the consultative group on international agricultural research
technical advisory committee

report of the tac quinquennial review mission to the international center of tropical agriculture

tac secretariat
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

REPORT OF THE TAC QUINQUENNIAL REVIEW MISSION TO THE INTERNATIONAL CENTRE FOR TROPICAL AGRICULTURE (CIAT)

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1977

REPORT OF THE TAC QUINQUENNIAL REVIEW MISSION

TO THE

INTERNATIONAL CENTRE FOR TROPICAL AGRICULTURE (CIAT)

Sir Charles Pereira (Chairman)

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MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

Whitehall Place
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12 October, 1977

Dear Dr Cummings,

I have pleasure in formally transmitting to you the report of the first TAC Quinquennial Review of CIAT. All Panel members were very conscious of the heavy administrative responsibility which TAC had placed on them. The substitution of thorough Quinquennial Reviews for the more frequent visitations previously carried out by donors was agreed by CGIAR in order to secure more staff time for uninterrupted research effort. This places upon the Review Panel heavy responsibilities to ensure for donors a critical assessment as to whether their funds are being well used for the purposes agreed by CGIAR.

At CIAT, the Director, staff and Board of Trustees are faced with a task of formidable scope and complexity in research for the support of national developments of food production in so vast and varied a region.

The persistence of so much agricultural and urban poverty in a continent with such extensive untapped resources presents a challenge, not only to science, but also to economic, social and political skills. In the first few years the CIAT program attempted to concentrate directly on the detailed problems of small farmers and was able to demonstrate many ways in which their agricultural techniques could be improved. This program, however, proved impossible to focus at a level which would initiate major improvements in the food production of the region. The Trustees have therefore undertaken a major reorganisation over the past three years. The Review Panel was well-timed, in that we visited CIAT at the stage when a new program was gathering momentum under a new Director. We are glad to be able to assure TAC that the reorganisation has been successful and that the program is now addressed to targets which will have a major impact on the agricultural prosperity of tropical Latin America, while the whole Center, rather than a special group within it, is concerned that the small farmer should benefit from these advances.

In our visits to field work in Brazil, Colombia and Guatemala, we received much courtesy and hospitality from the Governments and national research organisations of these countries. We were encouraged by the joint research programs and the evidence of close cooperation between CIAT and national research staff which we observed in all three countries.

Dr Nickel and his staff made thorough preparations for our visit and cooperated most constructively in our enquiries. I am most grateful for the help and hospitality which we received.

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Dr Ralph W. Cummings
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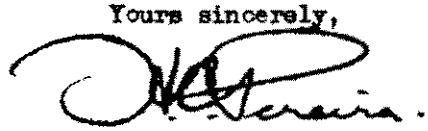
Finally, I can assure you that the Review Panel worked hard and conscientiously and were supported by expert organisation from our member-secretary, Mr Philippe Mahler. We were therefore able to complete the draft report in time for discussion with the Director and his senior staff and with the Chairman of the Program Committee of the Board of Trustees on the final day of our visit.

Having now experienced both the IRRI and CIAT Quinquennial Reviews, I would strongly recommend to TAC that preliminary visits by the Review Panel to the developing countries most concerned with a Center's output, and discussion of the draft report with the Director and with at least some members of the Board of Trustees, should be standard procedures in TAC reviews.

Yours sincerely,



Charles Pereira

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REPORT OF THE QUINQUENNIAL REVIEW PANEL TO CIAT

April 14 - 29, 1977

I. INTRODUCTION

1. At its fifth meeting, in July 1973, the Consultative Group on International Agricultural Research (CGIAR) saw the need to assess the overall scientific quality and effectiveness of the work being carried out by the International Agricultural Research Centres (IARCs). A Sub-Committee on Review Procedures was established and reported to the CGIAR in November 1973. Further to the deliberations of the CGIAR, the revised report of the Sub-Committee made the following recommendations to the CGIAR and to its Technical Advisory Committee (TAC):

> "The CG needs periodic independent external assessment of the overall scientific quality and effectiveness of each center, and of the continuing need for its work, with special emphasis on the need to ensure that activities are not continued longer than necessary, and that activities of lower priority are replaced by those of higher priority. Such assessments are not appropriate on an annual basis, but should be scheduled no less frequently than every five years. Such assessments are equally needed by the Centers themselves, and it is the practice of the Centers to organize them (sometimes separately for major segments of the research programme, rather than for a Center as a whole). The CG looks to the TAC to assure that such periodic external assessments are made; it would seem feasible for the TAC to meet its responsibilities in most cases by: (1) assuring itself that the Center's assessment process is adequate, and; (2) participating in the Center's assessment process by mutual agreement with the Center's Director. If the TAC considers it necessary, it can lay on a special assessment process separate from that organized by the Center for its own purposes.
>
> "We recommend that: (1) the TAC and the Centers develop an agreed forward schedule and agreed standards and methods for conducting such periodic external scientific assessments; (2) the TAC adopt a regular procedure for participating in such assessments, reviewing their results, making any independent assessments it may consider necessary, and reporting its judgement to the CG".

2. The TAC accepted this mandate on the following general terms of reference:

> "On behalf of the Consultative Group, to assess the quality and value of the scientific program of the Centers in order to assure the Consultative Group members that the operations being funded are being carried out in line with declared policies and to the full international standard expected.
>
> "It is hoped that the review will inter alia assist the International Centers themselves in planning their programs and ensuring the validity of the research priorities recognized by the Boards of the Centers".

3. TAC also charged the Secretariat to draw up a schedule for such review and to prepare draft Terms of Reference for the review missions. The Review Mission to IRRI was carried out in late 1975, that to CIMMYT in Spring 1976, and that to CIP in Autumn 1976. CIAT was then selected as the fourth Centre to be reviewed and the Terms of Reference for the Review Mission, after consultation with the Director General of CIAT, were finalized as follows:

Terms of Reference of the Quinquennial Review of CIAT

In pursuance of the main objective, defined above, the Mission was requested to give particular attention to the following aspects of the work of the Centre:

"(i) The results of past research and training programs at the Center and the use to which the results have been (or are planned to be) put;

(ii) the relevance, scope, content and objectives of the present and planned programs of research at the Center in relation to (a) the broad mandate of the Center, and (b) the immediate and long-term needs for increased food supplies globally, and to advise on the future composition and balance of the program of research;

(iii) the current conference and training programs being undertaken or planned by the Center and the factors affecting the use of trainees by the recipient countries once their training has been completed;

(iv) the effectiveness of the work conducted under the information service and outreach programs of the Center, and its impact on recipient countries;

(v) the expenditures of the Center in relation to the quantity, nature and quality of its research and training programs;

(vi) the adequacy of the resources available to implement the programs of research and training recommended above;

(vii) the constraints which may be hindering the achievement of the Center's objectives, and possible means of reducing or eliminating such constraints;

(viii) the effectiveness of coordination of activities at the Center, both in respect of internal consistency and balance of program elements, and in particular with reference to its linkages with other national and international organizations."

4. "On the basis of its review, the Mission will report to the Chairman of TAC its views on the need for any changes in the basic objectives or orientation of the Center's program elements, and on means of improving the efficiency of operations, and will make proposals for overcoming any constraints identified under item (vii). While the Mission should feel free to make any observations or recommendations it wishes, it must be clearly understood that the Mission cannot commit the sponsoring organization viz, the CGIAR/TAC."

5. The preparations for the Quinquennial Review were conducted in close cooperation with the Director-General of CIAT who was consulted on the composition of the Review Panel, the list of major questions to be addressed by the Review and the programme. TAC and Consultative Group members received progress reports on these preparations at the 14th and 15th meetings of TAC. In addition, donors to CIAT were invited to comment on the terms of reference. Prior to starting the Review, the Panel members received from CIAT and from the TAC Secretariat a number of documents, which are listed in Annex III.

6. The Review Panel was first divided into two groups which visited some of the CIAT outreach activities before assembling at CIAT headquarters, Palmira, on 17th April, 1977. One group examined CIAT/ICTA cooperative activities in Guatemala. Another group went to Brazil and visited EMBRAPA headquarters at Brasilia and the Campo Cerrado Station. This group then spent a day at Carimagua in the Llanos Orientales of Colombia, visiting CIAT/ICA cooperative activitiesin the field of pastures and beef production research.

7. The Review Panel spent the first week at CIAT headquarters, listening to the presentations of the activities and programmes and visiting the experimental fields, laboratories and other facilities of the Centre. During this week, the Panel also visited several sites at which CIAT is conducting experiments and trials at Santander de Quilichao, Popayán and Caicedonia. The presentation and the field visits provided ample opportunity to the Review Panel Members for discussion with the research staff of CIAT at all levels.

8. The second week at CIAT headquarters was mostly devoted to writing and discussing the several drafts of the report and to examining some critical issues further with the Director-General and the staff. On the last day the Panel met with the Director-General and with the Senior Staff, as well as with the Chairman of the CIAT Programme Committee. The broad conclusions of the Review Panel were presented by its Chairman, and the reactions of the Director-General of CIAT and his staff as well as those of the Chairman of the Programme Committee were noted.

9. The composition of the Review Team, and its itinerary and programme schedule, are given in Annexes I and II respectively.

II. CIAT AS AN INTERNATIONAL RESEARCH AND TRAINING CENTRE

A. THE MANDATE AND ITS INTERPRETATION

10. In its description of the mandates of the International Centres, the Consultative Group allots to CIAT a very broad task: "CIAT has the objective of improving agriculture in the lowland humid tropics, especially in Latin America" (CGIAR, N.Y., 1976).

11. From its establishment in 1967, the Board of Trustees interpreted this mandate as "To accelerate agricultural economic development and increase agricultural production and productivity of the tropics to improve the diets and welfare of the people of the world." These terms remained unaltered until 1977, while the Board progressively evolved its programme policy.

12. These objectives have been pursued through major research and development programmes over the main food crops of the region, cassava and field beans, and through cooperative programmes with IRRI on rice and with CIMMYT on maize. Animal production programmes in beef cattle and in swine were also launched, and in 1973 there was added a Small Farm Systems Programme. The crop improvement programmes followed the successful principles of both IRRI and CIMMYT, but the animal and small-farms programmes departed from this pattern, to seek broader and less specific objectives. CIAT thus became unique among the International Centres by having research programmes on both crops and livestock.

13. Since the early 1970s there has been a complete move away from a disciplinary-based programme to a commodity-based multidisciplinary team approach emphasizing production systems.

14. All of CIAT's programmes have been subject to frequent and intensive review, both internally, by the Programme Committee on behalf of the Board of Trustees, and by external review teams. There as been a particularly heavy pressure of external review activities on CIAT's programmes. In 1974, an external review conducted by IDRC studied the Swine Programme. An international advisory committee for the Bean Programme met first in 1975 and again in December 1976; it proposes to meet annually "to review progress.....and comment upon its appropriateness for bean research in Latin America."

15. An external review team studied the Beef Production Systems Programme in May 1973, and external consultants assisted in a review by the Board of Trustees which approved proposals for a radical revision of the Beef Programme in 1976.

16. The Cassava Research Programme has had five reviews by the Cassava Advisory Committee, the latest in 1975.

17. In April 1975, a two-day workshop on the Small Farm Systems Programme was followed up by a four-man Task Force which led the Director-General to recommend to the Board of Trustees that the programme be terminated. This action did not imply a diminished attention to small farms but, in the words of Dr. Nickel, was intended: "to ensure that the job of developing and validating technology for the small farmer, and concern for improving the welfare of the poor, users and consumers alike, will be a job, not of a special team, but of every member of staff."

18. By agreement with the Director-General, the TAC Quinquennial Review Team integrated into its proceedings a review of Farming Systems Research by an independent "Stripe Review" team which is to visit four of the Centres.

19. As a result of the very substantial reorganization of the work on both beef production and small farm systems, the TAC Review Panel found a great deal of new work at an early stage of implementation. With the Director-General and two Associate Director-Generals all appointed within the last two years, and with several new senior staff, there was a very strong atmosphere of change.

20. The Panel wished to record its impression that the Centre has benefited substantially from the reorganization and that there is a convincing sense of purpose in the way the revised programmes are being undertaken.

21. The interpretation of the very broad mandate of CIAT has thus been effectively clarified and redefined. The Review Team believes that this Centre must now be given the opportunity to settle down and make uninterrupted progress.

22. Attention is drawn to the time, effort and resources which have already been expended in the review of CIAT programmes; also to the recommendations of the Bell Committee that the

TAC Quinquennial Review should be used by the Consultative Group, by the two Secretariats and by donors, so that interruptions of productive research work may become less frequent, and the time and energies of senior staff may be less eroded by over-frequent reviews.

B. STRATEGY OF RESEARCH

23. Within the wide range of subjects which could be covered by its mandate, CIAT has concentrated on the efficient use of well-established methods for the improvement of crop production technologies in the main food crops of Latin America. In crops alone, CIAT has already undertaken a heavy workload by initiating major programmes on cassava and on beans, and by adapting to the region and actively promoting advances in the technologies of production of rice and of maize as developed by IRRI and CIMMYT. A major crop improvement programme in forage legumes and grasses also provides the foundation of the Beef Program. The international and inter-centre aspects of this strategy are considered in sections C and D below.

24. The initial strategy in the field of animal production was less sharply focused. The programmes assessed the constraints on production applied by disease, by nutrition and by management at the small-farm level. Technologies for the overcoming of these limiting factors were studied for low levels of purchased inputs.

25. During the first five years of experience, a valuable assessment was achieved of the incidence and the economic impact of stresses from disease, nutrition and management factors. In both beef cattle and swine the major constraint is now considered to be that of nutritional stress. The programmes have therefore been redefined with sharper focusing on pasture production and beef cattle management and on the better nutrition and husbandry of swine. The main orientation of CIAT to the objective of helping low-income producers and consumers remains paramount.

26. The Review Panel endorses these changes in emphasis. Concern that the cattle health and management aspects might receive inadequate attention was assuaged by information about a new major programme of disease prevention studies which was in process of negotiation, financed independently of the Beef Production Programme but to be carried out in close cooperation with it. Pasture assessment and herd management studies are included as a strong component of the Beef Production Programme as discussed in Chapter IV A.

27. Finally the overall aim of CIAT's research policy must be considered. The Consultative Group has firmly declared that "the highest priority must be given to achieving

a marked increase in food production in the less developed countries themselves ..... The research and training programs sponsored by the Group seek to arm the developing countries with superior varieties of essential crops and improved systems for the production of food plants and animals ..... Productive agriculture is both an economic and a humanitarian imperative in the developing world. The rural sector must generate savings and production to move development forward: it must overcome the hunger and malnutrition that are the familiar lot of poor people everywhere" (CGIAR, N.Y., 1976).

28. In its crop development programmes, CIAT is unequivocally working on the lines laid down by the Consultative Group. In the programme for beef production, however, CIAT has addressed its main effort purposefully to the largest undeveloped land resource of Latin America, the infertile, highly acid soils of the savannahs. With growing populations and increasing density of settlement in the existing agricultural areas, some 300 million extra hectares can be brought into productive use by the creation of new technologies which are well within the scientific capacity of CIAT and of the national institutes working in cooperation with CIAT. These vast savannahs, the "cerrado" of Brazil and "llanos" of Colombia, Venezuela and similar lands in Perú, Bolivia and other tropical countries in Latin America, have the immense advantage of a fairly reliable rainfall of over 1,000 mm in a well-defined wet season, with a dry season of up to six months. They are characterized by the low fertility of "allic" soils (leached acid soils with high levels of exchangeable aluminium).

29. Improved varieties of pasture grasses, forage legumes and food crops, especially cassava, beans and upland rice, selected for tolerance to allic soils and for productivity with a minimum of purchased inputs, are scale-neutral in their application and will permit major food production increases and the opening up of large areas for farming settlement.

30. It must be emphasized, however, that in agriculture everywhere plants cannot flourish without an essential supply of mineral nutrients. Nitrogen can be won from the air by legumes associated with nitrogen-fixing soil bacteria, and technologies to improve this are in hand. Purchased inputs of phosphorus, calcium, magnesium, sulphur and other elements can be reduced by good agricultural techniques, but can never be eliminated if a

cropping system is to be maintained and substantial yields of produce containing these elements are to be sold off the farm. Some form of agricultural credit and supply organization, essentially a role for national government institutions, is therefore implicit for increased food output. Apart from nutrients there are, of course, other institutional constraints, of which, in Latin America, land tenure is of particular importance.

31. There are many more fertile areas of Latin America which are already producing crops and livestock. If CIAT were to concentrate on these areas, the initial response in agricultural output would be more immediate than can be expected from the savannahs. The more fertile areas, however, already include examples of advanced technology developed by private enterprise and by national institutions with both bilateral and multilateral support. Development of these fertile areas is clearly within the capacities of national governments if they make good use of the help already available to them. As an International Centre with world-wide support, CIAT is undertaking the more difficult long-term scientific and practical task of developing technologies for a major new agricultural resource to meet future increases in the food requirements of Latin America. The Review Panel endorses this strategy.

C. TRAINING STRATEGY

32. An essential element of CIAT's overall strategy is its training programme. Via this programme a cadre of professionals with special competence in CIAT's commodities is being built up, in particular throughout the American tropics. As was strongly evident from the Review Panel's visits to Guatemala and Brazil, these trainees are highly regarded and constitute a most important link for CIAT in its technology testing and transfer activities. Without such contacts familiar with CIAT's research and technology development, it would be far more difficult for CIAT both to liaise with national institutions and to be confident of fruitful cooperation.

D. COOPERATION WITH NATIONAL PROGRAMMES

33. CIAT has a vigorous "outreach" policy, now designated as "International Cooperation"; it is based on links with national institutions for both the transfer of technology and joint studies for its improvement, as well as the provision of feedback on country needs. World-wide networks are being established for the field testing of cassava, bean and forage varieties, together with regional networks for rice and maize variety trials (organized in cooperation with IRRI and CIMMYT). These networks of field tests are assisted by stationing trained staff in the collaborating countries. At present nine such staff are in post, two of them supported by Core funds and seven by special funding. Proposals are under discussion to double this number and to serve additional countries or regions in 1978 if funding can be arranged.

34. The Review Panel was able to assess examples of these relationships at first hand. Four of its members, Messrs.Thurston, Robles, Rogers and Mahler, visited Guatemala where CIAT has resident staff involved directly in an institution-building role with the Instituto de Ciencia y Tecnología (ICTA); CIAT and CIMMYT both train instructors for ICTA and supply much of the technology and information to be taught. The Review Panel considered that CIAT was giving decisive assistance, which was highly appreciated by Guatemala, to a rice and bean programme of rather unique interest. The technologies used were borrowed directly from the IARCs and from other sources of help, and were validated by direct tests in the farmers' fields. In Guatemala,scientific staff are few in number and change posts frequently. Training is therefore of the greatest importance and is highly appreciated.

35. In two other countries, Brazil and Colombia, another group of Review Panel members, Messrs.Dillon, Hutton, McCosker, Ortiz, Mendez, Pereira and Weniger, were able to observe discussions between CIAT and the national agricultural research institutions, EMBRAPA and ICA, on the establishment of joint programmes for beef production on the allic soil savannahs.

36. The outstanding feature in both the negotiations was the mutual confidence and respect which permitted the establishment of a single joint programme in each country. Thus, in Brazil there will be a single joint "EMBRAPA/CIAT Cerrado Pasture Improvement and

Beef Production Program". The Director of Research of EMBRAPA, who is currently a member of TAC, said that experienced CIAT scientists stationed in Brazil would be welcomed in a leadership role. In Colombia, the long established relationship between CIAT and ICA had been re-invigorated by the setting up of a joint ICA/CIAT team to conduct pasture research and beef production studies on the llanos at Carimagua.

37. The whole Review Mission Team also visited a newly acquired experimental site at Santander de Quilichao, where the relations between CIAT and the farming community were evidently very close; a Colombian foundation had purchased the 180 ha. farm and assigned it to CIAT for a nominal rent. This new development will provide a valuable facility for screening materials and technology on allic soils, with a minimum of travelling.

38. In order to minimize documentation for travel, especially for sending nationals of other Latin American countries to CIAT for training, formal bilateral agreements are proving useful. Bilateral agreements with Brazil, Costa Rica, and Peru are under negotiation. Staff training represents a major activity in international cooperation, and is commented upon in Chapter V.

39. The individual commodity programmes have different patterns of international cooperation. The most formal is that of the Bean Production Systems Programme in which, at the request of the TAC, CIAT accepted responsibility in 1975 for coordinating and assisting a Latin American Bean Research Network. Since the basis of CIAT's international relations policy is one of personal contact, nine scientists each undertook responsibilities for up to three countries in this network. Research leaders and senior scientists from the national programmes have been invited to CIAT, and both training and documentation services have been intensified. The organization of the first International Bean Yield and Adaptation Nursery for 1977 has resulted in 128 requests covering 90 sites in 35 countries. More than 20 of the 155 parents in the crossing programme have been included, at the request of national institutions.

40. The Rice Improvement Programme combines a relay operation for IRRI with a vigorous and effective input of local adaptation work for the region. Collaboration has been particularly close among the Central American countries. Representatives of national rice

programmes from 14 countries met in 1976 to discuss the International Rice Testing Programe for Latin America. As a result of these tests, several promising lines have been selected by individual countries and named by them for release as improved varieties. The CIMMYT-CIAT Regional Andean Maize Unit promotes and organizes trials of CIMMYT and CIAT materials in the region, organizes meetings of national maize specialists and helps with establishing national programmes. Fourteen Tropical Andean Zone Trials and 9 Highland Andean Zone Trials were supplied during 1976 to cooperate with national institutions in Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela. The Cassava Production Systems Programme, in addition to production training, sent seeds and multiplication material to 28 countries during 1976 and Regional Trials were established in Guyana, Mexico, Brazil, Venezuela and Ecuador. IDRC support a CIAT Field Specialist in Cassava for the Latin American Region and another, based in the Philippines, for Asia. The newly organized Beef Production Programme has pursued active discussions with countries having allic soil savannahs, Colombia, Brazil, Venezuela and Peru being most immediately concerned. The very successful animal health studies and swine nutrition programme created much international interest. Collaborative research was conducted with ICA, and three substantial workshop meetings were held in 1975 on hemoparasites (85 participants from 17 countries), external parasites of economic importance in Latin America (75 specialists from 21 countries), and studies of country livestock industries (with 29 participants from the Americas).

41. The Review Panel was impressed with the scope and vigour of CIAT's current efforts to establish relationships with countries and their institutions throughout Latin America and overseas.

E. RELATIONSHIPS WITH OTHER INTERNATIONAL CENTRES

42. At present, both CIMMYT and IRRI have staff members permanently stationed at CIAT as part of the relay teams on maize and rice respectively. Proposals are under discussion for the addition of four more senior scientists, one from IITA to work in Brazil as a relay for cowpea production, two from ICRISAT to work at CIAT (Palmira) as a relay for sorghum and millets and for peanuts respectively, and an additional specialist on "upland" rice from IRRI to be stationed at CIAT (Palmira). Relay work from CIAT to other centres is likely to begin with cassava. Here the Review Panel believes that the division of work between Latin America and Africa fails to make use of the resources of CIAT and IITA in the most effective manner. African cassava mosaic is the major constraint on production in Africa. It does not occur in the Americas, although the vectors (white fly species) are present. The strictest quarantine precautions are therefore essential, and at present not even true seed is permitted to enter from Africa. However, the strong programmes in physiology, pathology and entomology at CIAT could usefully supplement the breeding and agronomy work of IITA and the Panel recommends that this linkage be strengthened. The posting of a member of the CIAT Cassava Production Systems team to IITA might prove to be the best way to establish a relay linkage.

43. The outposting of specialists from one International Centre to work at another involves inevitable difficulties in defining jurisdiction, and the Panel does not think that these have yet been resolved between CIAT and IRRI. Nevertheless, it strongly endorses the development of these linkages.

III. CROP PRODUCTION PROGRAMMES

A. THE CASSAVA PRODUCTION SYSTEMS PROGRAMME

(i) Introduction

44. The cassava programme is one of the three major research programmes on commodities within the CIAT organization.

45. Cassava has received little attention from "modern" agricultural science until the last decade. The justification given by the Centre is that cassava is a major food of 300-500 million people, that almost all of it is grown by small farmers, and that most of it is used as human food in tropical developing countries. Average world yields are about 10 t/ha./year of fresh roots, and these yields have remained stagnant.

46. Increased production will depend on generating improved production technology and improved higher yielding varieties, and on training researchers and production specialists from countries where cassava is important. The major target audience of this effort will be the small farmer in the tropics who both produces and consumes cassava.

47. Historically, CIAT decided to initiate work on cassava in 1971 with the financial assistance of CIDA. Unlike other major food crops, the cassava programme started without the benefit of a large knowledge base and with access to only very small germplasm collections.

48. The mandate of CIAT is to work on increasing cassava production primarily in the Americas and Asia, while IITA, because of the importance of African common cassava mosaic (which occurs in Africa but not the Americas), will work on increasing African cassava production and the problem of African common cassava mosaic.

(ii) Objectives

49. The objectives of the cassava programme are:

a) To develop the technology for efficient production and utilization of cassava with low input levels where cassava is presently grown.

b) To develop technology for cassava production using medium fertilizer inputs on the vast under-utilized allic soil areas of the tropics.

c) To transfer the technology of cassava production systems and of improved genetic material to national agencies for further development and application to local situations.

d) To contribute to the training of personnel at the technical level in national programmes oriented towards development of leadership and skills in application of improved cassava production technologies throughout the tropical areas of the world.

e) To cooperate with national institutions in promoting cassava acreage expansion, increase of productivity, and utilization through the supply of technical advice.

(iii) Organization

50. At the time of the Panel's visit, the CIAT cassava programme was staffed by a Leader, five Senior Scientists, and one half-time Senior Scientist supported by eleven scientists and ninety other staff members. The Leader is a plant physiologist and the Senior Staff consists of an entomologist, a plant nutritionist (half-time), a plant breeder, a plant pathologist and an agronomist. All of the above are CIAT core staff. In addition, a postdoctoral fellow is an associated cropping specialist, and two visiting scientists are a plant physiologist and a cassava drying specialist. They are funded by CIDA and and ODM. A special project in production outreach is funded by CIDA for an outreach production specialist for Latin America and the Caribbean, who is stationed at CIAT.

51. Another outreach production specialist for Asia (funded by CIDA) is stationed at SEARCA, Los Baños, Philippines. It is planned that one Senior Scientist (Entomology) will spend a year in Brazil with EMBRAPA.

52. The Panel considers the headquarters team to be an enthusiastic, well-balanced multidisciplinary group who appear to work well together. Three Senior Scientists, an economist (to refill a vacated position), a breeder and an agronomist specializing in cultural practices are projected for 1977-1978, while the half-time plant nutritionist will become full-time in 1978.

53. Although the centre for the work of the cassava programme is at CIAT headquarters, important components of the programme such as regional trials, testing for disease and

insect resistance, and fertilizer trials are based at off-station testing sites. For example, 90 percent of the regional trials in Colombia are made in farmers' fields. Important sites for off-station trials are nine sites in Colombia ranging from 10 to 1,760 meters in altitude. Trials have been made in Guayana, Ecuador, Mexico and are planned for Brazil, Venezuela and Peru.

54. At CIAT, well-equipped laboratories for physiology, plant pathology and entomology are available as well as biometric services, greenhouse and field facilities, and support services for the various components of the programme.

(iv) Scope of the Work

55. Work on the cassava programme began in 1972 with a physiologist (the team leader) and a plant pathologist. Initially, an urgent problem was to eradicate cassava bacterial blight which threatened to destroy the germplasm collection at CIAT, and this was successfully done. Other staff arrived in 1973, and by 1974 the core staff was working and research progress had begun.

56. Cassava is presently a broadly adapted crop and CIAT, in the development of improved technology, is making use of this broad adaptation. If necessary, cassava varieties adapted to specific agro-ecosystems will be developed. Thus, basic information is obtained on the factors involved in an efficient plant type with broad adaptability, resistance to diseases and pests, and the many characters of agronomic importance.

57. These desirable characters are then combined through breeding to produce improved germplasm. The germplasm thus developed is then tested under low-level input conditions in a wide variety of conditions, both within and outside Colombia, and superior germplasm is then selected. Superior germplasm is a major factor in the technology; however, other components are also important. When varietal resistance to diseases and pests cannot be found, control methods based on clean seed, simple cultural practices and biological control are developed. Chemical control is only considered as a last resort or for protection of clean planting material. When superior germplasm is selected, the appropriate cultural practices are determined in different zones and then the complete package analyzed for economic viability.

(a) Germplasm and Breeding

58. The world's largest collection of cassava germplasm, now over 2,400 accessions, has been assembled at CIAT. The collection still has to be maintained vegetatively in the field, but promising studies are underway to reduce the expense and dangers of this procedure. True seed of the collection is also being maintained. The Panel recommends that further collections of cassava should be added, but with the greatest care to avoid the introduction of diseases and insects. It would also be advisable to add additional Manihot species to the collection. These may be useful in future work on inter-specific crosses.

59. In addition to evaluation and selection within the germplasm collection, over 30,000 cassava hybrids are produced each year at CIAT. Under the fertile conditions at Palmira the best selections have yielded 60 t/ha./year in experimental trials without inputs of fertilizer, pesticides or weed control. Even in the allic soils of the llanos, with moderate fertilizer inputs, yields of 30 t/ha./year have been obtained. Although these results are most encouraging, many site-specific problems remain. High yields, disease and pest resistance, ease of harvest, starch content and long postharvest shelf life are needed.

60. New promising lines are tested in four locations in Colombia, and the best of these are further evaluated in regional trials throughout Colombia and in other Latin American countries in cooperation with local agencies. Local varieties are always used as checks, and the CIAT selections are consistently high yielding.

61. The breeding programme has developed efficient and sound breeding methods, and works closely with other team members. Input from the several disciplines of the team is an integral component of the breeding programme. The addition of a second breeder to the team is clearly justified if the many needs and objectives of the programme are to be met. In addition, breeding at present is entirely intra-specific and wider crosses (including inter-specific) need to be initiated.

62. True seed from CIAT's breeding programme has been sent to breeders in 50 different countries.

(b) Plant Pathology

63. Diseases are a major limiting factor to increased cassava production in many areas of the world. Cassava bacterial blight, the super-elongation disease, Phoma leaf spot, the several Cercospora spp. leaf spots, and a complex of preharvest root rots are especially important in Latin America and the Caribbean region.

64. Cassava bacterial blight (CBB) is perhaps the single most important disease of cassava on a world-wide basis, and work at CIAT using clean seed and rotations has demonstrated how farmers can effectively control the disease. High levels of resistance to CBB have also been identified in the germplasm collection which is being utilized by the breeding programme. Resistance has also been identified for the superelongation disease, the Cercospora leaf spots, and Phoma leaf spot. The problem of root rots of cassava is being approached by searching for varietal resistance and the manipulation of cultural practices such as ridging.

65. Farmers have serious problems storing planting material (stem sections or stakes), but recent work at CIAT has shown that planting stakes can be stored for 30 days after an inexpensive fungicide treatment. By selecting healthy cuttings taken from plantations free of systemic causal agents (i.e., bacterial blight, bacterial stem rot, the superelongation disease, the frog skin disease, viruses and mycoplasma, and other vascular and epidermal diseases), it has been demonstrated at CIAT that it is possible to avoid disease dissemination.

66. Since cassava originated in the Americas, it is subject to more diseases and pests in that region than in areas into which cassava has been introduced such as Asia and Africa. It is important, not only to the Americas, but to cassava growers in other tropical areas, that efficient practical means of controlling these diseases be developed before they spread to other areas. Studies to prevent their dissemination to other areas should also be encouraged.

(c) Entomology

67. The control of the many serious insect pests of cassava is approached principally through the use of host-plant resistance, biological control and cultural methods. Almost no pesticides are used on cassava at present and, whenever possible,

control methods that require few or no chemical inputs by the farmer will be utilized.

68. On a world-wide basis, the several species of mite that attack cassava are the most important pests. They are also the most difficult to control, but promising lines with moderate resistance to mites have been identified at CIAT. Good resistance to thrips is present in over 50 percent of CIAT's germplasm collection and future breeding efforts will use this resistance.

69. Resistance to white flies and scale insects has also been identified. Recent outbreaks of mealy bugs in Brazil and Zaire will probably justify initiating a search for resistance.

70. No resistance to the hornworm has been found in CIAT's germplasm collection, but work at CIAT has shown that biological control is effective against hornworms. Parasites (Trichogramma spp., Polistes ssp. (wasps) and Bacillus thuringiensis)have been successfully used, not only at CIAT but also in farmers' fields. Studies on other aspects of cultural control, the use of insect attractants, chemical control, and host-plant resistance are being made with the object of developing an integrated control of insects that requires very few inputs from the farmer while providing economic and environmentally sound pest management. The Panel commends this effort.

(d) Plant Physiology

71. Much of the effort in physiology has gone into defining the ideal cassava plant for the environment at CIAT, and into determining how this ideal must be modified for other cassava growing areas. In order to increase production per hectare it is necessary to select a plant type that efficiently utilizes solar energy to produce starch. Work to date has shown that the efficiency of the cassava plant in producing roots is largely determined by the plant's leaf area index, and that the optimum leaf area index (ratio of leaf surface to ground surface area) is about 3. Long leaf life has also been studied and found to be an important yield determinant. This information is important, and is being utilized by the breeder in providing guidelines for the most efficient selections of an ideal

plant type. Effects of fertility and water stress relative to the ideal plant type will be included in future studies.

(e) Plant Nutrition

72. Cassava is grown on a wide variety of soil types throughout the world and is able to produce a crop under a variety of poor soil and stress conditions. It is uniquely adapted to acid soils of low fertility, and therefore emphasis has been given to soil fertility studies in the llanos at Carimagua. The effects of various levels of lime and N, P and K have been studied in addition to the interaction of P x K. These studies have shown that cassava responds well to only 1/2 t/ha. of lime while most other crops need higher levels. Yields of 36 t/ha. per year were obtained with cassava in the llanos using 1/2 t/ha. of lime and moderate levels of fertilizer inputs.

73. Germplasm is being screened for resistance to aluminium toxicity and low levels of phosphorus found in the soils of the Colombian Llanos and other areas of Latin America such as the Cerrado of Brazil.

(f) Agronomy

74. The task of the production agronomist is to put together the information obtained by research and make it available to farmers. Using information developed by physiology and plant pathology, a system of rapid cassava propogation has been developed by which 36,000 plants can be produced from one plant in one year. These results have been made available to farmers through cooperating national agencies. Agronomy also tests the outstanding clones developed by the breeding programme. Most of this testing is done in Colombia because of its wide range of environmental conditions. Trials are made in cooperation with several Colombian national agencies which are involved in credit, extension and technical assistance. Ninety percent of these trials are in farmers' fields. Two years of results in eight Colombian locations, varying from sea level to 1,700 meters, demonstrated that CIAT selections were superior to local check varieties because of superior germplasm and improved cultural practices.

75. Simple cultural practices found to be superior were: a) selection of clean planting material; b) inexpensive chemical treatment of planting material ($3.00 US per hectare); c) weed control by herbicides; d) biological control using insect parasites; e) modest fertilizer recommendations only for allic soils, and; f) planting in ridges in heavy clay soils to avoid root rots.

76. The Panel sees a possible danger in the long-term cultivation of cassava in a monoculture and in utilizing low levels of inputs in cassava production. These practices could lead to an increase in disease and insect problems and to an exhaustion of nutrients in the soil. The Panel was pleased to learn that the long-term effects of monoculture on the balance of nutrients are being studied. The Panel recommends continuing these studies and also developing inexpensive methods of replacing nutrients, especially with legumes.

77. The agronomist also conducts international regional trials.

(g) Economics

78. An agro-economic study of cassava production on 305 farms in five distinct zones in Colombia has provided useful information on the technology and level of input used in cassava production. Farm size, yield, inputs, credit, technical assistance and use of machinery were among the components studied. The importance of diseases and insects was assessed, and insights into why farmers used different cropping systems (cassava alone or with beans or maize) were also obtained.

79. These studies are important and, with the addition of an economist in 1978, should be continued to help the cassava team in determining priorities for future research.

(h) Cassava Processing

80. A major deficiency of cassava is that it is a highly perishable product, as roots begin to deteriorate as soon as two days after harvest with some varieties, especially if damaged. Cassava is a highly efficient biological energy source, and technologies for the stable production of large quantities of carbohydrate using limited resources are being developed. Limiting technological factors in the large-scale use of cassava as an energy source are harvesting and processing.

81. Harvesting is a difficult and unpleasant task and is a major labor cost in production. In areas where large-scale cassava production is planned, efficient cassava harvesters need to be developed, as commercial harvesters are either unavailable or inefficient.

82. A project with the Tropical Products Institute (London) has studied simple storage methods and a simple solar drying system, but much more work needs to be done in the area of storage technology. The Panel recommends that CIAT, in cooperation with other entities, should expand activities in postharvest deterioration, starch extraction, drying and the use of cassava by-products which are now largely wasted; such studies should be directed towards practices which can be utilized at the small village and small farmer level. The Panel recommends that CIAT should not become involved in storage and drying technology for heavy industrial use.

83. Preliminary trials at CIAT have shown that cassava produces high yields of high protein forage. The CIAT location is a very fertile area, and it is not known whether these high yields can be repeated on the poorer acid soils where they could form a food supplement for cattle in the dry season. Preliminary results suggest that the forage is well utilized by cattle. However, methods of storage (e.g., silage) and large-scale feeding trials are required to assess the real potential. The Panel recommends that these complementary studies be continued and expanded in cooperation with the animal scientists.

(v) Constraints on the Programme

84. If projected senior staff are added to the programme, the Panel does not see major constraints to the personnel component of the programme. Off-station testing sites are generally adequate but the Caribia Station on the north coast of Colombia, representative of a major cassava growing area, lacks adequate facilities.

(vi) Conclusions

85. The Panel was impressed by the progress made so far by the cassava team in developing technology for increased cassava production. It has convincingly demonstrated that cassava can compete with any tropical crop in the world in terms of calories produced per hectare per unit of time.

86. The challenge of increasing production on the acid soils with low fertility in the tropics and of delivering adequate technology to small subsistence tropical farmers with few or no inputs is still to be met.

87. The Panel recommends that CIAT and IITA discuss and enter into an agreement on responsibility for the various research components constituting the IARC programme on cassava. CIAT, by concentrating exclusively on cassava rather than on several root crops, has a more comprehensive programme and should be more actively concerned with Africa. Since African common cassava mosaic exists only in Africa, breeding work will obviously have to continu physically at IITA, but responsibilities for the breeding work should be discussed and agreed upon by IITA and CIAT. Any arrangement or agreement made should include safeguards to ensure that no risks of introducing African cassava mosaic into the Americas can occur. The Panel recommends that this matter be studied by the forthcoming Quinquennial Review of IITA and that it then be referred to TAC for policy guidance.

B. THE BEAN PRODUCTION SYSTEMS PROGRAMME

(i) Introduction

88. Beans (Phaseolus vulgaris) are a very important source of protein in the diets of middle and low income families who are unable to afford, or do not produce, animal protein. Indeed, nearly 35 percent of world production occurs in the Latin American region and an estimated 80 percent is produced on small farms, the majority of the crop growing in association with maize. Production is predominantly on small holdings which are often in isolated areas, on difficult terrain, and with little mechanization and limited technical inputs. To add to his difficulties, the small farmer is faced with credit limitations, poor extension services and marketing problems. The form of land tenure gives little incentive to invest in higher inputs.

89. Per capita production of beans in Latin America has shown a declining trend during the last 10 years. Under conditions of low technology, yields are commonly from 500 to 600 kg/ha. This situation is unlikely to change rapidly unless price incentives stimulate investment in improved technology on the farm or a technology can be devised which fits a low cost situation.

90. The most important single factor limiting yield is plant disease. CIAT assisted in carrying out a disease survey in 12 countries and determined that common mosaic virus, rust, anthracnose, angular leaf spot and bacterial blight are major pathogens. Pest problems such as Empoasca and Diabrotica are also very important. Add to this the fact that adequate supplies of clean seed, at a reasonable price, are rarely available, and it is evident that a major research effort is imperative if widespread protein deficiency is to be avoided in Latin America. Few nations have a bean improvement programme of an adequate standard. This places a heavy responsibility on CIAT.

(ii) Objectives of the Programme

91. The objective is "to increase yield and total production of dry beans (Phaseolus vulgaris) in the tropics, especially in Latin America".

92. As its short-term strategy, the programme will concentrate on the incorporation of disease resistance into high yielding crossbred selections and nationally important

varieties. The emphasis will be on bean common mosaic virus, rust, anthracnose and angular leaf spot among the diseases, and on Empoasca among insects. The programme has not yet developed resistant sources or methodologies reliable enough to allow successful breeding programmes for resistance to bacterial blight and golden mosaic diseases.

93. Of the many different cultural systems used for bean production, four main areas for concentration have been identified:

"a) The large scale production under well watered or irrigated conditions where neither the availability of purchased inputs nor length of season limit yield.

b) The short season and commonly low fertility growing conditions found in areas of Central America.

c) The associated cropping situation in which climbing beans are grown together with other crops, commonly maize.

d) The variable growing season situation under which plants would require homeostatic mechanisms allowing them to maximise yield under extremely variable rainfall conditions.

94. This objective will be attained by technical and varietal improvements, through training scientists and collaborating with scientists working in national bean programmes. However, the wide range of farming conditions and cultural practices under which beans are grown in the tropics requires certain logistical and technical limitations to be imposed on the CIAT programme. Initially, emphasis is towards low cost improvements and a limitation on responsibilities to Africa until 1980. Protein production per unit area will, for the present, take priority over the improvement of protein quality.

95. For certain aspects of the programme, the soil and climatic conditions at CIAT are atypical. Consequently, about half of the bean work is done at CIAT, while other locations for experimental work have been chosen to be as representative as possible of the major bean growing areas in Latin America.

96. The Panel recommends, however, that better information on the location and extent of the different ecological zones in which beans are grown would be helpful in planning priorities. An outside agency might be encouraged to assist in undertaking such a survey.

97. The Panel approves the objectives of the Bean Production Systems Programme.

(iii) Organization

98. Since the inception of the programme in 1973, the team has grown appreciably, enabling a greater emphasis to be placed in the last two years on breeding, agronomy and the movement of materials and developed technology towards national programmes. Currently, the senior staff is made up of: 8.5 core specialists (plus one vacancy), two Special Project posts, and one post-doctoral. In support are 23 research associates and assistants (three vacant) and 28 technicians (four vacant). The supporting staff is fairly evenly distributed between senior research workers. The core specialist workers are: a microbiologist (Head of Programme), two agronomists (one vacant), a physiologist, an economist, two plant breeders, two pathologists, an entomologist, and a soil scientist who spends half of his time with the bean team. The post-doctoral fellow is a plant breeder, and the visiting specialist is concerned with germplasm. In the near future, there will be a requirement for staff to meet the needs of a rapidly expanding international collaboration. An additional agronomist for 1978 and an additional breeder for 1980 are planned. The total staff in the bean team numbers some 140 people.

99. The Panel noted that there was an integration of scientific disciplines, with breeding and agronomy as the core of the programme. Each worker's responsibilities were clearly defined.

100. The leader's time is divided between research leadership and organization, an active research programme, some training responsibilities and, not least, frequent meetings with visiting committees, etc. The Panel feels that some arrangements should be made to allow the team leader to spend more time stimulating and doing research aimed at the achievement of objectives.

101. The question may be asked as to whether an interdisciplinary organization is the best way of running research. It is clear that, within the bean programme, there is a positive gain in having all disciplines within the one team. Examples where one worker has influenced another are frequent: e.g., the physiological work on carbohydrates has influenced the work of the microbiologist; the microbiologist has given encouragement to the breeder to investigate the inheritance of nitrogen fixation, etc. Although several

of the workers are labelled as pathologists or agronomists they have, in fact, had a large component of plant breeding training. The Panel concluded that the interdisciplinary type of organization was running smoothly.

102. The Panel's attention was drawn to some problems associated with collaborative work with universities outside Latin America. When agreements are reached, it is sometimes necessary for the CIAT workers to spend time in making the overseas workers familiar with the kind of work needed in Latin America. The Panel understood that for some collaborative arrangements this can be significant in relation to the time available. Further, there is increasing evidence that genotype-environment interactions are such that some of the work undertaken overseas would have to be repeated at CIAT to check its application. The collaborative work with overseas bodies is to be encouraged, but such contracts should be made with care to avoid overloading CIAT staff.

103. The Panel had a good opportunity to discuss the programme and to see something of the field work. The CIAT staff are dedicated, enthusiastic and of a high calibre.

(iv) Scope of the Work

104. There are many facets to the bean programme. It encompasses economics, germplasm assembling and screening, agronomy, plant breeding, plant protection, physiology, microbiology and soil science. International collaboration and training are both a significant part of the total effort. The current programme is basically only four years old.

(a) Germplasm

105. Germplasm development is the most important function and all team members have a varying commitment. The collection has been screened and important genes are being identified. This has proved of enormous value in providing material to national programmes. Hybrid material, resulting from crosses made at CIAT, is also supplied. In addition to supplying the segregating F_2 generation, there is also the facility to supply F_6 to F_8 generations according to the various needs of national programmes. The bank holds some 14,000 accessions, and each is evaluated for up to 50 different attributes. So far some 800 entries have proved promising. There has been a good back-up by the Biometrics Unit which has developed

the SIFFRI programme for information retrieval; it is said to be superior to any other currently available.

106. The Panel commends the work on germplasm and would hope that a well planned plant-collecting programme will be devised with the objective of obtaining genotypes possessing characters required for the plant improvement, physiology and plant protection work. A temporary team member, with the necessary experience, should be employed for this purpose.

107. The Panel understood that the CIAT scientists are aware of the dangers of moving seeds from one country to another. However, the Panel feels that it is necessary to emphasize that not everything is known about seed-borne disease and that the utmost caution should be exercised in the movement of plant material. Seed samples are sometimes received in poor condition and it is necessary to plant them in the greenhouse as soon as possible. The existing greenhouse facilities are poorly maintained and need improving. The Panel recommends the acquisition of a new greenhouse, properly equipped for receiving introduced seed lots.

(b) Plant Breeding

108. Beans are a notoriously difficult crop to improve by plant breeding and the CIAT programme has some complications peculiar to Latin America. The breeders have recognized the strong regional preferences for colour, the great variation in ecological regions where beans are grown, and the varying incidence of pathogens in different geographical areas.

109. CIAT now has an enormous potential for making crosses and combining desirable characters. As an example, there is one area at CIAT where 130,000 F_2 plants have each been inoculated with one or more diseases. The breeders are concentrating on disease resistance combined with different bean colour, growth habit and maturity. All material leaving CIAT was said to have a yield at least as good as the current best black varieties. The breeding methodology was demonstrated to the Panel and, on present knowledge of plant breeding methods, could not be criticized. A time-table of variety production was presented which may well prove optimistic.

110. Attention is also focused on breeding for greater stability of yield in four plant types. There is reason to believe that red-seeded beans will be produced which are equal in yield to black bean varieties. In field plots, the Panel was shown some climbing beans, associated with maize, which are of considerable promise. This work could form a valuable point of integration between the two commodity programmes, as could collaboration between the bean and cassava teams.

111. By 1977 the bean programme will generate 2,000 F_4/F_5 families per growing season, and plans are underway for two systems of multi-location testing: **(1) involving three locations in Colombia, and; (2) in elite international nurseries. It is planned that the multi-locational testing will include material homogeneously resistant to several key diseases.**

112. The Panel believes that the appointment of a third breeder should not be delayed until 1980. The third breeder will be required for work with species related to P. vulgaris and will need to explore some basic genetic problems. Valuable studies with P. lunatus (lima bean) are being carried out at Gembloux, Belgium, in collaboration with CIAT. CIAT work on related species could not produce results for several years, and therefore the initiation of such a programme should not be long delayed. The appointment of a third breeder would facilitate any work designed to integrate commodity programmes in that it would allow other members of the team more time to consider problems related to commodity integration.

113. It was stated by CIAT workers that the greatest impact on the transfer of their technology would come if the continuity of workers in national programmes could be improved. This is no responsibility of CIAT but the problem might in some way be brought to the attention of cooperating governments.

(c) Plant Protection

114. The control of pathogens is approached by plant breeding, cultural and chemical methods. It is clear that breeding varieties resistant to all diseases will be a long process.

115. The Panel was pleased to learn that the production of "clean" seed has a high priority because some diseases (e.g., anthracnose and CBMV) are seed

transmitted. Farmers saving their own seed are in a vulnerable position. CIAT has clearly demonstrated the major yield increases possible simply by using clean seed. However, the mechanism to produce seed free from disease is poorly developed in national programmes. CIAT could emphasize seed production problems in relevant publications. The Panel recommends that a course be designed for training in the production and multiplication of "clean" seed.

116. A continuous screening process is in operation in order to identify sources of resistance to the major pests and diseases. The Panel considers that this work — related to common bacterial blight (Xanthomonas phaseoli), rust (Uromyces phaseoli), anthracnose (Colletotrichum lindemuthianim), powdery mildew (Erysiphe polygoni), web blight (Thanatephorus cucumeris), root rot (Rhizoctonia solani) and the virus CBMV and golden mosaic — is going well.

117. A disease of unknown cause termed "Problem X" is causing trouble and, if no solution is soon found, the Panel recommends that the full-time attention of a research worker be devoted to this problem, also calling on the expertise of other disciplines.

118. The entomological work concentrates on screening for resistance to the leaf hopper (Empoasca kraemeri), the mite (Polyphagotarsonemus latus) and Zabrotes subfaciatus. These studies should continue to be supported.

(d) Plant Physiology

119. Concomitant with the breeding and agronomy work, it has been a principle of the bean team that there should be an understanding of the architecture of the plant and a determination of the components of yield. Such an understanding might lead to the planning of changes in plant architecture or maturity features. A classification of four plant types has been arrived at: Type I is determinate in habit and the main stem node number stops at flowering time; Type II is indeterminate with a short vine, and the main stem node number increases after flowering; Type III is indeterminate with a long vine, but is non-climbing and artificial support for the plant is not necessary; Type IV is indeterminate with a long climbing vine, and

support is needed. Various characters have been recorded associated with each plant type. Such work has been of value to the agronomist, breeder and the microbiologist. Shading and CO_2 enrichment studies have been carried out to relate carbohydrate levels in the plant to pod set and retention. In addition, the physiological studies have evaluated germplasm for photoperiod sensitivity. Drought and waterlogging effects have also been considered.

120. These are important studies, and it is to be commended that strategic research and applied work are interacting in such a productive manner. The Panel was pleased to learn that more emphasis is being given to climbing beans and to associated cropping, and strongly supports this development.

(e) Microbiology

121. In the world context of diminishing energy resources, the ability to fix nitrogen is a most important characteristic of the bean plant.

122. Beans have a sad history of not responding to inoculation with Rhizobium and thus, at an early stage in the work of the microbiologist, isolates from different sources and soils were collected. Plants inoculated with effective strains of Rhizobium gave yield increases in Colombia, in cool climates, averaging 50 percent. The next stage was to examine the differences between varieties when inoculated with the same strain. Some most interesting and valuable results have come from this work. Cultural systems, plant density, and effect of association with maize, have been analyzed. Marked differences were obtained between varieties. This programme is now at a stage where active cooperation with the plant breeder is enabling the inheritance of nitrogen fixation to be determined. This is unique in plant improvement programmes. Selection for nitrogen fixation could be more easily carried out if better greenhouse facilities were available.

123. The Panel considers that this microbiological work deserves continuing support.

(f) Agronomy

124. Much of the agronomy work is dedicated to yield trials. Other trials are designed to determine varietal adaptability to different climatic regions. As an intermediate step in the transfer of elite material to national programmes, some new selections with disease resistance are about to go into trial. The sets of trials differ according to seed colour and shape preferences, growing conditions in the regions, and disease priorities. Programme scientists will be invited to select the best materials for inclusion in their own more detailed trials.

125. In 1976, international bean yield trials were initiated and also adaptation nurseries were planted. The principles of the trials are: a) to identify widely adapted varieties; b) to promote the movement of elite plant material in Latin America, and; c) to identify varieties of particular value in specific ecological conditions.

126. Other work involves different planting densities of maize and beans, varying spatial arrangement of maize and beans, relative time of planting of maize and beans, the importance of the maize or bean genotype on final yield, and the large-scale testing of climbing cultivars. It is regretted that, at present, there is no active maize breeding to complement beans under a mixed cropping situation. Maize breeding is not the responsibility of CIAT but this work could be a special project, an important part of which might be undertaken in collaboration with the ICA programme.

127. Soil science studies have examined the use of phosphates of differing solubilities, for example rock phosphates, and the genotype differences in tolerance to phosphorous deficiency. Time has been devoted to the local problem of boron deficiency.

128. The Panel noted that the studies of phosphates and their behaviour in soils will be undertaken by the IFDC project at CIAT.

(g) Economics

129. The economics group aims at ensuring that the priorities of the programme are relevant to production problems in farmers' fields. By means of the

questionnaire, farmers have given information on farm practices and these have been corroborated by field observations. Levels of technological input varied widely according to the areas sampled. Certain limiting factors have been quantified in relation to yield. It is planned to extend these studies to countries other than Colombia where the initial work has been carried out. The economics group also plans to carry out with local agencies a farm-level test of alternative technologies in the Huila district of Colombia. This will involve 30 farms, three bean types (I, II and IV) and two sets of cultural practices. As with the other work, this will provide feedback to the rest of the bean team, as well as enabling the economists to better contribute to design elements of the bean programme.

130. The Panel approves the strong integration of economics within the bean programme and, in particular, supports the collaborative work ex ante technological evaluation and field validation with its consequent feedback to technology design.

(v) International Collaboration

131. In 1975, the bean programme was requested by TAC to coordinate a Latin American bean research network. Each national programme is unique in relation to its degree of development, local needs, etc. Because of this, it was decided to allocate up to three countries to each scientist in the CIAT bean programme. There were exchange visits by counterpart workers and CIAT personnel. Germplasm delivery and technical assistance help were accelerated by this arrangement. The variation of the rust pathogen from region to region was taken care of in 1976 by testing more than 100 varieties selected as resistant or as differentials in 14 locations throughout Latin America. This type of collaboration provides vital information to CIAT, at the same time being of help to the participating countries. Problems not worked on at CIAT are assessed in other areas, e.g. drought in Peru and golden mosaic virus in Guatemala, El Salvador and Brazil. CIAT also multiplies breeding material at the request of participating countries.

132. It is obvious that international collaboration is of vital importance. Some members of the Review Team were able to see the significant results being obtained in Guatemala, and it was especially pleasing that, on occasion, the collaboration is a two-way process.

However, international projects place a considerable restriction on the time of CIAT scientists, and this is likely to increase in the coming years.

(vi) Training

133. Training has been a considerable component of the bean programme. In 1975, for example, the programme, with about 20 per cent of the research budget, received 38 per cent of the research trainees who included postgraduate research interns, M.S. or Ph.D. students and postdoctoral fellows. Short courses were also given to upgrade research scientists in national programmes.

(vii) Constraints on the Programme

134. No major constraints were found. Efficiency would be improved by reducing the training load on the most senior staff, and by improving greenhouse facilities.

(viii) Conclusions and Recommendations

135. It was found that the interdisciplinary organisation was running smoothly, and the Panel approves the objective of the programme. The work is conducted in an enthusiastic manner, and valuable results are emerging.

136. The Panel recommends that an experienced plant collector be attached to the team and that a new, and properly equipped, greenhouse be constructed for plant quarantine purposes.

137. The Panel recommends that the appointment of a third plant breeder should not be delayed, and approves the trend towards more work on climbing beans and associated cropping. Species related to P. vulgaris should be included to a greater extent. The Panel believes that consideration should be given to initiating a collaborative programme with ICA, aimed at improving maize varieties specifically for the associated cropping system.

C. THE RICE IMPROVEMENT PROGRAMME

(i) Introduction

140. With the exception of Brazil, which grows mainly upland rice, the Latin American countries have adopted the semidwarf, high yielding varieties in about 40 percent of their rice areas. The possibility of irrigating land for rice represents one of the greatest potentials for increased production of a basic food commodity.

(ii) Objective

141. CIAT has defined its rice objective as "To increase yields and stabilize production of rice in tropical Latin America with reduced inputs thereby increasing both incentives for production and consumption by the needier segments of society".

(iii) Organization

142. The present staff comprises a Network Coordinator who is leader of the programme, together with an engineer and a plant breeder. One senior staff member is based on a cooperative agreement between CIAT and IRRI. Two other senior posts are budgeted, an agronomist and a pathologist; one of these will replace the engineer. Personnel of all grades totals 37 for 1977, with some 51 staff members projected for 1978. Funds have been requested from UNDP for an integrated training and international cooperation project which includes an international cooperation input for rice. The proposal for an agronomist and a pathologist in the budget reflects the need to work on disease problems, to transfer and adapt management technology, to increase seed production and to coordinate training.

143. The present rice programme evolves from an earlier, and very successful, input into research. Indeed it would be difficult in such a short time, and with such limited resources, to achieve a greater impact, with such beneficial results, than has the rice programme at CIAT. It is generally agreed that the rice programme has done most to develop the good image of CIAT and of IRRI throughout the region. The history of the rice programme is already well documented.

144. Originally there was only one senior scientist and the maximum advantage was taken to collaborate with the Instituto Colombiano Agropecuario (ICA). As an example of this fruitful collaboration, in Colombia, the average yield of irrigated rice went from 3 t/ha.

in 1966 to 5.4 t/ha. in 1975. With each year there is a greater proportion of new varieties used by farmers. The variety CICA 4, distributed in 1971, gave yields varying from 50 to 100 per cent above the traditional varieties. This work justifies the policy established in agreement with CIAT, and which has been generally agreed as "each country should determine the rice policy it needs and desires". The benefits of high yielding varieties have, for the most part, been for low-income consumers.

(iv) Strategy

145. Four main biological constraints limit yield — rice blast, hoja blanca, its vector (Sogata plant hopper), sheath blight and leaf scald. Of these, rice blast is the most important. The presence of bacterial blight (Xanthomonas oryzae) was confirmed in Latin America in 1976. Resistance to blast breaks down rapidly, and there is a continual need to produce varieties with improved resistance. To overcome the disease problems two approaches are made: 1) multiline varieties, and; 2) combining resistance factors from several parents (i.e., multiple resistance). Resistance to the Sogata plant hoppers, the vectors of hoja blanca virus, is available as a single dominant gene derived from IR 8 . Identification of additional genes for resistance, and their incorporation into superior lines, is planned in order to face the possible occurrence of biotypes of the past. Breeding for resistance to sheath blight and leaf scald diseases has not yet been initiated.

146. A fundamental decision was taken that nurseries should be formed with plants adapted for the region. In particular, the plants should meet the requirements of special agronomic problems, grain type and quality for milling and cooking. Twenty-eight sets of nurseries (VIRAL) were despatched in 1976 to 10 countries in Latin America. This was a significant development.

147. Appropriate material from IRRI will continue to be evaluated for both deep water and upland conditions. After initial evaluation at CIAT, any material suitably adapted, with good yield potential, grain quality and resistance, will be multiplied to make up nurseries for the International Rice Testing Programme for Latin America.

(v) International Cooperation

148. The "Seminar on Rice Policies in Latin America", which took place in Cali, Colombia, in 1972, established an agreed policy with IRRI concerning international cooperation. In

1976, a programme of international rice trials for Latin America was established, and responsibility for coordination with national institutions rests with CIAT. Eight nurseries were received from IRRI representing rice for upland conditions, a rice blast nursery, a sheath blight, a deep water and one nursery of varieties for high salinity. Only the latter was not planted at CIAT.

149. The CIAT rice programme collaborates with different international institutions in the distribution of new seed varieties. As a result of this cooperation, ICTA selected one line in 1976 and named it for Guatemala; also the rice programme of INIAPselected and named another line.

150. The Panel considers that the execution of international coordination is a fundamental step in the promotion of technology leading to the increased production of rice. The visits made by senior staff to national programmes have renewed the interest of the national institutions. This was clearly demonstrated to those members of the Panel who visited Brasilia.

151. In addition, the Panel commends the training aspects of the rice programme. There is clearly an international demand in Latin America for extension visits by CIAT staff.

(vi) Constraints on the Programme

152. The Panel considers that, in spite of the impact the rice programme has had, there remains much more to be done. Objectives will be difficult to achieve unless the personnel is brought rapidly to full strength.

153. The lack of trained personnel at national level will put severe restrictions on the transfer of new technology and the adoption of new, high yielding varieties. Upland rice has received little attention and will present even greater problems. Upland rice cultivation is often of a temporary nature since it is used principally as a"colonisation" crop before the establishment of pasture. It is hoped that close cooperation between CIAT and IRRI will bring real benefits in this respect.

(vii) Conclusions

154. The Panel believes the rice programme at CIAT to have been highly successful. Currently, 80 per cent of rice production in Colombia is from new varieties. Equally successful has been the training of technical personnel for national research and development programmes.

155. The creation of a good image for CIAT has stimulated the demand for more CIAT/IRRI work on all aspects of the rice crop in the region, especially in relation to rice blast.

156. The Panel commends the proposed new posts, and suggests that early emphasis be given to upland rice with particular emphasis on disease resistance.

D. THE ANDEAN REGIONAL MAIZE UNIT

157. During 1976, a new programme evolved and was designated as the CIMMYT-CIAT Andean Regional Maize Unit. There has been a reduction in CIAT-originated work, while international cooperative activities and crop promotion have been increased. The Senior Staff consists of an entomologist (Coordinator) and a plant breeder. Funds for the maize relay unit are provided through a grant to CIMMYT from CIDA. Provision has been made for a third scientist.

158. Operations were initiated in May 1976 when one senior staff member was posted to Cali, and in January 1977 the second member of the team arrived at CIAT. No further increase in staff is projected.

159. The objective of the Unit is to provide a link between CIMMYT-CIAT and the Maize National Programme of the Andean Region (Bolivia, Colombia, Ecuador, Peru and Venezuela). The team travels extensively throughout the region — some 60 per cent of the time so far in 1977. Work at CIAT includes experiments with material originating at CIAT and Andean Zone regional trials. Selection criteria include plants for poorly drained soils, plants with reduced height, and plants carrying the opaque-2 gene and vitreous endosperm. Some seed multiplication is carried out for testing in the Andean Zone national programme. The Unit will also promote the exchange of material, assist in the organization of biennial maize workshops, promote training courses for production agronomists, produce an annual report on maize improvement, promote the establishment of maize production programmes with the objective of increasing yields per unit area and, finally, identify candidates for training both at CIMMYT and CIAT.

160. This is a formidable list of objectives for a small team spending half of its time travelling. The question has to be asked as to whether certain requirements of the Andean Region are being adequately assessed. There are two aspects particularly important to Latin America which, in the Panel's opinion, are not adequately covered by the CIMMYT-CIAT collaboration. The bulk of beans is produced in a mixed cropping system with maize. Considerable effort is devoted to the production of improved bean plants but nothing is being done to determine whether improved maize types could be produced for the specific crop association. This aspect may be so regional that CIMMYT would not consider it to be

one of its objectives. The second aspect the Panel wishes to draw attention to is that many diseases and pests are serious problems for maize in the Andean region. In 1976, downy mildew of maize (Sclerospora sorghi) was reported for the first time in several countries in Central America, Venezuela, Bolivia and Brazil. It has caused serious yield losses in Venezuela and may become one of the major problems of tropical maize in the Americas. Considering the seriousness of the problem, the magnitude of the effort to control S. sorghi cannot be adequately handled by existing CIMMYT-CIAT personnel in the Andean region.

161. The Panel recommends a thorough assessment of the situation of downy mildew infection in Latin America.

162. More attention needs to be given to the definition of the respective responsibilities of CIMMYT and CIAT for the improvement of maize production in Tropical Latin America.

E. THE ROLE OF CIAT IN GERMPLASM COLLECTION AND CONSERVATION

(i) General Considerations

163. CIAT has a major commitment to the collection and distribution of germplasm. In pastures and forages some 2,000 accessions, including 570 Stylosanthes, are in the collection. More than 2,000 entries in the cassava germplasm collection have now been evaluated. In 1976, CIAT accepted primary responsibility under IBPGR for the maintenance and characterization of Phaseolus germplasm; of the 12,000 samples already received some 7,000 have been multiplied and characterized morphologically; another 3,000 are currently being multiplied. It is clear that storage and evaluation of the total collection is a massive undertaking.

164. Numbers alone are not an indication of the completeness of a collection or the extent to which total genetic variation has been sampled. Indeed, as the work progresses it is becoming evident that there is a need for further detailed collection. Sufficient evidence is now available to indicate where active collection should take place. For example, it is estimated that only a small proportion of the genetic material of climbing beans is at CIAT. The situation is probably better for bush beans. The work of the plant physiologists and pathologists would benefit if a wider range of germplasm were available. Physiologists and pathologists are in urgent need of certain plant characters which the breeder can also incorporate into the material for final distribution. Wild genotypes could be in danger of physical loss and there is an urgent need to widen the genetic base available at CIAT.

(ii) CIAT Proposals

165. Being aware of the importance of plant collections, CIAT has planned a new Unit of Germplasm Development. The excellent new seed-store facilities should be complete by the end of 1977. In addition, specific funding has been provided for computer services for information retrieval and computer analyses. The new Unit has been charged with "the responsibility of assembling, maintaining, evaluating and distributing germplasm in support of Phaseolus beans, cassava and forage legumes." The evaluation aspect is commented upon below.

166. By 1978 the staff running this Unit will include a geneticist, a biochemist and a physiologist, and by 1979 it is proposed that the total staff will number thirty, including nine of professional grade. The geneticist will have responsibility for the storage facility and for assembling, maintaining and distributing germplasm. He will also have the responsibility for a catalogue system. The biochemist will control the analysis of seeds, e.g. for protein, organic acids and trace metals, and of plants, e.g. for enzymes and content of various elements. The biochemist will also have the task of monitoring characters important for consumer nutrition. The physiologist will maintain the vegetatively propogated germplasm and will develop new methodology for storing and distribution. The culture of meritism tissue and the use of very low temperatures will also be part of the physiologist's duties.

167. Cooperative work will be set up with Latin American, United States and European centres.

(iii) The Panel's Appraisal

168. Grave dangers exist whenever germplasm is moved from country to country or from continent to continent. CIAT has very good cooperative arrangements with the Colombian plant quarantine authorities and full precautions are observed. Nevertheless, the Panel draws attention to the need to provide for an additional protected greenhouse for the reception and indexing of material and for continuous improvement of techniques for the prevention of the transmission of diseases.

169. CIAT scientists are cognisant of the problem, but the use of advanced techniques for distribution of seed and asexual propagative material are not yet in operation. The techniques of meristematic tip culture and storage under liquid nitrogen should be strongly encouraged. Meristematic tip culture can eliminate viruses and fungi from the plant material, but this must be confirmed by subsequent indexing. Furthermore, viroids cannot be eliminated by this technique. Storage under liquid nitrogen for many years would reduce the expensive planting of asexually propagated collections in the field where they can be lost or infected by pests and diseases. Costs of investment in such techniques for the safe handling of germplasm are small in comparison with that of the urgent work which would have to be undertaken were new major diseases to become established. The need to improve quarantine techniques in topical America is well illustrated by the arrival in recent years,

probably through commercial channels, of three serious diseases, coffee rust (Hemileia vastatrix), downy mildew of maize (Sclerospora sorghi) and bacterial blight of rice (Xanthomones oryzae).

170. It may be desirable to grow some species at an intermediate site where the crop is of no importance and where rigid inspection and phytosanitary measures can be taken. For example, some tropical crops are screened in transit at Kew Gardens, England. The introduction of a serious disease into a new area could have disastrous repercussions; CIAT is aware of the implications.

171. The Panel has reservations concerning the proposals for "Germplasm Development". The function of a germplasm bank should be separate from allied sciences. The central objective is the assembling, maintaining and distribution of germplasm. Additionally, it is necessary to develop a data storage and retrieval system. The work of the proposed geneticist and, particularly, the physiologist, can be related to the central requirement of a germplasm bank and these proposed posts are endorsed. However, their main activities should not be physically centred within the new building at CIAT because of security risks and other hazards such as fire. The Panel believes that there are many facets of the ongoing commodity programmes where a well organized biochemistry laboratory, under a senior biochemist, could make a significant contribution. The Panel is not able to endorse the concentration of biochemistry in "germplasm chemotaxonomy" as indicated in the budget projections and recommends a wider role in the commodity programmes.

F. THE SPECIAL STUDIES UNIT

172. This new Unit was started in 1975, in part to provide a mechanism to ensure that certain activities of the former Small Farms Systems Programme were not neglected. Its main activity is devoted to exploratory studies on innovative new production systems involving new crops, combinations of crops and animals, and crop combinations not covered by the major commodity groups. The Unit is now understaffed, owing to the departure of its only Senior Scientist in 1976. The total team is at present composed of four scientists and 12 supporting staff.

173. The Special Studies Unit has initiated work in some important areas including minimum tillage, use of living mulches, cycling of nutrients from one crop to another in associated plantings, and unconventional use of nitrogen-fixing trees or shrubs, e.g. Leucaena leucocephala, in perennial/annual crop associations.

174. Minimum tillage and living mulch work is of special importance to the humid tropics in general, and Latin America in particular, because of the frequent cultivation of steep lands and the dangers of soil erosion. Small farms growing tree crops or root crops are specially vulnerable, and the adoption of soil protection and conservation practices is a necessity if these farmers are to survive and profit on steep lands.

175. The Panel considers that there are a number of problems in Latin America which could usefully be investigated on an exploratory basis by the Special Studies Unit. For example, the demonstration of known soil and water management techniques on the hillsides of the Andes and in the humid lowlands calls for a larger involvement by the Special Studies Unit at the experimental sites of the commodity groups, especially when these are on small farms.

176. A professional sociologist engaged in studies on the adoption of new technology by small farmers is attached to this group.

IV. THE ANIMAL PRODUCTION PROGRAMME

A. THE BEEF PRODUCTION PROGRAMME

(i) History

177. CIAT commenced work on a Beef Production Systems Programme at the end of 1969, with a group of scientists in the different disciplines essential to making progress in the attainment of CIAT's objectives in beef production. At that time, the overall objective was "to increase cattle productivity in the lowland tropics of Latin America between the tropics of Cancer and Capricorn and at elevations below 1000 m." It was recognized, however, that the main priority was the development of techniques for economic beef production in the vast areas of highly acid infertile soils unlikely to be intensively used for cropping.

178. In July 1973, CIAT invited a number of scientists from various countries to join a Beef Cattle Review Team to examine and evaluate the progress which had been made in CIAT's beef programme since its inception. The summary of the Beef Cattle Review Team's findings and recommendations is contained in the report made to CIAT. This review team found that CIAT's Beef Production Systems Programme was too wide, and needed confining to activities in the priority areas to achieve success.

179. The previous seven years' work of the former Beef Production Systems Programme defined the pasture problems in the difficult infertile, high acid, high aluminium (locally called "allic") soils of the Colombian llanos. With the state of knowledge at that time, it was not found possible to produce a persistent legume so vital to improved pasture development in these areas.

180. Recently CIAT has presented a "Proposed Structure and Activities of the Beef Production Program" which concentrates research and development on the problems of the infertile acid soil areas of the South American tropics. The new title, "Beef Production Programme", is a reflection of a changed emphasis in this important work. It augurs well for the future development of successful legumes and pastures which will markedly increase beef production in the poor, highly acid soils of the Colombian llanos and Brazilian cerrado.

(ii) Organization and Strategy of CIAT's Current Beef Research

181. The Beef Production Programme is very complex because of the relatively large number of disciplines and activities involved, the considerable distances between testing centres

and the problems connected with the integration and deployment of senior and technical staff. At present, most of the research is done at CIAT headquarters in Palmira, at Carimagua in the Colombian llanos and in the Cauca Valley on a farmer's land at Santander, 41 km from Cali. A new 185 ha. property on poor acid soil (ultisol) has recently been obtained at Santander. Here, promising legumes and grasses will be selected for further trial at Carimagua, and at the Cerrado Resources Centre near Brasilia in collaboration with EMBRAPA.

182. At present there are 18 senior core staff positions of which three are vacant. In 1978 there will be a total scientific and supervisory staff of 50 together with 141 clerical and other staff. Also there is one non-core scientist actively engaged in special aspects of the Beef Production Programme.

183. Contacts between the Beef Production Programme and other International Centres will be minimal and can only be expected to develop slightly in the future. This is because the nature and objectives of the beef programme at CIAT are generally quite different from those at the other relevant centres (ILCA and ILRAD).

184. Relationships with national programmes will increase in the future. A major collaborative programme is in progress with ICA at Carimagua (recently renogotiated), and another comprehensive programme has been planned in association with EMBRAPA at its Cerrado Resources Centre. The establishment of the new CIAT station in Santander is on land purchased for the purpose by the Fundación de le Educación Superior (FES) and leased to CIAT at a nominal rent. These agreements allow CIAT to do all aspects of research within its Beef Production Programme in both Colombia and Brazil in direct collaboration with national scientists. The selva region (tropical rain forest) of South America is being cleared for pasture improvement in a number of countries. Senior beef staff are being considered for outposting to a selva station in Peru or Brazil.

185. These activities at the national level serve a basic research function rather than an outreach function. It would seem that there is a need for expansion of outreach to other countries in the impact area. A first step towards this is already contemplated in a survey programme to characterize areas in terms of climate, soil topography, vegetation, infrastructure, pastures, beef production, animal health and economics. A similar study,

with special reference to cattle reproduction in selected areas of Latin America (the llanos of Colombia and Venezuela, the cerrado of Brazil, and the selva of Peru), is being planned to start late in 1977.

(iii) Main Objectives and Fields of Investigation of the Beef Programme

186. These can be summarized briefly as:

- Assembly of a germplasm collection of ecotypes of legumes (and associated rhizobia) and grasses by active field collection and introduction through correspondence with national institutions.
- Selection of promising legumes and grasses and their further evaluation (usually with grazing) at CIAT headquarters, Santander, Carimagua and the Cerrado Resources Centre in Brasilia, all representing different stress conditions.
- Determination of mineral deficiencies in soils in the target areas, effects of the important nutrients on growth of promising legumes and grasses, and the identification of pasture plant lines tolerant to soil stresses (including Al) and efficient in the use of phosphorus.
- Seed production and efficient seed production technology of the best legume and grass lines.
- Assessment of promising legume-grass mixtures (with economical fertilizer additions) in terms of animal performance at Carimagua and the Cerrado Resources Centre in Brasilia.
- Study of individual components of animal management and health under various nutritional levels imposed by native and improved pastures.
- Integration of the different components studied, including those indicated by economic surveys and analysis in the target areas, into beef production systems in cooperation with national institutions.

(iv) Comments on Different Facets of the Beef Production Programme

187. (a) Experimental Sites

(aa) The development of the new Santander station should speed up the preliminary identification of promising legumes and grass ecotypes for trial at Carimagua, the Brazilian Cerrado Resources Centre and elsewhere. However, if there is

too much effort at Santander, the real problems posed in the llanos and in the cerrado will not receive the concentrated attention which is urgently required for CIAT's success.

(bb) At present there is only one senior scientist stationed at Carimagua. It is suggested that more scientific staff are needed on this station, particularly as progress is made towards successful legume-based pastures in the llanos.

(cc) It is recognized that active clearing of the selva region of South America is taking place and that serious scrub regrowth problems have occurred. However, senior staff should not be posted to selva stations in Peru or Brazil before the complex and extensive llanos and cerrado research and development is firmly established. If a decision is eventually made to commence work in the selva, collaboration with IVITA of Peru should be seriously considered.

188. (b) Use of Backup Services

(aa) In the implementation of the beef production programme it is essential that all experiments are properly planned with the aid of the Biometrics Unit. In this way, definitive results, whether positive or negative, will be obtained from all the work in progress. It is better to carry out fewer, well planned experiments than a range of observation trials which often given results of doubtful value. When large scale grazing experiments are being established, the biometrician should have an active role at the planning stage. Parameters often overlooked by the scientist can then be incorporated into the experiment so that meaningful results can eventually be obtained.

(bb) The capacity to monitor the mineral status of plants and soils needs to be considerably improved at CIAT by the provision of modern equipment and by placing a skilled analytical chemist in charge of the chemical laboratory.

(cc) CIAT greenhouse facilities are inadequate for raising all the legume and grass ecotypes being collected in the field, for testing resistance to soil stresses (e.g. Al), diseases and insects, and for any crossing work needed.

189. (c) Legume and Grass Improvement

(aa) In the search for adapted legumes, most of the previous work has concentrated on the Stylosanthes species, particularly S. guyanensis, and this has been due in part to a lack of legume agronomists. If success is to be achieved in the infertile, very acid soils of the llanos and the cerrado, the scope of the legume evaluation research will need to be expanded in the field. More work is needed not only with the Stylosanthes species, but also with several other legumes including the Centrosema species, the Desmodium sp. like D. ovalifolium, and Leucaena leucocephala. For example, if the nutrient and rhizobium problems of Leucaena at Carimagua could be solved, this legume could make a marked contribution to the provision of high protein forage during the dry season. Also, the area of the grass Brachiaria decumbens is rapidly increasing throughout the South American tropics, so it is essential to find a legume which is compatible with this vigorous grass species. Any expanded legume evaluation work in the field will require at least a second agronomist.

(bb) The inclusion of a grass agronomist in the new beef production programme is a progressive move. Preliminary evaluation of the large number of grass ecotypes available in the gene pool needs to include suitable grazing treatments with cattle. However, once the more promising ecotypes have been identified, there is a need for simple experiments to determine their ability to give liveweight gains in young steers over the main growing season. Small plots up to 5 ha., and in duplicate of the various grasses with a common legume, could be used for this purpose. Such experimentation would ensure that only one or two of the most promising grasses is used in large-scale grazing experiments which demand considerable inputs of a range of resources including research staff, labour, cattle, fencing, etc.

(cc) It is noted that three of the vacant senior scientist positions are for a forage breeder, plant pathologist and plant nutritionist respectively. The Panel supports these core appointments as they would considerably strengthen the work on selection and improvement, particularly in legumes, for resistance to disease and soil stresses (e.g., A1). However, the aims of the breeding work need to be clearly defined if success is to be achieved.

190. (d) Soil Mineral Deficiencies

(aa) The economic correction of soil mineral deficiencies presents a challenge in the more remote areas of the llanos and cerrado with poorly developed infrastructures. Careful attention needs to be given, in the staffing arrangements for the new Beef Production Programme, to the problems associated with mineral deficiencies in the infertile, acid soil areas. Solution of these problems is vital to the progress of the whole beef programme and needs to be given the highest priority. Most of the regions are deficient in phosphorus, an essential for growth, protein production and persistence in both legume and grass. As sulphur is as important as phosphorus to growth and protein production of legumes and grasses, the sulphur status in the soil profiles of the llanos and cerrado should be surveyed as soon as possible by CIAT or by contract with an appropriate organization. Minor elements likely to be deficient in many areas include molybdenum and zinc, and these should be given special attention. Because of the importance of phosphorus in the soil-pasture-animal system, a major effort is justified in:

- Intensive studies of the value of rock and other forms of phosphate in the establishment and maintenance of legume-grass pastures.
- Selection of legume and grass lines with a high efficiency in the use of phosphorus.
- Determination of the minimal phosphate applications necessary for the persistence of promising legume-grass mixtures under continuous cattle grazing, and the monitoring of the phosphorus transfer from the soils to pasture and animal.

(bb) The provision of relatively cheap phosphate is vital to the development of improved pastures in CIAT's target areas. It is important for CIAT to encourage the survey and collection of data on native phosphate deposits in South America through national and international organizations, especially that of I.F.D.C.

191. (e) Seed Production

The development of seed production technology for the promising legumes and grasses needs to be intensified, not only by CIAT but also by national and private organizations in the South American tropics. Technology associated with economic

tropical pasture seed production is in its infancy, and requires a lot more effort to ensure that increasing quantities of commercial seed are available to farmers for the rapid expansion in tropical pasture development envisaged. As CIAT develops improved seed production technology for its new pasture cultivars, it is essential that this technology be made available quickly through suitable CIAT training courses and direct contact with national organizations.

192. (f) Cattle Aspects in Assessment of Improved Pastures

(aa) In testing the productivity of improved legume-grass pastures, the following aspects need to be taken into consideration:

- establishment of a test pool of cattle, adequate in number and quality (test herd);
- application of appropriate cattle management, particularly seasonal mating, controlled weaning and calf rearing;
- supplementary feeding with special reference to P, Cu and Co;
- identification and control of specific diseases in the test herd, particularly those contributing to calf mortality and affecting reproductive performance.

(bb) The testing of grasses and legumes, singly or in combination as pasture, requires a ready supply of suitable cattle. This involves steers for pasture testing (legume persistence and liveweight gain) and cows for studies involving calving and mating management in the framework of pasture improvement. The Panel believes that the test herd is inadequate in number and quality and needs to be strengthened considerably. Furthermore, use of a single Bos indicus breed (e.g., Nellore) should be considered. Such a process takes several years, and it is therefore urgent that the purchase of selected breeding stock be initiated as soon as possible.

(cc) To make maximum use of improved pastures, modern methods of animal management have to be used. In the llanos of Colombia and the cerrado of Brazil current management practices, involving continuous mating and natural calf weaning, as well as health, could be substantially improved. It is therefore essential that the beef programme pay particular attention to appropriate beef cattle management

practices. Such activity should not depend on the successful establishment of legume-based pasture; indeed, it is desirable that it start immediately on native pasture.

(dd) In a similar way, much of the target area is known to be phosphorus deficient for cattle, while other specific mineral deficiencies are suspected, e.g., in copper and cobalt. There is no reason why work on the availability of phosphorus in the pastures, and phosphorus utilization studies, should not be initiated immediately, i.e., before pasture development. Study of copper and cobalt deficiencies by survey techniques and specific supplementation trials could also be initiated.

(ee) The efficient utilization of cattle for pasture evaluation (liveweight gain and reproduction) depends on the use of animals which are free of specific diseases which limit performance, e.g. gastrointestinal parasites in growing cattle and reproductive diseases in breeders. It is therefore important that special attention be paid to the health of the cattle pool.

193. (g) Incorporation of Improved Pastures on Farms

(aa) It needs to be emphasized that, when improved legume-grass pastures are available, it is unlikely that they will be sown on more than 10 to 20 per cent of the area of any particular property by even the most progressive farmers. Hence, considerable attention needs to be given by CIAT to the integration of improved pasture with native pasture in the llanos and cerrado. The partitioning of improved and native pastures between growing steers and reproducing cows needs to be carefully balanced for the highest economic returns from a beef enterprises.

(bb) The importance of crops like rice, cassava, sorghum and peanuts as profitable precursors to the establishment of improved pastures needs attention. These crops could be used for supplementary feeding in the dry season. Cropping could well become an adjunct to beef production in the llanos and cerrado. Improved pastures build up soil fertility and structure, and would allow periodic cropping in these areas provided it was not frequent enough to cause soil deterioration and erosion.

194. (h) Importance of Animal Health

The improvement of animal health and management could make a significant impact on cattle production irrespective of the provision of improved legume-grass pastures. It is necessary for national or international organizations to intensify work on aspects such as calf mortality, and reproductive and parasitic diseases.

195. (i) Economic Aspects of Pasture Improvement

(aa) The economist should take an active part in the planning of any management-oriented grazing experiments. In the early phases of the programme, the economist can make a most important contribution by rapidly identifying the various constraints to production and their relative magnitudes. Further feedback in economic evaluation of both potential and actual research results is necessary in order to make regular adjustments to the research programme so that an improved and profitable beef production system is developed. This can then be transferred with confidence to national organizations and beef producers.

(bb) Individual components of the beef production systems involved will need to be evaluated against the economic background of the different countries. The final evaluation of the economic aspects of the beef production systems should be made in a national context, and not only by CIAT.

(v) Summary and Conclusions

196. The revised Beef Production Programme which has been recently instituted is a satisfactory and well planned balance of activities, except in a few instances which have been commented on by the Panel. The temptation to expand into other target areas should be resisted until the current programme is well established. The Panel recommends the following:

- More emphasis should be placed on soil mineral deficiencies in the target areas, and a senior chemist should be appointed to be in charge of soil, plant and animal tissue analyses. A much higher throughput of analyses with modern automated equipment is essential backup to the beef production team.
- Work on mineral nutrition of cattle should be concentrated on the flow of phosphorus in the soil-pasture-animal system.

- Since selection of successful legumes is vital to the whole beef programme, a greater range of legumes should be evaluated over a wide range of environments. Accordingly there is an urgent need for a second legume agronomist.
- It should not be overlooked that a healthy, well managed, high quality cattle herd is an essential for the adequate testing of any improved pastures developed.
- After so much reappraisal and change, this programme should now be given the time to make uninterrupted progress.

B. THE SWINE NUTRITION UNIT

(i) Objectives and Activities

197. The Swine Nutrition Unit, formerly "Swine Production Systems", has recently been reorganized. The activities formerly consisted of "Research on development of feeding systems based on available feed stuffs, prevention and control of swine diseases and parasites, development and demonstration of complete swine production systems".

198. The new title "Swine Nutrition Unit" clearly indicates the scope of activities envisaged by the reorganization as far as research is concerned. The objectives are nutritional studies, especially on the substitution of cereal grain by rice polishings, cassava meal, banana waste and molasses, and also the use of opaque-2 maize as a partial substitute for high quality protein requirements in integrated life-cycle feeding programmes for swine. These activites are carried out at CIAT, and also in collaboration with INIAP in Ecuador and ICA in Colombia. With the collaboration of the University of Guelph, a pilot plant was installed at CIAT for the production of single-cell protein using cassava as an energy substrate.

199. The Unit's major activity aims at the transfer of established technology to swine production in Latin America through training courses both at CIAT and national institutions. At CIAT, courses of six months' and six weeks' duration are offered, while CIAT staff assists with national and regional courses, seminars, and workshops following specific requests from various countries, e.g. Bolivia, Ecuador, Peru and Nicaragua. It is expected that approximately 100 swine specialists will be trained at CIAT alone during a five-year period. These specialists form national nuclei and, in turn, transfer the technology to the producer level. The Swine Nutrition Unit has strong international links, especially with Bolivia, Colombia, Ecuador, Costa Rica and Peru. Particular emphasis is placed on the establishment of a swine research and development network and the evaluation of the economic feasibility of swine production in Latin America.

(ii) Comments

200. Swine production plays a relatively minor role when expressed statistically as an element of agricultural production in Latin America. It should be emphasized, however, that a high percentage of subsistence farmers in tropical Latin America depend on swine

production both for an animal protein source in their diet and/or for a significant part of their cash earnings utilizing by-products of their family enterprise (household waste and farm produce). The strength of CIAT's Swine Nutrition Unit in training for swine production is thus particularly relevant to the economy of the small producers throughout the region.

201. The Swine Nutrition Unit's training programme has been very successful in certain Latin American countries. In a number of countries, piggeries have been established for the purpose of training national swine extension workers and providing a breeding facility for the importation of improved breeding stock for multiplication and distribution to small producers. These programmes are now beginning to yield results, but the national specialists still require the support of CIAT for both further training and guidance. The Review Panel considers that to remove this very important support function of CIAT would result in a break in development in which CIAT without doubt plays an important role in Latin America. It should be noted that, in some countries, a rapid increase in the population of pigs is taking place.

202. The pig herd and the Swine Nutrition Unit's installations should be recognized as unique facilities in tropical South America for the evaluation of non-traditional feed resources in swine nutrition and, as such, they should be exploited to the fullest extent.

203. This work, which concentrates on the use of by-products, is particularly relevant in a world where there is increasing competition between the human and animal populations for energy and protein sources.

204. Although the single-cell protein collaborative research work in the Unit is of particular interest to the cassava programme in the long term (utilization of excess production), it is felt that the justification of this work depends on the broader concept which aims at developing technology (fermentation, microbiological aspects, etc.) for the production of single-cell proteins utilizing readily available sources of energy and not on the specific use of such proteins in swine nutrition in Latin America.

205. It is apparent that the training aspects of the Swine Nutrition Unit have been particularly effective in many countries for several years. When it is realized that this intensive programme depends on two core staff members, the record is even more impressive.

(iii) Conclusion

206. Taking into account the Unit's substantial training programme and its national and regional impact, the relevance of its emphasis on the use of alternative sources of energy and protein for swine rations in Latin America, and the possibility for economic evaluation of these alternatives within individual systems in different countries, the Panel recommends that this programme be maintained within the core budget.

C. ANIMAL HEALTH RESEARCH AT CIAT

207. The Review Panel gave special consideration to animal health research at CIAT, both in the context of the Beef Production Programme and in relation to the Texas A&M Special Project for Ectoparasite and Hemoparasite Research.

208. With regard to the Beef Production Programme, it was felt that the primary function of the veterinary staff was to maintain the health of the breeding herd and experimental cattle so as to ensure that animal disease does not interfere with the assessment of pasture quality by animals. It was noted, however, that this service function would not require the full-time efforts of two senior staff members. Neverthless, it is necessary to provide expertise in several veterinary disciplines (pathology, bacteriology, parasitology, etc.). The Panel therefore recommends that the veterinary component of the Beef Production Programme remain strong and suggests that the research effort of these veterinarians be directed towards problems which have immediate relevance to the beef programme, viz.: (i) phosphorus availability and utilization by cattle, and; (ii) gastrointestinal parasites and lung worms in young cattle.

209. The members of the Panel were impressed with the work being carried out by the Texas A&M team on ectoparasites and hemoparasites. However, this was clearly not directly relevant to the objectives of the Beef Production Programme. Furthermore, the Panel was aware of the limitations imposed by certain aspects of animal health (notably calf mortality, reproductive diseases and parasitic diseases) on achieving maximum beef production from tropical or other pastures in much of South America. The Panel was informed of the efforts being made to finance the continuation of the Texas A&M work at CIAT and of the possibility of expanding this to other fields of animal health. The Review Panel therefore strongly recommends that CIAT collaborate in broader studies of cattle disease in tropical Latin America, and that this work be supported by donors on a bilateral or international basis. Such work should include economic analyses of disease impact and control.

V. TRAINING AND CONFERENCE PROGRAMMES

210. CIAT's training and conference activities were initially organized in part independently of its research programmes. However, in 1976 the modus operandi was changed so as to give the major role in training to the commodity research teams. The provision of organizational and logistical support, together with responsibility for non-commodity based courses (such as communication methods), remained with a central training and conference unit. This unit employs two senior staff members supported by ten professionals and nine others. Its annual expenditure is about nine per cent of CIAT's operating budget.

211. The objectives of the programme are:

a) "To contribute towards alleviating the shortage of trained manpower in areas of research, production, and technology transfer in country programmes.

b) To help in identifying production problems in CIAT's mandated commodities through conferences and workshops and in planning research and development strategies.

c) Development of regional coordination networks of research and production scientists through workshops, designed for research analysis and planning.

d) Training of postdoctoral and predoctoral scientists, and collaboration with commodity programme staff as a source of future trained staff for central and outposted positions of CIAT programmes."

212. An essential feature of the training programme, which the Review Panel strongly endorses, is that from 60 to 90per cent of training is conducted through field activities. Thus, trainees within each commodity training programme actually plan, lay out, plant, record and analyze the results of a personal field experiment during the course of their training, and are also involved in the management of commercial fields and visits to farms.

213. While the field activities of trainees are often of assistance to the commodity programme scientists, there is no doubt that the provision of training courses can be demanding on the scientists' time. To some extent, this can be mitigated by the use of standard audiovisual packages for individual use by the trainees, as have already been

developed by the Training and Conference Unit in collaboration with the scientists responsible for some of the commodity courses. In the Review Panel's view, these audiovisual packages are excellent and it expects them to find a ready market in the national programmes in CIAT's region. However, they cannot fully substitute active participation by scientists in the commodity training programmes. The Review Panel therefore hopes that care will be exercised in ensuring that a disproportionate share of the research scientists' time (especially of senior staff) is not allocated to training activities.

214. With the above proviso, the Review Panel agrees that commodity-oriented training is best provided via the commodity programme teams. They have the expert knowledge and, from their active engagement in research, can best stimulate and motivate trainees. Moreover, as noted in section II C, there is no doubt that the development of a cadre of trained specialists in CIAT commodities is essential to the achievement of CIAT's goals. Without the linkage to national institutions provided by CIAT's trainees, it would be far more difficult for CIAT's scientists to establish cooperative field tests, to obtain feedback on technology needs, and to have a channel for the transfer of technology.

215. The Panel believes, for example, that a major obstacle to technology transfer throughout the American tropics is the lack of expertise in and facilities for the production of clean seed. Since seed production is or could be carried out by commerical rather than government enterprises, the Review Panel commends CIAT policy on the admission for training of non-government seed specialists.

216. The total number of professional staff receiving postgraduate training at CIAT from 1968 to 1976 inclusive has been 733. By far the majority of these were from Latin America. Of the total number, some 20 per cent were research scholars, visiting research associates, and postdoctoral fellows who had the benefit of working in close research association with CIAT scientists.

217. The distribution of trainees is illustrated in Table 1 below. Overall, the Review Panel considers that CIAT's present training activities are on the right lines and represent about the maximum that the Centre is staffed to undertake. Since the effort could not be expanded without serious interference to research output, it is clear that significant emphasis should be placed on assisting national institutions to conduct their own training courses. Major attention should therefore be given to helping trainee instructors

to learn how to teach the technologies learned at CIAT. Help with training manuals and documentation should also have a high priority.

218. Also important to CIAT's responsibilities in research and technology transfer is its active conference programme. In the Panel's view, this is functioning efficiently and fruitfully.

219. It has not proved possible for CIAT to follow the career records of all of its trainees, but the Information Staff are still in touch with some 400 of them and are supplying them with literature.

Table 1. TRAINING ACTIVITIES

Number of professionals trained at CIAT in 1975 and 1976

	1975	1976
Postgraduate research interns	58	61
Postgraduate production interns	45	25
Short course participants	20	28
Special trainees	27	29
Research scholars	20	19
Visiting research associates	21	18
Postdoctoral fellows	3	8
TOTAL	194	188

Number of professionals trained at CIAT from 1970 to 1976 in each commodity programme

Bean Programme	123
Beef Programme	171
Cassava Programme	140
Rice Programme	74
Swine Unit	60

VI. CIAT'S DEVELOPING CONTRIBUTION TO TROPICAL AGRICULTURE

(i) General Considerations

220. Before considering CIAT's developing contribution to tropical agriculture, it must be emphasized that the Centre is a very young institution and was funded only in 1968. In developing countries, it commonly takes 10 years to create new usable agricultural technology and a further decade before impact on production can be measured.

221. CIAT's major products are agricultural technology, improved germplasm and trained manpower. The adoption of products of this type is often frustrated by economic, social and political factors at the national level. Nevertheless it is necessary for an IARC, such as CIAT, to assess its impact on farmers in the region it serves. This should not be done to enhance the image of the Centre but to provide a vital feedback of information to its research and training programme. The Panel recommends that CIAT develop a method for monitoring its contribution to tropical agriculture.

222. It is too early in the history of the Centre to expect its potential impact to have been attained. However, examples of CIAT's contribution have been recorded.

(ii) Rice

223. CIAT's major contribution to tropical agriculture has been with rice. It should be noted, however, that CIAT had a solid base of technology, germplasm and trained scientists on which to build before it began its rice programme. The most dramatic increases in rice production occurred in Colombia, although other Latin American countries have benefited greatly from CIAT's rice programme. Ecuador and Guatemala have released CIAT-IRRI-ICA varieties under local names.

224. On examining the Colombian case, it can be seen that the efforts of Colombian government agencies and the Rockefeller Foundation in rice research began 20 years ago, and that more recently CIAT has had a direct link with IRRI. Furthermore, the CIAT programme in rice in Colombia has, from the beginning, been a comprehensive programme established jointly by CIAT, ICA (Colombian Agricultural Institute) and the Colombian National Rice Grower's Federation.

225. Economic studies have shown the impact of improved technology and varieties on rice production in Latin America, not only on production but also on producers and consumers. In Colombia, national average yields were already 3 t/ha. in 1966 but rose to 5.4 t/ha. in 1975. Production increases in Colombia were dramatic: 680,000 t in 1966 to 1.6 million t in 1975. Most of the increased production came from irrigated, not upland, rice. In fact, the share of total output coming from upland rice fell from 32 to 10 percent.

226. As a result of this expanded production in Colombia, real prices received by the producers have been reduced. The Colombian government's policy of prohibiting exports meant that producers did not capture all of the benefits, but that consumers did benefit greatly. It should be remembered that benefitting low-income consumers is among CIAT's objectives.

227. Since 1967, the annual expenditure on rice research and related activities by CIAT and the Colombian Government and its agencies (in constant 1970 dollars) has never exceeded one million dollars. The benefits to Colombia over the period from 1964 to 1974 are estimated at 200 million US dollars.

228. These results are raising questions on the balance in the distribution of benefits between consumers and producers, and CIAT is analyzing them in order to better define its research strategy.

(iii) Other Commodities

229. It is more difficult to measure the contributions of other CIAT crop and animal programmes to tropical agriculture. Most of CIAT's research and training activities are just reaching their "cruise speed" and it is thus too early to properly assess their impact.

230. The CIAT swine programme has a large fund of knowledge and experience in swine production systems. Its research results, and especially the trained personnel who have transferred improved practices in swine production technology throughout Latin America, have formed the basis for a substantial contribution to increased swine production.

231. Although the Cassava Production Systems Programme is only five years old, some positive contributions can already be cited. For example, the Panel had the opportunity to see the adoption of some of the improved cassava production technologies, recommended by CIAT, by farmers of the Colombian Coffee Grower's Federation near Caicedonia, Colombia,

where about 5,000 ha. of cassava are grown. Specific CIAT-recommended practices which have increased yields from a previous average of 17 t/ha. to 45 t/ha. in the region were: 1) the elimination of cassava bacterial blight in the region by sanitation practices and rotation; 2) a new planting technique on ridges which eliminated a serious root rot problem; 3) the use of wasps for biological control of the cassava hornworm, and; 4) weed control.

232. CIAT cassava varieties have outyielded local materials in regional trials in Colombia, Ecuador and the Dominican Republic. Ninety percent of the trials in Colombia were on farmers' fields and without fertilizers, yet CIAT lines averaged yields of 30 t/ha., nearly four times the national average. A CIAT line sent to the Dominican Republic has been named there and is to be released as a new variety because of its superior performance.

233. The bean programme is even younger than the cassava programme, but already some contributions from its research and training activities are apparent. A network of bean researchers is developing in Latin America from the bean scientists trained at CIAT. Supplying seeds free of diseases to farmers enabled them to double and triple their yields in Colombia and Guatemala respectively. In Colombia, ICA has recently released two new bean varieties developed in a joint CIAT/ICA programme.

234. The training of young researchers and production specialists from the tropics of Latin America is described in Chapter V. Their contribution to agriculture in Latin America is almost impossible to quantify at this time, but will perhaps be greater over time than that of the short-term benefits of improved technology and germplasm.

(iv) Conclusions

235. The major contribution of CIAT, jointly with IRRI, has been improved rice varieties for Latin America. The basis of this has been the technology developed by IRRI, and by CIAT and its predecessor organisations. The superiority of the product, and the presence of an infrastructure consisting of well organized farmer organizations with access to biological and economic inputs, have also contributed.

236. The rapid uptake of the rice technology, more rapid than would commonly take place in a developed country, occurred in spite of the absence of strong national research infrastructures.

237. The impact of cassava on a limited area (Caicedonia) demonstrates the rapid uptake of a viable technology when an active farmer organization exists.

238. The Panel considers that the technology being developed by the cassava and bean programmes will be taken up by small farmers when suitable infrastructure is provided at the national level.

239. Although the bean programme has a technology which has been convincingly demonstrated to double and triple yields, the absence of an effective seed production system has placed a severe limitation on the uptake of the product.

240. The most lasting impact of CIAT's work on agriculture in Latin America is likely to be the effect of its training programme which has produced over 730 graduates to date.

VII. ORGANIZATION AND MANAGEMENT OF CIAT

A. ADMINISTRATION, PERSONNEL AND BUDGET

241. Under the Board of Trustees and the Director General, line management functions are exercised by the Associate Directors General for Research and for International Cooperation. The Associate Director General for Research is responsible for research support services and off-campus research programmes as well as all on-campus research. The Associate Director General for International Cooperation is responsible for training, conferences, information services and the cooperative programmes which are not an integral part of the core research operations.

242. The commodity programme staff cover an array of disciplines and the beans, beef, cassava and rice programmes are led by a soil microbiologist, soil scientist, plant physiologist and plant breeder respectively. Thus, there are no leaders of scientific disciplines as such but the members of any particular discipline cooperate on an informal basis.

243. CIAT has a total staff of approximately 1,000; this includes posts for 54 international staff of which 43 were filled at the time of the Panel's visit (and five offers of appointment had been made). CIAT proposes to increase its senior staff positionsto 61 in 1978 and 65 by 1980. There is a total of 151 support (scientific and supervisory) staff positions, giving a ratio of slightly less than 3:1 support to senior staff. Whilst the support staff are virtually all Colombian, the senior staff are truly international, covering 15 different nationalities including nine from the host country.

244. CIAT spends 69 per cent of its core operating budget on personnel services of which 35 per cent is for international staff and 53 per cent for local staff, six per cent for trainee stipends, five per cent for temporary labour, and one per cent for consultants.

245. In addition to its senior staff, the Centre has four postdoctoral fellows, two from developed and two from developing countries. This is fewer than at the other Centres which commonly have 10 or more such staff. The salaries and perquisites of postdoctoral fellows, which form part of the training budget, are fully competitive with other Centres. CIAT has explained that its postdoctoral fellowships programme only started in 1975. It is proposed to have eight such posts in 1978, 10 in 1979, and 15 from 1980.

246. CIAT also has eight special project funded staff involved in beans, cassava, the Andean maize project (funded separately through CIMMYT) and the Guatemala ICTA project. Additional special project funded staff are proposed.

247. The Centre has a standard set of procedures for personnel policies and a staff policy committee dealing with staff management. It recruits its international staff for a two-year probationary period, normally followed by a "continuing appointment".

248. The Panel was impressed with the quality and dedication of both the senior and the support staff. It was generally agreed that the question of housing seemed to be the one difficult problem. CIAT has relied on the local housing market to supply good quality, rented accommodation for its senior staff. This market is becoming more competitive and CIAT management may need to develop a programme to ensure a steady supply of houses.

249. Hitherto CIAT has had an annual budget process but for FY[S] 1978-79 the Centre is one of three in the CGIAR system chosen to develop a two-year budget, following the recommendation of the CGIAR Review Committee. The Centre's system of budgeting is a standard procedure whereby programme leaders assemble budgets for their programmes after which CIAT's management adjusts these to fit into a general overall strategy for the Centre's budget. Although the CGIAR Secretariat has issued technical guidelines for the construction of centre budgets so that they conform to a standard pattern for the system, the CGIAR does not issue any guidelines on financial availabilities in a budget year, so that the Centre has to propose its own level of expenditure.

250. CIAT's operating budget has shown a steady growth since the Centre started. In constant 1977 dollars, the annual budget has grown from $1.564 million in 1969 to a projected $9.610 million in 1980; this will give a total operational expenditure of approximately $72 million over that period. The growth of the grain legume, cassava and livestock programmes between 1971 and 1980 will respectively be: $0.17 to $1.50 million; $0.46 to $1.33 million and $0.89 to $2.65 million. Training, on the other hand, has shown less growth ($0.45 in 1971, $0.70 in 1973, $0.83 million in 1980).

251. The Centre has had a comparatively modest capital investment to total approximately $15 million (in constant 1977 dollars) by 1980. In 1977, CIAT proposes to allocate

$536,000 for the development of the Carimagua Station; nearly 50 per cent of this will be spent on housing and buildings.

252. Staff vacancies in 1976 resulted in a comparatively large surplus ($756,000) in that year; there is a projected surplus of $285,000 in 1977. The Centre has a sound basis of donor support, 14 donors having pledged support in 1977.

253. The Centre has a computerized financial control system, and monthly printouts enable it to keep track of expenditure by programme and by discipline within each programme. This information is of considerable value to management, particularly if a system of programme component costs were to be adopted in future.

254. At $145,000 per man-year of senior scientist in 1976, CIAT's costs compare favorably with other Centres in the system, and the Panel believes that the Centre exercises very effective financial management.

255. The Panel was not made aware of any major financial constraints affecting the programme.

B. LIBRARY AND INFORMATION SERVICES

(i) Objectives

256. The Library and Information Services provide basic support for the research and training activities at CIAT; contribute to the transfer of technology developed by CIAT to appropriate audiences in almost 50 countries; and are also responsible for the institution's public image.

(ii) Comments

257. The Library and Documentation Service, which has 37,500 volumes and receives 1,300 journals, meets the requirements of its scientific users by a monthly distribution of "Pages of Contents" (distribution 1,500) and by maintaining a documentation service for cassava (complete world literature), beans (selected for tropical conditions), agricultural economics (restricted to Latin American publications), and tropical pastures and forages which will start in June 1977. Except in the case of the recent trainees, who receive a one-year subscription free of charge, these services are available at a nominal cost of $3.00/year to scientists throughout Latin America. Formal arrangements have been made in a number of countries for payment to be made using a coupon system through the country offices of IICA, and for distribution of the "Pages of Contents" and abstract cards (available in Spanish or English) through national information centres. Abstracts are compiled annually and produced in book form. A total of 180,000 pages of photocopy are made monthly.

258. The Information Service supports the scientific programmes by producing a wide range of high-quality publications to meet the different needs of reports, proceedings, technical and semi-technical proceedings, and training manuals. These are all published in both Spanish and English while some have been translated into Portuguese and Indonesian. National institutions are also translating CIAT manuals into Portuguese. An internal newspaper is produced which helps keep the staff informed of general activities within the Centre.

259. The Public Information Office is responsible for the reception of the impressive number of visitors to the Centre (4,000 in 1976). This important function not only serves as the front line for the projection of CIAT's image but also as a filter to restrict the flow of visitors whose very numbers could interfere seriously with the continuity of the scientific work.

260. The physical facilities occupied by the Library and Information Services house an impressive number of staff (three senior plus 18 scientific and supervisory plus 42 support, totalling 63) and services. Although the general standard of accommodation is high, some sections, notably the editorial section, appeared to the Panel to be crowded. It would appear that some consideration should be given to the possibility of improving the library air conditioning, particularly in the reading areas. An adequate series of maps is also needed.

261. It was noted that the final designed or planned shelf space of 40,000 is almost filled (37,500). The present proposal to meet this situation, the introduction of a microfiche system, being more economical and practical, was considered by the Panel to be a reasonable alternative to building extensions. The Public Information Office is also discussing the introduction of a video tape system for producing 16 mm films for teaching and public relations purposes. This appealed to the Panel as a logical extension of this service's activities.

262. CIAT's Library and Information Services are probably the best available in Latin America in the agricultural field, with regard to both coverage and services offered. Because of this, and the desirability of maintaining and if possible extending CIAT's role in this field, the Review Panel believes that consideration should be given to strengthening inter-library communications, e.g. with the libraries of IICA-CIRA and ICA in Bogotá and IICA-CIDA in San José, etc., and was interested to note that a link with DIALOG (Lockheed, California) had been discussed.

(iii) Conclusion

263. The Review Panel considers that the Library and Information Services are efficiently discharging their responsibilities both to CIAT staff and to the Latin American agricultural community as a whole.

C. SUPPORTING SERVICES

(i) Biometrics

264. The Biometrics Unit acts as a service, training and research unit. In the absence of the Senior Scientist on study leave, a postdoctoral fellow is in charge of the Unit. There are also posts for five scientific and supervisory staff.

265. The Unit is equipped with desk top computers, and has a terminal linked by the microwave system to an IBM 370/145 at the National Department of Statistics in Bogotá.

266. The programme, as set out by the Unit, covers:

a) Design and analysis of experiments in plant and animal sciences.

b) Information systems for germplasm collection.

c) Design, programming and modelling for economic analyses.

d) Training.

e) Research to improve methods in the above functions.

267. As in most research organizations, the degree of mutual planning of experiments between the Biometrics Unit and the research groups varies, but the staff estimated that about 50 per cent of the projects analyzed by the Unit were jointly planned by the Unit and the programme concerned. The staff expressed a desire for closer cooperation at the planning stage of all investigations in which they would be involved at the processing stage; this is strongly supported by the Panel.

268. The Unit has been closely involved in the development of the information and analyses system for the bean germplasm collection, SIFFRI (Sistema de Información de Fitomejoramiento de Frijol), which depends on the SAS system of North Carolina State and PL/I (IBM). The SAS system is compatible with the EXIR system of the University of Colorado, but the USDA has found it to be superior. The germplasm collections of cassava and forage legumes do not yet use computerized information systems.

269. The members of the Unit felt that they could play a useful role, not only in data processing but also in the adaptation and development of statistical approaches and experimental design for tropical crops and conditions. In this they would welcome opportunities for contact and collaboration with biometricians at other IARCs.

270. Recognizing the weaknesses in biometrics and experimental design in many national programmes, the Panel would encourage efforts by the Centre and the IARC system to increase competence in these fields.

(ii) The Infrastructure and Operation of the Station

271. The CIAT station at Palmira is a highly successful example of architectural design. It is maintained to a very high standard; the buildings and gardens are impeccably clean and well ordered, the laboratories are in good repair, and the Panel found only the greenhouses and potting sheds to be below the high standards expected of an International Centre. The capacities of laboratories, conference rooms and visitors' accommodation are, in general, ample for the programmes in hand or planned, although there is some shortage of office accommodation for which an additional building is proposed.

272. Greenhouse accommodation is, however, inadequate for the programmes now planned. The Panel considers that three additional greenhouses are required at the Palmira site for the following purposes:

a) A greenhouse with special provision for the containment of insects and pathogens. This is essential for the quarantine of introduced germplasm, especially of forages collected in vegetative phase, and for the indexing of material before dispatch to other countries.

b) A greenhouse for rhizobial work on beans and forage legumes.

c) A greenhouse for forage breeding.

The Panel notes that only one such greenhouse is included in the forward budgeting (for 1978) and recommends that consideration be given to the provision of these facilities.

273. The 520 ha. of experimental station land has been effectively developed for irrigation from deep wells. Some mild soil salinity was encountered and was successfully reduced by leaching under irrigated rice, grown as a commercial crop. A good network of roads, 35 km. in total, has been constructed by station staff to a high standard, and much of it has been bituminised. Three km. of irrigation ditches have been constructed with soil-cement lining. The land has been levelled and the standard of crops and of agronomy appeared to be very good. This example, to many hundreds of students and several thousand

visitors from Latin America, is an instructive demonstration of the standards needed for fully effective agricultural research. Tractors and equipment appeared to be well maintained, as were a substantial fleet of buses, trucks and pickups.

274. Many of the operations are labour intensive, and there are some 300 support staff involved in the operation and maintenance of the buildings, laboratories, farm and transport fleet.

275. The Panel was well satisfied with the organization of the service and support operations.

VIII. THE ORGANIZATION OF SCIENCE DISCIPLINES

(i) Allocation of Responsibilities

276. The staff of CIAT is organised in multidisciplinary teams working on commodity-based programmes. There is little or no formal organisation or hierarchy within scientific disciplines. The Panel supports the multidisciplinary approach to agricultural problems and is satisfied that it secures close collaboration between the scientists in the commodity programmes.

277. Difficulties remain, however, in the arrangements for coordination within disciplines which have produced problems in the organisation of laboratories. The Panel considers that this represents a current weakness in the organisation which can be remedied without detriment to the multidisciplinary approach. Two requirements are essential if the scientific staff and the soils laboratories, plant science laboratories and greenhouses are to make their optimum contributions to research. Firstly, a senior member experienced in tropical conditions should be designated for each major discipline (e.g., soil science, plant science, entomology, animal nutrition and animal health) with the responsibility of ensuring that less experienced colleagues have the help and advice necessary to carry out their tasks. Secondly, in each laboratory, the clear responsibility and authority for the organisation of facilities, staff and equipment should be given to an experienced scientist, usually but not necessarily the same person who is responsible for professional staff.

278. Laboratory committees are necessary and useful, but their decisions need to be executed by individuals with personal responsibility. In particular, in addition to the current provision of greenhouse space being inadequate, the Review Panel considers the management and maintenance standard of the greenhouses and potting sheds to be below that essential to the success of the research work.

(ii) Soil Science, Plant and Animal Nutrition

279. CIAT's commitment to the development of both crop and livestock production on infertile soils at minimum input levels over major geographical areas implies a close study of existing nutrient levels in soils and of their transfer to plants and animals. The Panel considers that the capacity for throughput of plant and soil samples is at present

inadequate for this task. The Panel endorses the proposal made by CIAT that a well-trained analytical chemist be given responsibility for the supervision of this work, the laboratory organisation, the development of the methods of analysis and the installation of automated analytical equipment. The Panel is impressed by the spaciousness of the laboratories and considers that, with a modest addition of equipment, the throughput of plant and soil analyses could be increased to the level needed. At present, the soil scientists do not include a soil physicist, and the attention paid to measurement of water storage capacity of soil profiles and its relation to root development is minimal. The pasture development side of the beef programme, and the adaptation of cassava and rice varieties to infertile acid soils with severe dry seasons, will inevitably require some quantitative study of water storage in soil profiles, the intensity of water stresses, and the extent of root development. While this may not yet warrant a Senior Scientist, and the team which this implies, some expertise in soil physics should be acquired at the associate scientist level.

(iii) Biochemistry

280. The need to assess the protein content and quality and the nutritional values of crop and forage varieties under development is clearly essential. There are also many other ways in which a well-equipped biochemical laboratory could help all the commodity programmes. The Panel was glad to learn that an earlier proposal to develop this laboratory within the building which houses the germplasm store has been altered, but hopes to see a strong biochemistry group developed.

(iv) Animal Sciences

281. Several animal science disciplines are represented at CIAT, including management, health (pathology, bacteriology, parasitology), and bovine and swine nutrition. The recent reorganization of the Beef Production Programme has given little opportunity to develop a formal structure of collaboration between animal scientists of the same or related disciplines. The Panel believes nevertheless that a firm effort should be made to develop closer collaboration among CIAT's animal scientists. The Panel was pleased to learn that weekly seminars are a feature of the reorganized Beef Production Programme and feels that they should contribute significantly to the integration of young scientists who have recently joined the group. The laboratory facilities for animal science are being used

adequately for the present activities but the suggested study of phosphorus relationships in soil, plant and animal will require further equipment and more detailed laboratory management. The Panel considers that closer relationships between the animal scientists and the Biometrics Unit would be desirable, although it appeared that some additional expertise in animal experimentation may be needed in the latter.

(v) Economics

282. CIAT's economists are integral members of their respective commodity teams. Their major role is to interact and bring an economic (not just financial accounting) perspective to their colleagues in the design and development of new technology. To do this, they need to know enough about the technical processes to be credible. While economists need to learn the commodity, the production specialists also need to interact with economists. The Panel supports the placing of the economists within the commodity teams.

283. The three secondary roles of the economists are: 1) to collect and evaluate macro data on trends and prospects for their team's commodity and on related markets such as that for fertilizers: 2) to gather field survey data as background information and as a basis for evaluating the constraints to productivity increase, and; 3) to collaborate in setting up field experiments and to collect farm level experimental and field data to evaluate the profitability and risks of proposed technology.

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(vi) Promoting of Inter-disciplinary Discussion

284. Seminars are a well established method of securing interaction between scientists of different disciplines. The Panel was glad to learn that a programme of seminars had recently been organized. Seminars are held twice a month and are sometimes given by visitors. Attendance at international meetings, both overseas and within the Latin American region, are important means by which scientists keep in touch with recent advances in their disciplines. The literature information service provided by the CIAT Library is excellent and is an important aid to the maintenance of scientific standards among both staff and trainees.

IX. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

285. The Panel is satisfied that:

1) CIAT is operating fully in accord with the stated objectives of the Consultative Group and is interpreting its mandate in a manner which is acceptable both to the Group and to the countries in the humid tropics.

2) Scientific work is conducted with vigour and integrity, and to the standards expected from the international centres.

3) The Training Programme is providing an important measure of technical improvement for the countries in the region and is much appreciated by them.

4) The trainees are supported by an enterprising Information Service which follows up their training courses with a supply of technical news and literature in subsequent years.

5) The policy of CIAT is to move outwards from the atypically favourable soils and environment of Cali and, while based firmly on the good facilities at headquarters, to make best use of the wide range of environments presented by Colombia and by the countries in tropical Latin America and the Caribbean.

6) CIAT is working to produce its main impact on the agriculture of the region through the stimulation of national institutes by the training of staff, by the input of technology and by active collaboration in joint projects.

7) CIAT is giving priority to technologies which assist the poor, both producers and consumers; and its work on crop improvement, pasture development and livestock nutrition is scale neutral.

8) Through cooperation with IRRI, a substantial initial impact on rice production has been achieved; active cooperative work with CIMMYT and with national institutes on maize improvement in the Andean region is in progress. The major programme on cassava has demonstrated on farmers' fields highly encouraging progress in food production and resistance to pests and diseases. The Panel considers that arrangements to give more CIAT support to cassava work in Africa should be

studied by the IITA Quinquennial Review. The strong team working on beans has made encouraging progress on an immensely difficult task. The search for resistance to a formidable array of pests and diseases will need wider collection of germplasm.

9) By embarking on major pasture-animal research to develop beef production on the infertile acid savannas, which cover over two million square kilometers in Latin America, CIAT aims to develop a major new food supply source which Latin America must have to support both population growth and rising standards of living.

The Beef Production Team needs a strong veterinary science group concerned with the problems of beef herds on infertile savannah soils. The former useful and successful programme on wider aspects of animal health is not suitable for core funding by CIAT, but remains a necessity for the region. CIAT should give full cooperation to any such project mounted by bilateral or by multilateral aid.

10) The budget is adequate for the tasks of CIAT, and is well managed; the Panel no constraints which impeded the execution of the work.

11) The buildings and laboratories are of a high standard, and with the exception of the need for provision of further greenhouses, we found no important deficiences.

12) The staff is generally of a high scientific and technical calibre. CIAT has recovered rapidly from the extensive changes in policy and personnel of recent years, by means of which a necessary reorganization into multidisciplinary teams working on sharply focused projects was achieved. The Panel endorses these changes and concludes that the TAC and the Consultative Group can be confident that the Centre is on the right lines and will be most productive if subject to a minimum of disturbance for the next five years.

B. RECOMMENDATIONS

1. Stabilization of Policy

286. The Panel wishes to emphasize that CIAT has undergone very substantial programme and policy changes over recent years, together with important changes in senior staff and directorate. The Panel considers that the Centre has emerged from these changes with an improved organisation and more sharply defined objectives. It now strongly recommends that the Centre be given a period of stability and the opportunity to make uninterrupted progress.

2. Forward Planning

287. While the introduction of simple new technologies via training programmes has had a useful early impact, most agricultural research and development is medium-term or long-term. The major programme for beef production from the infertile acid savannahs is in the latter category. With vigorous and evolving research in progress, forward planning must be very flexible in order to be able to exploit successes. The Panel recommends that the Centre should not therefore be asked to detail long-term prescriptions for the separate programmes. A budget projection to 1981 has been produced by the Centre and the Panel is confident that in each programme the aims for the medium-term future are sufficiently clear.

3. Coordination of Regional Survey Activities

288. The Panel noted with approval the proposals by the Deputy Director General for international cooperation to increase the study of regional ecology and economic activity. The proposals under the separate programmes for the collection of more ecological, land-use and farming systems information, under the Deputy Director General for Research, are also supported. The Panel recommends that there be a positive effort to integrate and classify the regional information thus obtained. This could be assisted by a more active use of the Coordinating Committee which was set up on the cessation of the Small Farm Systems Unit, but may need the allocation of junior scientists to codify and process the data collected.

4. Assessment of Contribution

289. To provide a vital feedback to its research and training programme, the Panel recommends that CIAT develop a method for monitoring its contribution to tropical agriculture. This is an important undertaking to which the economists serving in commodity teams are well placed to make a contribution.

5. Training of Trainees

290. The number of technical staff requiring extra training in the region is so large that CIAT must mainly aim to train instructors. The Panel recommends that a substantial part of the course programme be devoted to methods for teaching the technologies which the students are learning.

6. Training for Seed Production

291. A major direct effect on crop production is known to be achieved by clean seed, but national arrangements for the multiplication and distribution of clean seed of improved varieties is sadly deficient throughout the region. Training in this technology should therefore have a high priority in CIAT programmes and should be available to suitably qualified personnel of commercial seed producing enterprises.

7. Avoidance of Soil Exhaustion from Low Input Cropping

292. A danger of applying low-input technologies to soils of low fertility is that they may lead to soil exhaustion if the nutrients removed by crops and lost by leaching are not replaced.

293. The Panel recommends that nutrient balance studies for minerals, including the more important trace elements, be conducted to monitor CIAT recommendations for low-input cropping systems on infertile soils, in order to ensure the adequate replacement of nutrients and avoid soil exhaustion.

8. Improvement of Soil Conservation Procedures

294. The ever increasing subsistence farmer population on steep hillsides has already caused severe soil erosion in the country, as seen from road and air on the Panel's travels.

295. The Panel recommends that higher priority should be given by CIAT to the incorporation of well known soil conservation techniques into all of its farming activities. This calls for agronomic skill rather than for research.

9. Increased Germplasm Collection in Beans

296. The Panel has concluded that the search for pest and disease resistance in beans will need a wider range of germplasm, including related species. The Panel therefore recommends the early engagement of an experienced plant collector as a temporary member

of the bean team. The third plant breeder for this team should be appointed before 1980 in order to work on related species.

10. Provision of Greenhouses

297. The assembly and quarantine of newly collected plants and seeds, and the indexing of material for issue, require more greenhouse space. The Panel recommends the provision of a greenhouse with full containment facilities for insects and diseases.

298. The breeding of pasture legumes offers a potentially valuable input to the Beef Production Programme and a greenhouse is needed for this work.

299. A third greenhouse is needed for nitrogen fixation in beans and in forage legumes. The Panel is not certain whether the present and forward provisions for additional greenhouses cover the above requirements and suggests that this be reviewed.

11. Animal Health Studies in the Beef Production Programme

300. The Panel recommends the retention of sufficient scientists in animal health within the Beef Production Programme in order that research work of immediate relevance to the health of herds on the improved savannah be undertaken. Work on calf mortality, reproduction and parasitology is suggested, and especially a thorough study of the availability to animals of phosphorus in soils and plants.

12. Reduction of Review Activity

301. As set out in Chapter II of this Report, CIAT has undergone an intensive series of external reviews as well as frequent internal re-assessments. Added to the burden imposed by the training programmes, by visiting scientists, and by travelling to visit national programmes, the time of senior scientists is eroded to an extent which causes the Panel some concern. Research work will not flourish if too much is left to the less experienced members of the commodity teams without full participation by the Senior Scientists.

ACKNOWLEDGEMENTS

The Panel wishes to express its gratitude to Dr. J.L. Nickel, Director General of CIAT, and to his staff for their very helpful cooperation in the study of the Centre's many activities and in facilitating the work of the Panel members. The Panel is also grateful to the Director General of ICTA, Guatemala, to the Director of Research of EMBRAPA, Brazil, and to their senior staff, for receiving its members at their stations, for supplying information, and for guiding Panel members on their visits to CIAT outreach activities. The Panel also wishes to thank the lady secretaries and other staff at CIAT who helped so diligently and efficiently in making the draft report ready before the Panel's departure from CIAT.

ANNEX I

COMPOSITION OF THE REVIEW PANEL

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ANNEX II

ITINERARY AND SCHEDULE

I. Visit to Brazil and Carimagua, Colombia.

(Messrs. Pereira, Dillon, Hutton, McCosker, Ortiz Mendez, Weniger)

Tuesday 12 April.

p.m. Visit to EMBRAPA, Cerrado Resources Centre, 30 km from Brasilia. Meeting with staff.

Wednesday 13 April.

a.m. Visit to experimental plots and installations at Cerrado Resources Centre

p.m. Discussions with EMBRAPA and CIAT staff.

Thursday 14 April.

Visit to Goiania EMBRAPA Rice and Beans National Centre and to State Research Farm. Visit to a private farm. Return to Brasilia.

Friday 15 April.

a.m. Panel discussions. Departure for Manaus.

p.m. Arrival Manaus. Short visit to EMBRAPA Station and experimental plots of tropical pastures. Departure for Bogotá.

Saturday 16 April.

Visit to Carimagua Station. Return to Cali.

II. Visit to Guatemala.

(Messrs. Robles, Rogers, Thurston, Mahler)

Wednesday 13 April.

Arrival Guatemala City.

Thursday 14 April.

Meeting with Director-General and senior staff of ICTA, and CIAT personnel in Guatemala. Presentation of organization and programmes.

Friday 15 April.

Visit to ICTA Regional Production Centre, Gutyapan. Meeting with Centre's staff. Visit to Production Training Course staff and trainees. Visit swine nutrition trials and bean improvement trials.

Saturday 16 April.

Departure for Bogotá.

III. Visit to CIAT Headquarters, Palmira, Colombia.

(Whole Review Panel)

Sunday 17 April.

a.m. Assembly of Review Team at CIAT headquarters.

p.m. Internal organization meeting and allocation of tasks to team members. Tour of CIAT facilities, buildings and experimental fields.

Monday 18 April.

a.m. General discussion with Director General and Associate Directors General.
Presentation by Cassava Programme.

p.m. Presentation by Bean Programme.

Tuesday 19 April.

a.m. Presentation by Rice Programme.
Visit to bean, cassava and rice fields.

p.m. Presentation by Training and Conference Programme.
Presentation by Beef Programme.

Wednesday 20 April.

a.m. Travel to Santander de Quilichao (Cachimbalito).
Visit to forage trials at Cachimbalito.
Visit to new CIAT sub-centre site (El Limonar).

p.m. Travel to Popayan experimental site.
Review of Bean Programme field activities at Popayan site.
Return to CIAT.

Thursday 21 April.

a.m. Presentation by CIMMYT/CIAT Andean Regional Maize Unit.
Presentation by Swine Nutrition Unit.
Presentation by Germplasm Development Unit.
Visit to maize fields, swine unit and germplasm facility.

p.m. Presentation by Texas A&M Special Project for Ecto/Hemoparasite research.
Presentation by Library and Information Services.

Friday 22 April.

a.m. Visits of selected team members to:

a) Animal Health labs and Hemoparasite Unit.
b) Crop Physiology, Plant Pathology and Entomology labs.
c) Soil labs.
d) Germplasm and breeding activities.
e) Biometrics Unit.
f) Station Operations presentation.

p.m. Report writing.

Saturday 23 April.

Field trip to Caicedonia.

Sunday, Monday 24-25 April.

Writing and typing of the draft report.

Tuesday, Wednesday 26-27 April.

Meeting of team to discuss report and follow up discussions with selected staff members.

Thursday 28 April.

Final review and typing of report.

Friday 29 April.

Discussion of conclusions with CIAT Directorate.
Presentation of conclusions.

ANNEX III

LIST OF MAIN DOCUMENTS MADE AVAILABLE TO THE REVIEW PANEL

1. Background papers, CIAT February 1977.

   (including several historical and legal documents, programme reviews, positions papers and inter-centre agreements)

2. Objectives and Strategy of CIAT - March 1977.

   (discussion paper for the TAC Quinquennial Review)

3. International Cooperation Strategy - CIAT April 1977.

   (presentation to the Review Panel)

4. CIAT Annual Reports 1974, 1975, 1976.

5. CIAT 1978-1979 Programme and Budget and Projections to 1981.

   (draft for consideration at the meeting of the Executive Committee, 4-5 March 1977)

6. Latin America: Trend Highlights on Beans, Beef, Pork, Cassava, Rice and Corn - CIAT Internal Document, 12 December 1976.