4) The institutional and technical backstopping role of CIAT in the creation and operation of FLAR has been a critical part of the evolution of rice research organisation in Colombia. The presence of a Colombian national in the senior management team is cited as a strongly positive factor in maintaining and fine-tuning the collaborative relationship between CIAT and the Government of Colombia.

The challenge for CIAT, as for the Government of Colombia, is to ensure that the work undertaken in partnership genuinely reflects the international character and mission of CIAT, as well as serving the needs of the host country.

7.3 Research Partnerships

CIAT has a long history of research collaboration with NARS, other Centres and advanced research institutes (ARIs). These partnerships have subsequently broadened to include partners from the private sector and the non-formal sector. The research activities are embedded in the different projects of the Centre (see Chapters 2,3,4,5,6). System-wide linkages are elaborated in Section 7.4.

During the early years of the Centre, the dominant mode of partnership was through bilateral arrangements with NARS on research, training, and technology transfer. This subsequently evolved into multinational, regional, or global networks. Examples of these are PROFRIJOL and PROFRIZA for beans in LAC, PABRA in Africa, the Cassava Network in Asia, the Cassava Biotechnology Network, Forage Network in Asia, and others. These networks have served as effective platforms for joint research between and among CIAT and the NARS, and contributed significantly to the advancement of research, technology development and technology transfer by the Centre.

The Centre also has research linkages with other CGIAR institutions, such as IITA on cassava, ICRAF on the African Highlands Initiative and natural resource

management, IRRI and WARDA on rice, ILRI on tropical forages, IPGRI on genetic resources, and others.

In addition, CIAT has strong research partnerships with other international organisations such as the Centre de Co-operation Internationale en Recherche Agronomique pour le Developpement (CIRAD now IRD) and CSIRO. CIRAD scientists are stationed at CIAT headquarters for joint research on rice and crop protection.

Cognisant of the importance of advanced biology applications to its research agenda, the Centre in recent years has established new collaborative linkages with advanced research institutes (ARIs) and Universities in the US and Europe on biotechnology research.

CIAT has extensive research linkages in the area of natural resource management. For instance, the Centre has research linkages with the World Bank and seven countries in Central America, the World Resource Institute, the US Geographical Service (USGS), and the World Conservation Union (IUCN), for the development of sustainability indicators.

In addition, CIAT has strong research partnerships with several ARI's on for modelling and decision-support systems research for natural resource management, including the Universities of Wageningen and Florida, and Kings College (London).

Moreover, the soils research group is linked with numerous advanced research institutes for development of crop and phosphorus models, including Universities of Bayreuth, Paris, Complutense de Madrid, Cornell, Ohio State, Michigan, London UK.

During the last decade, including the period under review, the Centre has further broadened its linkages to include partners from the private sector and the non-formal sector. These research collaborations, such as FLAR and CLAYUCA for rice and cassava, respectively, are both multinational and multisectoral. The Centre was instrumental in initiating and catalysing these novel partnerships that bring together the resources and expertise of CIAT, the public sector and the private sector to undertake research on CIATs mandate commodities (see Section 3). This mode of partnership is evolving to be a model for CIAT and the other Centres of the CGIAR.

Another novel research partnership evolved at CIAT in recent years – the partnership with the non-formal sector in the Centre's different commodity improvement and natural resource management projects. This evolved concomitant to the Centre's increasing emphasis on participatory research approaches.

CIAT is also embarking on a system of partnership that can be considered "new" in the CGIAR system – the concept of a Science Park. Within its campus in Palmira, the Centre hosts about 18 different organisations from the public sector, universities and research institutes, and other CG centres to undertake research and development on various themes that contribute to CIATs goals.

The Panel highly commends the Centre for the breadth and depth of its research linkages. These partnerships enrich the research agenda of the Centre, create collective ownership and accountability for CIATs mandates, and generate resources and synergy to pursue the Centre's goals and objectives.

Because CIAT has had extensive and varied experiences with different forms of research partnerships (e.g., networks, consortia, joint ventures, collaborative projects), the Panel **recommends** that CIAT carry out an analytical review of this experience to derive lessons for itself and other CGIAR institutions.

7.4 Systemwide Activities

Collaboration among CGIAR centres takes three forms:

- Centre to Centre relationships based on a shared mandate: e.g., CIAT and IITA on cassava, CIAT and ILRI on livestock and forage work.
- Bilateral or multilateral Centre to Centre relationships based on mutual research interests: (e. g., CIAT with IFPRI, ILRI, IPGRI, ISNAR, etc.).
- Participation in CGIAR's systemwide programs.

This section summarises the Panel's impressions on CIAT's role and involvement in the CGIAR's systemwide programs.

In 1996 the CGIAR initiated a series of Systemwide Initiatives and Programs to address issues that cut across the centres and to foster greater collaboration among the IARCs. CIAT has been a strong participant in systemwide activities from their start in 1996. At present the Centre takes part in nine CGIAR-level systemwide activities. In three it plays a leading role (as convener or co-convener), in four of the remaining six it carries responsibility for a major component or project within the program, and in two it participates on par with other collaborating centres. These are listed in Table 7.1.

Table 7.1 CIAT's Involvement with CGIAR's Systemwide Programs

Leading Role	Major Responsibility	Participant
Ecoregional Program for Tropical Latin America	SW IPM Initiative (led by IITA)	SW Genetic Resources Program (Led by IPGRI)
SW Program on Soil, Water, and Nutrient Management (Co-convener with IBSRAM)	SW Livestock Program (Led by ILRI)	SW Initiative on Genetic Resources (SINGER–Led by IPGRI)
SW Initiative on Participatory Research and Gender Analysis	SW African Highlands Initiative (Led by ICRAF)	Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN–Led by CIP)
	SW Initiative on Alternatives to Slash-and-Burn (Led by ICRAF)	

The Panel's terms of reference did not include an assessment of these systemwide programs, including those where CIAT plays a leadership (i.e., convening) role. This would have necessarily involved assessing the contributions of all partners– not just CIAT. Nevertheless, the Panel gained some impression of CIAT's specific contributions to these systemwide efforts. These were noted, where relevant, in the preceding chapters. What follows are the Panel's general observations about CIAT's involvement with CGIAR's systemwide programs.

- CIAT is one of the most "connected" centres within the CGIAR – in the sense of its collaboration with other CGIAR centres. Playing a leadership or major contributor role in eight systemwide activities reflects a major commitment to cross-centre work.

- CIAT has been generally successful in the roles it has played in carrying out systemwide activities. The Panel has noted these in the earlier chapters. Prominent among these are the following:

    - The 1999 CCER on Soil and Plant Nutrition and Agricultural Research Systems Research at CIAT notes that the SW Program on Soil, Water and Nutrient Management has been successful in early stages, but that it is far from achieving expected synergies. The CCER notes that the participants were very pleased with the role CIAT and IBSRAM played as co-convenors.
    - The Systemwide Initiative on Participatory Research and Gender Analysis has generated a number of useful methodologies and tools and helped operationalise their use in plant breeding and crop and natural resource management.
    - CIAT's contribution to the SW IPM Initiative (co-ordinating the Global Whitefly IPM Project) has been very successful, as exemplified by its impact

on slowing the spread of cassava mosaic disease in East Africa (see Box 4.2.2).

- The Panel considers two factors as significant contributors to CIAT's success in joint work with other institutions: 1) an internal corporate culture that fosters participatory work and collaboration, and 2) its spectacular success in fund raising.

7.5 Training Unit

The objective of CIAT's Training Unit is to "strengthen knowledge, abilities, attitudes and competencies of our partners in the areas of agricultural research and rural development through graduate training in order to improve the capacity of national research and development systems to conduct co-operative and individual research and development projects."

The role and responsibility of the Training Unit have changed dramatically since the last EPMR. CIAT no longer sponsors its traditional group training in general agriculture and commodity production. These courses, as foreseen in the previous EPMR have been devolved to other institutions. The training effort is now dedicated to individualised in-service training, including thesis research, and specialised courses in areas of new technology. Training is linked to the demand expressed by partner governments and organisations. CIAT has developed 22 short courses in a wide variety of specialised areas. In addition, CIAT now offers two or three more elaborate, multidisciplinary courses each year. In 1999 biotechnology and GIS advanced courses were offered. In collaboration with universities in 49 countries, CIAT hosts and provides supervision to approximately 25 - 30 MSc and PhD thesis students at any one time. The Training Unit also offers materials backup too much of the non-formal training that CIAT undertakes through its participatory research activities.

CIAT formal training is now provided in new modes of delivery. From a staff level of 23 in 1996, including one international staff member, the Training Unit has been reduced to 3, all recruited locally. Much of the preparation of course materials is now contracted out, in some cases to former CIAT employees working in (EATs - see Section 9.2). Teaching and resourcing of courses is provided by CIAT scientific staff. Where CIAT training used to be financed solely through the core budget, most is financed today by partner institutions themselves, through CIAT projects, or by special training funds provided by donors.

In the period under review CIAT has trained 648 men and 444 women professionals, of whom about 85% are from Latin America, 10% from the developed countries, and 5% from Asia and Africa. The Panel notes that many training materials are available in Spanish only, and assumes that this limits training efforts outside Latin America.

The Panel commends the Centre for moving to a demand-led, partnership model, which integrates CIAT's professional and technical resources with the training needs expressed by developing country partners. It notes that the move from large production courses to specialised advanced short courses may have created some gaps in the network of contacts that CIAT maintains with NARS. The Panel urges CIAT to consider how training might better reinforce CIAT's profile and links with NARS.

Given the combination of capabilities in the Training Unit, the Information and Documentation Unit, and the Communications Unit, the Panel encourages CIAT to explore the possibility of providing increased training at reasonable cost in a Distance Education format. Such an initiative could support many other CIAT activities, including the Telecentres project.

7.6 Information and Documentation Unit

Otherwise known as "the Library", the Information and Documentation Unit provides a link to the immense and growing body of scientific knowledge that is relevant to the work of CIAT and CIAT's partners. Its objective is to provide comprehensive information services to on-site and off-site clientele. In a rapidly changing field, the challenge will be both to continue to expand its virtual facilities, and to ensure that its users are aware of the remarkable new information services that are becoming available. The potential usefulness of CIAT's information facilities, especially to NARS partners, is exceedingly high.

The traditional role of a library is to receive information products like books and journals, and provide them to users. The modern library accesses information in multiple forms, in some cases direct from authors, and makes it available both to off-site users through the Internet and to on-site users in hard copy, or by use of electronic resources. The role of the library is to intermediate between sources and users as license and patron authenticator. In the period under review, the CIAT library has embraced the modern role. A number of services have been added, including access to online catalogues, journal licensing, electronic photocopying, CD ROM databases, grey literature, bibliographic information and search tools, as well as CIAT publications. NARS users have routine access to bibliographic bulletins, tables of contents, and quick custom bibliographies. The Systemwide Ecoregional Program operates an active e-mail network with over 2000 NARS, development agencies, and NGOs. Formal and informal training has been offered in Latin America to ensure a critical mass of professionals able to take advantage of new services.

In order to provide continuous upgrading of CIAT's own service capacity, the library has 300 interchange agreements agricultural institutions and universities, and is a member of the agricultural libraries network AGLINET. To the same end, CIAT staff participate regularly in international professional associations and networks. The Panel encourages CIAT to continue to explore economies of scale and synergies that could be generated through collaboration with other libraries inside and outside the CGIAR.

The Library is recognised within CIAT as a very solid unit, whose orientation toward service and the anticipation of user needs is strong. Because of the strength of the national staff, it has been possible to maintain this high level of performance without recruiting internationally.

The Panel commends CIAT for the accomplishments of the Information and Documentation Unit, and encourages the staff to continue its proactive and energetic approach to its work. The Panel urges CIAT to ensure that its internal and external users are kept up to date on the services the Unit can provide.

7.7 Communications Unit

The Communications unit supports the partnership philosophy of CIAT through its work in scientific publishing, in public awareness, and through the development of CIAT's website.

CIAT's scientific publishing is a critical factor in maintaining its credibility. The Communications unit provides support to the research programs through editing journal articles, producing technical books, and packaging CIAT electronic products. Scientific publishing in the review period has seen continued emphasis on genetic resources, the publication of new titles on natural resource management, and new electronic products such as Floramap™.

CIAT's relationship with a wide variety of non-technical partners requires a focus on public awareness. This involves the design of a coherent and compelling corporate image, development of public awareness materials which project this image, the preparation of presentations for key events, and support of CIAT interactions with the print and other mass media. CIAT materials emphasise the priority CIAT attaches to poverty alleviation, integration of advanced tools into problem-solving research, focus on participatory methods, and innovative collaborative arrangements. The corporate annual report, "CIAT in Perspective", as well as the institutional bulletin, promotional brochures and videos reiterate CIAT's commitment to rural people, CIAT's international relevance, and its global reach.

Through its media links, the unit aims at wide distribution of "science stories" in Latin America, and targeted distribution of selected stories to major media and specialised publications in North America and Europe. This strategy has resulted in articles in the Economist, and other major media. Communications staff has provided a short course for journalists on biotechnology issues. CIAT co-operates with the CGIAR system public awareness efforts, where its materials are appreciated.

The Communications Unit participates in the ongoing development of the CIAT website, with the objective of a providing a site that gives ready access to CIAT facts and

themes from inside and outside CIAT. A steering group within CIAT co-ordinates support to the website development.

The Communications Unit has also been involved in the development and implementation of a CIAT/IDRC project on Telecentres for Marginalised Communities. In this highly innovative project, CIAT will test institutional models for the provision of telephone/ fax/ email centres in small communities - a kind of technological leap-frogging, which dovetails with participatory research and planning models emerging at CIAT and elsewhere. The Panel urges that this work be integrated with other community-level research of CIAT.

The work of the Communications Unit is imaginative and original. The Panel was impressed by the high quality of CIAT publications and public awareness materials. It commends especially the efforts made to consolidate CIAT's corporate image as an organisation oriented to the problems of poor people and the difference that scientific research can make to them.

CHAPTER 8 – GOVERNANCE

8.1 Board of Trustees

8.1.1 Introduction

The CIAT Board of Trustees is responsible for the overall functioning of the Centre. In the context of the goals and purposes of the CGIAR system, the Board determines the centre's objectives, direction, budget and program. It delegates the implementation of this program to the Director General and Centre staff, and monitors the performance of management in meeting the program goals.

8.1.2 Board Composition

According to the constitution of CIAT, the Board of Trustees is composed of no more than 17 members, including three ex-officio representatives of the Government of Colombia, and the Director General. As this is a relatively large size Board, one place has been allowed to remain unfilled for the past three years. The membership includes an appropriate range of scientific and management expertise relevant to CIAT, including private and voluntary (NGO) sectors, as well as university, national, and international public sectors. The geographic balance of the Board reflects the program involvements of CIAT in its strong representation from Latin America, with members from Asia and Africa. The current Board includes 8 developing country nationals, 8 developed country nationals, 6 women and 10 men. (Table 8.1)

By Statute, the Board includes four Colombian nationals. The Minister of Agriculture, the Rector of the National University, and the Executive Director of CORPOICA serve ex officio, while the fourth is elected by the Board. A Colombian Chairman Emeritus attends most Board meetings, without vote, as honoured guest and informal ambassador. This unusual arrangement has proved highly effective in providing continuity and wisdom to the Centre.

The Board secretariat function is carried out with great precision and dedication by a member of CIAT staff, whose appointment as Secretary to the Board is renewable every two years.

Table 8.1

CURRENT BOARD MEMBERS

Centro Internacional de Agricultura Tropical (CIAT)

Term 2000-2001

Name	Bot Committees	Gender	Region Country	Discipline	Nom. By	Start term	Re-elected	End term
Holm-Nielsen, Lauritz *** ****	C-BOT, M-ExFin, M-PC, M-AC, M-NC	M	Europe/Denmark	Botany	CGIAR	2/21/97	12/03/99	12/03/2002
Chaparro, L. Fernando ***	VC-BOT, M-ExFin	M	LA/Colombia	Sociology	Board	12/12/97		12/01/2000
Contini, Elisio	M-PC, M-AC, M-ExFin	M	LA/Brazil	Economics	Board	12/12/97		12/01/2000
Fogelberg, Teresa***	M-PC	F	Europe/Netherlands	Sociology/Anthropology	Board	12/04/98		12/07/2001
Gebhardt, Christiane	M-PC	F	Europe/Germany	Plant Pathology	Board	12/12/97		12/01/2000
Girard, Colette M.	M-Exfin, M-PC, C-NC	F	Europe/France	Natural Resources	Board	2/21/97	12/03/99	12/03/2002
Jones, James, W.*	M-ExFin, C-PC	M	NA/USA	Agricultural Systems	Board	12/04/98		12/07/2001
Maeno, Nobuyoshi**	M-PC	M	Asia/Japan	Agronomy	Board	12/03/99		12/06/2002
Paul, Samuel	C-AC	M	Asia/India	Public Institutions Management	Board	12/1/95	12/04/98	12/07/2001
Sibale, Elizabeth	M-PC, M-NC	F	Africa/Malawi	Plant Breeding	CGIAR	12/04/98		12/07/2001
Pantin, Graciela *	M-AC	F	LA/Venezuela	Sociology	Board	12/04/98		12/07/2001
Valent, Barbara	M-PC	F	U.S.A.	Biochemistry	Board	12/03/99		12/03/2002
Moncayo, Victor Manuel	M-PC	M	LA/Colombia	Lawyer	Ex officio	03/15/97		Indefinite
Samper, Armando ****	M-NC C-Emeritus	M	LA/Colombia	Agricultural Economics	Board	4/01/82		Indefinite
Schoonhoven, A. van ****	M-ExFin.	M	Europe/Netherlands	Entomology	Ex-Officio	9/23/99		04/2000
Uribe, Alvaro F. ****	M-PC	M	LA/Colombia	Zootechny	Ex-officio	11/1/97		Indefinite
Villalba, Rodrigo	M-BOT	M	LA/Colombia	Social Sciences & Law	Ex-Officio	08/01/99		Indefinite

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Update: 31-Mar. 2000

* Appointed as Trustee Elect in December 12/97 to begin their first term in Dec./98.
** Appointed as Trustee Elect in December 4/98 to begin his first term in Dec./99
*** M-ExFin - Sub-committee on Compensation
**** Ad-hoc Sub-committee on Security

NOTE: One position remains open (BOT-41, Feb./97)

M-BOT = Member Board; C-BOT = Chair Board; VC-BOT = Vice Chair; M-ExFin. = Member Executive & Finance Committee; M-PC = Member Program Committee; M-AC = Member Audit Committee; M-NC = Member Nominating Committee; C-Emeritus = Chairman Emeritus

8.1.3 Committees

8.1.3.1 Executive and Finance Committee

The Executive and Finance Committee consists of the Chair, Vice Chair, Director General, chairs of all Board Committees, plus two members at large. In response to recommendations of two previous reviews, the responsibility for financial issues has passed from the Audit (formerly Audit and Finance) Committee to the Executive and Finance Committee. Subcommittees on resource mobilisation, security, and compensation report to the Board through the Executive and Finance Committee. All Committees report to the full Board, which empowers the Executive and Finance Committee to act on the Board's behalf between annual meetings.

8.1.3.2 Audit Committee

The Audit Committee on behalf of the Board supervises and receives the reports of the Internal and External Auditor. It plans the commissioning and implementation of the annual External Audit and pursues in detail issues raised by the External Auditor's report. The External Audit is contracted to a different company periodically.

8.1.3.3 Nominations Committee

The Nominations Committee plans for the orderly replacement of outgoing Board members, with careful attention to expertise, geographic, and gender balance. The Committee also manages the process of electing the Chairperson and Vice Chairperson.

8.1.3.4 Program Committee

The Program Committee advises the Board on issues pertaining to CIAT's mandate, strategy, program of research, and scientific quality. It recommends the annual Program and Budget to the full Board for approval. Its members participate in the Annual Review of the Centre.

8.1.4 Recent History

CIAT's Board of Trustees has faced major challenges in the past five years. At the time of the last review, a very significant strategic change was underway but not yet fully implemented. Because of the illness of the Director General, the Chair of the Board had stepped in as Interim Director General until a replacement was appointed. In addition, unanticipated financial constraints made it necessary to undertake two separate reorganisations including severe downsizing in each case. The Board also dealt with the impact of the abduction of a staff member and ensuing legal issues which emerged. More recently, the Board had to undertake a second Director General search effort within five years.

The Board has been absorbed with one urgent matter after another during the

period under review, and this has imposed substantial demands of time and effort on all Board members. In principle the full Board meets once a year, with Program Committee attendance at the Annual Review, and one further Executive and Finance Committee meeting. In practice, the Board has met twice a year in four of the five years under review.

The Board has weathered these demands in good form, and risen to the challenges implied by the simultaneous appearance of funding shortfalls, security concerns, personnel changes, and major strategic adjustments. Moreover, the determination of the Board to provide maximum stability in institutional structure and research management over the past three years has minimised the destabilising impact of the external conditions in which CIAT operates.

8.1.5 Assessment of Current Functioning

8.1.5.1 Culture of the Board

CIAT Board of Trustees is a lively and dedicated group. Each member is encouraged to participate fully, and does so. Members receive information on a regular basis from the Chair. The transparency of the Board's approach to doing business is increasing. The quality of its deliberations is high, and could be even higher given the calibre of the members. Introductory material provided by CIAT, and attendance at the Annual Review, along with training sessions sponsored by the CGIAR, have reduced the time it takes new members to contribute fully. It is clear that mutual respect among the Board members and the willingness to tackle problems in a pragmatic way create a constructive atmosphere. The Board might capitalise these resources even more effectively by investing time in a team-building retreat similar to those undertaken by the management team.

8.1.5.2 Director General Search Process

The management of the selection process for a new Director General was exemplary. On an ad-hoc basis, the Board appointed a committee consisting of both Board members and outside expertise to carry out the search process. The Search Committee consulted widely with stakeholders in seeking applicants from a wide variety of sources. It presented to the Board a shortlist of qualified candidates that reflected genuine diversity in scientific and management approaches. The interviews included meetings with staff, and the Board solicited feedback from these meetings.

8.1.5.3 Level of Engagement

One of the tasks of a CGIAR Board is to determine the correct level of engagement in the Centre's policy formulation, strategic planning and programme oversight. Boards are enjoined not to stray into operational areas that are clearly the prerogative of management. At the same time, it is essential for the Board members to be fully informed about operations and well versed in the issues that influence management

decisions. The Board of CIAT has been, if anything, overly respectful of the line between Board and management. While receiving excellent information about financial outcome, for example, it is not clear that the Board interacts substantively on financial allocation questions. The budget approval discussion in the Board is focussed on the "bottom line". While this may be justified in times of crisis when solvency is an urgent matter, the Panel urges the Board to refocus its attention on resource allocation and the monitoring of implementation. The Board should use the budget as a planning tool, and as a vehicle for substantive discussion of strategic issues. Budget presentations by the staff should be designed to support such discussions.

8.1.5.4 Program Committee Agenda

Program committee deliberations include thorough review of each project, based on very detailed project reports. Both the materials presented and the tenor of these discussions tend to be drawn to the level of the "trees" rather than the "forest". This deprives the Centre of some of the wisdom available to it, and underutilises the talents of the members. In the view of the Panel, there is a need to address program themes and issues at a different level of analysis. The Board discussion of linking its project reviews to implementation rates is a useful beginning. The Panel urges the Program Committee to deliberate on its agenda, with a view to providing stronger guidance to the Centre on CIAT's program problematique, trade-offs, and opportunities as well as on projects. The Program Committee needs to identify the supporting information and the level of interaction with program staff which will enable it to establish and pursue a strategic agenda.

8.1.5.5 Committee Articulation

Although committee mandates are well defined in the CIAT by-laws, in practice the articulation between agendas of the full Board, Executive and Finance Committee, Programme Committee and Audit Committee is not fully developed. The Executive and Finance Committee operates with a large agenda, and its meetings include many topics which then reappear on the agenda of the full Board. In addition, the Audit Committee still receives some financial reports, which are not strictly within its purview. Committee meeting schedules sometimes overlap in ways that make full attendance impossible. As a result, some issues are handled more often than necessary, yet in inadequate depth by the full Board. As a means of making the operations of the Board more efficient, the Panel encourages the Board to use the Executive and Finance Committee to plan the overall Board meetings, including agendas, in a way that optimises the input of Board members. In this way, the commitment of 15 – 20 days of valuable time normally implied by Board membership can be used to greatest effect.

8.1.5.6 Interaction with Staff

Board members seldom visit field sites for the purpose of interacting with CIAT staff and partners. Such visits can serve to provide information about the context of CIAT's operations, improve the Board members' grasp of the issues confronting the

Centre, and at the same time the visits have strong representational value in the field. Having a Board member in tow may give occasion for field staff to reinforce important contacts with host governments and other partners.

The Board interacts more frequently with the scientific staff at CIAT Headquarters, but this seems to be a matter of personal and professional interest rather than a deliberate part of its program of activities. The advantage of such interaction is that it allows the Board members to appreciate in more depth both the CIAT program, and the environment in which the scientists are working. Issues such as security, spousal employment, security of tenure, career planning and family implications of employment at CIAT are specific to context. Board members need to be aware of the whole picture in order to make appropriate decisions on policies and priorities. Arguably, this was a factor in the departure of the previous Director General. The Panel urges the members of the Board to increase their interactions with CIAT staff both at headquarters and in the field.

8.1.5.7 Varia

CIAT's Constitution and By-laws are clear and accessible. The Board Handbook is a valuable reference tool, kept current by the Board Secretary. Board Members are covered by health, accident and liability insurance. The Board has adopted the "Reference Guides on Roles, Responsibilities, and Accountability of Centre Boards of Trustees" published by the CGIAR Secretariat, and implements its recommendations for Board Chair evaluation.

The Board includes members capable of stepping in as interim Director-General, and of moving in to positions of Chair and Vice-Chair.

8.2 Centre Commissioned External Reviews (CCER)

The concept of CCERs emerged at the CGIAR Mid-Term Meeting in 1995, and was further developed by TAC and the CGIAR Secretariat. External reviews are considered the cornerstone of the CGIAR's system of accountability, and are expected to cover four major areas: program priorities and strategy, relevance and quality of science, achievement and impact, and governance and management. CCERs may be commissioned in any area that a Board may choose, but one of their main uses is to assess the relevance and quality of science. Thus evaluation of science is a key theme of the CCER concept.

CIAT describes its science evaluation process as follows: "CIAT's evaluation framework includes two dimensions: research strategy and quality of science. The strategic process evaluates if CIAT research has the right goals, meets stakeholder needs, is feasible, has adequate projected outputs, and the right resources and organisation to deliver these. The scientific quality review concerns issues such as: is our science rigorous, cutting edge, and of high international standards; are the methods used optimal

and is the peer review process appropriate. The Internally Commissioned External Review (ICER) concerns a review of the quality of science" [7]

The CIAT Board of Trustees monitors the quality and relevance of the research program through, *inter alia,* Centre Commissioned External Reviews (CCER). The Board follows a process that includes approving a list and plan for reviews. External consultants carry out the review. The Board approves the selection of a Chair for the review and Management then selects the rest of the CCER panel. A Board representative meets with the Chair, or confers with him or her by telephone to ensure that Board concerns are taken into account. The Management then comments on the report, which is sent to the Board for discussion, including actions to be taken on its recommendations or suggestions. A year later, a considerable part of a Board meeting is devoted to following up on implementation of the CCER recommendations and suggestions.

The Board considers the CCER to be a major element in evaluating the quality of science at the Centre. As such, CIAT's original plan was to conduct one review a year, following a planned schedule for projects or areas to be reviewed.

8.2.1 CCERs Conducted During the Review Period

Four CCERs were commissioned by the Board during the review period, covering Resource Management (1995), Genetic Resources and Biotechnology (1997), Crop Improvement (1998) and Soils, Plant Nutrition and Agricultural Systems (1999). In addition, an ICER commissioned by the CGIAR on Genebank Operations (1995) is considered by CIAT to be the equivalent of a CCER. The EPMR Panel refers to these in respective chapters.

8.2.2 Future Strategy

The Board plans to schedule CCERs covering all aspects of Centre activities such that they support the next EPMR. In addition, CIAT plans to commission a CCER on Management.

8.2.3 Overview and Assessment

The coverage of the CCERs is shown in Table 8.2. The Panel notes that the Project most reviewed was Genetic Resources which was the subject of two major reviews and was linked as a key partner in the 1995 CCER of *Resource Management.* Projects on Beans, Cassava, Rice and Tropical Forages were the subjects of a major *Commodity Improvement* CCER (1998) and were also strongly linked to two reviews, CGIAR *Genebank Operations* ICER (1995) and the *Resource Management* CCER (1995). The Biotechnology and Production Systems projects were reviewed twice, each of them being reviewed once as a main focus and once as a project linked to another

[7] Terms of Reference of the Review Panel, Internally Commissioned External Review (ICER) 1997, Integrated Conservation of Neotropical Genetic Resources (Project SB-1) and Enhancing the Understanding and Use of Agrobiodiversity Through Biotechnology Methods (Project SB-2).

review. Projects reviewed once as a main foci were Beans in Africa; Soils and Plant Nutrition; Hillsides; and Land Use; while Systemwide Soil, Water and Nutrition; IPM and the former Forest Margins Program were linked to a review. Projects not covered by a review during the period were Rural Agroenterprises, Linkages with NARS, Farmer Participatory Research, Impact Assessment, Ecoregional Program for Tropical Latin America and the former Savannah Program.

All CCERs mentioned the quality of science, although most of the assessments were based on observations of the panel and their experience, and none indicated the use of quantitative evaluation methods. Nevertheless, the CCERs did discuss quality of science explicitly, which aided the work of the Panel.

The CCERs were useful to the Panel's deliberations and made its tasks easier. The Panel emphasises that it comments in different chapters on the opinions presented by the CCERs, and in most cases the Panel expresses its agreement.

The Panel commends CIAT's Board for commissioning the CCERs and for their quality— which in most cases was quite high – and for its plans for CCERs in the future. Each presented well argued, provoking recommendations and suggestions.

The Panel was concerned that in some cases the follow-up to the CCERs may not have been consistent. The Panel believes the Centre would benefit from a CCER on the broader NRM work and on participatory research.

Table 7.1
COVERAGE OF CIAT PROJECTS BY CENTER-COMMISSIONED EXTERNAL REVIEWS (CCER), 1995 - 1999

ICER/ CCER, Date	SB_1	SB_2	IP_1	IP_2	IP_3	IP_4	IP_5	PE_1	PE_2	Hill-Sides PE_3	PE_4	PE_5	SN_1	SN_2	SN_3	BP_1	SW_1	SW_2	SW_3	Forest Margin	Savannah
Plant Nutrition & Agriculture Systems 1999									●			●						●		●	
Commodity Improvement 1998	•	•	●	●	●	●	●														
Genetic Resources & Biotech. 1997	●	●						•				•									
Resource Management 1995			•		•	•	•			●	●				•					●	●
ICER-CGIAR Genebank Operations 1995	●		•		•	•	•														

● = main foci (one of)
• = linked to the Review

Code for the Projects:

SB_1	Genetic Resources	PE_1	Integrated Pest Management (IPM)	SN_3	Farmer Participatory Research
SB_2	Biotechnology and Agrobiodiversity	PE_2	Soils	BP_1	Impact Assessment
IP_1	Beans	PE_3	Hillsides		
IP_2	Beans in Africa	PE_4	Land Use	SW_1	Ecoregional Program for Tropical Latin America
IP_3	Cassava	PE_5	Sustainable Systems for Smallholders	SW_2	Soil, water & Nutrient Management
IP_4	Rice	SN_1	Rural Agroenterprises	SW_3	Participatory Research & Gender Analysis
IP_5	Tropical Grasses and Legumes	SN_2	Linkages with NARS'		

CHAPTER 9 – ORGANIZATION AND MANAGEMENT

9.1 Organisational Structure

At the time of the last EPMR, CIAT was organised along program lines in what was called a "soft" matrix. Although the centre carried out its research in 28 projects, the organisational structure itself was based on 6 Programs, 6 Units, and 5 Scientific Resource Groups. A management team of 9 members was organised hierarchically, with 2 Deputy Directors General. The 1995 EPMR recommended that the centre moves to a full matrix organisation, and accentuate the role of the project leaders by involving them fully in project definition, planning, and budgeting.

The current organisational structure of CIAT (Figure 1) reflects a decision of the Board and Director General to compress the pyramid structure, to decrease the size of the Management Team and to reduce the number of projects to 16. Since 1996, these projects form the basic organisational unit in CIAT. They correspond to the requirements of the TAC priorities and the CGIAR system matrix.

In an effort to develop and reinforce an integrated vision of CIAT's values and practices, the Management Team is now organised horizontally, with each member reporting directly to the DG. The members have made an effort to create a culture of teamwork through regular weekly meetings and facilitated management retreats. Leadership when the DG is absent is rotated among the members. With a research program consisting of 16 widely diverse projects, one of the most important functions of the Management Team is to promote co-ordination among CIAT activities and projects and to provide an integrating vision of CIAT's overall strategy.

The Panel notes that the Management Team may be considered large for an organisation the size of CIAT. It observes, however, that it is actually smaller than in the past, and that the lack of hierarchy within the team appears to have fostered greater participation and access for all CIAT staff.

As called for in the last EPMR, project leaders are now responsible for planning, budgeting and financial implementation of projects. Each project leader reports directly to a member of the Management Team, as do unit managers in the service and support areas. The intention of management in introducing this structure was to reduce the number of reporting levels, and to improve the access of staff to the senior management. It seems clear that these objectives have been accomplished.

The Panel was struck by the strong support expressed by staff at all levels for the increased openness of senior management to the perspective and concerns of the staff. This openness has paid off in a strong sense of commitment to the corporate values of CIAT. The effort to foster a spirit of co-operation among units, and collaboration across organisational boundaries has in large measure overcome a tradition of management by fiefdoms.

This being said, the Panel notes that the ideal of integration of CIAT's research program is not fully achieved at the present time. The increased authority of the project leaders to plan and manage research projects has brought with it increased workload in the form of financial and other management tasks. The need to organise research along lines determined by the availability of donor contributions with diverse timeframes and reporting requirements also decreases the freedom of CIAT scientists to reallocate human and material resources readily. In addition, through the removal of even a "soft" matrix, the place of discipline-based interaction is relegated to informal settings in an already heavily loaded schedule. These factors diminish the ability of CIAT scientists both to undertake long-term research commitments, and also to make short term adjustments.

At best, research teams should be able to form and dissolve around problems with maximum flexibility. Nevertheless, this goal must be achieved while maintaining adequate accountability for results, and transparent budgetary practices.

The Panel urges CIAT to introduce a mechanism by which CIAT scientists will be able to dedicate adequate time to benefit from interaction with disciplinary colleagues.

While not wishing to prescribe a particular model, the Panel encourages CIAT to ensure that its organisational structure promotes integration of its research activities, and maximises the ability of biophysical and social scientists to focus together on research goals organised by problem.

9.2 Research Management

9.2.1 Priority Setting

CIAT's last major strategic planning exercise was done in 1991 ("CIAT in the 1990s and Beyond: A Strategic Plan"). It guided the thrust of CIAT's research programme over the past decade. This plan resulted from an interactive process between the Board, management, internal task forces and leaders of national programmes. Since then, CIAT used the medium-term plan (MTP) exercises to adjust its strategy, e.g., move from programmes to projects, pilot initiatives in non-mandate crops, business development initiative. The 1998-2000 MTP included input from the Regional Forum for Latin America and the Caribbean as well as from a wide spectrum of CIAT scientists. Some external partners nevertheless deplored a limited consultation before the introduction of these significant changes.

Given some of the key strategic issues CIAT is facing at this point in time (see Chapter 10) and given the donors' shift to increasingly targeted short term funding for what is a long term research agenda, now is the time for CIAT to redefine its vision and long term strategy. Concern has been raised that the Centre is moving away from its mission, that it is in too many markets, and that it is time to stop "patching up" the old strategic plan and engage in long term thinking. A new strategic planning exercise was

started recently with a target completion by the summer of this year but it has been put on hold until the arrival of the new Director General. The Panel considers this a prudent move.

Priority setting at the project level has been very participatory both internally and with partners. Indeed some of the projects have a participatory planning by objectives (PPO) approach with periodic adjustments in response to expressed farmer needs.

9.2.2 Organisation of Research

CIAT fully implemented its shift from a programme to a project based research management structure in 1996. The programmes were self-sufficient groups with all the expertise they needed. In view of the funding shortfalls this could not be sustained. Research activities were grouped under 16 projects that have their own budget but, for the most part, have to share their scientific staff with other projects.

Projects are managed by project managers who report to one of two research directors. Scientists are "housed" in one project and report to that project manager although they generally work on two or three projects. Considerable responsibility and accountability has been devolved to project managers. They have to define their projects, set objectives, raise funds to complement whatever unrestricted funds they receive, deal with partners, manage their staff, manage their budget and periodically report to management and to the donors involved in their project. In CIAT it is the project manager's role to "sell" his/her project to donors and the management team's role is to help the project managers in this endeavour but not do it for them. The Management Team also considers that the project manager position is a "temporary position" in the sense that someone can rotate in or out of it. Project managers, therefore, are not permanently promoted in the position. They keep their prior salary and are given a "responsibility allocation" but only as long as they stay in the position.

Although the project organisation has been in place in CIAT for close to four years and although it is a common practice in research management, it has not yet received wide acceptance in CIAT and it has not entirely produced the hoped for results. Some of the expected advantages of the project organisation were to improve long term planning, help reach a critical mass of expertise, decentralise authority and accountability, decentralise innovation, create more entrepreneurial research groupings and improve transparency. Some of these objectives were achieved.

A large number of CIAT scientists, however, find fault with the present structure. They complain that it fragments staff, creates overlap, splinters scientific effort and focus, hampers integration, interaction and team building, creates internal competition for funds within CIAT, reduces the capacity of scientists to explore, and makes long term planning more difficult. A recent CCER also concluded that the project arrangement had some negative effects on research efficiency. In addition project managers complain that they have to spend a considerable amount of their time (50% or more for many) on

project management, and project staff complain that they have to spend too much time on fund-raising, meetings and planning.

Yet some staff favour the set-up and some projects perform very well and do not seem to suffer from the woes listed above. Hence, the project structure, *per se*, may not be the cause or the sole cause of the problems. Projects are successful or unsuccessful for a variety of reasons: having a clear focus, manageable size, minimum critical mass of scientists, right mix of disciplines, having a good project leader, adequate funding, etc. While the panel has not attempted to disentangle these and other critical success factors for each project, it observes that "integration of effort" is a common intra-project as well as inter-project issue at CIAT.

Integration in three domains is particularly important: 1) along disciplinary lines; 2) in output terms; and 3) in blending genetic research with NRM research. Disciplinary integration requires cross-projects mechanisms (formal or informal) enabling scientists in the same or associated disciplines to learn from and provide support to each other. Integration in output terms is both an intra-project issue (for those projects housing several disjointed activities) as well as an inter-project concern. CIAT's earlier organisation facilitated this through "programs". The challenge CIAT faces now is to generate a similar integration without a formal program structure. This places a significant responsibility on the directors.

The third integration domain (blending genetic research with NRM research) is also an intra-project as well as inter-project concern. This is a complex problem as it involves co-operation among staff with radically different scientific orientations. However, the Panel believes that, with its dedication to the cause and lengthy experience in addressing the issue, CIAT has a unique comparative advantage to generate novel means of bridging the gap.

In conclusion, as integration of research efforts is a cross-cutting issue for the Centre, the Panel **recommends** that CIAT include in its next strategic planning exercise an in-depth examination of the composition of its project portfolio and the mechanisms used to foster intra-project and inter-project integration.

9.2.3 Project Planning, Budgeting, Monitoring and Reporting

Restricted grants are prepared by the project manager or scientist who will be in charge of it (project leader) with help from the Project Office and according to a detailed procedure. The proposal requires management approval. Once donor funding has been officially confirmed, the project is assigned a budget and a budget code. This gives the project leader his/her financial authority and budget ceiling for this project. The project's budget line is closed when commitments reach the project's budget ceiling or when the project completion date is reached. A donor database was created, and updated recently, to help the project leaders in their contacts with donors. A project budget

monitoring system was developed internally in 1997, following consultation with project leaders, and it has been upgraded since then.

These procedures and system are a significant improvement over the past. They ensure accountability, transparency, and consistency. Project leaders and managers are sent very detailed monthly reports that are expected to allow easy monitoring of their budget. This, however, is not the case. A large number of project/sub-project leaders complain about numerous problems (erroneous charges, late postings, multiple reporting) and about having to spend considerable time at the end of each month reconciling their reports with their budgets. Several projects have hired an administrative assistant to deal with these and other administrative issues.

The Panel considers project budget monitoring and reporting to be a critical management issue in the Centre. While some project leaders blame this situation on the shift to projects, the Panel believes that most of the problems stem from system and procedural problems. Some of the main reasons for these problems are the limitations of the system/software and the delayed posting to the project budgets of charges such as salaries, travel, lab, charges from and to CIAT's outposts. This means that a project leader could therefore consult the system and find that money is available when in fact it is not. Additional problems stem from completeness of the forms used in the budgeting process as well as multiple data entry and complexity of reporting both due to the multiplicity of donors and of sub-projects (the number of reporting statements to be prepared by the Finance Department each year is now in the hundreds!).

While the data provided by the reporting system is sufficiently up-to-date and accurate for periodic reporting to management, it is of limited usefulness to a project leader's day-to-day needs and it requires significant work to prepare donor reports. A redesign of the system is planned for 2000. The upgrade will allow real time posting of all charges and it will be accessible by all CIAT offices.

Apart from this system redesign, the Panel suggests that CIAT give consideration to the following:

- Clarify the role, accountability and involvement of the different actors in the monitoring and reporting process (project leader, Project Office and Finance Department) and increase the dialogue between them.
- Consider providing increased support to the project leaders, e.g., from the Project Office and the Finance Department, or by assigning a trained project co-ordinator for a group of projects.
- Clarify the terms and conditions of contracts with donors (e.g., type of expenses and overhead to be charged to the projects).
- Train project leaders and their administrative staff on basic project management and project financial management.

The Panel notes that, following a recent reporting problem on a GTZ project, GTZ has agreed to assist CIAT in reviewing the processes, procedures, manuals and

organisation structure of the Finance Department. This is to be done in calendar year 2000. With the system redesign described earlier and also planned for this year, this should help alleviate CIAT's project monitoring and reporting problems.

This notwithstanding, the present information systems do not provide the project leaders with relevant, timely and accurate financial information, and therefore the Panel **recommends** that CIAT elevate the priority assigned to the redesign of its financial information systems, processes and procedures.

As a final point related to project planning, the Panel notes that funding of some CIAT activities is tied with appointment of specific donor-identified scientists. This is not unique to CIAT. While this situation reflects the current realities in the funding environment of the CGIAR, the Panel considers that qualifications and competency of the staff proposed by the donor must meet the standards of scientific excellence espoused by CIAT. It is not in the long-run interest of CIAT to dilute its scientific excellence. When faced with such a dilemma, the Panel would urge CIAT to uphold its standards of scientific excellence at the expense of additional funding.

9.2.4 Information Systems

The last EPMR recommended that a strategic plan for the development and organisation of information systems in CIAT be formulated as soon as possible. CIAT conducted a major analysis leading to the development of proposals for large new investments in information systems. Management decided in 1998, after discussion with the Board of Trustees, that the scale of the proposed investment exceeded what was feasible within existing financial constraints. A new working group developed a proposal for a more modest reorganisation that was approved by the Management in 1999. CIAT also undertook a full Y2K compliance exercise.

The Panel finds that CIAT's management of information systems has been pragmatic and cost-conscious, but that The Centre still lacks a coherent centre-wide Strategic Development Plan for information systems.

9.3 Institutional Management

9.3.1 Leadership and Management

At the time of the previous EPMR, CIAT was in the process of recruiting a new DG and one of the panel's recommendations was that "in its consideration to fill the position of Director General, the Board carefully consider the importance of a leadership style that will reintegrate the CIAT community and encourage participation in decision-making processes...". Since then, CIAT management had the challenging task of turning around this large and complex centre under difficult conditions, e.g., decreased funding, staff reductions, security problems. In this context, the Panel wishes to commend CIAT's

Management, and its former Director General in particular, for demonstrating effective managerial leadership and for exhibiting the leadership style the previous panel was hoping for.

Based on a large number of interviews with CIAT staff and managers, the Panel sees the key achievements and contributions of the former DG in the areas of finance, management and human resources as:

- restoration of the centre's financial integrity
- constitution of a strong management team
- introduction of a participatory style of management
- improved relations and communications with staff, including the creation of two associations for staff not represented by the then existing association and union
- greater transparency at all levels
- creation of various committees and working groups
- creation of special funds, e.g., Staff Development Fund (FDRH)
- introduction of a carry-over policy for core budgets
- introduction of performance-based financial incentives for managers
- improvements in the performance appraisal system, from the DG downward, including a 360-degree feedback for managers

The Panel notes that these achievements address many of the concerns expressed by the 1995 EPMR. Some of these achievements are discussed further in appropriate parts of this chapter.

The present CIAT management team (MT) has been in place since April 1996. It is composed of seven members: the Director General, the four Directors (Genetic Resources, Natural Resources, Co-operation, Strategic Planning), the Financial Manager and the Executive Officer (in charge of Administration). The members of the MT consider that it operates exceptionally well and the Panel agrees that it does indeed fully operate as a team. During the DG's absences the acting assignment rotates between members of the MT and the members also act for each other. Members of the MT evaluate each other's performance as part of the 360-degree performance appraisal system presently being tested at CIAT. The MT meets once a week and has a fairly structured agenda: periodically it meets informally with a few scientists, once a month it is briefed on financial issues by the financial Manager and twice a month it discusses special topics. The MT also goes on retreat twice a year, outside of CIAT, with a facilitator, to discuss strategies and priorities. The only reservation the Panel might have is that, while members of the MT are declared to be all equals, the fact that two of them do not have the title of Director may result in a perception of hierarchy between them. This is further discussed under the Financial Management section.

While relations between management and staff were an issue at the time of the 4th EPMR this is not the case today. CIAT now has four associations/unions representing staff: two were created at the instigation of the former DG (the Assistants/Associates

Advisory Committee and the Secretaries Advisory Committee) and two have been in existence longer (the Workers Union and the Principal Staff Association). Each of these groups meets with the management team between two and four times a year. The representatives of all four groups unanimously praised management for the progress in communications over the last five years, for the quality and transparency of relations and for management's responsiveness to the issues they raise. The staff associations/committees are represented on various CIAT committees, panels and funds (e.g., Harassment and Discrimination, Pricing, Staff Development, Bio-diversity) and new initiatives have resulted from their suggestions (e.g., the creation of the Staff Development Fund, the introduction of 360 degree feedback, the availability of the staff manual on-line and on CD-ROM for out posted staff). Representatives of these groups have also been involved in the development of CIAT policies and, for the first time, in the recent round of interviews of the candidates for the Director General position.

9.3.2 Human Resources Management

9.3.2.1 Staffing

Although major staff reductions (28%) had already been made during the period covered by the last EPMR (1989-1994), further severe cuts had to be made during the period covered by this EPMR due to funding shortfalls. From 1995 to 1999, CIAT's total staff decreased by 32% (see table 9.1). Over the last ten years this means a total CIAT staff reduction of 55%. Turnover (i.e., the percentage of staff leaving CIAT each year) for internationally recruited staff (IRS) has remained stable and at a relatively normal level over the past few years (in a 15 to 20% range). For nationally recruited staff (NRS) it has been much higher, in a 40 to 45% range in 1996 and 1997 when most of the staff reduction occurred, and around 35% over the last two years. Although these figures include contracts that terminated and were renewed, they seem somewhat high, especially since the number of NRS staff has rebounded in 1999 when it increased by 5%.

With respect to reductions by major areas within CIAT, Table 9.1 shows that total staff in Research decreased by 23%. Reductions were even higher in Research Support (-34%) and in Administration and Finance (-43%). Concerning reductions of NRS and IRS staff, NRS were more affected than IRS: -32% vs. -8%, even though the number of NRS has actually increased in 1999. As a result, IRS staff now represent 11% of total staff vs. 8% five years ago. Within the IRS category, however, one should note that the decrease is entirely among senior staff (from 72 to 56) while the total for senior research fellows, postdoctoral fellows and visiting scientists has increased from 19 to 28.

Staff cuts of the magnitude experienced by CIAT are never easy to implement and it is therefore very much to the credit of CIAT management to have implemented drastic reductions in a way that showed care and concern for staff. This was underlined by the staff associations/committees and by the workers union. Praise was already given to CIAT management during the last EPMR for how it handled the previous round of cuts; this Panel strongly commends management for its handling of the latest round of reductions.

Table 9.1: CIAT Staffing, 1995–1999

	1995	1999	Percentage Change
- Research	549	421	-23%
IRS	81	75	- 7%
NRS	468	346	-35%
- Research Support	189	125	-34%
IRS	6	6	0%
NRS	183	119	-35%
- Administration and Finance	346	196	-43%
IRS	4	3	-25%
NRS	342	193	-44%
Total	**1084**	**742**	**-32%**
- Internationally Recruited Staff			
Male	75	65	-13%
Female	16	19	+19%
Total IRS	91	84	-8%
- Nationally Recruited Staff			
Male	699	428	-39%
Female	294	230	-22%
Total NRS	993	658	-34%
TOTAL	**1084**	**742**	**-32%**

Given the high level of unemployment in Colombia, the lower level staff whose job was cut had the highest risk, of all CIAT staff, of not finding another job. One way in which CIAT helped them was to encourage them to organise themselves in unipersonal companies (mostly suited for individual NRS scientists) or in small enterprises – workers association companies or EATs - better suited for the provision of services. EATs were encouraged to compete for contracts to perform a number of the services CIAT needs (e.g., cleaning, cafeteria and housing service, switchboard, drivers). Contracts are bid every two years but the contracts themselves are for one year with the possibility for CIAT to cancel. The initial one-year contract, however, was guaranteed. This had the effect of giving those staff at least short term security by letting them perform essentially the same work at the same place, though under different legal arrangements and at less favourable conditions. But, being small private enterprises, EATs are free to offer their services on the market, which several of them have done. With the help and advice of the National Apprenticeship Service (SENA), CIAT also trained departing staff in how to start their own business and it offered legal and administrative assistance to the EATs. While the Centre may, in some cases, have been able to find somewhat cheaper service

providers on the market than the EATs, this approach ensured CIAT that it had people that knew the organisation and knew what was expected of them.

Before making the staff cuts, CIAT management provided staff and their representatives with information on the reduction goals. In making the redundancy decisions, it took into account individual circumstances (e.g., performance, time to retirement, gender, family responsibilities, health status). CIAT also helped those staff who did not opt for an EAT or a unipersonal company to find a job elsewhere. This whole approach allowed CIAT to avoid labour disputes despite the large cuts and despite a switch to fixed term contracts from indefinite contracts. It also maintained goodwill and loyalty to CIAT among both departing and remaining staff.

This approach, however, may not be feasible if further cuts were needed. CIAT management feels that it would be financially difficult to pay for separation costs of permanent staff. Hence the institute would have to let go of fixed term staff, i.e., the most recent recruits, whose cost is lower and whose expertise is possibly most up-to-date. This would therefore increase staff unit costs and possibly reduce overall quality.

9.3.2.2 Gender and Nationality Diversity

Table 9.1 shows that female staff was less affected by the reductions than male staff. In the IRS category female staff actually increased by 19% while male staff decreased by 13%, so that women now represent 23% of IRS staff compared to 17% in 1995. While this is an overall improvement, the proportion of women decreases as one goes up the organisation ladder or up the salary structure, e.g., 41% of research fellows/visiting scientists but only 7% of project managers/unit heads (one in fifteen), and 17% of senior management (one in six) are women. It should also be noted that there are no women in the post-doc fellows category, which is generally a good recruiting ground for the centres.

In the NRS category female staff were also less affected by reductions than male staff (-22% vs. –39%) and they now represent 35% of NRS staff (42% when excluding workers) vs. 30% five years ago. But in this category, contrary to the IRS, the proportion of female staff increases as one goes up the ladder: 26% of technical staff but a notable 46% of managers/administrators are women. Recent recruitments show an increase at the technical and professional levels too.

It should be noted that CIAT provides its Board with detailed data relating to gender: by level for IRS and NRS, for the current year and past years, for current staffing levels and for recruitments, by salary level, for turnover, for training and for the composition of the various CIAT committees. Concerning recruitment, the data also compares the proportion of women who applied, who were short-listed and who were selected. For 1999 the proportion of females short listed for vacancies is always higher than the proportion of female applicants, which reflects either higher qualifications of the female applicants or a conscious diversity effort by CIAT management. For those types of positions where more than one person was being recruited during the year, the

proportion of women selected is higher than the proportion of women applicants (where there is only one vacancy to be filled the proportion is of course 100% or 0% depending on whether a woman was selected or not). These figures are better than in 1998 but cannot yet be considered a trend. This effort at recruitment compensates for the fact that the proportion of females departing CIAT is higher than their proportion of total staff.

Concerning training, data from the last 2 years show that NRS women receive proportionately somewhat more training than men. Data for IRS staff seems to show the opposite though the numbers are small and therefore not conclusive. With respect to promotions, however, women do not fare as well as men: only one woman for eight IRS promotions over the last two years (12.5%), and 12 women for 35 NRS promotion this past year (34%). With respect to internal committees, while the situation varies from year to year, women are generally represented in all committees and, there is generally more than one woman in each committee; in most committees the proportion of female members is between 20% and 50%.

While aggregate figures for female representation in CIAT are encouraging, the Panel encourages CIAT to ensure a better male-female balance in those areas and organisation levels where females are underrepresented and in those fields of expertise where the proportion of women in the international pool of talent is higher than in CIAT.

With respect to national origin of CIAT IRS staff, US nationals and Colombian nationals constitute the two largest groups (27% and 14% respectively). The distribution by major geographical areas is: North America (USA and Canada): 31%; Europe: 29%; Central and South America (including Colombia): 21%; Africa; 14%; Asia: 2%; Australia: 2%. With respect to work location of the IRS staff, 58 (69%) are stationed at headquarters and 26 (31%) are stationed abroad, compared to about 25% stationed abroad at the time of the previous EPMR.

9.3.2.3 Disciplinary Breakdown

Table 9.2 indicates the disciplinary breakdown of CIAT scientists as of September 1999. The disciplinary breakdown of 70% biophysical scientists to 24% socio-economic scientists may not provide an appropriate balance for CIAT's research program. The Panel noted that, in general, biophysical research in natural resources increasingly is being done at the system level. The Panel also noted that, since social science research often requires significant amounts of time in the field, it is probably not possible for the nine social scientists (one of whom is a full time administrator) to provide adequate amounts of rigorous social science research.

Table 9.2 CIAT's Disciplinary Breakdown September 1999

Bio Physical Scientists	50	70%
Crop Management	19	27%
Pest Management	13	18%
Germplasm	11	15%
GIS	5	7%
Ecology	2	3%
Socio-Economic Scientists	17	24%
Social Science	9	13%
Economics	8	11%
Other	4	6%
TOTAL	**71**	**100%**

9.3.2.4 Impact of Security Issues

Given the situation in Colombia, the panel looked at the impact of security, or lack thereof, on the IRS staffing of CIAT. It is clear that security is a major issue for most if not all staff. How much each staff is affected in his/her personal and professional life, however, depends on personal circumstances, e.g., whether they have a spouse and children, their degree of tolerance to risk, their preferred type of recreational activities (outdoor activities are riskier), whether they need to conduct research in risky areas, etc. Some staff are so concerned that they have left or would prefer to leave. Others state that the situation is not as bad as it is purported to be, especially if one takes appropriate precautions, or people simply adjust to it.

In terms of recruitment, CIAT claims that, so far, it has been able to recruit at the level of expertise it needed. What is very difficult to assess, however, is the extent to which the candidate pool is being affected, i.e., there may well be good candidates for CIAT's vacancies but many others may simply not have applied because of the security problem. On the assumption that staff with children would be the most affected and the most likely to leave or not to apply, the Panel looked at IRS recruitments and departures over the last five years. From 1995 to 1998 there are, on average, as many staff with families who are leaving then there are who are joining CIAT. In 1999, however, there is a clear change with hardly any staff with children joining CIAT. But CIAT was making a concerted effort at recruiting younger people so that it is not clear what caused the shift. In conclusion, it is clear that the security situation does affect staff's lives but the degree to which this may affect staffing is uncertain.

9.3.2.5 Performance Appraisal

Significant improvements were made to the performance appraisal system during the past five years. While CIAT has several performance appraisal forms tailored to different levels of staff, with increasing detail as one goes up the organisational ladder, they are all based on the same approach. The appraisal system for IRS is described in detail in a manual published in 1999, which includes, among other, definitions and criteria for ranking relative performance, criteria for determining financial rewards, and a complaint procedure. For NRS staff the policies and procedures are essentially similar.

For the director general, the management team and all project and unit managers, the appraisal is based on a Responsibility Performance Agreement (RPA). For all senior staff the appraisal is based on a work plan or on a set of objectives. RPAs, work plans and objectives are agreed upon between staff and their manager at the beginning of the year and then documented. They include targets and indicators, which aim at measuring outputs rather than inputs. However, and wherever possible, these targets and indicators should be quantitative rather than descriptive. For managers, the appraisal includes, among other, elements on leadership of science, financial management, human resources management, team performance, managerial teamwork, management of relations with donors and partners.

Except for workers, the appraisal process starts with the staff's self-assessment. For all staff the performance is discussed between the staff and his/her first-in-line supervisor and so are objectives for the following year as well as training and development needs. The appraisal is reviewed by the second-in-line supervisor and signed by both evaluators. For NRS staff the appraisals are reviewed by an Evaluation Committee composed of the executive officer, the financial manager, head of the human resource department, and a staff representative. The staff member is given a copy and has the opportunity to make final comments in writing. The appraisals of IRS are reviewed by an Evaluation Committee composed of the director general and the two research directors. The Evaluation Committee, after consultation with the other directors, does a relative ranking of staff performance and determines how meritorious performance is to be rewarded, i.e., by an increase in the salary base or a one-time bonus or a combination of both. About 10 to 15% of staff receive bonuses. Essentially the same process applies to managers, though for them the financial reward is called Responsibility Performance Payment, which can also be paid as a salary increase or as a bonus, and a ceiling is defined in advance. As a matter of practice it seems that managers are rarely or never given awards beyond 80% of the defined ceiling. The Evaluation Committee is also responsible for overseeing the whole performance appraisal process and for recommending the financial envelope available for salary increases and bonuses.

While performance appraisal was identified in the 1995 EPMR as an area in need of improvement, this Panel believes, in view of the changes made during the period under review, that the concerns expressed five years ago have been fully addressed and that the present performance appraisal system is excellent. If anything, it might be somewhat too detailed in view of where industry standards are going. While, just like in any other

organisation, there is not 100% compliance (e.g., some managers do not engage in a full performance discussion with their staff), the staff representatives feel that the process is much better than in the past and that it is fair, equitable and generally applied. It has resulted in clearer objectives, better training opportunities and better staff satisfaction. Part of this success is certainly due to the appraisal system itself but part may also be due to the fact that training was offered to both staff and appraisers.

9.3.2.6 Compensation and Benefits

The Panel did not have time to look at compensation and benefits in any detail, but it did look at three recent reports on the subject: a 1997 IPGRI report on IRS salaries and benefits in seven CG centres, a 1998 IDRC commissioned survey of program staff compensation in various organisations, and a just released 1999 survey of compensation within the CG system. All three studies seem to indicate that CIAT's compensation package is in about the middle of the pack.

The local salary surveys, which CIAT procures twice, a year and the information that the Human Resources Office gathers on its own from local companies do not point to a lack of competitiveness due to compensation. The CIAT staff associations and the staff the Panel spoke to did not mention compensation as an issue. On the contrary, some staff, both IRS and NRS, expressed satisfaction with the conditions offered by CIAT though, undoubtedly, the staff who lost their job and came back as members of EATs must feel differently.

On the other hand, at least some CIAT managers feel that the compensation package is becoming less competitive on the European market. They are also concerned that recruitment at mid-career or for some types of expertise (GIS, biotech) is increasingly difficult. There is also a concern that, with increasing donor funding problems, it will become harder to retain high calibre staff.

9.3.2.7 Training and Development

An important improvement implemented by CIAT management during the period under review was the creation of the Staff Development Fund (FDRH) in 1997. The FDRH had a significant impact on training and development opportunities available to all staff. From discussions the Panel had with staff, it also seems to have been a significant factor in improving morale.

Prior to the creation of the FDRH, training and development activities supported by the Centre had to be job related and were apparently not equally available to all staff. Since the creation of the FDRH, training and development/education opportunities are open to all staff for job-related as well as personal development. A staff development committee examines all requests, prioritises them and decides which ones will be funded and in what proportion. For example, group training and English training are generally covered at 100% while secondary, graduate and post graduate education are generally not covered at 100% and have to be taken outside of work hours. Priority is given to job-

related training and to group training, though neither of these are requirements. Most requests appear to be granted and a significant portion of their cost covered. The number of staff using the FDRH to take formal education has significantly increased in the three years since its inception: from 64 in 1997 to 109 in 1999. The staff associations feel that the selection process is fair, that the system offers opportunities that were not available before and that these opportunities are here for staff to seize. An assessment of the FDRH's effectiveness and impact is presently under way.

Of note, also, is the training program offered to seven groups over the past few years. This covered teamwork, conflict resolution, communications, advice to the group's manager, and a group retreat facilitated by a consultant. Several persons suggested that such training might be offered to all CIAT managers. In view of recent problems encountered in donor relations and of wishes expressed by staff themselves, the Panel suggests that more systematic English training be offered to staff or at minimum to all those staff having to deal with other CG centres, with people in non-Spanish speaking countries or with visitors. Limitations in English or French also prevent some NRS staff from being out posted in Africa or Asia. The Panel is also pleased to note the very large number of IRS staff whose mastery of Spanish is such that they can conduct their business in Spanish, which is especially useful in the field.

While much progress has been made in the area of training and development and while this is generally considered a staff member's own responsibility, CIAT needs to ensure that its staff, and especially its senior staff, remain at the cutting edge in their field of expertise. To that effect CIAT needs to provide increased time and incentives for development activities such as writing refereed journal articles, attendance at significant seminars and conferences.

9.3.2.8 Varia

In addition to the major changes mentioned above in the area of human resources management, CIAT has also introduced or revised a number of policies, for example: Harassment and Discrimination Policy (3/1997), Diversity of Staffing Policy (3/1998), Code of Conduct for Internationally Recruited Staff (1/2000); the latter includes a statement on conflict of interest and procedures for complaints and appeals. These policies are issued in English and Spanish. The Panel was favourably impressed with their general level of clarity, detail and precision.

To encourage staff participation, as recommended by the 4th EPMR, CIAT has, in addition to the four staff associations/committees/union, at least 15 standing committees and several ad hoc panels. While such a large number of participatory bodies runs the risk of leading to "management by committees", this does not appear to be the case and the Panel heard no comment or complaint to that effect. The Panel did not have time to verify the extent to which these committees are active or effective but, with one exception, it didn't hear comments that they are not. The one exception relates to harassment and discrimination.

The Panel overwhelmingly heard from staff that people in CIAT are treated fairly and equitably, that there are few complaints of harassment and discrimination, that the one case of harassment mentioned to the Panel was dealt with effectively, that there is no gender discrimination, and that there are good conflict resolution procedures to deal with problems that arise. But the Panel also heard at least some concern that a few managers may be getting away with aggressive behaviour, e.g., yelling at subordinates who may be unwilling to come forward with complaints for fear of losing their job in this uncertain funding situation. Not all staff appear to know how the Harassment and Discrimination Panel operates and doubts were expressed about its effectiveness in dealing with such situations. Concerns were also expressed about unequal benefits for NRS staff in various parts of the institute (e.g., in terms of cars or language training) and of the unequal treatment of students working in various parts of CIAT. The Panel suggests that CIAT management, in co-operation with the four staff associations, verifies the extent and seriousness of these concerns and, if appropriate, takes the necessary measures.

Also worthy of note is, through the Social Welfare Fund, CIAT is helping staff acquire housing or face special life events. In addition to providing funds, advice and counselling is given on, e.g., home budget management, spending habits. This is done through two funds, one in which staff make voluntary contributions and one in which CIAT makes a contribution; both contributions are 5% of salary. An average of ten staff a month make use of this Social Welfare Fund.

9.3.3 Administration

The Administration Department of CIAT (hereafter referred to as Administration) covers nine units: International Staff; Human Resources (which deals with NRS staff); Purchasing; Maintenance; Food and Housing; Institutional Protection (i.e., security); Miami Office (for purchases in the USA); Bogota Office (for liaison with the Colombian administration); and the Legal office. The services covered by the first two units (International Staff and Human Resources) have been discussed extensively in section 9.3.2 above (Human Resources Management).

Over the past five years, and just like the rest of CIAT, Administration has undergone major changes in terms of staffing, budget, client orientation and ways of doing business. Administration should be commended for its systematic approach to making these changes. A team was constituted to look at which services were strategic for CIAT (and should therefore be kept in-house), which could be re-engineered, which could be contracted out and which could be eliminated altogether. As a result of this analysis, the staff of most units was significantly reduced while a few were slightly increased and all units saw their budget significantly reduced.

For the entire Administration Department staffing was reduced by 55%, from 274 staff in 1995 to 123.6 in 1999 (the legal adviser only works for CIAT for 60% of his time); this is a significantly higher reduction than for CIAT as a whole (-32%). Administration's budget was reduced by 52%, from US$ 5.7 million in 1995 to US$ 2.7 million in 1999, i.e., a US$ 3 million reduction that is twice the reduction objective it was

assigned. Administration now represents 18% of total CIAT staff (vs. 25% in 1995) and 8% of total CIAT budget (vs. 16% in 1995).

The staff reductions were done in the same manner as described in the Human Resources Management section (9.3.2) and the outsourcing was done mainly with EATs. Other cost reducing measures were implemented concurrently, e.g., inventories were substantially reduced, the organisation structure of the department was flattened, many personnel contracts were changed from indefinite to fixed term, the positions of departing unit managers were downgraded, the number of secretaries was reduced and they were trained to become administrative assistants, overtime payment was replaced by compensatory time, students were used under agreements with local universities. Revenue enhancing measures were also pursued, e.g., Administration was active in obtaining tax refunds from the Colombian Government (about US$ 100,000 per year), and some of the services were put on charge back with, for some, the objective to recover their cost (Food and Housing, Motor Pool).

At the same time it was implementing the above measures, the Administration Department also changed its own work culture. Emphasis was put on client service, cost consciousness, teamwork, integration of IRS and NRS staff, and better planning and appraisal. For the latter, the departmental unit managers discuss, as a team, the performance of the past year and the major objectives for the coming year. Each unit then agrees with the Department manager on very detailed objectives.

All these changes have resulted in much improvement over the past 5 years. With a few exceptions, the quality of services offered by Administration as well as its responsiveness are generally considered high by staff and by the organisations housed on CIAT premises. While this picture is very positive, there are nevertheless a few complaints and there is room for further improvement. For example, overhead charged are considered high; the prices charged by Food, Housing, Graphics and the Miami Office are also considered high and above market. The organisations hosted by CIAT at headquarters (i.e., in the CIAT Research Park) also believe that there needs to be more clarity and uniformity to what they are being charged. Similarly, it is not clear to CIAT staff making purchases through the Miami Office why the prices are sometimes higher than what they are quoted by the providers (apart from the overhead being charged). The representatives of organisations hosted at CIAT also find CIAT's travel contractor expensive and unresponsive, to the point where some of them are now buying their own travel tickets in Cali.

Apart from the general description made above, a brief list of achievements and issues by major unit is presented below:

Purchasing covers the usual functions of such a unit as well as the warehouses. It has a set of written procedures, including for purchases over the Internet. Total purchases reached US$ 6.4 million in 1999, not including the Miami Office, which handled US$ 2.2 million worth of purchases. The Panel originally had concerns about some of the purchasing procedures, namely what appeared to be a lack of competitive bidding for the

purchase of cars (one of the largest items after laboratory equipment and supplies, and computer equipment). However, while a pure competitive bidding process was not used, the unit has obtained prices, which other suppliers were not able to match, much less beat. The internal and external auditors, questioned on the matter by the Panel, were satisfied with the process. Over the last five years the unit also succeeded in reducing the inventories by 60%, from US$ 770,000 to US$ 310,000. Its plan is to reduce inventories by another 50% after doing a consumption analysis of the slow moving items. The unit reduced its staff by 53%. The Miami Office, organisationally separate from the Purchasing unit, increased its staff from 6 to 8 over the last 5 years to also provide services to other CG Centres. It was set up to expedite and reduce the cost of making purchases in the USA. It adds a percentage to purchases it handles in order to recover its costs.

Maintenance covers the maintenance of the physical plant, engineering, systems operation (water, electricity, steam, telecommunications, heat and air conditioning, lab equipment, etc.), the motor pool, the repair shop and the transportation of personnel. The unit reduced its staff from 90 to 27 during the period under review and it went from self-sufficiency in 1995 to mostly contracting out to EATs in 1999. Vehicles are bought by CIAT at advantageous conditions and tax-free and they are leased to CIAT units and sold at public auctions after 4 years. CIAT has an agreement with the Colombian Government, by which it can sell the cars without having to pay taxes, thus recovering a substantial portion of the original cost. Since 1996 CIAT also made substantial savings on electricity by buying from private providers.

Food and Housing reduced its personnel by 71% and contracted with EATs to perform most of its services. The unit manager meets monthly with the representatives of the various staff associations to evaluate food services and she periodically compares prices with the market. Internal customers, however, claim to be able to find better deals on the local market. The unit is expected to recovers its costs, and does so, partly by marketing its services both internally and externally (e.g., offering its food and housing facilities to other companies for conferences and seminars).

Institutional Protection. As discussed elsewhere in this report, security is a major issue at CIAT given the local conditions. The unit has kept its 19 staff over the last 5 years but has seen its budget reduced by 25%. The unit ensures protection of the facilities through a contract with a private firm, which is periodically replaced; but it ensures personal protection with its own staff. The unit manager co-ordinates with local authorities, consulates and other companies, organisations, airlines, etc. The unit has developed an emergency evacuation plan as well as guidelines, brochures and recommendations for staff. It conducts awareness meetings for staff and disseminates information on the internal CIAT network. Apart from ensuring security on the campus the unit also developed a number of measures to ensure, to the extent possible, the security of staff in their homes, in their children's school and on their way to and from work. The head of the unit informs the Director General on the security situation as required, the management team weekly and the staff at large at least monthly. An audit/review of CIAT's security set-up, conducted by an outside firm, is presently under way. The staff

realises that CIAT cannot control the security situation but they are generally satisfied that CIAT is taking the appropriate measures to ensure their protection. The Panel shares this view.

Legal services are provided to CIAT by its former lawyer who now is only at 60% in the employ of the Centre. The services rendered are those of a classical in-house legal unit: standardising legal contracts and agreements, insurance contracts, advice to management, etc.

International Staff and Human Resources cover all personnel related functions, including occupational health. Their combined staff increased from 16 to 18 during the period under review (+13%) but their budget decreased by 15%. Their achievements have been extensively covered in Section 9.3.2 and hence need not be discussed further here.

9.3.4 Financial Management

9.3.4.1 Financial Situation

CIAT's total revenues reached an estimated level of US$ 33.3 million in 1999 (figures for 1999 are not yet final as of the writing of this report). This total includes self-generated revenues but excludes recovery of indirect costs and is not adjusted for unpaid European Union funding. During the period under review total revenues fluctuated between US$ 32.2 million in 1995 and US$ 33.6 million in 1998 (see Table 9.3). While, at first glance, this could be considered a positive outcome in a period of general funding shortfalls, the key factor is the continued substantial decrease in unrestricted funding: from US$ 23.4 million in 1995 to US$ 17.8 million in 1999, a 24% decrease, and a 53% decrease over the last 10 years. Unrestricted funding now represents 54% of total revenues vs. 73% in 1995 and 85% in 1989. The picture is even bleaker when one looks at unrestricted funds available for research. Given the reluctance of many donors to recognise the need for full cost recovery almost by definition non-research expenses (e.g., management, administration, internal services, financial provisions, termination costs) have to be essentially covered by unrestricted funds. As a result, unrestricted funds, which can be allocated to research now represent only about 30% of total resources available (still 46% in 1995 but between 27% and 33% over the last 4 years) – see Table 9.4.

Because of this situation, CIAT made great efforts to generate other funding and was mostly able to compensate for the decrease in unrestricted funding, which explains the fairly stable total income. As a result, CIAT's financial results over the last three years were balanced. Operating expenditures exceeded revenues in 1995 and in 1999 but the three intermediate years showed a surplus. After taking into account recovery of indirect costs (between US$ 0.8 and US$ 1.6 million) and contract termination costs (especially high in 1996 and 1997), CIAT had a total operating deficit of about US$ 2 million in 1995 and 1996 and a slight surplus in the last three years (between US$ 0.1 and US$ 0.6 million). Table 9.5 shows that resource allocation to research had dipped in

1996/1997, due to the high contract termination costs, but had slightly surpassed its 1995 level by 1999 (US$ 24.9 million). Research-related allocation decreased by 45% from 1995 to 1999 and the allocation to internal services and management decreased by 13%.

CGIAR's 1998 Annual Report, in its Table III-5, shows that the distribution of CIAT's expenditures, by category, in 1998 was:

- 55% for Personnel, about the same as CIMMYT but somewhat above the other major centres and above the CGIAR average of 50%
- 33% for Supplies and Services, lower than the other major centres and than the CGIAR average of 37%
- 7% for travel, about average
- 5% for depreciation, also about average but lower than the other major centres

The depreciation of the Colombian peso, the effect of the carry over policy and a slower than planned implementation of research projects lowered the cost of implementing the research agenda which resulted in operating surpluses and, in turn, allowed a replenishment of the operating fund close to its 1995 level of US$ 5 million. This is still below many other CG centres and below the CGIAR guidelines of 90 days of operating expenses. However, the auditors have no major concern about the level of the Operating Fund as they do not think that it seriously hampers CIAT's operation. Nevertheless, management should continue replenishing the fund and, meanwhile, continue to pay close attention to cash management.

The Panel also examined CIAT's investments. From 1992 to 1996, and especially in 1993/1994, CIAT heavily borrowed dollars for reinvestment in Colombian pesos in order to take full advantage of the differential between the devaluation rate and inflation rate of the peso. During 1993/1994 these investments peaked at US$ 43 million and the borrowed funds reached up to US$ 24 million. An Investment Committee was created in 1993 to make investment decisions. While these investments paid off handsomely (US$ 4.4 million in 1994) they were speculative and risky. In 1994 the Board recommended a re-evaluation of the goals of the investment program and in 1995 it requested that the Investment Committee seek legal and economic advice. In 1996 the Board decided that borrowings for the purpose of investment had to have prior Board approval. It also set a US$ 10 million ceiling for these borrowings and it requested quarterly reports to the Board Chair and to the Chair of the Board's Audit Committee. There is also monthly reporting to the Management Team. In 1997 management changed the composition of the Investment Committee which decided to liquidate all of its investments in pesos. The Panel notes, after confirmation with the new external auditor, that CIAT now follows a more conservative investment policy, which the Panel finds more appropriate for an organisation such as CIAT. All transactions are now also monitored by the Internal Auditor.

9.3.4.2 Finance Department

To assess the operation of CIAT's Finance Department the Panel relied heavily on three sources: 1) the external auditors, which replaced the previous audit firm less than two years ago, 2) a joint CGIAR Secretariat/German GTZ team which recently conducted a review of CIAT's financial management systems and procedures following a problem which arose in a GTZ funded project, and 3) CIAT's internal auditor. The Panel's own observations confirmed the very positive views of the external auditors, the internal auditor and the CGIAR/GTZ team[8].

The structure and organisation of the Finance Department are consistent with its mission. It is led by experienced professionals but its downsizing over the last few years and the replacement of some of the departing staff by more junior staff has impeded the strengthening of its functional areas. Nevertheless, CIAT managers and staff praise the Finance Department for the "huge improvements" in client orientation, responsiveness and transparency that occurred during the period under review.

The Finance Department satisfactorily operates the needed financial processes and provides good analytical assistance to managers in the conduct of their business. Detailed procedures have been written or updated and documented over the last 3 years and the manual of procedures is being updated. Financial reporting is of professional standard and the management team gets adequate, timely and sufficiently accurate information to help in its decision–making process. The Board of Trustees gets a quarterly report. However, as discussed earlier in Section 9.2, while project and sub-project leaders get detailed budget reports on their projects, the accuracy, timeliness and, therefore, usefulness of the information provided needs to be improved. Similarly, the quality of reporting to donors needs improvement. The main reason is that the financial system is composed of many sub-systems, not well integrated, and sometimes with antiquated software. As a result, the Finance Department has a hard time coping with the increasing complexity and multiplicity of reporting requirements due to the increasing level of restricted funding.

Other achievements worth mentioning in the financial area during the period under review are:

- The creation of a carry-over policy that allows managers to carry over to the following year those funds which they have not spent. The introduction of this policy had the immediate effect of giving managers and staff a tangible incentive not to go on year-end spending sprees so as not to "lose" the money remaining in their budget. This made staff more cost-conscious because the savings made in their unit are for their unit to keep.

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[8] In order to avoid numerous quotes, the Panel wishes to acknowledge that, with the agreement of the CGIAR/GTZ team, the remainder of section 9.3.4. draws very heavily from the report of the team, without identifying direct quotes; the report itself is attached as Appendix VII.

- The participatory approach to decision-making through the creation, under the encouragement of the former Director General, of a number of committees, e.g., Resource Mobilisation Working Group, Capital Committee, Pricing Committee and the participation of the Finance Department in a number of other committees.

While the Panel's assessment of the Finance function in CIAT is very positive, there are nevertheless areas which CIAT management will need to look into:

- The respective roles and accountabilities of the Finance Department, the Project Office and the project leaders in project planning, budgeting, monitoring and reporting as well as into related systems.
- The distribution of costs between direct costs and overhead and the level of overhead being charged to projects (a CGIAR Secretariat review is underway to develop a common methodology and framework on indirect costs).
- The lack of consistency in the amount of overhead being charged to host organisations.
- The need for greater clarity, consistency and precision in contracts with donors.
- The quality of communications between Research, Finance and the Project Office.

The Centre had already identified these issues and work has started on several of them.

CIAT ensures financial compliance of its operations and oversight of its financial function through an internal auditor, the external auditors and the Audit Committee. The structure for compliance and oversight is thus in place but the CGIAR/GTZ team believes that there is a need to further strengthen compliance in the Centre. In view of the earlier discussion on project budget monitoring (Section 9.2), the Panel agrees with the team and endorses its recommendations, some of which are to:

- Re-emphasise the role of the Finance Manager as a key partner in the Management Team.
- Enhance the accountability culture in CIAT along the lines of the Committee of Sponsoring Organisations (COSO) Internal Control Framework comprising the elements of control environment, risk assessment, control activities, monitoring, and information and communication.
- Assess options for strengthening the accountabilities and efficiency of the service delivery and compliance roles of the administrative staff located in the decentralised business units by re-examining the structural linkage between Finance and the decentralised administrative staff.

To conclude, the Panel wishes to commend the Finance Department and its manager for its achievements since 1997, when the new Financial Manager was appointed. While the department faced staff and budget cuts, like all units in CIAT, it also had to deal with, among other:

- an increasing workload resulting from the increase in restricted funding
- less than adequate systems and software
- the changes and confusion resulting from the move to projects from programs
- the need to "reconstruct" a number of its files after the departure of some of the staff and of the last Director Finance and Administration
- the need to deal with the legacy of two sets of figures and of the remnants of past unclear transactions
- a compromised integrity of the financial function.

It is worth noting that whenever managers or staff complained about financial matters, they took great care in pointing out that it was not the Finance Department staff they were complaining about but processes, procedures or systems. They added that they generally found the Finance Department staff to be helpful, co-operative and competent.

9.3.4.3 Internal Auditor

The Panel is pleased to note that the Internal Audit Unit, which reports to the BOT, does a commendable job of ensuring the financial compliance of CIAT's operations. As the concept of a modern internal audit function is evolving, the Internal Audit Unit has moved from control based auditing to risk based auditing so as to evolve from problem correction to problem avoidance. The auditor carries out periodic risk assessments of major areas in the Centre, makes detailed recommendations to the Director General, and the Board's Audit Committee, monitors their implementation, participates right from the start in the development of relevant procedures and systems so as to build-in compliance and needed controls from the onset. It also offers advice and help to CIAT managers. This approach is in line with the CGIAR's auditing guidelines presently being developed and it should be pursued further since it offers more value-added to Centre management than the traditional internal audit function. The Internal Auditor meets once a month with the Director General and twice a year with the Audit Committee.

TABLE 9.3

CIAT BUDGET OVERVIEW 1995 - 2000

(In Millions of US$)

	1995 Actual	1996 Actual	1997 Actual	1998 Actual	1999 Estimated	2000 Indicative
Income						
Unrestricted	23.40	22.14	20.45	18.26	17.97	17.80
Special Projects	8.20	8.46	10.23	11.40	11.50	13.00
Systemwide Programs	0.30	0.40	0.88	2.36	2.85	3.00
Self - Generated	0.29	2.10	0.87	1.54	1.00	1.00
Total Income	**32.19**	**33.10**	**32.43**	**33.57**	**33.32**	**34.80**
Expenditures						
Unrestricted	25.00	20.64	15.99	17.18	16.83	17.77
Special Projects	8.20	8.46	10.23	11.40	11.50	13.00
Systemwide Programs	0.30	0.40	0.88	2.36	2.85	3.00
Funds & Provisions	1.60	1.40	2.18	2.54	3.04	2.24
Sub - Total Expenditures	**35.10**	**30.90**	**29.28**	**33.48**	**34.22**	**36.01**
Recovery Indirect Cost	**-0.91**	**-0.80**	**-0.85**	**-1.22**	**-1.55**	**-1.60**
Sub Total CIAT Expenditures	**34.19**	**30.10**	**28.43**	**32.26**	**32.67**	**34.41**
Sub Total Operating Surplus / (Deficit)	**-2.00**	**3.00**	**4.00**	**1.31**	**0.65**	**0.39**
Contract Termination Cost	**0.00**	**5.20**	**3.39**	**1.19**	**0.24**	**0.00**
Total CIAT Expenditures	**34.19**	**35.30**	**31.82**	**33.45**	**32.92**	**34.41**
Total Operating Surplus / (Deficit)	**-2.00**	**-2.20**	**0.61**	**0.12**	**0.40**	**0.39**
Reserves at end of year [1 - 2]	**5.00**	**2.80**	**4.21**	**4.21**	**4.61**	**5.00**

TABLE 9.4

Resource Allocation 2000

Resource Allocation 1995 - 2000						
	1995	1996	1997	1998	1999	2000
Research						
Unrestricted Research	46%	33%	27%	29%	31%	30%
Special Projects	23%	23%	31%	33%	33%	36%
Systemwide Programs	1%	1%	3%	7%	8%	8%
Reseacrh Related	13%	11%	10%	9%	7%	8%
Total Research	**82%**	**69%**	**72%**	**78%**	**79%**	**82%**
Non Research						
Internal Services, Management &						
Administration	13%	13%	12%	12%	12%	12%
Funds & Provision	5%	18%	17%	11%	9%	6%
Total Non Research	**18%**	**31%**	**28%**	**22%**	**21%**	**18%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 9.5

Budget Comparison 1995-2000

	In million US$					
PROJECTS/UNITS	1995	1996	1997	1998	1999	2000
	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
Research Projects	23.0	19.3	19.4	23.1	24.2	26.0
Other Research	1.5	1.5	0.6	0.6	0.7	0.7
Total Research	24.5	20.8	20.0	23.7	24.9	26.7
Research Related	4.4	4.0	3.4	3.2	2.4	2.7
Internal Services, Mgment.	4.6	4.7	3.8	4.1	4.0	4.4
Funds	1.6	1.4	2.1	2.5	3.0	2.2
Contract Termination Cost	0.0	5.2	3.4	1.2	0.2	0.0
Total Resource Allocation	35.1	36.1	32.7	34.7	34.5	36.0

CHAPTER 10 – GENERAL ASSESSMENT AND STRATEGIC ISSUES

10.1 Evolution of the Mission, Strategy and Priorities

For more than 30 years, CIAT has worked on problems of crops and natural resources of major importance to the poor in Latin America and elsewhere in the tropical world, including beans, cassava and tropical forages and crop and livestock systems. Located in Latin America, CIAT lies in the centre of origin for many important crops and has played a key role in germplasm preservation and use, both for Latin America as well as for other parts of the tropics. CIAT has been a long-time leader in the analysis of social processes, systems modelling, and the use of GIS in NRM research. Although two of CIAT's most important long term achievements, African bean research and the Asian cassava research, were accomplished outside the region, CIAT has been substantially a regional centre and has only recently made the decision to increase the modes core resources deployed outside the region.

In the view of the Panel, the Centre has yet to meet fully its global mandate in genetic resources conservation. Genetic resource conservation under international trusteeship is a significant responsibility for the Centre, but it has been unable to meet that responsibility with adequate support. The gene bank needs serious upgrading and represents a responsibility that the Centre should not avoid.

In the Panel's view, CIAT must develop a comparative research strategy and methodology for its NRM reference sites. The development of sustainable livelihoods and production systems in heterogeneous ecological and social systems is a complex undertaking. In its NRM research, CIAT has had some success in fostering the incorporation of participatory methods into the culture of biophysical scientific research at the Centre. Progress has been made in embedding the NRM scientific research in local ecological and social realities. However, the opportunity for comparative strategic research inherent in the reference sites has not been exploited satisfactorily.

During the review period, following a period of study and reexamination that began in the early 1990s, CIAT underwent significant restructuring that resulted in more emphasis on natural resource management research. An increased focus on poverty alleviation brought added emphasis on participatory research and social sciences. A program structure was adopted that divided up the work of the commodity programmes and special units and placed their elements in one or more of 16 projects. Centre-wide leadership for the new projects was shared between a Director for Natural Resources and a Director for Genetic Resources, with the 16 Project Managers reporting to the relevant Directorate. Integration among projects was to be ensured by the two responsible Directors. The assessment of the Panel is that while effective integration has yet to be achieved, the will exists and the way will be found. In spirit, the centre has bridged the cultural divide between its two major areas of endeavour, and the determination exists to achieve effective integration. This will require an appropriate research framework, methodologies, and processes that allow for successful integration.

CIAT has continued its excellence in science with exemplary programs in areas such as integrated pest management, forage improvement, participatory research, land use, GIS tools and biotechnology. The Centre has productive collaborative relationships with advanced research institutes, NARS and other partners. In the view of the Panel, the Centre's position in the research spectrum in relation to alternative suppliers of the research should be reviewed on a continuing basis.

In an attempt to use best its scientific capacity and facilities, and to augment synergistic scientific capacity at the Centre, CIAT has ventured into the implementation of a research park concept with some 18 scientific organisations now operating on the campus. The Panel encourages further exploration and formalisation of this approach and believes that it should be expanded to field as well as laboratory-based research. Presently, the CIAT field facilities are under-utilised with perhaps a majority of the area being planted to sugar cane.

10.2 Achievements and Impact

During the period under review major improvements were made in the area of institutional management. The recently departed Director General and his team demonstrated the participatory leadership style called for by the 1995 EPMR. The Management Team also established a strong corporate culture which permeates the institution. The core values of CIAT, modelled by the DG and the Management Team, and reflected at all working levels, are: transparency, fairness, participation, service orientation, cost-consciousness, and output-based performance evaluation. The application of these guiding principles is what allowed CIAT to re-build its financial integrity, to significantly reduce its administrative costs and to implement a major downsizing without labour problems. While they may not be as measurable as in the research area, these achievements have in no small part contributed to the fact that CIAT remains an exciting place to work and, therefore, contributed to CIAT's overall achievements by moving CIAT decisively into a modern management ethos.

The major achievements and impact of the Centre are long term in nature. Some of the achievements that were realised during the period of the review include:

- The panel considered the African Bean Program state-of-the-art in the integration of natural resource management research with germplasm improvement. The genius of this approach has been the utilisation of improved bean germplasm as the "entry point" to develop and achieve the adoption of effective NRM technology.

- New tropical forage cultivars (*Brachiaria sp.*) were deployed with the potential to enhance sustainable productivity through pasture renovation and improved natural resource management on 170M ha. A major (but pleasant) challenge of the Centre is to reach agreement with enthusiastic private sector seed companies that will result in equitable near-term access to this impressive improved germplasm.

- The IPM project has organised and is leading a global project on white flies that may prove exemplary to the CG System. It represents a "task force" or "thrust" approach that has mobilised global scientific resources to address a world wide problem.

- CIAT has developed a fully equipped land use and GIS laboratory and has become a leader in broad scale environmental and sustainability modelling and other studies.

- CIAT has been the global leader in the development, implementation, and institutionalisation of participatory methods to help increase the effectiveness of plant breeding and NRM research.

- CIAT cassava research in Asia has been path-breaking in the industrialisation of a subsistence crop through improved germplasm and market development that has contributed significantly to poverty alleviation in the regions affected.

In its strategic research CIAT is attempting to combine commodity and resource management into an integrated systems approach in its efforts to increase food production and economic growth, without jeopardising the natural resource base on which future progress depends. They are trying to accelerate further the incorporation of advanced science into the Centre's efforts to share, international responsibilities with the national program partners, and develop collaborative approaches with greatly expanded range of institutions. The Panel finds that CIAT has made significant progress toward these expectations. In the view of the Panel, the Centre deserves the continuing support of the donor community.

10.3 Strategic Issues

10.3.1 Focus and Integration

CIAT has a constituency with almost infinite needs and it operates in some very complex and challenging research environments. When this situation is combined with the current global funding environment, it is not easy to maintain focus and to achieve integration among activities with diverse financial support. The Panel commends Management for its achievements in this regard, notes significant exceptions, and urges continuing vigilance to ensure that the essential focus and integration are achieved and maintained.

10.3.2 Security

Security is an underlying issue at CIAT, because of the well-known internal situation in Colombia. All reasonable precautions have been taken by CIAT to minimise the risk to staff and their families. However, the widespread feeling that risk of personal mishap are higher than normal has some detrimental effect on staff well-being, though not apparently on their working conditions and productivity. In a few cases, security concerns led to individual staff decisions to change their contractual arrangements at

CIAT. Evidence does not exist that such concerns affect CIAT's ability to hire IRS, beyond the usual restrictions faced by international employers for posts in developing countries.

The lack of complete security imposes some limitations on the conduct of field work, as certain locations in Colombia must be avoided, but given the vast geographical area and many countries served by CIAT, there are many suitable alternative sites for research. Hence, on the whole research programs have not suffered because of this problem. The security issue must be kept under constant watch and review, but currently it is not of a magnitude that requires action beyond the precautionary measures already in place.

10.3.3 Facing Virtual Reality

Nothing in economic history has moved as fast as the information revolution. The paradigm of research is changing as ever more powerful computers have the ability to deal simultaneously with numerous complex databases. Reductionist research is giving way to complex modelling of biological, physical, and chemical systems in an increasingly integral manner, providing insights to researchers that were beyond the imagination just a few years ago. If CIAT is to maintain a credible research presence, renewal of staff capacity, additional bandwidth in connection to the Internet, and continuing modernisation of equipment are essential.

10.3.4 Disciplinary Balance

In September 1999 CIAT had 71 PhD scientists, seven of whom were administrators. The panel examined and debated the staffing pattern in relation to CIAT's programmatic priorities and noted the expected dominance of the biophysical sciences. Social scientists comprise 24 percent of the staff with approximately half of those being economists. Because social science research often requires time concentrated in a single field site, it is probably not possible for the nine social scientists (one of whom is a full time administrator) to provide adequate amounts of rigorous social science research. On the other hand, the biophysical scientists at CIAT also have extensive responsibilities in relation to the staff available so the panel made no judgement on the appropriateness of the staffing pattern.

10.3.5 Donor Driven Research

CIAT's current research program is financed both by unrestricted contributions, and by 140 restricted research grants of varying size and type. These restricted research grants are funded from 40 different sources, and together they account for approximately 70 percent of CIAT's research budget. The funding sources include traditional CGIAR donors, the host country, universities, private companies, NGOs and research foundations – each of which supports the research program of CIAT for its own reasons. The challenging task for CIAT management is to interact with its many donors in such a way that each individual grant contributes to the overarching goals of CIAT's mission.

Creating a coherent and dynamic research program out of this diverse patchwork of available resources has drawn on the skill and vision of CIAT's leadership. Project scientists have become entrepreneurs in the best sense. The Panel congratulates CIAT on the success of its efforts, but calls attention to the danger of dispersal of its efforts over too wide a spectrum of activities. Donor-led research investment may compromise CIAT's focus on its central goals, or encourage overinvestment in favoured areas.

10.3.6 Quality and Relevance of Science

The scientific work at CIAT in the physical, biological, and social sciences generally is of high quality. The results usually go beyond the report level and are published in refereed journals of international relevance (the latter being particularly true when the work is done in collaboration with advanced research institutions). The scientific work is focussing on the relevant problems at the appropriate level. As a result, much of the scientific work is of an applied nature.

The outputs of CIAT's work and adoption by its clientele also provide a means of evaluating the quality and relevance of science conducted at the Centre. The commodity projects of the Centre are very successful in generating new germplasm that is widely adopted. The biotechnology, soils, IPM, participatory research, GIS and modelling work is of excellent quality that implies a sound scientific basis. CIAT is also a leading Centre in the use of social sciences in its NRM work. Finally, the Panel noted that a number of graduate students from well known, world class universities do their MS and/or PhD degree research work at CIAT.

The Panel concluded that science at CIAT is of good quality and relevant.

10.3.7 Intellectual Property Management

Intellectual property is an important concern that will have profound implications in the operations of CIAT and other CGIAR centres in the near future. The CGIAR has operated historically and made its major achievements in the milieu of free exchange of scientific information and technologies. That environment has changed dramatically within the past decade, because of imperatives of the Convention on Biological Diversity and the World Trade Organisation, and the emergence of the private sector as a major player in life science research and development.

Within a short span of time, the "rules of the game" have changed. The major inputs to and outputs of CIAT's research – germplasm, varieties, information, scientific tools, and others that used to be in the public domain and readily accessible and available to CIAT and its partners, have become subject to significant IP concerns. IP issues will become even more pervasive in the future. Thus, management of intellectual property to ensure the successful pursuit of its mission will be a major challenge for CIAT and the CGIAR.

10.4 Vision and Strategy

10.4.1 Principles of Engagement

Many and varied opportunities will confront CIAT in the modern world order of research, and it is essential to identify principles that will guide the Centre's scientists in deciding among the options:

- Poverty alleviation – this is an essential criterion and the basic rationale for the existence of the CG System.

- International Public Goods – this is agreed by all to be a primary criterion for research conducted at the IARCs.

- Comparative advantage – unless CIAT enjoys a clear comparative advantage for engaging in a particular type of research, it is less likely to be the most effective provider of that research.

- Probability of success – this is a criterion that must always be considered in relation to research. Every need does not represent an opportunity.

10.4.2 Transition to a New CG Model

The Panel considers that CIAT is making the transition to a new model among the CG Centres. It is working to implement an effective model for blending NRM and germplasm research. It has become a more open centre and the hub of the research establishment for the region, while maintaining international presence and impact. It has combined a core long-term agenda consistent with its mission and mandate with a realistic involvement in the current research market as represented by its research park. The panel commends the centre for the effective management of this evolution and offers a strategic recommendation as the Centre looks toward the future.

Advancing NRM Research

The need for improved natural resource management is equal to or greater than the need for improved germplasm. Because of its inherent complexity, using NRM as a primary organising principle of research has proved difficult at CIAT and throughout the CG System. Centres that should constitute a global resource for the several major agro-ecosystems of the world have yet to realise that goal. The Panel is concerned that many good scientists have come and gone and much has been contributed, but the cumulative outcome is not clear. That is, the information (data), knowledge, and wisdom may not have been systematically preserved in the institutions and that a robust corpus of knowledge on NRM may not have been built and preserved. The complexity of NRM has also affected the relevance of research to the farmer, and the actual and perceived impact.

Because all successful research endeavours at the Centre, such as participatory management research, are characterised by the maintenance of core competencies and institutional memory, the Panel **recommends** that CIAT ensure that its research strategy for NRM be explicitly cumulative in nature.

CIAT has used effectively its participatory germplasm improvement programmes and their products as an entry point to gain the confidence of farmers and facilitate complex NRM research. Perhaps the most effective example is the African Bean Program (see Chapter 3). CIAT projects currently use two methods for creating an entry point into a community: technology and social process.

Because CIAT has used effectively the products and processes of its participatory germplasm improvement research as an effective entry point to gain the confidence of farmers and facilitate the more complex but equally essential NRM research, as exemplified by the African Bean Program, and because technology and social process are recognised as potentially effective entry points into communities, the Panel **recommends** that CIAT further develops its "entry point" model to help identify optimal entry points for its NRM research projects.

The Panel recognises that achieving the current objectives of the Centre requires core competencies based on different research paradigms. To succeed, CIAT must reconcile those paradigms at the operational level and live with the healthy tension that will always be associated with productive interdisciplinary research.

ACKNOWLEDGEMENTS

The EPMR Panel expresses its sincere appreciation to the Board, Senior Management and all staff of CIAT for their support and assistance during this review. In particular, the Panel wishes to thank Aart van Schoonhoven, the interim Director General and the other members on the Management Team: Douglas Pachico, Director (Strategic Planning), Jacqueline Ashby, Director (Natural Resources), Rafael Posada, Director (Regional Co-operation), who also accompanied the group to Brazil, Juan Garafulic, Finance manager, and Jesus A. Cuéllar, Executive Administrator. The Panel is grateful to the management staff, all of whom co-operated fully with the Panel in the organisation and implementation of this EPMR. They deserve our special thanks for ensuring that the Panel was provided with a good working environment, effective secretarial and technical support, and wonderful hospitality.

The Panel Chair and two members has the opportunity to visit the host country officials in Bogota. The Panel wishes to thank Vice Minister Luis Arango Nieto of the Ministry of Agriculture and Alvaro Uribe Calad of CORPOICA for their valuable comments and information.

The Panel was fortunate to visit some of CIAT's country programmes and partners in Central America, Brazil, East-Africa and Asia, and wishes to express its gratitude for all the support, information and hospitality provided by CIAT's outreach staff and the Centre's collaborators in the countries that were visited. The Panel appreciated the warm welcome and hospitality it received from the staff of EPAGRI and EMBRAPA in Brazil, Miguel Ayarza and Jorge Beltran of CIAT in Nicaragua, and the representatives of NARS and farmer organisations in Central America, Eastern Uganda and Western Kenya. The Panel wishes to express its special thanks to Dr. Roger Kirkby of CIAT for organising the visit to Eastern Africa, and to Dr. Peter Kerridge of CIAT for organising the visit to Asia. The Panel is grateful to Mrs. Bertha Adilia Jarquin, Mr. Frederik Ali Fungani and Mrs. Maria de Lurdes Barreto Pereira, and their colleague farmers for their hospitality and for sharing their experiences on research with the members of the Panel.

There are a number of other CIAT staff who either directly or indirectly helped the Panel by providing the necessary logistical, computing, printing, and other support. They are many indeed, but the Panel wants to mention especially the tremendous help received from Gloria de Escobar (Secretary to the Board of Trustees), Maria Eugenia Cobo (Operations Co-ordinator), Carlos Meneses (Information Systems Unit, Data Assistance and Office Aide), Luis Alberto García (Communications Unit) and Gloria Cecilia Vasquez (Food and Housing) and their efficient and well-managed teams. The CIAT drivers receive a warm thanks. The Panel greatly appreciates the kind services provided by the staff in the guest house reception and the CIAT restaurant. The Panel would especially like to thank Lucy Marín, who secured the adequate supply of *pandebono*.

The Panel was fortunate to have Maria de San Juan of the TAC Secretariat assisting in the word-processing and preparation of this Report, in addition to handling a number of other report-related tasks. She was ably assisted by Carmen Montini of CIAT.

It is the Panel's pleasure to also thank the TAC Secretariat (particularly Sirkka Immonen who accompanied the Panel throughout) and the CGIAR Secretariat (particularly Selçuk Özgediz who joined the review team for the final week) for the co-ordination and management of this review and for guidance throughout. The Panel thanks Irmi Braun-Castaldi from the TAC Secretariat for making travel and administrative arrangements during the Initial and Main Phases of the review.

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Experience: 1970-71: Visiting Scientist, Wheat-Programme, CIMMYT, Mexico. 1971-75: Associate Plant Breeder, IRRI. 1978-79: Visiting Scientist, Department of Plant Pathology and Crop Physiology, Louisiana State University. 1976-80: Plant Breeder, IRRI. 1981-present: Professor of Plant Breeding and International Agriculture, Department of Plant Breeding and Biometry, Cornell University. Since 1993: Present position. Consultant to TAC, Rockefeller Foundation, McKnight Foundation, BOSTID. Member or Chairman of several policy and executive committees. Member of several scientific associations. Member of 2nd EPR of IITA 1982. Chair of the 4TH EPMR of ICRISAT 1996. Consultant to the 5th EPMR of IRRI 1998. Developing country experience in Asia, Africa and Latin America. Author of over 60 scientific publications including a book in 5 languages.

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Experience: 1961-65: Assistant with regard to Soils and Soils Fertility, 1965-66: Chief, Soils Work, 1967-69: Assistant Professor of Soil Science, Department of Agricultural Production, 1972-76: Associate Professor, Soil-Plant-Water Relationships, Director of the Agricultural Experiment Station. 1976-85 and from 1995 to present: Professor, Soil-Water-Plant Relationships (undergraduate and postgraduate), 1982-85: Professor, Plant Physiology (undergraduate forestry), 1994-1998: Dean Faculty of Agriculture and Forestry Sciences, 1998 to date: Professor, Agronomy of Annual Crops – all these posts at the University of Chile. 1984-89: Cereals Physiologist / Agronomist, ICARDA. 1990-94: Wheat Physiologist and Leader Wheat Management and Physiology, CIMMYT. 1984-1994: Professor Mediterranean Agronomic Institute, Zaragoza, Spain. Has participated in various international congresses. Speaks Spanish and English. Author or co-author of about 150 publications.

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Education: B.A. (Majored in Foreign Service and International Politics), Pennsylvania State University (1968); M.S. (Majored in Development Sociology), Cornell University (1970); Ph.D. (Majored in Organisational Behaviour and Social Action), Cornell University (1973).
Experience: 1974-75: Lecturer (equivalent of U.S. Assistant Professor) in Rural Sociology, Faculty of Agriculture and Forestry, University of Dar es Salaam, Tanzania. Taught two undergraduate courses in introductory rural sociology and a graduate course in development

sociology; 1975-76: Consultant, USAID/Tanzania. Was involved in the collection and analysis of data for an evaluation of the National Maize Project; 1977-78: Volunteer, Watoto Wa Kimamba. Taught sewing and assisted with marketing for a women's co-operative; April 1977-June 1977: Consultant, USAID/Tanzania. Sociologist for the Arusha Planning and Development Project design team; 1978-79: Visiting Assistant Professor of Rural Sociology, Cornell University. Taught an introductory rural sociology course working with the Centre for International Studies; 1979-1981: Leader of interdisciplinary research team (resource economist, policy analyst, air-photo interpreter, animal production specialist, rural sociologist) on utilisation and management of water primarily for livestock use in the eastern communal areas of Botswana; 1979-82: Senior Research Associate, Centre for International Studies, Cornell University; 1982-83: Project Co-ordinator Land Tenure Centre, University of Wisconsin. Leader of joint Land Tenure Centre/Cornell University interdisciplinary team for research on village institutions in Botswana undertaken for the Ministry of Government and Lands; 1984-87: Assistant Professor, Department of Forestry and Resource Management, University of California Berkeley. Taught graduate and undergraduate courses in the sociology of natural resource management. Carried out research in rural California on the effect of land holding size and residence on natural resource management, and factors affecting environmental protest in rural areas. 1987-89: Associate Professor (Acting), Department of Forestry and Resource Management, University of California Berkeley; conducted research in rural California on the effect of patterns of timber land ownership on poverty and a comparison of attitudes about forest management held by recent and long standing residents of forest communities; Since 1989: Present position. Since 1998 Rudy Grah Chair in Forestry and Sustainable Development. Teaches graduate and undergraduate courses in research methods, interdisciplinary approaches to environmental science, conservation and the environment in sub-Saharan Africa, and the sociology of natural resource management. Carries out research in rural California on the relationship between changes in forest industry employment and changes in welfare dependence, the ecological and social effects of changes in land holding patterns over a 40 year period, and how local institutions influence the local expression of macro social and economic change. As Visiting Research Fellow, Centre for Applied Social Sciences, University of Zimbabwe (1991-92) conducted research on community management of trees and woodlands with particular emphasis on tree planting by women and on the role of narrative in struggles over land. Has undertaken various consultancies, examples of which are:- In October 1983 was a consultant to the Harvard Institute of International Development to prepare a paper on rural incorporation for USAID Workshop on Rural Development Research. in June 1989, was a member of the quinquennial external review panel for International Council for Research on Agroforestry and 1999-2000 assessed the effects of including culture in natural resource programming in Mozambique and the rural U.S. for the Ford Foundation.

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Experience: 1986-1997: Member of the Faculty, Graduate School, and Legume Breeder/Research Associate Professor, Institute of Plant Breeding, University of the

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Experience: 1958-80: University of Hawaii - Lecturer and Assistant Professor of Agronomy (1958-65); Associate Professor of Agronomy (1965-70); Professor of Agronomy (1970-80). 1965 Consultant (Ford Foundation) and Senior Agricultural Advisor, Aswan Agricultural Development Centre, Egypt. 1968: Visiting Professor in Agriculture, University of Brisbane. 1968-69: Visiting Scientist, IRRI. 1971: Senior Fellow, East-West Food Institute. 1973-76: Chief, Soil and Water Management Division, USAID. 1978-80: Chief,

Agriculture and Rural Development Division, Bureau for Asia, USAID. 1980-94: Senior Scientific Advisor to the CGIAR Secretariat. Since 1995: present position.
Panel Member of the Farming Systems Study (1977-78) and CGIAR Resource Person in the Reviews of CIAT (1977 and 1984), CIMMYT (1982 and 1987), CIP (1983 and 1989), IBPGR (1985), ICARDA (1983), IITA (1977 and 1983), ILCA (1981), ILRAD (1980 and 1986), IRRI (1982, 1987, 1992, and 1997), and WARDA (1986). Consultant to CIP Review (1995). Panel Secretary to 1st ILRI EPMR (1999). Panel Chair to 4th EPMR of ICARDA (1999). Member of several scientific societies and author of numerous publications.

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Experience:
1973-75: CIDA Bilateral, Nigeria Desk.
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1985-92: CIDA Multilateral (CGIAR, Commonwealth, UNDP).
1993-95: CIDA, Head of Aid, Guatemala.
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1991-94: IIRSDA, Côte d'Ivoire. Board Member and Chair of Program Committee.
1993-1997: CIP, Board of Trustees, (Chair '95-97).

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Experience: 1959-62: Research Assistant and Associate, Iowa State University. 1962-65: Economist and Assist. Chief, Agric. Economics Unit, Organisation of American States, Washington, D.C., USA. 1965-72: Agric. Economics Advisor for Mexico, Central America and the Caribbean Region, The Ford Foundation, Mexico, D.F. 1966-72: Part-time Professor, Agric. Economics Centre, Postgraduate College, Chapingo, Mexico. 1972-77: Agric. Advisor and 1974-77 Representative, The Ford Foundation, Brazil. 1977-85: Professor, Agric. Economics, Head of the Agric. Economics Department, and Director of the Research Division, Catholic University of Chile. 1986-88: Chief, Research Development Centre, Research and Technology Development Division, FAO, Rome. 1988-98: Dean, Faculty of Agriculture and Forestry, Catholic University of Chile; since 1999: present position. Member of numerous committees and review missions. Member of Boards of several Foundations and Business. Membership of various professional associations. Several honours and distinctions. Extensive travel throughout the world since 1951 in professional, academic and private activities. Member of the 2nd EPMR of IFPRI (1990). Chair of the 4th EPMR of IITA (1995).

TERMS OF REFERENCE
FOR EXTERNAL PROGRAMME AND MANAGEMENT REVIEWS
OF CGIAR CENTRES

BACKGROUND

Context

The Consultative Group on International Agricultural Research (CGIAR) is an informal association of over 50 members that supports a network of 16 international research centres in agriculture, forestry and fisheries. The CGIAR aims, through its support to the Centres, to contribute to promoting sustainable agriculture for food security in developing countries. Because the Centres constitute the core of the CGIAR, the effectiveness of each Centre is crucial to the continued success of the CGIAR (as a System).

Each Centre is an autonomous institution operating within the mandate assigned to it by the CGIAR, and is governed by a legally constituted Board that has full fiduciary responsibility for managing the Centre. To ensure accountability in an essentially decentralised system, each Centre is expected to be responsive to the CGIAR, which provides financial support for its work.

The CGIAR has established a tradition of External Programme and Management Reviews (EPMRs) to provide a mechanism of transparency and accountability to the Members and other stakeholders of the CGIAR System. EPMRs are the joint responsibility of TAC and the CGIAR Secretariat, and are conducted for each Centre approximately every five years. As each Centre is autonomous, EPMRs provide a measure of central oversight and serve as an essential component of the CGIAR's accountability system.

Integrated System of Reviews of Each Centre

Besides the EPMRs, Centre Commissioned External Reviews (CCERs) are undertaken at each Centre. These CCERs are commissioned by the Centre Boards to periodically assess the quality and effectiveness of particular aspects of a Centre's work. The terms of reference (ToRs) for each CCER are determined by the Centre, based on broad principles endorsed by the CGIAR at ICW95 (ref. document entitled *Improving the Quality and Consistency of CGIAR's External Centre Reviews*, dated October 24, 1995).

EPMRs complement the CCERs by providing a CGIAR-commissioned and comprehensive external assessment of the Centre's program and management, especially its future directions and the quality and relevance of its research. The ToRs for the EPMRs (which update the "standard ToRs" endorsed by the CGIAR at MTM95) are provided below. Guidelines for undertaking the reviews are issued separately.

TERMS OF REFERENCE

Objectives and Scope

EPMRs seek to inform CGIAR members that their investment is sound, or recommend measures to make it so. Members of the CGIAR and other stakeholders can be informed whether the Centre is doing its work effectively and efficiently. EPMRs are both retrospective and prospective; and help ensure the Centres' excellence, relevance and continued viability, and the CGIAR System's coherence. Each review is expected to be strategic in orientation and as comprehensive as the situation warrants.

The broad objectives of EPMRs are to: a) provide CGIAR members with an independent and rigorous assessment of the institutional health and contribution of a Centre they are supporting; and b) to provide the Centre and its collaborators with assessment information that complements or validates their own evaluation efforts, including the CCERs.

The EPMR panel is specifically charged to assess the following:

a) The Centre 's mission, strategy and priorities in the context of the CGIAR's priorities and strategies;
b) The quality and relevance of the science undertaken, including the effectiveness and potential impact of the Centre's completed and ongoing research;
c) The effectiveness and efficiency of management, including the mechanisms and processes for ensuring quality; and
d) The accomplishments and impact of the Centre's research and related activities.

The topics expected to be covered by the EPMRs are listed below.

TOPICS TO BE COVERED

A. Mission, Strategy and Priorities

- The continuing appropriateness of the Centre's mission in light of important changes in the Centre and its external environment since the previous external review.
- The policies, strategies, and priorities of the Centre, their coherence with the CGIAR's goals (of poverty alleviation, natural resources management, and sustainable food security), and relevance to beneficiaries, especially rural women.
- The appropriateness of the roles of relevant partners in the formulation and implementation of the Centre's strategy and priorities, considering alternative sources of supply and the benefits of partnerships with others.

B. Quality and Relevance

- The quality and relevance of the science practised at the Centre.

- The effectiveness of the Centre's processes for planning, priority setting, quality management (e.g., CCERs, peer reviews and other quality and relevance assurance mechanisms), and impact assessment.

C. Effectiveness and Efficiency of Management

- The performance of the Centre's Board in governing the Centre, the effectiveness of leadership throughout the Centre, and the suitability of the organisation's culture to its mission.
- The adequacy of the Centre's organisational structure and the mechanisms in place to manage, co-ordinate and ensure the excellence of the research programs and related activities.
- The adequacy of resources (financial, human, physical and information) available and the effectiveness and efficiency of their management.
- The effectiveness of the Centre's relationships with relevant research partners and other stakeholders of the CGIAR System.

D. Accomplishments and Impact

- Recent achievements of the Centre in research and other areas.
- The effectiveness of the Centre's programs in terms of their impact and contribution to the achievement of the mission and goals of the CGIAR.

ITINERARY OF THE EPMR PANEL

In the autumn of 1999, the Panel Chair and one Panel member met with Dr. Grant Scobie, Director General of CIAT 1995-1999. They also attended CIAT's Board meetings held at CIAT Headquarters in Cali 26 November - 3 December 1999. The whole panel visited the CIAT headquarters 17 - 23 January 2000 for the Initial Phase of the Review. Senior research and management staff gave presentations on the mission, goals, organisation, strategic planning, partnerships and financial issues. The Panel was also briefed on specific project activities, operational functions and support services of CIAT during group and individual meetings with Centre staff. Representatives of The Staff Association and the Internal and External Auditors were met. Three panel members visited the Ministry of Agriculture and the CORPOICA in Bogota.

From 23 January on, the Panel split into groups to visit CIAT's regional staff and collaborators in Central-America (23 – 28 January), Brazil (24 January – 2 February), and Eastern Africa (31 January - 4 February). In Managua, Nicaragua, the group was briefed on CIAT's activities in Central America, and on the dual-purpose livestock systems, bean network and the use of decision tools among other topics. They saw a NRM reference site in San Dionisio, where they met farmer and NGO partners. The SOL concept and CIAL research was discussed. They visited a TROPILECHE on-farm site. In Honduras the group visited the reference site in Yorito and a SOL. They heard about biophysical charaterisation, rural agroenterprises and local organisation strengthening. The group also visited farmers fields and heard about participatory research and monitoring.

In Brazil in the rice growing area of Santa Catarina state the group visited EPAGRI headquarters in Florianópolis, and the EPAGRI rice experiment station, where they met a senior scientist of FLAR. The visited a rice farmer and a private mill, Urbano Agroindustrial LTDA. In the state of Bahia at the EMBRAPA research station in Cruz das Almas, the group heard about the activities and collaboration with CIAT, and visited a small farmer-participatory project dealing with cassava improvement, which followed the model of CIAL. In Brasilia D.F. the group visited EMBRAPA's Secretariat for International Co-operation and the Biotechnology Centre, CENARGEN. Finally the group was introduced to the forage research activities at the Cerrados Centre of EMBRAPA.

Three panel members visited CIAT field programmes in East-Africa. The visit included meetings with CIAT staff at the Kawanda Agricultural Research Institute where the work on beans, IPM, soils and participatory research was introduced. The group also met the Director of ASARECA, a CIAT collaborator, and collaborating scientists at the Namulongo Agricultural Research Institute. In Iganga and in Nabango, Eastern Uganda, the group visited farmers involved in investigation of legume covercrops, green manure and bush beans, and in commercial seed production. In Western Kenya the group visited two regional KARI research centres, Kakamega and Kisii. They met a PRIAM farmer research group. They also met some national and ICRAF scientists collaborating with CIAT in Nairobi.

One Panel member joined the Regional Cassava Network annual meeting in Vietnam and met CIAT staff and collaborators in Asia. He visited a CIAT Community Research Management project site in Hong Ha commune, Vietnam, and also four project sites of the Forages for Smallholders Project in Malitbog, Mindanar in the southern Philippines.

The Panel reassembled at CIAT headquarters on April 3rd 2000 for the Main Phase of the review. The Panel had a chance to hear additional presentations on CIAT today, impact of its research and partnerships from the Management Team and meet staff members for further information and clarifications. The chapters of the report were shared with the Management Team and the relevant senior staff at the Panel Draft stage. On 19 April the report was presented to the Board Chair and other Board members present and subsequently to the CIAT staff.

DOCUMENTS PROVIDED TO THE REVIEW PANEL

A. Documents Provided by the TAC AND CGIAR Secretariats

1. Review Processes in the CGIAR, 1988.
2. CGIAR Priorities and Strategies for Resource Allocation During 1998-2000.
3. Report of the Fourth External Programme and Management Review of the Centro Internacional de Agricultural Tropical (CIAT).
4. Report of the First External Programme and Management Review of the International Livestock Research Institute (one of the most recent EPMR reports).
5. The TAC Commentaries on CIAT's 1998-2000, 1999-2001 and 2000-2002 MTPs.
6. A list of centre-specific issues drafted by the Centre for incorporation into the standard TOR of the review.
7. 'Update on the use of CCERs' (memo from TAC Chair).
8. Guidelines and TOR for EPMRs.
9. Medium-Term Resource Allocation 1998-2000: Centre Proposals and TAC Recommendations.
10. Lucerne Declaration and Action Program (pp. 7-12).
11. Most recent CGIAR Annual Report.
12. Most recent CGIAR Brochure and Directory.
13. Financial Requirements of the 1999 CGIAR Research Agenda (latest MTM99 doc).
14. Terms of Reference for External Programme and Management Reviews of CGIAR Centres.
15. Organisation and Management of the CGIAR System: A Review, 1993. (S. Özgediz, Public Administration and Development, Vol. 13, 217-231 (1993); copyright 1993 by John Wiley & sons, Ltd.).
16. Reference Guides for CGIAR International Agricultural Research Centres and their Boards of Trustees, August 1997.
17. CGIAR ICW99 End of Meeting Report and MTM99 Summary of Proceedings.
18. Evaluating Research Institutions: Lessons from the CGIAR. (S. Özgediz, Knowledge, Technology, and Policy, Winter 1999, Vol. 11, No. 4, pp. 97-113.

To Relevant Panel Members:

19. Governance and Management of the CGIAR Centres, 1991 S. Özgediz, Study Paper No. 27, copyright 1991, first printing October 1991).

20. Most recent volume of the CGIAR Board of Trustees Directory (October 1999).

21. CGIAR 1998 Financial Report.

22. Committees and Units of the CGIAR: Roles, Responsibilities, and Procedures.

23. Most recent CGIAR financial guidelines and manuals relating to:

    (a) Financial Management Guidelines, Series No. 1 (January 1988)
    (b) Accounting Policies and Reporting Practices Manual (October 1993)
    (c) Financial Guidelines - Audit Manual (July 7, 1995)

B. Documents Provided by CIAT

To all Panel Members:

24. The last board approved strategic plan of the centre.

25. The latest annual funding request.

26. A paper summarising the main achievements, constraints and impact of the centre programmes since the last CGIAR external review. It includes a summary of actions taken in response to the last EPMR.

27. The current organisation chart.

28. List of senior staff.

29. Most recent annual reports, and comparable research report of programs.

30. The latest Medium-Term Plan of the centre.

31. A paper summarising the main achievements, constraints and impact of the centre programmes since the last CGIAR external review (Sourcebook for the Fifth External Program and Management Review).

32. The current organisation chart, with a brief description of the centre's internal management structure, including the composition and terms of reference of each major committee.

33. List of senior staff with brief summary of qualifications.

34. Centre Commissioned External Review Reports.

35. List of reports of major planning conferences, internal reviews, expert meetings, etc., which have had a major influence on the direction of specific centre programmes (information for each project available in the Sourcebook).

36. Summary of actions taken in response to the last EPMR (included in the Sourcebook).

37. A list of staff publications during the period under review.

38. List of the agreements for co-operative activities with other centres and Institutions.

39. List of ongoing and recently completed contracted projects.

To some Panel Members:

40. Charter and other basic documents establishing the centre, along with subsequent amendments.

41. Table showing composition of the Board over the last five years, along with an indication of the term of office of the current members and their roles on the Boards.

42. Board handbook or rules of procedure.

43. Table showing allowances, benefits, and salary ranges for each category of Staff.

44. Table showing personal data on internationally recruited staff by programme, including each job title, incumbent's location, period of tenure, gender, nationality, age, salary over the last three years, funding source (excluding names).

45. Table summarising turnover of staff over the last five years by staff Category.

46. List of international staff vacancies and how long positions have been Vacant.

47. Brief description of the centre's information management systems and procedures (e.g., library and documentation, archives and records management, computer and information technology, management information systems).

Made Available to All Panel Members:

48. Set of minutes covering Board and Board committee meetings since the last External Review (and reports of Board committees to the full Board if not included in the minutes).

49. Staff manual or a description of current personnel procedures for international and locally recruited staff.

50. Local compensation surveys used by the centre.

51. Reports of external auditors, including management letters, and financial officer's reports to the Board since the last External Review.

52. Most recent internal audit reports.

ASSESSMENT OF CIAT'S RESPONSE TO THE RECOMMENDATIONS OF THE 1995 EXTERNAL PROGRAMME AND MANAGEMENT REVIEW (EPMR)

The 1995 External Programme and Management Review (EPMR) of CIAT made 16 recommendations. CIAT's response to these recommendations has been taken into account in the appropriate sections of the Report. The 1999 update provided by CIAT and the Review Panel's assessment of the status of implementation of the recommendations is presented in this Annex.

EPMR RECOMMENDATIONS

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
Commodity Research Programmes 1. That the Bean Programme give higher priority to research on nitrogen fixation and nutrient cycling in bean production systems, particularly in Africa.	BNF and low P tolerance research were conducted in collaboration with INRA, France until 1997, when the funding for the postdoctoral scientist ended. Collaboration continued through exchange of germplasm and methodologies. DNA markers for BNF were identified under greenhouse conditions and their usefulness under field conditions is tested. Selection under low soil fertility (under minimal application levels of P and no N) have become standard field operations in the breeding program. Additional financial resources are being sought in collaboration with INRA	Research work on understanding mechanisms and breeding for low P tolerance is important by itself, and in relation to BNF, particularly under field conditions. Nutrient cycling studies may be considered under PE projects if additional resources become available.	Implemented partially during the period under review 1995-99
2. That CIAT undertake genetic and ecophysiological research to increase both yield and viability of the seeds of the most important tropical grasses and legumes.	With the reduction of the financial resources available to CIAT during the 1995/96 period research on seed biology could not be continued. This decision was partially based on the evidence that the private seed industry in Latin America has taken up this research.	While the research area is important, the Panel concurs with the decision to discontinue the work in light of (1) funding limitations and (2) similar work by alternative suppliers.	Not implemented

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
Natural Resources Management Research 3. In view of the limited resources, the Panel recommends that: • The number of research sites be reduced; • Board and Management consider the options for consolidating existing programme structures; The Land management SRG should become either a programme or a unit depending on the orientation that CIAT considers more appropriate to its future.	These recommendations were considered and incorporated into the project structure introduced at CIAT in 1997. All Programs were closed and 16 projects were established, among them the land use project (PE4). CIAT closed down NRM research in Brazil sites at this time and changed the nature of its research collaboration with Brazil to one that no longer is based on the outposting of CIAT scientists to Brazil. Collaboration in soil research continued through the Soil Water Nutrient Management Program, in which EMBRAPA is a major partner. Three Ecoregional reference sites where established, one each for the priority mandate ecoregions –Savannahs, Hillsides and Forest Margins. Ecoregional reference sites were defined as the principal locations for CIAT projects and partners to demonstrate the impact on the ground of combining germplasm improvement and improved resource management research. This does not preclude CIAT projects from work in other research sites, but projects are expected to show significant effort in and contribution to the reference sites by means of annual workplans developed with partners for each ecoregional reference site, and annual evaluation of research progress in each site.	The reduction of the number of research sites would have had more effect if co-ordinated scientific efforts had been more focused on the remaining sites. The 1996 move to a project structure has led to some integration but also appears to have had some fragmenting effects. The land management SRG has been incorporated into PE-4. This project which includes GIS is high quality, effective, and has the potential to integrate much of the research in this area.	Implemented partially during the period under review

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
4. That CIAT establish a Soils Unit, which should follow an integrated approach with emphasis on organic matter, soil biota and nutrient cycling. The funding of a Soil Biologist to be located in the Unit should be given a high priority.	These recommendations were considered and incorporated into the project structure introduced at CIAT in 1996. All Programs were closed and 16 projects were established, among them the soils project (PE2). A strong working partnership with TSBF through the Soils Water Nutrient Systemwide Program has increased the flow of research results and capacity in the area of Soil Biology.	This recommendation is partially implemented. CIAT has a soils project, which has a different connotation than a Soils unit. The Soils unit is supposed to provide services. The soils group is considering soil organic matter, soils biota and nutrient cycling and should emphasise soil organic matter and nutrient cycling even more.	50% Implemented partially
Research Support 5. A new head of the GRU should be appointed as soon as possible. Experience is needed in strategic thinking on genetic resources, as well as in marker technology and the computing aspects of the population genetics/dynamics.	The position was filled and continues to be occupied by a highly competent specialist in germplasm conservation since May 1996.	A highly qualified and competent head of GRU has been managing SB-1 since 1996.	Implemented

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
6. That CIAT establish more biosafe greenhouse compartments for contained experiments, in line with its own biosafety guidelines.	In 1997 CIAT established four bio-safety glasshouse compartments of 30m2 each. These are currently being used for growing transgenic rice, cassava and Brachiaria. In 1999 a 125m2 screenhouse facility was added for post-flowering growth of transgenic rice. Because of the increasing demand for testing transgenic germplasm, not only generated by CIAT, but also by regional partners, CIAT plans to double the currently available space in the near future.	CIAT has adequate and appropriate biosafety glasshouse facilities.	Implemented
7. That CIAT should only undertake field trials with transgenic materials after obtaining approval from the government concerned.	In December 1998, the government of Colombia approved the regulations for testing genetic modified organisms under field conditions. CIAT has submitted applications for obtaining permission to plant under the new norms controlled field testing of transgenic rice lines resistant to rice hoja blanca virus. CIAT conducted in 1999 an international workshop on conducting field studies of transgenic rice and their release in the field.	The Panel is pleased with the way CIAT has been working with the Colombian authorities to secure approval for field testing of transgenic rice. The Panel suggests that CIAT initiate the same process with other LAC countries where CIAT may undertake a similar trial.	Implemented
8. That the VRU, in collaboration with relevant entomologists, devote greater attention to the epidemiology of major virus diseases of CIAT's mandate crops, as a prerequisite to integrated control of both viruses and their vectors.	These activities continue in the IMP project (Project PE-1). In addition, the system-wide whitefly project and the USDA appointed insect vector specialist have made an inventory of whitefly transmitted viruses and farmers methods of their control.	These activities are given adequate attention in the current IPM project (PE-1).	Implemented

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
9. That CIAT incorporate the Biometry Unit into a broader unit headed by a senior scientist, to handle scientific data management and decision support systems.	These recommendations were considered and incorporated into the project structure introduced at CIAT in 1996. All Programs were closed and 16 projects were established, and in the process of downsizing accompanying the change to a project structure, some support staff from Biometry decided to become private enterprise consultants in the area. Those projects with a strong demand for biometry capacity acquired the remaining CIAT staff with this expertise and/or were allocated operating budget with which to subcontract this support from within CIAT or from outside consultants. The Information Services Unit assumed the responsibility for scientific data management.	The panel believes that Biometry is important in CIATs research activities, and is critical with the expanding activities in applied genomics and bio-informatics. Access to a broader and varied competency appears satisfactory with the current practice of sub-contracting and/or by consultancy.	Not, because of the reorganisation

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
Research Management 10. Adoption of the organisational structure depicted in Figure 7.1, of which the main elements are: • Establishment of a position of Associate Director for Research Support and Information Services in place of the existing post of Associate Director for Natural Resources Management; • The research support units and the units handling information systems and services should report to the new Associate Director.	As indicated in the 1995 CIAT response, the incoming DG reviewed the structure of the senior Management Team. He decided to align the structure of the Management Team around the key elements of CIAT's strategy: improving productivity, managing natural resources, and doing research together. Directors for Germplasm Research, Natural Resource management Research, and Regional Co-operation are principally responsible for leading CIAT's strategy along each of these lines. Recent experience has confirmed that this structure serves CIAT well by bringing to bear specialised leadership expertise for each of the three central elements of CIAT's strategy.	CIAT opted for a different organisation structure.	Not implemented

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
11. The use of the matrix depicted in Figure 7.3, to describe the conceptual interaction between competency groups (which include both SRGs and Units) that provide input and the research programmes that are essentially responsible for output. All research projects should continue to be implemented within Programmes or Units.	CIAT's organisational structure has been considerably simplified since 1995, and the implicit matrix has been essentially discarded. CIAT currently implements its research program through a simplified structure of 16 projects instead of the previous organisation of six research programs and five units matrixed with five scientific research groups. CIAT recognises the need to periodically reassess its project portfolio and anticipates that the project portfolio may be revised as part of the upcoming Strategic Plan 2001-2010 in which other organisational issues may also be revisited.	CIAT chose a project-based organisation structure, also favoured by TAC.	No
12. That management engage scientific staff in project definition and ensure that all programme heads and project leaders are fully aware of all aspects of project management and budgeting.	Such training has been provided and funding is available through the staff development fund if additional training needs are identified. Training has also included team building skills.	Projects leaders and scientific staff are not only aware but engaged in most aspects of project management and budgeting. With the current project structure, opportunities for extensive scientific and administrative interactions are in place.	Implemented

1995 EPMR Recommendations	CIAT's 1999 Progress Report	2000 EPMR Panel's Comments	Implementation Status
13. That, in its consideration, of candidates to fill the position of Director General, the Board carefully consider the importance of a leadership style that will reintegrate the CIAT community and encourage participation in decision-making processes by programme leaders and scientists.	In 1995 a new Director General was appointed with a strong commitment to a participatory leadership style to integrate the CIAT community. Recently the appointment of another new Director General was made with the same criteria for leadership style again being an important consideration.	The recently departed Director General fully satisfied the criteria proposed by the 4th EPMR	Implemented
Financial and Human Resource Management 14. That the Operations and Programme Committee regularly monitor the adequacy of staff numbers in each research programme and discipline, and advise the DDG (Research) of any corrective measures needed. Such monitoring should cover not only the senior scientists but all other research staff as well.	The Management Team has assumed the responsibilities for monitoring staff numbers.	The project budget system allows detailed monitoring of staff numbers by the Management Team.	Implemented

1995 EPMR Recommendations	CIAT's 1999 *Progress Report*	2000 EPMR Panel's Comments	Implementation Status
15. That the performance assessment system be suitably modified to improve the performance planning and feedback processes used by supervisors, and to strengthen the standard-setting and monitoring roles of the DDGs and Evaluation Committee.	A new performance appraisal system was implemented. The new system is transparent, open and fair and is managed by an Evaluation Committee composed of key members of the Management Team. Training accompanied the transfer to the new system. The system requires that each staff member is evaluated for performance, to be signed by the evaluated. A second evaluator assures that the process was fair. A system of performance awards has been put in the place and budgetary reserves are made for this purpose. Starting in 1999 on a trial basis, a full circle evaluation system will be tested for future use.	The recommendation was fully and satisfactorily implemented.	Implemented
16. That a strategic plan for the development and organisation of information systems in CIAT should be formulated as soon as possible, for consideration by Management and Board. The emphasis should be on establishing a coherent Centrewide system, rather than on hardware and software problems.	A major analysis leading to the development of proposals for large new investments in information systems was conducted. However, Management decided in 198, after discussion with the Board of Trustees, that the scale of the proposed investment exceeded what was feasible within existing financial constraints. A new working group developed a proposal for a more modes reorganisation that was approved by the Management in 1999.	This has been dealt with in a pragmatic & cost-conscious way. Because of its high cost the proposed system was not implemented. Instead, changes were made to the existing systems but there is as yet no coherent centre wide system. The Panel suggests that CIAT now prepare a new Strategic Development Plan for CIAT info-systems.	Implemented

Review of CIAT Financial Management System

INTRODUCTION

Review Group: A team comprising Stephan Kall (GTZ), Rudolf Korntheuer (GTZ), Hock-Chye Ong (CGIAR/ICLARM/IPGRI/IRRI Internal Audit Group) and Ravi Tadvalkar (CGIAR Secretariat) conducted a review of CIAT's Financial Management System at the center's headquarters in Cali, Colombia on March 8-10, 2000.

Objective: The overall objective of the review was to assess the adequacy of the CIAT Financial Management System and, if necessary, to recommend appropriate corrective measures to strengthen it. In the context of a specific problem with a BMZ funded, GTZ administered project, the review sought to determine whether CIAT's mechanisms to ensure compliance with donor grant conditions are adequate.

Proces: the team interacted with the Management team of CIAT in addition to holding detailed discussions with Finance staff, internal and external auditors, J. Ashby, Director NRM (supervisor of the project [PRGA] funded by the BMZ grant), heads of information and administration. By an open and constructive approach by CIAT's acting DG and his colleagues, which included full access to CIAT documentation, facilitated the review team's work.

ASSESSMENT

Overall

Objectives: Service and compliance are key objectives and accountabilities of a Finance Group in any enterprise. The Finance Group provides the necessary service by:

- operating the financial processes that enable the enterprise to conduct its business, and
- furnishing analytical assistance to management, for implementing its business objective.

Finance Procedures and Staff: The work of CIAT's Finance Group is guided by a procedures manual (updated recently). The processing of financial information and the quality of routine financial reporting is of a professional standard. The procedures manual adequately links CIAT's financial processes to its legal obligations.

CIAT has roughly halved its staffing in the administrative and finance functions in the past five years. CIAT has been innovative in managing this reduction by outsourcing its activities, and by effectively managing the downsizing. Nonetheless, the reduction is reflected in significant overtime levels by existing staff. Additionally, downsizing has impeded the strengthening in the Finance groups functional areas.

Service Objective: The structure and organisation of the CIAT Finance Group are consistent with its service objective. The functional areas of budgeting, treasury and accounting are led by experienced professionals. The quality of CIAT's internal financial reporting is good, but external reporting to donors needs improvement. Financial systems need to be upgraded to allow efficient processing and improved analytic support for "budget holders" who exercise authority over components of the CIAT budget. The areas of financial information management and donor reporting require improved leadership.

Compliance Objective: The structure for overall compliance is in place with an office of an internal auditor, availability of competent external auditors and mechanisms for the board of trustees to provide the necessary oversight.

There is a need, however, to strengthen the compliance function of the Finance Group and the Budget holders, to support CIAT's decentralised management approach, and to cope with increasing levels of restricted funding and the resulting complex reporting requirements. The latter particularly requires management attention to ensure that the three parties that are involved -- Project Managers or budget holders, the Finance Group, and the project Office -- can fulfil their respective obligations harmoniously.

For this goal to be reached, budget holders must become more knowledgeable about basic financial principles, their assistants be more functionally integrated with the central finance function and the project office. Finally, the Finance Group as a whole must be more attentive to its compliance obligations. To do so more effectively, finance staff should improve their English fluency using the existing CIAT Staff Development program, as most grant documents are in English.

CGIAR Initiatives: Two existing CGIAR initiatives are relevant to CIAT's on-going efforts to strengthen its financial systems and examination of indirect costs. In collaboration with the Centres, the CGIAR Secretariat has launched a program to survey the existing financial systems at all centres in order to evaluate options for a common technology and software platform. (the survey team visited CIAT a few weeks ago). The results of this work, likely to be available in the next four to six months, will assist CIAT in making its own choices in this area. A similar program to develop a common methodology and framework on indirect cost is also underway with analyses completed at five pilot centres. This work should assist CIAT in its own examination of indirect costs and overhead rates for inter-centre activities.

Specific

BMZ Grant: The problems with the BMZ grant are possibly the result of miscommunication between budget holders and the Finance Group, due to inadequate understanding of grant obligations. An accounting mistake was made in the 1998 accounts (treating a long-term commitment as expenditure), and was carried over subsequently in reporting to GTZ six months later. CIAT's evident misreading of the successive requests for clarification from GTZ compounded the problem. Budget holders

were not aware of the significant infraction of accounting rules, although the Finance Department appears to have been, and hence CIAT did not respond adequately until earlier this year. The relatively poor quality of the financial report submitted to GTZ compounded the problem. It is important to note that the issue did not represent a misuse of funds but was an accounting infraction. Nonetheless, the accounting infraction if not corrected would have caused CGIAR to breach its own compliance obligation.

RECOMMENDATIONS

Overall

- Re-emphasise the role of the Finance Manager as a key partner in the Management Team.
- Clarify the joint-accountability of both Finance and Budget Holders on all matters relating to the financial management, monitoring, and reporting.
- Enhance the accountability culture in CIAT along the lines of the Committee of Sponsoring Organisations (COSO) Internal Control Framework comprising the elements of control environment, risk assessment, control activities, monitoring, and information and communication.
- Strengthen the linkages and communication among Budget Holders, Project office, and Finance.
- Make training and education of project financial management a mandatory requirement for Budget Holders to enhance their basic financial management skills and knowledge for monitoring the financial and budgetary aspects of their projects.
- Assess options for strengthening the accountabilities and efficiency of the service delivery and compliance roles of the administrative staff located in the decentralised business units by re-examining the structural linkage between Finance and the decentralised administrative staff.
- Review the feasibility of the various options and choices for replacing CIAT's financial information systems along the lines of the CGIAR system-wide review on financial information systems.

Specific

- The GTZ grant for PRGA, presently frozen, should be made operational within the next four weeks under the following conditions: submission of a revised and realistic business plan reflecting the current status and mode of the program, and an ex-post audit of the project. The audit's TORs should be jointly developed with GTZ.

CIAT DIRECT RESEARCH ALLOCATION 1999
($US thousand)

Projects Ranked by Unrestricted Core		Projects Ranked by Restricted Projects & Systemwide Income	
Land Use	1322	Beans in Africa	2382
Biotechnology	1229	SystemwideParticipatory	1800
Rice	1188	Hillsides	1508
Soils (PE2)	1120	Systems	1135
Genetic Resources	914	Systemwide Soils (SWNM)	1000
Hillsides	906	Beans	984
Beans	834	Biotechnology	894
Forages	685	Rice	715
NARS Linkages	618	Land Use	652
Systems	576	Cassava	596
IPM	405	Agroenterprises	564
Participatory Research(SN3)	387	Forages	555
Cassava	383	IPM	462
Agroenterprises	346	Impact Assessment	418
Impact Assessment	313	Ecoregional	300
Ecoregional	0	Soils (PE2)	270
Systemwide Soils	0	NARS Linkages	186
Beans in Africa	0	Participatory Research (SN3)	84
Systemwide Participatory	0	Genetic Resources	34

Projects Ranked by Core as % of Total		Projects Ranked by Total Income	
Genetic Resources	96%	Hillsides	2414
Participatory Research(SN3)	82%	Beans in Africa	2382
NARS Linkages	77%	Biotechnology	2123
Rice	62%	Land Use	1974
Land Use	58%	Rice	1903
Biotechnology	58%	Beans	1817
Forages	55%	Systemwide Participatory	1800
Soils (PE5)	47%	Systems	1710
IPM	47%	Soils (PE5)	1391
Beans	46%	Forages	1240
Impact Assessment	43%	Systemwide Soils (SWNM)	1000
Cassava	39%	Cassava	978
Agroenterprises	38%	Genetic Resources	948
Hillsides	38%	Agroenterprises	910
Systems	34%	IPM	867
Beans in Africa	0%	NARS Linkages	805
Systemwide Participatory	0%	Impact Assessment	731
Systemwide Soils (SWNM)	0%	Participatory Research(SN3)	471
Ecoregional	0%	Ecoregional	300

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GLOSSARY OF ACRONYMS

ACMD	African Cassava Mosaic Disease
AGLINET	Agricultural Libraries Network
Al	Aluminium
AHI	African Highlands Initiative
ARI	Advanced Research Institute
ASARECA	Agreement on Strengthening Agricultural Research in Eastern and Central Africa
ASB	Alternatives to Slash-and-Burn
ATIS	Alternative Trade Information System
BAC	Bacterial Artificial Chromosome
BGMV	Bean Golden Mosaic Virus
BIOTECH	Centro de Desarrollo Tecnológico e Innovación de Sistema Nacional de Innovación.
BNF	Biological Nitrogen Fixation
BOT	Board of Trustees
BPGR	International Board on Plant Genetic Resources
BRU	Biotechnology Research Unit
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CBN	Cassava biotechnology Network
CCER	Center-Commissional External Review
CD-ROM	Compact disk - read only memory
CENARGEN	Centro Nacional de Recursos Genéticos
COSO	Committee of Sponsoring Organisation
CG	Consultative Group
CGIAR	Consultative Group on International Agriculture Research
CGM	Cassava Green Mite
CIAL	Comité de Investigación Agrícola Local
CIAT	International Centre for Tropical Agriculture
CIFOR	Centre for International Forest Research
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CIP	Centro Internacional de la Papa
CIPASLA	Consorcio Internacional para la Aricultura Sostenible en Laderas
CIRAD	Centro de Coopération Internationale en Recherche Agronomique
CLAYUCA	Consorcio Latinoamericano y del Caribe de Apoyo a la Investigación y Desesarrollo de la Yuca
CONDESAN	Consortium for the Sustainable Development of the Andean Ecoregion
CORPOICA	Corporación Colombiana de Investigación Agropecuaria
COSO	Committee of Sponsoring Organisations
COSUDE	Corporación Suiza de Desarrollo
CRYO	Cryopresrvation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CT	Condensed Tannins

DDG	Deputy Director General
DG	Director General
DNA	Deoxyribonucleic acid
DSS	Decision Support System
EAT	Empresa Asociativa de Trabajadores
ECABREN	East and Central American Bean Research Network
EMBRAPA	Empresa Brasilera de Pesquisas Agropecuarias
EPAGRI	Empresa de Pesquisa Agropecuaria e Extensao rural de Santa Catarina
EPMR	External Programme and Management Review
EST	Expressed Sequence Tags
FAO	Food and Agriculture Organisation of the United Nations
FDRH	Staff Development Fund
FEDEARROZ	Federación Nacional de Arroceros of Colombia
FIAR	American and Caribbean Irrigated Rice
FLAR	Fondo Latinoamericano para el Arroz de Riego
FTE	Full Time Equivalent
FUNDARROZ	Fundación Nacional de Arroz of Venezuela
GIS	Geographic Information System
GRM	Genetic Resource Management
GRU	Germplasm Research Unit
GRU	Genetic Resource Unit
GTZ	Deutsche Gesellschaft für Technisiche Zusammenarbeit (Germany)
HCN	Prussic Acid
IA	Impact Assessment
IAEG	Impact Assessment and Evaluation Group
IAP	Impact Assessment Project
IARC	International Agricultural Research Centre
IBPGR	International Board for Plant Genetic Resources
IBRSRAM	International Board for Soil Research and Management
ICER	Internally Commissioned External Review
ICRAF	International Centre for Research in Agroforestry
ICW	International Centres Week
IDRC	International Development Research Centre, Canada
IFDC	International Fertiliser Development Centre
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
INIA	Instituto Nacional de Investigación Agrícola
INGER	International Network for Genetic Evaluation of Rice
INRA	Institute Nacional de Researche Agronomique
IPGRI	International Plant Genetic Resource Unit
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management

IPRA	Investigación Participativa con Agricultores (Participatory Research in Agriculture)
IRD	Institut Francais de Recherche Scientifique pour le Développment en Coopération
IRGA	Instituto Rio Grandense do Arroz
IRRI	International Rice Research Institute
IRS	Internationally Recruited Staff
IRTP	International Rice testing Program
ISNAR	International Service for National Agricultural Research
IU	International Undertaking
KARI	Kenya Agricultural Research Institute
LAC	Latin America and the Caribbean
MAS	Marker-aided selection
MT	Metric Ton
MTM	Mid Term Meeting of the CGIAR
MTP	Medium Term Plan
NARS	National Agriculture Research System
NCGR	The National Centre for Genome Resources
NGO	Non-Governmental Organisation
NRM	Natural Resource Management
P	Phosphorus
PABRA	Pan Africa Bean Research
PBM	Plant Breading Methodology
PGR	Plant Genetic Resources
PPB	Participatory Plant Breeding
PPO	Project Planning Objectives
PRIAM	Participatory Research in Agroecosystem Management
PRM	Participatory Research Methods
PROCINANDINO	Programa Cooperativo de Investigación Agrícola de la Región Andina
PROCITROPICOS	Programa Cooperativo de Investigación Agrícola de la Región Tropical
PROFRIJOL	Programa Cooperativo Regional de Frijol de Centroamérica, Mexico y el Caribe
PROFRIZA	Proyecto Regional de Frijol para la Zona Andina
QTL	Quantitative Trait Loci
RHBV	Rice Hoja Blanca Virus
RITA	Récipient á immersion temporaire automatisé
RPA	Responsibility Performance Agreement
SABREN	Southern African Bean Research Network
SCAR	Sequence Characterised Amplified Regions
SENA	National Apprenticeship Service
SGRP	Systemwide Genetic Resources Programme
SI-AH	Systemwide Initiative on African Highlands
SI-ASB	Systemwide Initiative on Alternatives to Slash and Burn
SI-IMP	Systemwide Integrated Pest Management Initiative
SINGER	Systemwide Information Network for Genetic Resources

SI-PRGA	Systemwide Initiative on Participatory Research and Gender
SOL	Supermercado de Opciones de Laeras
SPIA	TAC Standing Panel on Impact Assessment
SP-SWNM	Systemwide Program on Soil, Water and Nutrient Management
SP-SWNM	Systemwide Program on soil, Water, and Nutrient Management
SRG	Scientific Resource Group
SSR	Simple Sequence Repeat
SWP	Systemwide Program
TAC	Technical Advisory Committee
TPP	Tropical Pastures Program
TROPILECHE	Improved legume-based feeding systems for smallholder dual-purpose cattle production in tropical Latin America
TSBF	Tropical Soil Biology and Fertility Programme (Kenya)
UNDP	United Nations Development Programme
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
VRU	Virology Research Unit
WARDA	West Africa Rice Development Association