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TECHNICAL ADVISORY COMMITTEE

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REPORT OF THE TAC SUB-COMMITTEE MISSION
TO REVIEW THE RESEARCH NEEDS FOR PROTEIN PRODUCTION IN TROPICAL AMERICA

(Agenda Item ⁷4)

TAC SECRETARIAT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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CHAPTER ONE

INTRODUCTION

Background

1. The Technical Advisory Committee (TAC) reviewed at its Third Meeting in April 1972 a proposal submitted by the Inter-American Institute of Agricultural Sciences (IICA) entitled "Integral Plan for Research, Training and Technical Assistance for Protein Food Production in Central America and the Caribbean." The Committee was unwilling to consider support for the proposal in isolation from a consideration of the needs of the tropical zone of America as a whole. It accordingly established a Sub-Committee, to be constituted as a Review Mission, which would examine the research requirements of the zone and advise on the need for specific task forces to examine in more detail the specific requirements for research on priority problems of the zone. It became evident in discussion that food legumes, forage and beef cattle production were generally regarded as of top priority in the zone under consideration and this was reflected in the Terms of Reference of the Sub-Committee.

2. At the Fourth Meeting of the TAC, in August 1972 it was decided that, in view of the considerable current interest in North East Brazil, the Mission should examine closely the problems of that area which clearly fell within its Terms of Reference. The Chairman of the Sub-Committee agreed that arrangements would be made for the Mission to undertake such an examination.

Terms of Reference

3. 1) The Sub-Committee will consist of:
- | | |
|---------------------|-----------|
| Dr. L. Marcano | Chairman |
| Prof. Dr. D. Bommer | Member |
| Dr. I. Muriithi | Member |
| Mr. B.N. Webster | Secretary |

Dr. D. Hopper and Ing. M. Elgueta will assist the Sub-Committee to the fullest extent possible.

- 2) It is anticipated that the Sub-Committee will take only a general over-view of the region, its needs and ascertained gaps in research. The chief purpose of the Sub-Committee is to give guidance to TAC on the terms of reference for charging one or more small technical committees with the preparation of detailed recommendations of the most effective means for coordinating and conducting research on regional priority problems. It is anticipated that the Sub-Committee will have at its disposal the report of the IDB on Agricultural Research in Latin America as well as other documents to be provided by the Secretariat.
- 3) The Sub-Committee will report to TAC on the following matters:
- (i) A review of the ecology, environmental, vegetative and climatic characteristics of Tropical (Middle) America, including the Caribbean, that would permit the development of a definition of the region that would make a logical, homogeneous, geographic clustering useful for developing, conducting, diffusing and applying research results from a cooperative and coordinated programme of international,

regional and national research institutions.

- (ii) Once the region has been defined, the Sub-Committee is asked to provide an overall general analysis of the state of knowledge and the research presently focused on the problems of the major crop and livestock products used in the region as human food, giving particular attention to:
 - a) the programmes of the international, regional and national research and training institutions working in or directly serving the region through outreach programmes;
 - b) the regional need for improved protein supplies from grain legumes (especially dry beans) and beef cattle, the research required to underpin regional and national development actions to meet this need; and
 - c) the preparation of an outline of a potential network of research stations that might be involved in an integrated cooperative programme of crop and livestock research under the leadership of an international and/or a selected regional centre, including a suggested guideline for organizing and effecting the pattern of cooperative research, the outreach from the research centres and the dissemination of research findings.
- (iii) The terms of reference and composition of specific technical task forces to give detailed consideration to what should be undertaken to gain organized effectiveness, greater strength and comprehensiveness, and proper coordination of agricultural research on priority problems of the region.

Itinerary

- 4. In view of the relatively short time available for the Mission (18th November - 11th December, 1972) and the decision to devote particular attention to N. East Brazil, the itinerary originally planned was somewhat curtailed and was eventually finalized to include visits to only Brazil, Colombia, Venezuela and Costa Rica. A planned visit to Mexico, including CIMMYT, was cancelled during the course of the Mission to permit an additional day for consideration and drafting of the report.
- 5. The mission assembled at Recife, Brazil, on 19th November and subsequently visited Belem, Brasilia, Rio de Janeiro, Sao Paulo, Campinas and Nova Odessa in Brazil; Bogota, Palmira (Cali) and Carimagua in Colombia; Maracay, Cagua, Calabozo and Pariaguan in Venezuela and San José and Turrialba in Costa Rica. A detailed Itinerary appears in Appendix I.
- 6. Support for the arrangements made for the Mission at the country level was provided by FAO Country Representatives and national authorities responsible for research. Acknowledgements are made in Appendix III.
- 7. Immediately following the Mission a Summary Report (DDDR:IAR/73/9) was prepared and distributed for discussion at the Fifth Meeting of the TAC held on 30th January - 2 February, 1973.

CHAPTER TWO

DEFINITION OF THE ECOLOGICAL REGIONS OF TROPICAL AMERICA

8. The tropical lowlands of Latin America are not a distinct geographical region. Using Koeppen's classifications (Klages, 1949 - Fig. 1), the climatic types Af, Afi, Afwi (tropical rain forest climates), and Aw (periodically dry savanna climate), characterize this area from the climatic point of view. These climatic types roughly coincide with the hot wet equatorial, the tropical marine and the wet and dry tropical climatic zones used by Robinson 1961 (Fig. 2), the humid equatorial, humid tropical, marine savanna tropical, continental savanna tropical climatic groups of Papadakis, 1970, reaching in part to the latter's cool-winter tropical and humid tierra templada types. In the classification of Troll they comprise Tropical Zone, V1 - V4. The semi-arid part of northeastern Brazil belongs to the semi-arid tropical climatic group of both Papadakis' and Robinson's definitions and the "tropical dry - V4" of Troll.
9. To avoid unnecessary complication in its overall survey and to present an arbitrarily combined zoning of climates and soils, the mission decided to follow the report of Roberts and Hardin, 1966, and to define the lowland tropics of Latin America as those regions between the two tropics at elevations between sea level and 1,000 meters. Within this broad belt some major areas attract special attention for future development because of their potential, and currently sparse settlement. Other areas merit even greater attention because of their dense settlement and disparity in development which causes problems of poverty in large sectors of both the rural and urban populations.
10. The areas falling into the first category of high potential are listed in Roberts and Hardin's report of 1966 and include parts of the Amazon Basin and the Oriente. In the second category the littoral and Mata regions of coastal northeastern Brazil must be mentioned in view of their dense population, with prevailing high birth rates, and constant immigration pressure from the semi-arid part of the same area.
11. The main agro-climatic differences determining the successful cultivation of crops in the tropical lowlands of Latin America are less those of limitations in temperature and more the length of the rainy season, total rainfall, and edaphic limitations such as deficiencies in soil nutrients and drainage.
12. Summarizing the area under consideration into 3 main climatic types the following major agro-climatic categories may be recognized.

1. Tropical Forest Climate

- 1.1 The Amazon basin, the Orinoco basin and the Pacific coastal strip of Colombia. The problems of these inhospitable areas with prevailing typical rainforest climates are outlined in Roberts and Hardin's report. Agricultural development is faced with large tracts of low fertility soils in the nonflooded lands and calls for an integrated ecological approach including forestry, limnology, climatology and nature conservation. Considerable attention is currently being given to the Amazon basin as a result of the consistent policy of the Brazilian government to develop this region, still the world's largest natural tropical rainforest area. This tremendous task should receive urgent international attention and if possible assistance, to avoid foreseeable destruction

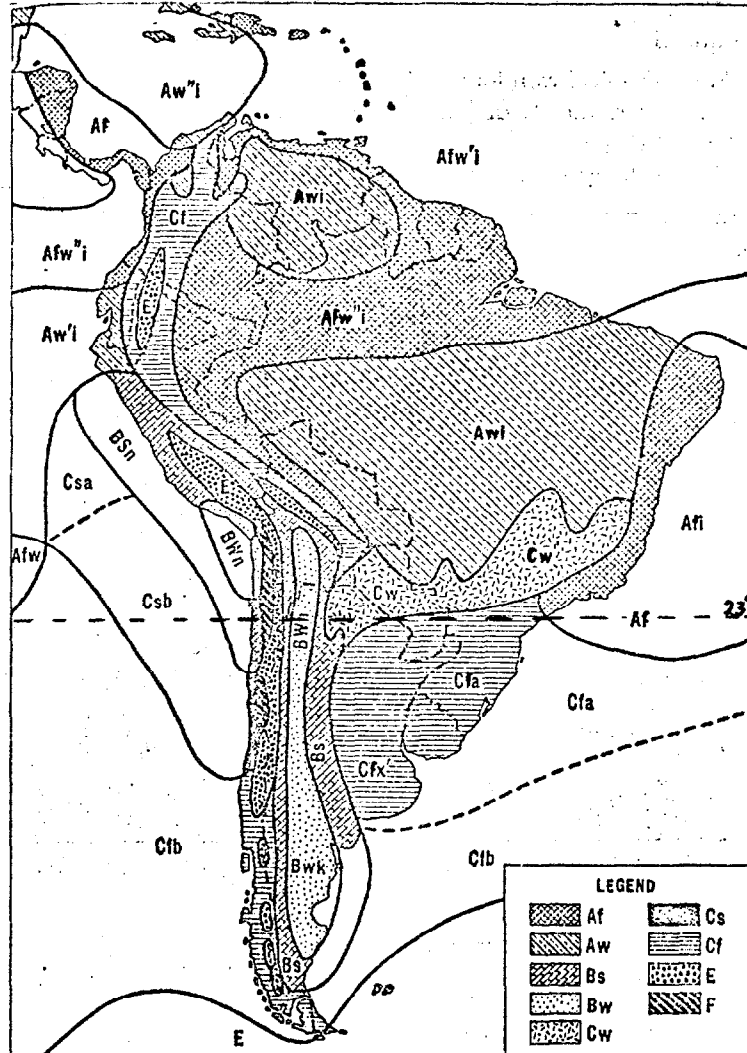


Fig. 1.

Climatic types of Latin America (See references in text).
Source: Klages, K.H.W., 1949. Ecological Crop Geography.

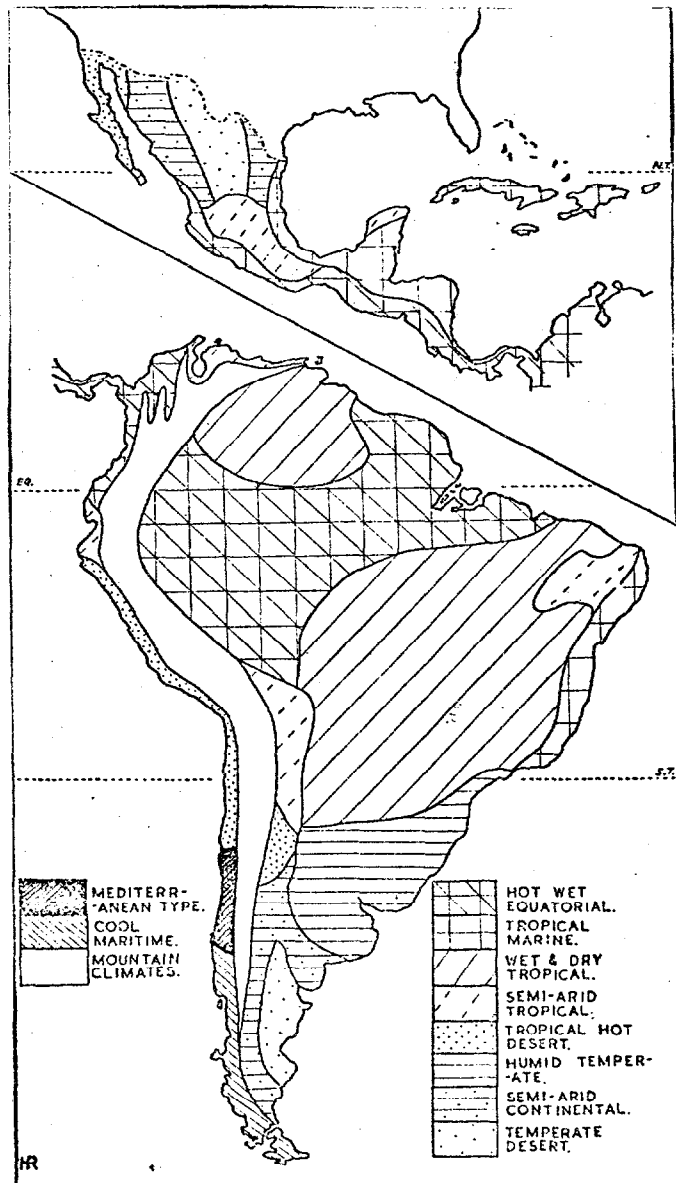


Fig. 2.

Tropical climatic zones of Latin America
Source: Robinson H., 1961. Latin America.

and serious ecological changes. To coordinate all research activities in the Amazon area the Conselho Nacional de Pesquisas of Brazil established in 1972 a Committee for the Humid Tropics.

1.2 The Litoral and Mata regions of the Brazilian coast from the State of São Paulo to the State of Paraíba, and the coastal plains of both the Caribbean and Pacific coasts of Mexico and Central America. Although total rainfall is lower and more irregular than in the areas under 1.1, both these areas have rather good soils but are in different categories with respect to development. While the coastal plains of Mexico and Central America could be further developed relatively easily, most of the Brazilian litoral is already a fairly densely settled area with a long agricultural tradition now in urgent need of agricultural intensification and structural changes.

1.3 The Eastern Foothills of the Andes - the Oriente - which covers the eastern slopes of the Andes between 400 and 1000m., from Venezuela and Colombia to Peru and Bolivia. Annual rainfall ranges from 1800mm. to 2600mm. with a distinct winter dry season of 4 to 5 months. Fertile soils offer good prospects for new agricultural development and the area is already being developed to some extent by the countries concerned.

2. Savanna Climate

A distinct dry season extends over 5 to 6 months but the total rainfall of the summer season is still between 1200 and 2000mms. The occurrence of a zonal vegetation of grass or woodland savanna is probably of edaphic rather than climatic origin.

2.1 Northern coast of Ecuador and northern coastal plains of Colombia

Both areas possess rather fertile soils which encourage development. Rainfall in the former is at the upper end and in the latter at the lower end of the annual rainfall range of 1200 - 2000mm.

2.2 The Llanos of Venezuela and Colombia

These flat plains occupy about 336.500 sq. kms. comprising approximately 1/3 of Venezuela and about the same portion of Colombia. A part of the area is subject to flooding at the end of the rainy season but large tracts of land have soils with good drainage. One of the main problems contributing to its sparse settlement and use only for extensive ranching is low fertility, with low pH and high aluminium toxicity.

2.3 The Campo Cerrado of Brazil

Low soil fertility similar to that of the Llanos is the main reason for the formation of the Campo Cerrado vegetation, covering the largest part of the 750.000 sq. kms. of the central plateau of Brazil. The topography of the area consists of plateau and gently undulating hills with friable soils of good drainage, makes it suitable for modern agriculture if the main constraint of low soil fertility can be overcome (EITEN, 1972).

3. Semi-arid Tropical Climate

Low and erratic rainfall is the most important characteristic of this climatic type which prevails in the interior plateau of southern Mexico, the northern portion of the peninsula of Yucatan, along parts of the narrow coastal margin of Venezuela, in parts of western Peru and Bolivia and in the interior of

northeastern Brazil. From the development point of view the latter appears to the Mission to have the most importance.

13. Subdivisions of these broad agro-climatic regions are being developed in several detailed programmes on crop zonation already in progress in the region. In the state of São Paulo, Brazil, the Instituto Agronomico at Campinas is studying the zonation of various crops whilst in Central America the CTEI, Turrialba is working on zonation of field beans, (ELGUETA 1972).

CHAPTER THREE

AGRICULTURAL RESEARCH ORGANIZATIONS IN THE COUNTRIES VISITED

I. National Organizations

A. Brazil

i) Research Organization

14. At the time of the Mission's visit the national agricultural research system was centralized in the Departamento Nacional de Pesquisas e Experimentação Agropecuárias (DNPEA)^{1/} which consisted of a General Directorate, comprising divisions of Experimental Statistics and Economic Analysis, and Documentation and Information; and technical divisions covering Agricultural Engineering, "Pedology," Plant Sciences; Animal Sciences; Animal Pathology and Agricultural Technology. The Headquarters of all the Divisions was in the Ministry of Agriculture in Brasília.

15. The DNPEA also has a decentralized network organization, covering the whole of the country, made up of the following centres and institutes:

- 1) Centro de Tecnología Agrícola y Alimentaria (CTAA) in the state of Guanabara;
- 2) Instituto de Pesquisas e Experimentação Agropecuárias do Norte (IPEAN) in Belém-Pará covering the states of Pará, Maranhã and the Território de Amapá;
- 3) Instituto de Pesquisa e Experimentação Agropecuária do Nordeste (IPEANE), in Recife (Pernambuco) covering the States of Piauí, Ceará, Paraíba, Rio Grande del Norte, Pernambuco, Alagoas and the Território de Fernando Noronha;
- 4) Instituto de Pesquisa e Experimentação Agropecuária do Leste (IPEAL) in Cruz de Almas-Bahia covering the states of Sergipe and Bahia;
- 5) Instituto de Pesquisa e Experimentação Agropecuária do Centro-Oeste (IPEACO), in Sete Lagoas - Minas Gerais, covering the states of Minas Gerais, Goiás and the Distrito Federal;
- 6) Instituto de Pesquisa e Experimentação Agropecuária do Centro-Sul (IPEACS), in Itaguaí - Rio de Janeiro, covering the states of Espírito Santo, Rio de Janeiro, and Guanabara;
- 7) Instituto de Pesquisa e Experimentação Agropecuária Meridional (IPEAME), in Colombo - Paraná covering the states of São Paulo and Paraná;
- 8) Instituto de Pesquisa e Experimentação Agropecuária do Oeste (IPEAO), in Campo Grande - Mato Grosso, covering the state of Mato Grosso;
- 9) Instituto de Pesquisa e Experimentação Agropecuária do Sul (IPEAS), in Pelotas - Rio Grande do Sul covering the states of Santa Catarina and Rio Grande do Sul;
- 10) Instituto de Pesquisa e Experimentação Agropecuária da Amazonia Occidental (IPEAOC), in Manaus - Amazonas, covering the states of Amazonas, Area y Território de Roraima y Rondônia.

^{1/} See proposal for reorganization in para. 27 below.

16. A very important agricultural research effort is also provided by the State Governments and the Universities of Brazil.

17. Amongst the most important of the State supported Institutes are those of São Paulo State, which include the Agricultural Institute of Campinas, the Animal Science Institute at Nova Odessa, the Forestry Institute at Tucuruvi, the Food Technology Institute at Campinas and the Biological Institute at São Paulo.

18. The research strength of São Paulo State is particularly important, the Agricultural Research Institute at Campinas having acquired a very high reputation throughout not only Brazil but the whole of Latin America. This institute has 205 professional (university level) workers in the Central Experiment Station and ten other experimental stations throughout the state, with one or two professionals in each, which serve to support and extend the activities of the Central Station.

19. The state of Pernambuco also maintains a strong research effort with 75 professionals working mainly in the Agricultural Research Institute (IPA) in Recife, with individual staff outposted to its six regional Experimental Stations.

20. The state of Bahia supports an important Biological Institute with 62 professional staff; in the Federal District the Department of Research and Experimentation of the Zoobotanical Foundation employs 35 professionals.

21. The state of Parana employs 17 professionals in six Experimental Stations, but only small groups of agricultural research workers are employed in other states.

22. The role played by the Research Departments of the Universities of Brazil is an important one, as indicated above, and particular mention should be made of the Escuela Superior Luis de Quiroz and other University Departments in the state of São Paulo; the Rural University at Km. 47 near Rio de Janeiro and the Federal University at Viçosa.

23. According to information available to the Mission, Brazil has a total of 3,350 graduate research workers in the fields of agriculture, forestry and related sciences. Of these 800 are in Federal Government stations, 900 in State Government employment and 1,500 in Universities and other Federal or State Government institutions of higher education. Only 15 professionals appear to be employed in research in the private sector, in the states of Rio Grande do Sul and Santa Catarina.

24. There is a total of 232 agricultural experiment stations and institutes in Brazil, of which 95 are dependant on the Federal Government, 90 on State Governments and the rest on Universities and other institutions.

25. The above statistics give a clear indication of the attention and interest given to agricultural research in Brazil, and an idea of the magnitude of financing implied. Unfortunately the Mission was unable to obtain concrete data on the actual expenditures involved.

26. There are two main aspects of the organization of the national research system to which the attention of the Mission was drawn and which it wishes to emphasise in the hope that it might prove possible to find a solution, not only during the reorientation of national efforts but also through outside assistance. These are the following:

- 1) The wide dispersion of effort. Of the total number of Experiment Stations 113 have 5 or less professional personnel, and 48 of those have only one man in charge of the research work; these figures give a clear idea of the extent of dispersion of effort.
- 2) The relatively low academic status of the great majority of research workers.

Of more than 800 professional research personnel in Federal Government service only 93 have had post-graduate level training. Although exact figures were not obtainable in respect of the remaining research workers of the country, the indications were, in general that only some 10% had post-graduate training.

27. It should be noted that the Mission was informed that the Federal Government had recently submitted to Congress draft legislation which was aimed inter alia at achieving better coordination of agricultural research efforts at the national, state and university levels, and at the same time to give greater administrative flexibility to the research system through the creation of a decentralized Government body "La Empresa Nacional de Pesquisa Agropecuaria" (National Agricultural Research Corporation). According to information obtained by the Mission this project had received considerable support and it appeared probable that it would be established. If so, favourable changes may be expected in quite a short while.

28. Even within the organization existing at the time of the Mission's visit national level technical coordination had been established through production line (commodity) oriented programmes. This system was relatively new and the Mission received the impression that it was not yet functioning adequately. Nevertheless national coordinators had been designated for the most important lines of production and national seminars had been held on a commodity basis to bring together all workers from whatever type of institution. It is hoped that the creation of the National Agricultural Research Corporation will reinforce and improve the operation of the various national commodity programmes.

ii) Other Research Programmes

29. The Mission became aware during its visits of the considerable assistance being given to various aspects of agricultural research by many organizations, both local and foreign. Special mention should be made of the programme currently being developed with the assistance of US-AID and the participation of the Universities of Purdue, Utah, and Mississippi, entitled PEPA (Programa Especial de Pesquisa Agropecuaria). The programme is associated with the development of the national coordinated commodity programmes and is being supported to the extent of some \$12 million distributed in approximately equal shares between technical assistance, equipment, and training of local personnel. The possible expansion of this programme for specific assistance to North East Brazil was brought to the notice of the Mission.

30. A further very important research activity is being promoted by the National Research Council (Consejo Nacional de Pesquisas) to coordinate all ongoing and planned research into the problems of the Amazon region. One of the main objectives of this activity is to provide a technological base for the extensive colonization projects of the National Institute of Colonization and Agrarian Reform, (Instituto Nacional de Colonización e Reforma Agraria - INCRA). A Special Committee, which has been established for the project is currently organizing an operational group to finalize a plan of work. According to information received by the Mission it is proposed to establish a major Research Centre at Agropolis, in association with the physical installations of INCRA, and subsequently to develop 5-10 auxiliary experimental centres for the different ecological zones within the Amazon region. The Mission believes that the major constraint to the development of this programme will probably be lack of adequately trained personnel rather than financial resources, which, in view of the great importance attached to the programme by the government, are expected to be forthcoming. Nevertheless it was made clear that both technical and financial assistance from outside sources would be welcomed.

31. Note was also taken by the Mission of two other technical assistance programmes under way in the country, one at Curitiba on increased crop production through the use of fertilizers, assisted by the Federal German Government, and one in North East Brazil on sorghum improvement assisted by the Ford Foundation, the Bank of the North East (Banco do Nordeste) and the University of Ceara.

32. The Mission was very impressed by the effect on the development programmes for the Amazon and North East Brazil regions, of the laws relating to "fiscal incentives", which provide tax reliefs to companies prepared to participate in the development process. Although the projects established under this programme are not themselves research projects, but rather production projects, a number of them are creating a need for, and thus a stimulus to, research.

iii) Bean Research

33. Beans are the subject of one of the major nationally coordinated commodity research projects referred to above. The national coordinator is situated at the University of Viçosa where some of the most important work on beans is in progress. A national seminar has already been held under the new programme, the basis of the national coordinated programme has been established, and a publication has been issued detailing major ongoing work and results.

34. Research programmes of some importance are being conducted at fifteen experimental stations throughout the country, situated at Manaus, Siete Lagos, Cruz dos Almas, Salvador, Fortaleza, Goiana, Viçosa, Belem, Recife, Pelotas, Santa Maria, Itagui, Campinas, Piracicaba and Joboticabal. Additional activities of minor importance are also under way according to the literature studied in some 34 other smaller centres.

iv) Beef Cattle Research

35. Two research divisions at the national level are participating in the beef production programme - the Animal Science Division and the Animal Pathology Division, thus creating a somewhat more complex and difficult situation with respect to national level coordination.

36. According to information received and the literature consulted, important research and training programmes on beef production are underway at the following centres.

- a) Instituto de Pesquisa Agropecuaria do Amazonia Occidental - Manao.
- b) Instituto Biológico de Bahia - Salvador.
- c) Departamento de Pesquisa e Experimentación, Brasilia.
- d) Escola de Agronomia y Veterinaria, Goiana.
- e) Escola de Veterinaria - Belo Horizonte.
- f) Escola Superior de Agricultura - Viçosa.
- g) Instituto de Pesquisa Agropecuaria do Norte - Belem.
- h) Escola de Agricultura do Amazonia - Belem.
- i) Instituto de Pesquisa Agropecuaria Meridional Curitiba - Paraná.
- j) Faculdade Veterinaria do Universidad Federal do Paraná - Curitiba.
- k) Instituto de Pesquisa Agropecuaria Nor-Este - Recife.
- l) Escola Superior de Veterinaria - Recife.
- m) Instituto de Pesquisa Agropecuaria Do Sul - Pelotos.
- n) Universidad Federal Rio Grande Do Sul - Porto Alegre.
- o) Pontificia Universidad Católica de Rio Grande Do Sul - Uruguaincana.
- p) Instituto de Pesquisa Agropecuaria de Centro-Sul - Itaguaí.
- q) Estación Experimental de Zootecnia - Nova Odessa.
- r) Escola Superior de Agricultura Luis de Quiróz.
- s) Faculdade de Medicina Veterinaria de la Universidad de São Paolo.
- t) Faculdade de Ciencias Médicas de Botucatu.

Although the above list includes several stations outside the tropical zone, their contribution to the overall livestock research effort is considerable and certain aspects of basic research, nutrition etc. are relevant to the tropical zone. A further 20 experiment stations are conducting projects of less importance on dairy cattle.

B. Colombia

i) Research Organization

37. Agricultural research in Colombia is concentrated mainly in the Colombian Agricultural Institute (Instituto Colombiano Agropecuario, ICA), a national organization which exercises centralized control over virtually all the national effort. The activity of the Universities and the States is relatively limited in the research field.

38. It is important to note that the ICA is also responsible for all agricultural extension programmes and also participates in higher agricultural education at the post graduate level, thus ensuring adequate coordination and linkages.

39. There are six national agricultural research centres (Centros Nacionales de Investigaciones Agropecuarias, CNIA) at Tibaitata-Bogotá; La Libertad - Villavieja; Tulio Ospina - Medellín; Palmira - Palmira; Turipaná - Montería; Nataima - Espinal; and 14 Experimental Stations dependant upon those centres.

40. The only important agricultural research conducted in the private sector in Colombia is that on coffee carried out by the Colombian Coffee Growers Federation.

41. The Centro Internacional de Agricultura Tropical - CIAT, at Palmira, Cali, plays an important contributory role to Colombian research through its activities in association with the Colombian CNIA's at Palmira and Turipana and the Experimental Station of Carimagua dependant on the CNIA of La Libertad.

42. At the time of the publication of the IICA survey entitled "Investigacion Agricola de la Zona Andina - 1969", Colombia had 28 agricultural research institutions of which 20 were entirely or partly dependant on the Federal Government, one on the Coffee Growers Federation and the rest on the Universities. A total of 414 professional research workers was employed, and the Mission noted the encouraging fact that 87% of these had post graduate qualifications.

43. Research activities are organized on the basis of production lines (commodities) and national level coordinators have been appointed for all major crops to maintain adequate exchange of information and ensure unified control of research activities.

ii) Bean Research

44. In Colombia, as in Brazil, beans (*Phaseolus* spp.) constitute the principal source of vegetable protein; cowpea and other legumes being utilized on a much smaller scale.

45. The Coordinator of the National Bean Programme was currently studying at IITA in Nigeria, but is normally situated at CNIA, Palmira, (adjacent to CIAT) where the major national bean research is conducted. Additional research is also carried out at the CNIA stations of Tibaitata; Tulio-Ospina; Turipana and Nataima, and at the Experimental Stations of Obonuco (Nariño) and Montelindo-Caldas.

46. The Field Bean improvement programme of CIAT (q.v. below, Chapter IV) is of major importance to the whole region.

iii) Beef Cattle Research

47. All the National Research Centres (CNIA's) with the exception of Nataima, and the Experimental Stations of Surbata-Boyaca, El Nus-Antioquia and La Sebra-Antioquia, conduct research on beef cattle and pastures. The most important of these activities are being developed at Tibaitata, and at the Experimental Station of Carimagua (in close association with CIAT).

C. Venezuela

i) Research Organizations

48. The greater part of agricultural research in Venezuela is concentrated under the aegis of the Directorate of Agricultural Research in the Ministry of Agriculture and Livestock. The Directorate controls a National Agricultural Research Centre in Maracay, and three regional centres in Maracaibo, Zulia, serving the west of the country, in Araure, for the west-central zone and in Maturin for the north-eastern region. Each Centre (CIA) has one or more dependant experimental stations.

49. An important contribution to research is made by the Venezuelan Universities, and in the private sector a substantial input is made by the Farmer Service Foundation (Fundación Servicio para el Agricultor).

50. At the end of 1971 Venezuela was said to have a total of 271 professional level research workers in agriculture, of whom 109 had received academic training to the post graduate level.

51. There is a National Agricultural Research Council whose task is to advise government on agricultural research needs, and which is currently working actively on the establishment of research priorities. The council has an executive arm responsible for handling the National Agricultural Research Fund which, in addition to financing specific research projects in the various centres also has an important programme financing post graduate research studies.

ii) Bean Research

52. Venezuela has a national coordinated research programme on field beans, the greater part of the work being carried out at the National Centre in Maracay from which the programme is coordinated. Additional work is done at the University of Zulia, Maracaibo; in the west-central regional station at Araure, and in the private foundation Farmer Service at Cagua, Aragua. Large scale regional variety trials are being conducted, mainly on private farms and farm settlements in various parts of the country, under the control of the participating regional centres and sub-stations. The national centres are concentrating mainly on the evaluation of yields of varieties whilst the Farmer Service is working on the agronomic aspects of mechanization, cultivation and fertilizer use, with special emphasis on production under irrigation. A total of seven professional research workers are participating in the field bean programme.

iii) Beef Cattle Research

53. The most important national programme in this field of research is that of the Experimental Station of Calabozo, dependant on the regional centre of the west-central region, Araure.

54. A beef production project (MAC-FAO VEN 17) which includes certain aspects of research, is currently in operation in the states of Barinas and Apure. It is jointly financed by the Ministry of Agriculture and the UNDP, and is operated by FAO and the Ministry.

55. The major research aspects of animal feeding (range, pastures and animal nutrition), are being handled by the National Agricultural Research Centre - Maracay (nutrition), the regional centres of Araure and Zulia and the Experimental Station for the dry zone at Duaca, Lara State (range and pastures). Only minor programmes are conducted in other centres.

56. The national Centre at Maracay also has a well equipped and staffed Veterinary Research Institute.

D. Central America

57. Although the Mission only visited Costa Rica it considered that it would be worthwhile to make some general comments on the organization of research in Central America, believing that these will be of assistance to a better understanding of the conclusions and recommendations of the Mission. The following information is based on the "Catalogo de Estaciones Agricolas Experimentales del Istmo Centro-Americano - (1971) - IICA-ROCAP".

58. A total of 52 research and experimental stations are listed, with a total professional staff of 238 of which 85 had post graduate qualifications. These figures do not however give a true picture of the situation as they include the Regional Research Centre of IICA at Turrialba, Costa Rica, and the private, commercially oriented, Experimental Station of La Lima, Honduras, which between them accounted for 85 professionals, 49 of whom had post graduate training. The remaining 50 stations had between them a total of only 153 professional personnel of whom only 36 had post-graduate training; 28 of the 50 stations had only one professional officer on their staff.

59. The above survey indicates clearly the generally low technical level and the tremendous dispersion of research effort in Central America. There are also great variations from country to country; for example El Salvador with 48 professionals has the highest number of professional research workers in agriculture, whilst Guatemala has only 4.

60. It is worth noting, however, that two important programmes have recently been initiated, with US-AID assistance, in Costa Rica and Guatemala, which include, amongst their objectives considerable improvements in various aspects of agricultural research. Furthermore the IICA/PCCMCA programme (see below II C) provides a tremendous stimulus to food crop, particularly bean, research.

61. On the basis of the statistics given above the Mission found it logical that an attempt should be made to provide for the Turrialba Centre to act as a Central Experimental Station, of a regional character, for Central America. It also appears equally important to make provision for a post graduate study centre, such as that provided by Turrialba which is now associated with the University of Costa Rica.

II Regional Organizations

A. The Turrialba Centre

62. The Mission feels it is necessary to clarify the respective position of the Instituto Inter-americano de Ciencias Agrícolas (IICA) and its dependancy the Centro Tropical de Enseñanza e Investigacion, Turrialba (CTEI). IICA is the Institute of the Organization of American States (OAS) charged with specific responsibility for regional developments in the field of agriculture. Its total budget amounts to US\$ 4.7 million annually.

63. In 1942 it initiated activities in Turrialba for the establishment of a post graduate training centre in tropical agriculture with supporting research facilities, and in 1944 the present station was established on 1,000 ha. made available by the Government of Costa Rica. Its objectives were: to upgrade as quickly as possible the research and extension cadres of all member countries of Latin America through the provision of post graduate training in all the disciplines of agriculture; to undertake research into common problems of the region and to provide a research function in support of the teaching function; to provide technical assistance to national post graduate schools through advice and the provision of fellowships, and to give guidance to national research organizations both on the institutional arrangements for, and the conduct of, national research programmes. To date over 400 post graduate degrees have been awarded.

64. In 1951 IICA started its decentralization, setting up technical personnel in three Regional Offices, in order to give more efficient assistance to countries in the Continent. The Office for the North Zone includes Mexico, the Central American countries, Panama and the Antilles, and has its headquarters in Guatemala. The Office for the Andean Zone, in Lima, covers Venezuela, Colombia, Ecuador, Peru and Bolivia. The Office for the Southern Zone, located in Montevideo, covers Brazil, Paraguay, Uruguay, Argentina and Chile. The General Headquarters is located in San José de Costa Rica.

65. In 1964 the Inter-American Centre for Agrarian Reform in Bogota was created, and from that time IICA has been distributing its budget among these main Offices:

General Headquarters	(San José, Costa Rica)
Regional Office	North Zone (Guatemala)
Regional Office	Andean Zone (Lima, Perú)
Regional Office	Southern Zone, (Montevideo, Uruguay)
Tropical Centre for Teaching & Research (CTEI)	(Turrialba, Costa Rica)
Inter-American Centre for Rural Development & Agrarian Reform	(Bogotá, Colombia)

Recently IICA has also established National Offices in almost all countries, south of the Rio Grande.

66. Regional and National Offices spend almost all their efforts towards the strengthening of national institutions and the establishment of regional cooperative programmes. For 1972-73 the total budget of IICA was US\$ 4,779,000 and of this, the amount contributed for the Teaching and Research Centre only, was US\$ 695,068, that is 14.5% of the total budget.

67. At present, the Turrialba Centre concentrates its activities in three departments:
1. Soils and Crops - giving special emphasis to leguminous grains and having an important programme for the improvement of cocoa, and a secondary one, for other crops, including the maintenance of a valuable coffee collection. 2. Animal Production, with emphasis on dairy herds for low, humid tropical areas. 3. Forestry, with an important programme in forest entomology and the selection of fast growing trees for humid tropical conditions.

68. Current Finances. The current budget of the Centre is US\$ 955,318 annually, made up from the following contributions:

IICA	\$ 695,068
US Atomic Energy Authority	105,000
Commercial operations of farm	59,000
Multinational Project of OAS	27,250
Netherlands Bilateral assistance	56,000
FAO-Timber Laboratory	13,000
	\$ 955,318*

(* Compare to a former budget of between \$ 1.5 million and \$ 1.7 million).

Current expenditure shows the swing from concentration on training to concentration on research, the latter accounting for 56% of expenditure.

69. Physical facilities. These are impressive and superbly maintained, clearly at very high cost. More than half the land at Turrialba is under pasture and a considerable portion of the balance under forest and plant collections. The soils are atypical of the humid tropics and not well suited for the legumes which form the main lines of current

crop research. Consequently much of the legume field work is carried out elsewhere in Costa Rica and in cooperative programmes (e.g. IICA/PCCMCA) with other participating territories.

70. Housing, classroom, laboratories, plant houses, library and office accommodation are more than adequate for the work being carried out, with the possible exception of livestock field laboratories and animal housing. These are insufficient, considering that animal production (mainly nutrition studies) forms the second main line of research at present.

71. The station has two radiation sources and an IBM 1130 computer - all under-utilized. The computer has worked an average of 100 hours per month (200 is reckoned to be reasonable usage) and little serious irradiation work seems to be undertaken at present. Some useful work has been done on cassava pollen irradiation and on beans but the impression was gained that the plant breeders were using a "shot gun" approach to induced mutation on various materials which come their way.

72. Staffing. The standard of the professional staff was quite high but all are suffering from uncertainty regarding the future. They admit that the station is running at little if anything over 50% capacity and are putting high hopes on receiving international assistance, either for the Legumes/Livestock programmes or in some other role such as a component in the proposed Genetic Resources Centres Network.

73. Future Plans. The Mission was informed that the present status of negotiations on the future of the Centre is as follows.

- a) IICA decided to reduce step-wise its contribution from US\$ 695,000.00 per year to US\$ 300,000.00, during a period of 5 years. The discussions that are being held by IICA with the Costa Rican Government, as well as with other Central American Governments, in order to change the structure of the Centre, are well advanced towards an agreement between IICA and the Costa Rican Government. These negotiations will change the Centre into a self-governing institution for the service of countries in Central America and the Antilles. Both parties will become sponsors of the Centre together with other Institutions or countries willing to provide at least US\$ 50,000.00 per year. The Centre could also receive donations from other international organizations.
- b) Discussions are also being carried out with the University of Costa Rica so as to reach an agreement by which the University would assume the responsibility of directing post graduate courses, granting the corresponding degrees.
- c) It has been planned for IICA to keep the library, document centre and computer centre, for the service of all countries in the American Continent. In any case the Library will physically remain in Turrialba.

74. The Mission understood clearly the nature of the new proposals for the future of CTEI and believes that the transfer of post graduate functions to the University of Costa Rica should prove workable, having been well impressed by the visit made to the University. Regarding the research function of the Centre, which is now regarded as its main role, the Mission was anxious to find a solution for the current under-utilization of the excellent facilities of a station which has a tradition and a high reputation for research in the region, and which has made a considerable impact, particularly in Central America. The current concentration of resources into three programmes, Crops and Soils (with especial emphasis on legume cooperative work in Central America), Animal Husbandry (with especial emphasis on tropical low-country dairying) and on Forestry (particularly forest entomology and the reforestation of impoverished soils), is commended. In addition the Mission was impressed by the germ plasm collections of cacao, coffee (one of the principal sources of rust resistant materials) and tropical fruits, and by the working collections of beans and cassava.

B. CIAT

75. The TAC is well aware of the programme and budget of CIAT and the Mission does not therefore propose to treat these in detail. The re-orientation of the CIAT programme in 1972 to two major thrusts, on beef and cassava, with subsidiary programmes on field beans, swine and farming systems is reflected in the current work at the centre. Relay work on rice and corn, in conjunction with IRRI and CIMMYT, is already making a considerable impact in the region.

76. Particular attention was given to the legume, beef cattle and cassava programmes and the Mission made the following observations.

77. Legumes: This programme has been expanded into a major regional effort. It has been designed ab initio to fit in closely with any other major effort on legumes and the initial impetus of the programmes has been maintained to the point of establishment of a regional workshop (following the earlier cassava model of CIAT) in early 1973. The Mission fully endorses the leadership assumed by CIAT in this field within the whole region. Nevertheless, believing that a certain minimal critical mass of research should be reached in such a regional programme, and not being in a position as yet to decide whether this point has been reached, the Mission wished to point out the possible future need to strengthen the bean programme of CIAT if it is to play its full leadership role in any regional network which may be established.

78. Beef cattle: The Mission was most impressed by the cattle programme, particularly the herd management trials on the llanos at Carimagua. Useful training programmes have already provided a nucleus of CIAT trained personnel in many countries of the region. The Mission believes that a regional livestock research network could be established with the participation of these former trainees, inter alia, and is convinced that leadership of such a programme could and should be taken by CIAT.

79. Cassava: Details of the cassava programme of CIAT are given in Chapter Four, III. In view of the lead taken by CIAT in cassava research, and the very impressive research programme under way, the Mission feels it necessary to emphasize the need for strong and continued support for both the research and outreach work on cassava being conducted by CIAT, with special attention to the cooperative programmes with countries of the region.

C. The Cooperative Food Crop Programme of Central America - PCCMCA

80. This activity grew out of a series of meetings held by the Rockefeller Foundation for maize specialists working in the Central American isthmus. The programme was subsequently extended to other areas, with the participation of Mexico, Colombia and Venezuela; and other crops, principally field beans.

81. The programme is currently financed by the Inter-American Institute of Agricultural Sciences (IICA) which provides the services of a Coordinator for the field bean programme, at present the IICA representative in El Salvador.

82. The programme is operated very simply, the Coordinator organizing annual meetings for interested professional staff in one or other of the participating countries. During these meetings the preceding years results are presented and evaluated and programmes are planned for the following year. The governments of the countries involved in the programme are fully informed of its activities and make all necessary assistance available; although no formal convention exists, all the countries accept the costs of the programme, both in respect of experimental work and attendance at the annual meetings: IICA provides the salary and travel expenses of the Coordinator and certain funds related to the conduct of the trials. The latter are relatively small however and the total expenditure of IICA, apart from the salary for part-time activities of the Coordinator, amounts to some \$20,000 annually.

83. In explaining the organization and scope of the programme to the Mission, the Coordinator emphasized that although the technical work carried out provided an adequate base for increased field bean production in the Central American countries, important results had so far only been obtained in El Salvador. Here, a Government decision to assist the promotion of bean production had led, through the application of the research results of the programme, to a considerable increase both in yields and total production.

84. A severe constraint to the programme, particularly to its technical trials work, is the lack of relatively small amounts of ready money when needed, to obtain seed, fertilizers, labour and other necessary inputs. This lack had sometimes led to the complete loss of trials and thus of valuable information.

85. All the countries in Central America, Colombia, Venezuela and Mexico participate in the programme, although the three latter take part only in the annual meetings and not in the regional variety trials.

86. The field bean programme, which has now been operating under the aegis of PCCMCA for over ten years, receives considerable technical assistance from the bean research group at Turrialba and particularly from the group leader.

D. The Regional Cooperative Beef and Forage Programme of the Andean Zone

87. This programme which is organized by IICA from its Andean Zone Regional Office, is basically organized in a similar way to the PCCMCA. The Coordinator is based in Quito, Ecuador; the participating countries are Ecuador, Peru, Bolivia, Colombia, Venezuela and, more recently, Brazil; CIAT also plays a very active part in the programme. During its relatively short life this programme has sponsored four technical meetings; prepared a review of all pasture work published in the participating countries and has contributed to the establishment of a germ-plasm bank for pasture and forage plants at Palmira.

88. The activities of the Programme, have, since its initiation, been oriented towards pasture species of the tropical zone and particularly towards the potential of forage legumes; much less attention has been given to pasture species of the high altitudes of the Andean zone.

89. The Programme operates with minimal financial resources, IICA providing the salary and travel costs of the Coordinator and certain funds to support the annual meetings, whilst experimental costs are borne on the budgets of the participating stations.

E. Sub-regional Soils Research Programme

90. An interesting example of a regional initiative in technical assistance to research activities was outlined to the Mission by Prof. Guido Ranzani, Director of the Centro de Estudios de Solos of the Universidad de São Paulo at Piracicaba. The Centro proposes to make expert personnel available to assist the less developed countries of the region including Paraguay, Bolivia and Ecuador, in the establishment of an infrastructure for soils studies including research, teaching and extension components. The project envisages the training of national technicians both in their home country and through short term fellowships in Brazil. Soil testing and subsequent mapping, of major agricultural areas will be conducted by the trainee national personnel under the guidance of the technical assistance experts. This survey will be followed by more detailed studies of priority areas. No language or social custom barriers are foreseen and the success of the project is expected to stem from a strong common regional interest to the problems studied. The Mission felt that this worthwhile initiative would form a model which could be copied to advantage by others of the more developed countries in the region.

CHAPTER FOUR

REVIEW OF SPECIFIC TOPICS

I. Beef Cattle Production

A. Introduction

91. In the countries visited by the Mission there is a continuous and expanding demand for fresh meat - principally beef - and research in beef production is accorded the highest priority in most research programmes reviewed. Although it was made clear to the Mission that there was a general shortage of protein in the diet of the majority of the population and that to a large extent this could be ameliorated, at least to the extent of correcting amino-acid imbalances by increasing even fractionally the animal protein intake, the region has important export markets for beef, the demands of which are tending in some countries to reduce the domestic supply.

92. The institution of meatless days (in reality days when beef is not sold), in some countries of the region, is diversely motivated however; in Colombia being aimed at stimulating exports and in Peru at restricting imports. Both motives point up the underlying need to increase beef production.

93. The extent of the required increase in meat production has been calculated ^{1/} (see Table I) for representative South American countries. If the two major traditional exporters, Argentina and Uruguay are excluded, the remaining countries, mainly in the tropical belt, are expected to have a demand in 1980 ranging from 153% at the lowest alternative, to 182% at the highest alternative of the 1970 total production. This implies growth rates of between 4.4% and 6.2% per annum in total meat production. It should be pointed out that as 78% of the total livestock units in these countries are cattle, the percentage of the total meat demand to be supplied by beef must be considerably higher.

94. The study suggests that the postulated demand for beef could exceed the practical possibilities of both local production and imports, necessitating substitution of beef by other meats - a most unpopular conclusion in a traditionally beef eating region.

95. Any marked increase in production will require close attention to the following factors:

- i) increase in herd size and the proportion of breeding females within the herd;
- ii) increase in off-take rates;
- iii) increase in weight of animals going to slaughter.

To achieve an increase in both herd size and off-take rates simultaneously implies a considerable improvement in reproductive rate, a reduction in the prevailing high rate of calf mortality, and a reduction in the age of animals going to slaughter.

96. To attain these desirable conditions it is quite clear that the basic nutrition of the animals must be improved, particularly from the point of view of sustained feeding, avoiding to the fullest extent possible the seasonal fluctuations in feed availability which are currently responsible for actual weight loss in animals going

^{1/} FAO, Perspective Study of Agricultural Development for South America - 1972. Draft.

1/ Total demand represents demand for food, exports and other domestic uses (with brackets). Domestic demand stands for demand for food only (within brackets).
 In Bolivia, Colombia, Peru and Venezuela, the domestic demand in 1970 is not met.
 2/ The 1980 projected internal demand figures are lower than the 1970 local production figures

TABLE I

Increase in Meat Production Required to Meet Total & Domestic Demand in 1980 1/

(* Refers to Demand Alternatives, (L) Low, (M₁) Medium, (M₂) Medium 2 and (H) High.)

	Projected demand in 1980 as indices of 1970 local production (1970=100.0)				Growth rate % p.a. required between 1970 and 1980 to satisfy demand			
	L*	M ₁ *	M ₂ *	H*	L*	M ₁ *	M ₂ *	H*
<u>Traditional exporters</u>								
Argentina	128.6	138.0	143.3	143.3	2.55	3.25	3.65	3.65
Uruguay	114.1	121.5	131.3	131.3	1.15	1.95	2.75	2.75
<u>Marginal exporters</u>								
Paraguay	134.5 (112.1)	145.5 (115.5)	159.7 (125.7)	165.5 (131.5)	3.00 (1.15)	3.80 (1.45)	4.80 (2.30)	5.15 (2.80)
Colombia	149.8 (131.7)	158.7 (137.2)	171.9 (145.1)	177.2 (150.0)	4.15 (2.80)	4.75 (3.20)	5.55 (3.80)	5.90 (4.15)
Brazil	152.4 (136.7)	160.3 (142.9)	177.9 (157.6)	182.6 (163.8)	4.30 (3.15)	4.85 (3.65)	5.95 (4.65)	6.20 (5.05)
<u>Non-Exporters</u>								
Chile	157.4 (156.8)	162.1 (161.5)	176.7 (176.1)	183.4 (182.8)	4.65 (4.60)	4.95 (4.90)	5.85 (5.80)	6.25 (6.20)
Bolivia	158.3 (155.6)	168.7 (164.3)	186.9 (178.3)	195.6 (186.9)	4.70 (4.50)	5.35 (5.10)	6.45 (5.95)	6.95 (6.45)
Ecuador	158.7 (154.3)	172.2 (164.3)	191.3 (179.4)	200.8 (188.9)	4.75 (4.45)	5.60 (5.10)	6.70 (6.00)	7.20 (6.55)
Peru	181.5 (181.5)	185.9 (185.9)	194.9 (194.9)	202.4 (202.4)	6.15 (6.15)	6.40 (6.40)	6.90 (6.90)	7.30 (7.30)
Venezuela	168.6 (167.7)	177.5 (176.4)	191.9 (189.7)	201.1 (198.6)	5.35 (5.30)	5.90 (5.85)	6.75 (6.60)	7.25 (7.10)
South America	141.9 (117.0)	148.0 (120.9)	158.0 (128.4)	164.8 (132.0)	3.55 (1.60)	4.00 (1.90)	4.70 (2.55)	5.10 (2.80)
South America excluding two exporters	153.5 (141.4)	157.1 (154.3)	171.2 (160.7)	182.3 (167.1)	4.40 (3.55)	4.60 (4.45)	5.50 (4.85)	6.20 (5.25)

Source: FAO Perspective Study of Agricultural Development for South America, 1972. Draft.

to slaughter during the dry season, which contribute in no small measure to calf mortality, and entail, of necessity, a long fattening period.

97. The Mission came to the conclusion therefore that amongst the major constraints to cattle improvement in tropical America, feeding was far and away the most important. Consequently considerable attention was devoted to this question, and the following review of factors contributing to improvement in the beef cattle industry deals in some detail with feeding problems and the work being undertaken towards their solution.

B: Cattle Feeding

1. Forage production

98. Feeding is regarded as the main limitation to increased cattle production throughout Latin America and its improvement was considered to be of the highest priority at all institutes and stations visited. In some stations there had obviously been a recent change in priorities as various aspects of breeding of beef and dairy cattle had previously been the subject of extensive research programmes, and had dominated earlier research efforts in animal husbandry. The allocation of continued high priority to breeding appeared to be limited, amongst the stations visited, to the Centro de Investigaciones Agronómicas in Maracay, Venezuela and the Instituto de Zootecnia in Sao Paulo, Brazil. The changed approach, to allocate first priority to feeding, was expressed most clearly in the Departamento Nacional de Pesquisas e Experimentação Agropecuária (DNPEA) in Brasilia, in CIAT, Palmira, Colombia and in CTEI, Turrialba, Costa Rica. The Brazilian attitude tended to leave cattle breeding to the farmer, and to concentrate research on feeding and especially on forage production. This attitude represented quite clearly the change of priorities which the mission found to be more or less general in the countries visited.

99. The predominant feed for cattle and other ruminants in Latin America, is supplied by grazing on native, semi-native or planted permanent range or pastures. There is therefore an overall heavy dependence upon seasonal feed productivity with the consequent fluctuation in animal production (weight gains and milk yields) which is typical throughout the tropical belt.

100. The research programmes and experiments, seen and discussed by the mission with research organizations and the staff of international and national institutes, reflected very well the main problems of the various regions but demonstrated considerable duplication resulting from insufficient contact between both stations and countries. In most areas available research results appeared to be well in advance of application at the farm level. This commonly encountered situation appeared to result partly from the insufficiency or even lack of adequate coordinating links with extension services, and partly, perhaps more importantly, from economic constraints resulting from the price relationship between inputs and outputs. In the opinion of the Mission the demonstration to the farmer of the improvement of economic returns from forage in animal husbandry is more difficult to achieve than that of any improvement in crop production. The Mission therefore felt that the economic evaluation of various alternative measures aimed at technical improvement which was in general lacking, or only just beginning, should be considerably strengthened throughout the zone.

101. The main aspects of pasture, forage and feed research in the areas visited by the Mission are presented below on the basis of ecological regions.

a) Agreste and Caatinga (Sertão) of Northeastern Brazil

102. The semi-arid areas of Northeastern Brazil (see Chapter V below) comprise a zone of cattle, goat and sheep raising, following traditional methods. In this zone, characterised by sporadic rainfall of short duration, feed and water shortage present a continuous problem. A UNDP/FAO-Livestock Project (BRA 71/552) will be started in the

near future to investigate the specific problems of feed, water and management systems, including cattle, goat and sheep husbandry. A further research project is also planned by DNPEA of the Federal Government of Brazil. IPEANE, the Federal station in which the project headquarters will be located, and IPA, the State station of Pernambuco, both at Recife, have a number of experimental stations in the zone which will provide the necessary experimental network. Both research centres seem, in the past, to have concentrated more research efforts on the Mata and Litoral areas of the zone than on the semi-arid part. Livestock improvement in this zone must be regarded as part of any integrated measures for rural improvement. This view was expressed very clearly by the Agricultural Division of the Superintendencia (SUDENE) which is responsible for the development of the N. Eastern zone. The Mission was informed that annual and tree crops, especially fruit, receive equal attention to livestock, re-settlement, and the land redistribution programme in the semi-arid environment.

103. The view of the Mission was that the specific situation of north-eastern Brazil merited special international attention but after such a brief visit it did not feel able to define specific measures for further international action (see Chapter Five).

b) Savannah Grassland

104. Vast savannah areas cover the tropical lowlands of South America. These are characterized by a 6 months dry season and soils of low fertility, poor in phosphate, nitrogen and some microelements, with low pH and high aluminium toxicity. Sparsely settled, with markets often far distant and an underdeveloped infrastructure, their dominating grass cover will clearly be used for a long time to come, predominantly under ranch farming (stock raising for beef) which forms the main enterprise of these areas at present. The rainfall pattern of the savannah (from 1,200 to 2,000 mms. in 6 months) offers distinct possibilities for future crop development if the necessary inputs, especially of fertilizer, can be used economically. The grass cover is mainly composed of species of medium to low forage value, better grasses and legumes usually providing only minor components of the cover.

105. During the mission, visits were paid to the savannahs of the Llanos in Colombia (Carimagua - the Experiment Station of ICA, and CIAT) and in Venezuela (Calabozo - the Experiment Station of CIA, and Pariaguán - Centro de Recría del MAC) and to the Campo Cerrado of Brazil (Estacion Experimental de Brasilia, IPEACO).

106. The improvement of native range by the introduction of exotic or improved indigenous forage grasses and legumes was an important aspect of the programmes in Carimagua, Colombia and Brasilia, and also formed part of the programme (but lacking a systematic approach) in Venezuela. The most advanced programme was the approach by CIAT in Carimagua to the problem of finding grasses and legumes for improved pastures with various levels of inputs, especially fertilizer, starting in the first place with good forage species adapted to the prevailing unimproved soil conditions. Equally important is the "Herd System Experiment" of this station which is testing herd and pasture management systems best adapted to the native range and to the first steps in the process of improvement. These steps include various controlled burning patterns to prolong the green forage period into the dry season, as a first means of shortening the serious forage gap in an ecological and economic environment in which forage conservation (e.g. silage making) has proved to date to be uneconomic.

107. The systematic approach and the type of experiments demonstrated by CIAT, should be repeated through a coordinated and adaptive approach in the stations of the other countries with similar savannah conditions, in an attempt to develop improved systems with wide applicability. Two exceptional approaches for the savannah area, noted by the Mission in Venezuela, were an experiment with intensive rotational grazing (on Pangola grass) in Pariaguán, and the development, management and utilization of irrigated pastures (Echinochloa polystachya) in Calabozo, directed to the combination of milk production with irrigated rice in the new Calabozo irrigation programme. Such site-

specific trials serve to emphasize the necessity for local research to complement any centralized work of wider adaptability.

c) Grasslands in Tropical Forest Climates

108. This section includes work done in various areas of the tropical lowlands in which original forest (tropical rain-forest and semi-deciduous tropical forest) is, or will be, replaced by grassland. Sites visited which belong to these areas were Nova Odessa, in the State of São Paulo, Brazil; IPEACS in the State of Guanabara, Brazil; CIAT in the Upper Cauca Valley, Colombia; Turrialba in the central part of Costa Rica; Recife in the coastal strip of Pernambuco and Belém, Pará, in the Eastern part of the Amazon area in Brazil. The rainfall pattern of these areas varies from a clearly defined 6 months dry season, comparable with the savannahs (e.g. the State of São Paulo) to well distributed rains in Turrialba, Costa Rica, and to a rainfall of 3,000 mms per year divided into two parts with 2/3 in one half and 1/3 in the other half of the year (e.g. in Belém). Soil conditions are generally more favourable than in the Savannah, with the special exception of large areas in the Amazon region, but soil deficiencies with respect to phosphate, nitrogen and minor nutrients, low pH and aluminium toxicity are still more or less widespread.

109. In all areas mentioned the testing for adaptability of forage grass and legume species has high priority. Legumes receive special attention because of their forage value, their contribution of inexpensive nitrogen to the sward and the ability of many of them to maintain high forage values well into the dry season. An important problem, noted in Turrialba, was very strong grass competition which tended to eliminate legumes from the sward. In all the legume work seen by the Mission, the example set by the Australian work and experience under semi-tropical and tropical conditions was very highly regarded, and many improved legumes, originally collected in South America, are being reintroduced from Australia.

110. In the State of São Paulo, Brazil, out of 9 million ha. of pasture (about 50% of the land area), 75% - 80% have been sown or planted as pastures at some time or another. Total productivity of the locally important Panicum maximum pastures has, however, declined in the last 40 years from a carrying capacity of 2.4 head per ha. to 0.6 head per ha. The main cause is felt to be an increasing lack of soil nutrients, especially nitrogen, which it has hitherto proved uneconomic to replace through fertilizers.

111. A well developed pasture rehabilitation programme was however seen at the Nova Odessa Centre. This programme has developed a recommendation for discing, with oversowing of a mixture of 4 forage legumes (Centrosema pubescens, Siratro, Phaseolus atropurpureus, Glycine Wightii and Stylosanthes guyanensis) at the rate of 4 kgs/ha, with phosphate fertilization; the same species are recommended in the State of Guanabara, and Siratro and Stylosanthes are used in hill pasture improvement in a programme carried out by IPEACS in the State of Espírito Santo. Both species seem to be equally successful in the pasture improvement programme at Belém, and a pasture/legumes programme conducted by a private company includes a similar range of species. Comparable studies are being made in the forage legume improvement programme of CIAT at Palmira and Carimagua, Colombia.

112. The widespread use of a limited number of species was also observed in the use of pasture grasses. For example, guinea grass - Panicum maximum, from Africa has for many years been very successful on the better, well drained soils all over the area. The same is true of Elephant grass - Pennisetum purpureum, Pangola grass - Digitaria decumbens, and others. Whilst pest and disease problems have reduced the enthusiasm for Pangola during recent years in some areas, e.g. São Paulo State, in other areas, e.g. Costa Rica and the Cauca Valley of Colombia it still plays an important role. At the same time other species, such as Brachiaria decumbens, successful for several years on the better soils of the Amazon area, have now spread to all pasture improvement programmes of the tropical forest climates.

2. Forage Improvement

113. The introduction and evaluation of forage species conducted in many Latin American countries over a long period is in urgent need of coordination. Similarly the systematic collection of forage legumes indigenous to Latin America, which is widely known as one of the main germplasm sources of this plant group in the whole tropical world, requires, equally urgently, a firmly coordinated effort. Native forage grasses of Latin America should also be included because all too often their potential value seems to be neglected in favour of the introduced African grasses.

114. A germplasm collection of forest legumes has been started in CIAT in cooperation with IICA, and IPEACS and the Nova Odessa station have been proposed by the Brazilian authorities as plant introduction and germplasm collection centres for the forage species of Brazil. Nevertheless only working collections seem to be handled at the moment.

115. Breeding efforts with forage grasses or legumes were mentioned at some centres visited. First selection programmes are underway at CIAT Colombia and in the Instituto Agronómico in Campinas, Brazil. In Belém, Brazil, a promising strain of Echinochloa pyramidalis has been released for pasture plantings in the inundated lands of the Amazon region. A superior strain of Stylosanthes guyanensis has been selected from Brazilian material in the IRI-Institute in Matao, and Nova Odessa is testing a promising indigenous pasture legume, Galactia striata, which has so far proved superior to all other pasture legumes commonly used. In the University of Piracicaba, Brazil, systematic genetic studies with the important molasses grass, Melinis minutiflora, are underway and selections of Elephant grass, Pennisetum purpureum, from the Federal Research Institute in Sete Lagoas, Minas Gerais, have been distributed for several years. Breeding of forage grasses and legumes offers considerable possibilities for advance and calls for overall strong coordination in the region. The importance of concurrent coordinated work on the strains of Rhizobium responsible for nodule formation on the legumes utilized in research programme is stressed. The work currently being carried out at IPEACS (Km 47, Rio-de-Janeiro) and CIAT would form a basis for regional cooperative work in this field.

116. Nitrogen fertilization of improved pasture is known to be very effective as a result of various experiments in the humid tropical lowlands of Latin America conducted over a number of years, and it may replace and surpass the use of forage legumes in some instances. However from the economic viewpoint, (the monetary input and output ratio), the use of nitrogen cannot be justified in many places. Research programmes in the various countries paid different attention to experimentation with nitrogen in pasture regions depending on national economic policies. Whilst the comparison of fertilizer and forage legume nitrogen in their contribution to grass growth was being carried out in Nova Odessa, Sao Paulo State, CIAT in the Cauca Valley and CTEI in Turrialba, are working on high nitrogen fertilization of Pangola grass in intensive grazing systems, the one for beef and the other for milk production. Because high nitrogen fertilization almost invariably forms part of any research programme on intensified pasture-animal production systems, economic analysis is of the greatest importance in this kind of research.

3. Fodder Conservation and Feeding of By-products

117. Research on more intensified measures of animal feeding, either for feed lots or for milk production, was encountered in various stations. Fodder conservation, difficult to justify economically in extensive ranching, received high priority in Nova Odessa for feed lots and in the Mata region of Pernambuco for milk production. The production of special silage crops such as maize and sorghum was included in the trials, as well as silage from fertilized pastures.

118. The use of cheap by-products for energy feed, e.g. molasses, rejected bananas and sugar cane tops, combined with urea as a replacement for part of the feed protein for ruminants, was found to be under thorough study in areas in which these products are easily available, such as in the Litoral of Pernambuco, in Turrialba and in the Aragua valley of Venezuela. The research at Turrialba on the replacement of milk in calf feeding by a supplement of bananas and animal fats, was considered worthy of special note.

119. Existing research results in the literature and new results, such as those on the use of rejected bananas at Turrialba, could and should be made available throughout the region by better coordination, as feeding recommendations developed from these studies would have a wide application under similar conditions.

C. Other inter-related factors contributing to increased production

a) Increase in herd size and off-take rates.

120. As suggested above (para 94) any increase in herd size presupposes an improvement in nutrition which would enable a larger herd size to be sustained. It is then clearly desirable to increase the proportion of breeding females in the herd. Recognizing that, in general, such increases must come from within the herd itself the final herd size will be dependent upon the number of female offspring (subject to improvement through selection) and the reproductive rate of the herd.

b) Improvement in fertility and reproductive rate.

121. The fertility of cattle herds in the areas visited is extremely low. The prevailing average calving percentage varies from as low as 30% to some 60% - against a desirable target of at least 70%. Low fertility in tropical America appears to be caused by a combination of factors, chief amongst which is grossly inadequate nutrition particularly during the breeding and suckling periods. Other contributory causes are a high burden of intestinal parasites, reproductive diseases and mineral deficiencies. The underlying reason appeared to the Mission to be poor general management, often attributed to "absentee" owners and managers. The situation could be greatly improved though the avoidance of seasonal fluctuations in nutrition, competent management of breeding stock to avoid high calf mortality and selection of breeding stock with proven high reproductive capacity.

c) Improving animal health practices.

122. Although the mission saw little evidence of decimating cattle diseases there appeared to be a need, in all areas visited, for the strengthening of national animal health services which should include diagnostic and disease investigation facilities. Such services, although not themselves strictly a research operation are considered to be an essential service to research in the provision of information on those disease conditions requiring detailed research. According to the information available prevalent diseases include foot and mouth disease, brucellosis, gastro-intestinal parasites, tick-borne diseases (Babesiosis and Anaplasmosis) and bat-transmitted rabies. For all of these there is either a known cure, or a vaccine, the use of which is limited by economic considerations, difficult communications and lack of trained personnel. The provision of adequate field veterinary services could lead to the national level programming of disease control and eradication, and consequently improved veterinary care at the ranch and farm level.

123. An interesting and important study is being undertaken at IPEACS on the incidence of toxic plants in the Brazilian savannahs. In some areas these lead to quite high cattle mortality and could explain many deaths from unidentified causes in other parts of the tropical grasslands. The need for wider dissemination of the Brazilian findings and regionally coordinated surveys of toxic plant incidence is underlined by the Mission.

- d) Increase in weight and reduction in age of animals going to slaughter.

124. The measures outlined above, particularly improved nutrition and subsequent increase in herd size, will automatically produce a younger, and with good management, a heavier animal to slaughter even without herd improvement through breeding. The Mission felt that once farmers and ranchers were shown that adequate year-round nutrition was feasible they would be encouraged to undertake breeding programmes aimed at production increases, through the gradual incorporation of heavier and earlier maturing strains of stock, utilising exotic breeds of which much good stock already seems to be available in the region.

- e) Infrastructural constraints.

i) Markets and Marketing.

125. Most marketing in the region appears to be conducted on a private basis, on the ranch or at municipal slaughterhouses, although stock auctions are held in Colombia. One result of this is that the producer is often at a disadvantage, because having trucked or driven his stock to either a slaughterhouse or a central pick-up point, he is virtually at the mercy of the buyer as his only alternative to sale is to return his animals to the farm. The vast distances involved and the poor condition of many roads and stock-routes result in a fair degree of weight loss and mortality during transportation. The Mission therefore believes that the provision of more slaughter facilities in the producing areas, the provision of competitive purchasing systems and quality grading and the improvement of stock transport systems, could well form subjects for more intensive investigation.

ii) Extension/advisory services.

126. In general the livestock extension services in the countries visited appeared to the mission to be inadequate, given the importance of the industry and its extensive nature. Links with research were not generally well established and all too often, through lack of transport, the extension personnel were unable to visit the farms in their areas with sufficient frequency and had to attempt to deal with farmers' problems at their own centres rather than on the farms.

iii)

127. Such topics as land tenure, availability and provision of credits, existence or otherwise of assured markets etc. (particularly as affecting the smaller farmer) were all brought to the notice of the Mission but were not examined in detail. It did seem however that there was a recognized need for the strengthening of economic and socio-economic research in closer association with technical research in the livestock industry, not only from the point of view of the cost/benefit analysis recommended for forage improvement programmes in paras 99 and 116 above but also on behalf of the smaller livestock farmers.

D. Dairying

128. Although the projected necessary increases in dairy products (based on milk) are not of quite such a high order as those for beef^{1/} they are still substantial. However they seem more likely to be attainable than those for beef, both through an increase in the number of cows being milked and through the overall improvement of milk yields.

129. With the exception of specialised dairy industries established near, or with adequate transport to, urban centres of high population, much of the milk yield of tropical America comes from the relatively short post-calving lactation of range cows. Although yields under the latter conditions can be improved through the use of better pastures and/or concentrates during lactation this practice is of doubtful economic

^{1/} The PSADSA gives annual growth rates of 3-4.8%

justification. Most increases will therefore have to be obtained in specialized dairying operations.

130. All countries visited had modern dairy operations in or near the cities and some excellent dairy research work was seen, in all the countries visited. Particular note was taken of that at Turrialba, which was specifically directed towards feeding practices for the low-country humid tropics.

131. There is much more scope for rapid improvement in the nutrition of dairy cattle, which are normally raised on sown pastures, and consequently for early increases in herd size, thus bringing more cows into milking. Better coordination of efforts is required however, and the Mission saw a need for the improved exchange of research results.

132. Research on yield increases is also under way in most countries of the region, and work on selection, milk recording and progeny testing was examined in Rio de Janeiro, Brazil, and Maracay, Venezuela. In both countries, artificial insemination, one of the most powerful tools for increasing yields, was being widely utilized. The Mission believes that the more widespread use of artificial insemination should form the subject of research programmes in the Central American countries where the demand for milk and milk products appears to be more acute.

133. The attention of the Mission was drawn to the potential importance of the water buffalo in the plains of the lower reaches and estuaries of the Amazon and Orinoco rivers which are subject to extensive intermittent flooding. Under such conditions buffaloes serve as an alternative to cattle in providing meat, milk and milk products, utilizing land that could not be used at all by any other domestic livestock. Nucleus herds exist in the area of N.E. Brazil and the economic potential of the animal, for the specific areas mentioned, should, in the opinion of the Mission, form a subject in any research programme for the area.

134. The need for improved coordination of livestock research work in Tropical America, aimed at the avoidance of duplication and the wider diffusion and sharing of research results, forms the basis of a specific recommendation by the Mission, calling in the first instance for a seminar, or working group meeting, which would examine the "state of the art" and formulate detailed proposals for regional cooperative activities.

II. Field Beans

135. Throughout Latin America the consumption of pulses together with nuts and seeds, supplied approximately 6.5% of the daily calorie intake and more than 15% of the protein intake, in 1970.^{1/} In the tropical areas, particularly in Central America, no less than 33% of protein intake was provided by the field bean (or dry bean) Phaseolus vulgaris.^{2/} The region is the largest single producer of dry beans in the world, accounting for a total production of 4.2 million tons out of a world total of 11.6 million tons. Brazil, with an estimated production of 2.4 million tons in 1971, produces more than half the regional total. There is an appreciable intra-regional export trade, mainly from Chile, Colombia and Mexico.

136. FAO's Perspective Study of Agricultural Development for South America indicates that, although the relative contribution of pulse foods to calorie intake may not change much by 1980, and that their contribution to protein and fat intakes may even be expected to fall off, absolute demand will rise considerably, requiring a 40% increase in production by 1980, or an annual increase of 3.1-3.5%. This increase is expected to be achieved through an expansion of sown area by 20% and a postulated increase in average yield of 17%.

137. The observations of the Mission bear out the popularity of field beans as a basic foodstuff for a large part of both the rural and urban populations of the region. They are evidently of major importance in the daily diet and their value as a protein source is enhanced by their cheapness; only soyabeans, amongst the legumes available locally provide a cheaper source of protein but apart from processed products they are not highly regarded as a foodstuff, except for animals, in tropical America.

138. It became clear, throughout the visits of the Mission, that many countries have assigned high priority to field beans research. Brief details have been given in Chapter Two of the bean programmes in the countries visited and examination of the literature^{3/} indicates that other countries in the region have comparable programmes entailing appreciable investment. It proved difficult, in the absence of really reliable data, to calculate the total financial input to bean research in tropical America but it is evident that the total investment is very high. A conservative estimate of the number of research workers involved suggests an annual input of at least 70 man years.

139. Equally evident was the fact that results to date are certainly not up to the level of what might be expected from the investment involved.

140. This appears to be the result of the tremendous dispersion of effort and, with the exception of Central America, an almost complete lack of communication and exchange of information between the various ongoing national programmes. There is therefore a pressing need for the better orientation and coordination of research programmes, and for the academic improvement and upgrading of many of the research workers involved.

141. The Cooperative Regional Programme of Central America (PCCMCA), conducted by I.I.C.A. has indicated, despite its slender technical and financial resources, the advantages which can be gained through the coordination of existing national efforts. The Mission believes that this programme could not only serve as an example for a more ambitious regional programme but could well serve as the basis for such a programme.

142. One of the early, short term advantages of such a programme would be the acceleration of the selection of improved varieties for specific areas, consequent upon the more widespread testing of the extremely variable genetic material available throughout the region in which is found the centre of genetic origin of the bean.

^{1/} FAO Production Yearbook. Vol 25. 1971

^{2/} IICA. Integral Plan for Research, Training and Technical Assistance for Protein Food Production in Central America & the Caribbean.

^{3/} Roberts, Lewis M. The Food Legumes, 1970.

143. In the longer terms such a cooperative programme should become involved in the testing of new varieties and associated cultivation techniques covering important aspects of irrigation, fertilization, pest, disease and weed control, and mechanization, all of which production factors might need to be improved to allow new varieties to achieve their potential under a wide range of ecological conditions.

144. It will be clear that a regional cooperative programme will require the support of an adequate research base, able to undertake fundamental breeding work aimed at the production of new bean varieties for testing within the region and oriented towards meeting the following basic needs of the region.

- a) Greatly improved production potential - the need for doubling or trebling of current yields has been suggested.
- b) Varieties resistant to diseases and pests.
- c) Varieties with improved protein content, in both quantitative and qualitative terms.

145. In addition the central research base should be able to undertake investigation into the production factors listed in para 143 above and into the socio-economic factors which limit bean cultivation by the small farmer and in particular which militate against his adoption of improved agronomic practices.

146. The Mission was unanimously of the opinion that the bean research programme of CIAT should form the basis for a broad regional cooperative research programme which could be organized on network lines. The programme of CIAT has already been expanded, with the needs of the region in view, and was designed, as indicated in para 77 to fit in closely with any other major effort on legumes within the region.

147. The Mission recognized that the field bean is best adapted to the upper altitude limits of the zone defined as tropical America, and should probably be restricted to such elevations, well exemplified by the situation of CIAT itself.

148. The recommendations of the Mission, with respect to beans, as expressed in the Summary Report issued in January 1973, accorded very well with the recommendations of the CIAT Seminar (February 1973) and are expanded in Chapter Six of this report.

III. Cassava

149. Although cassava was not specifically mentioned in the Terms of Reference of the Mission, it was seen to be a daily item in the human diet throughout the areas visited, and one of the principal carbohydrate sources for much of the population. All the countries visited demonstrated considerable interest in the crop although, contrary to the findings of the Mission with respect to beans and beef cattle, little research effort appeared to be expended on the crop.

150. Apart from the long term studies at the Agricultural Institute of Campinas, Brazil, and the important work of CIAT, other cassava research programmes (in Venezuela, Colombia and other parts of Brazil) are of recent origin and have so far made little progress. With the exception of some varietal selection and germ plasm collection work at Turrialba, research has been neglected in Central America.

151. The importance attached to cassava arises not only from its value in human nutrition, used either whole or processed in normal and special dietary regimes, but also from its widespread use as a stock feed and its very great potential for industrialization in the extraction and processing of starch, alcohol and other derivatives. An increasingly important use of cassava in tropical America is expected to be the substitution of cassava flour, in notable proportions, for wheat flour in bread making. Commercial trials have indicated some success in this process and a considerable expansion of this practice is anticipated in Brazil, Bolivia, Ecuador and Peru.

152. According to 1970 production figures Latin America produced nearly 40% of the world's total cassava with a total of approximately 35 million tons. Production projections for 1980 vary from 49-51 million tons which would require a growth rate of 3.2 - 3.6% per annum. Although much of this increase is expected to be met through increase in the planted area, especially in Brazil, important yield increases are foreseen in Colombia and Venezuela amongst the countries visited.

153. The initiation of cooperative trials between CIAT and collaborating national programmes during 1972 has laid the foundation for the gradual build-up of a region-wide network of experimentation and information exchange on cassava.

154. The basic objectives of the CIAT headquarters programme are the selection and development of varieties with higher yield potential and higher nutritional value (protein quality and quantity and starch content, depending on foreseen end-use); the development of farming practices and systems to increase production by the smaller (subsistence) farmer; studies on storage, marketing and processing, aimed at regularity in commercial supplies and, finally, the development of the regional evaluation programmes and information exchange mentioned above.

155. CIAT has established a collection of over 3,000 cultivars of cassava from the region, which form its basic germ-plasm bank, and has already evaluated several hundred of these. Quarantine regulations impose some constraints on the international transfer of materials but close cooperation with the cassava work of IITA in Africa is envisaged for materials which as yet cannot be exchanged.

156. An important aspect of the evaluation and screening programme relates to diseases and pests. Little is known about their economic importance, in terms of yield depression, but preliminary work indicates that at least six fungi, one bacterium and four or more insect pests are capable of causing considerable crop losses.

157. In addition to the work on screening of varieties for resistance to diseases and pests, research is being undertaken on various forms of tissue culture, as a means of avoiding disease transmission through the distribution of vegetative materials.

158. The cassava breeding programme of CIAT is aimed firstly at the production of high yielding varieties (usable by the small farmer with or without fertilizer) of good root shape, a high degree of resistance and low level of cyanide toxicity. Secondary factors are good storage capacity, good manufacturing types and high protein levels. Although some prominence had been given to the need for higher protein material in what is a low-protein food in any case, CIAT was now investigating the possibilities of adding protein to the finished (processed) product as an alternative means of improving protein intake in cassava diets. With IDRC assistance cooperative trials were in progress at the University of Guelph using single cell protein additives.

159. In parallel with the biological and agronomic trials on cassava CIAT is also conducting and continuing a series of basic economic studies on production costs, the efficiency of processing plants, price analyses and the economics of fertilizer application. As with the basic varietal trials studies will be conducted at several sites in cooperating countries and throughout Colombia.

160. The Mission was greatly impressed by the thoroughness of CIAT's approach to cassava research and emphasises the need for the programme to continue unabated.

CHAPTER FIVE

NORTH-EASTERN BRAZIL

161. Geographically this region of 1.647.298 sq. kms. covers 20% of the total land area of Brazil and includes the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and Maranhão. Compared with other Latin American countries (except Brazil itself) its area is surpassed in size only by Mexico and Argentina. The region, rich in tradition and Brazilian history, was inhabited 100 years ago by almost half of the Brazilian population. Still today one third of all Brazilians, or 29 million people live in the northeast.

162. Ecologically it is characterized by a distinct zoning running north-south parallel to the coast line (Fig. 3); the Litoral, the flat land on the coast and the Mata zone on the lower part of the eastern slope of the Brazilian plateau, have a tropical rain forest climate. This coastal zone stretches from Bahia to Rio Grande do Norte and is between 50 and 150 kms deep. Large plantations of cacao in the south and sugar-cane in the north are the characteristic vegetation features replacing the natural tropical rain forest.

163. A transitional zone to the semi-arid interior is the Agreste, with semi-humid conditions of 900 to 1000 mms of annual rainfall, starting at the upper part of the eastern mountain slope and extending westward with a similar depth to the Mata zone. Large parts are covered by dense bush or the characteristic "Caatinga" vegetation of the interior. However under favourable soil moisture conditions and with wet winds from the sea, a diversified agriculture, in small to medium sized farms, produces food crops (fruit and vegetables) for the markets of the cities on the coast.

164. Semi-arid conditions, with low and erratic rainfall, prevail in the interior, the so-called Sertão, which covers 800.000 sq. kms or 51% of the land area of the northeast. This area, three times larger than Italy and inhabited by 8 million people, covers much of all the northeastern states, except Maranhão, and is up to 1.500 kms wide. It is characterized by an open thornscrub vegetation allowing only the most extensive grazing. The main part of the population, and agriculture, is concentrated on the better soils along the courses of the seasonal rivers.

165. Extreme droughts, occurring periodically, cause serious famines, forcing the emigration of a large part of the population to the Litoral, to the south of Brazil and partly to the Amazon region. Following a well established tradition many of the people return to their semi-arid home country when better conditions are restored. In this semi-arid region water availability is a serious problem, not only for plant growth but also for drinking purposes. In spite of new discoveries and developments, surface water, collected in open ponds, is often the only water source for men and animals.

166. Many aspects of the development of north-eastern Brazil form part of the National Development Plan of the Brazilian government (Plano de Desenvolvimento do Nordeste). The Superintendencia de Desenvolvimento do Nordeste (SUDENE) in Recife, is the responsible federal agency for the region, carrying out a large number of development projects in various fields including industry, agriculture and colonization, using Brazilian and international loans as well as private investment.

167. In agriculture, land reform is considered as important or even more important than technical matters. Of 1.4 million farms occupying 64 million ha in the northeast, 0.86 million are smaller than 10 ha, that is to say 62% of all farms occupy only 4.3% of the agricultural land, whilst 7,700 farms of more than 1000 ha represent 30.7% of the total agricultural area. A special land reform programme, PROTERRA - (Programma de

O NORDESTE E SUAS REGIÕES

O grande espaço em marrom no centro é o Sertão, mais da metade do território do nordeste. A faixa verde e estreita engloba o litoral e a Zona da Mata, a amarela o Agreste. Em laranja, o chamado meio-norte, parte do Piauí e o Maranhão, onde penetra a floresta amazônica.



Fig. 3.

Ecological Zones of Northeastern Brazil
Source: Coelho, 1972.

Redistribuição de Terras e de Estimulo à Agroindustria do Norte e Nordeste) is currently seeking long term solutions to the problems of better land distribution and resettlement.

168. SUDENE coordinates the agricultural and industrial development of the region and contracts research projects for this purpose to research institutes and universities in the area. Agricultural research is widely dispersed in numerous agencies following the former traditional pattern in Brazil; for example, in the state of Ceará alone no less than 15 agencies are engaged in agricultural research. The current reorganization of agricultural research in Brazil will endeavour, inter alia, to coordinate these activities within priority oriented national and regional research programmes.

169. The Mission visited the federal agricultural research institute of the region, IPEANE (Instituto de Pesquisas Agropecuaria do Nordeste), and the most important institute of the State of Pernambuco, IPA (Instituto de Pesquisas Agronomicas). The centres of both institutes are located at Recife and have a number of experimental stations located in the various ecological and political divisions of the area.

170. University research appeared to be of much less importance than that of the institutes mentioned. During a visit to the Universidade Federal Rural of Pernambuco in Recife, one of the two federal agricultural universities in the northeast, (the other is located at Fortaleza, Ceará) it was pointed out that there is nevertheless interchange of scientific personnel between the universities and the research institutes and many research workers have dual employment.

171. The research programmes presented to the Mission indicated to some extent a reorientation of priorities resulting from the reorganization of Brazilian agricultural research into cooperative commodity programmes. In addition to this, most research programmes were also influenced by the development objectives of SUDENE (including fruit and industrial crop production) which as stated, contracts research to the research institutes and universities.

172. The general impression gained by the Mission was that industrial crops were given the same order of priority as food crops. In SUDENE a recent change in the development approach was pointed out. This involved a swing from the original main objective of "improving the environment", to the better adaptation of farming to the environment.

173. The potentials of various crops in the main ecological areas are widely studied but the main priorities, in commodity order, were given as cattle feed, rice and tropical fruits. For the Mata zone tropical fruits and feed-lot cattle fattening on sugar cane tops or Guinea grass plus urea, were given high priority in the research institutes, while in the Agreste zone milk production, using sorghum and corn silage plus urea, with a diversified crop production programme, was given a high order of priority.

174. Adapted, improved pasture plants are as important in the Agreste area as in the Sertão which seems to have a limited potential for some few annual forage grasses and legumes.

175. Cacti have been used as an emergency feed for a considerable time in this semi-arid area but are of very questionable utility because of their susceptibility to burning.

176. The Caatinga area is usable only for goats, and under present conditions 2000 ha of Caatinga, carrying 500 goats, is sufficient to provide reasonable living conditions for only one family.

177. Where suitable water and soil conditions are found in the Sertão however, crop improvement programmes (sometimes including irrigation) are underway, including rice, beans, cotton, corn, peanuts, sesame and sorghum.

178. In all discussions in the region improvement in animal production, especially beef, and in grain legumes was given high priority. So far the only contact made with international institutes was with CIAT in respect of rice breeding. In spite of 37 years of corn and bean breeding in IPA, Recife, it was felt that cooperation with other agencies would be of very great benefit and could lead to the improvement of research programmes.

179. Various international and bilateral assistance programmes are in operation or under development in the region. The mission took note of some programmes of recent origin and importance related to its main task, in particular a livestock development project under the auspices of UNDP/FAO (BRA 71/552) which was in its planning phase. It will be operated in close cooperation with IPEANE, SUDENE and ABCAR, the Association for Rural Credit and Extension. Main priorities for research are: a) Introduction and evaluation of pasture and feed crops with potential value such as sorghum, legumes and grasses (b) Feeding and management of cattle, goats and sheep with emphasis on pastures and feed storage. (c) Research on animal diseases. (d) Studies of integrated technological production systems (technological packages) and (e) Studies on methods for transferring technology to the conditions prevailing in North-east Brazil. These priorities are based on the guidelines of the National Research Commission of DNPEA.

180. IPEANE will further participate in the USAID programme, PEPA, (see above para 29) which includes priorities on cattle, beans and soybeans, corn, sorghum and rice.

181. The Ford Foundation was also developing a sorghum improvement programme in the area and a private agricultural research project, BRASCAN-Nordeste is financed by Canadian Banks. During the visit to DNPEA, the headquarters of Brazilian agricultural research in Brasilia, the mission was informed that further plans for a special national research project for the North-east were under consideration.

182. Although aware of the many and complex problems of north-eastern Brazil and of the various new international, bilateral and national activities in the area, the mission felt unable, after its short visit, to recommend at the moment specific action in international agricultural research for North-eastern Brazil. But the various crop and livestock improvement programmes should receive the fullest possible assistance from the international institutes e.g. on rice, beans, corn, cassava and beef from CIAT and, eventually, on sorghum from ICRISAT when that institute has developed sufficiently to include North-eastern Brazil in its outreach programme. The importance of the region to Brazil and South America, its population pressures in the coastal areas and its ecological difficulties in the semi-arid interior merit wide recognition. Further specific requests for international agricultural research assistance, which may be forthcoming, should therefore be considered very carefully.

CHAPTER SIX

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Introduction

183. On the basis of its review of the available agro-climatic and ecological classifications of South America, the Mission reached the conclusion, expressed in Chapter Two, that, for the sake of simplicity, it would follow the arbitrary definition of Roberts and Hardin (1966), and accept as "tropical America" that zone lying between the 23rd North and South parallels of latitude at elevations between sea level and 1,000m. As pointed out by Roberts and Hardin, above that elevation altitude affects temperatures sufficiently to create progressively more temperate conditions and although temperature within the zone is closely related to altitude it is generally uniformly high. Furthermore photoperiod is also fairly constant and the high level of solar energy is conducive to high photosynthetic activity. The main differences within the zone are attributable to variations in the total rainfall and its seasonal distribution and edaphic factors, principal amongst which are soil nutrient status and drainage.

184. Within the tropical zone three major agro-climatic categories were recognized - the tropical forest climate, the savannah climate and the semi-arid tropical climate. Representative areas within these categories are described above and the Mission wishes to draw special attention to the following areas currently undergoing development.

i) Amazon Basin

185. Very great efforts are being concentrated on development and colonization within the Amazon area. The Mission was unanimous in its opinion that uncontrolled development could cause serious and irreversible ecological changes in this area and foresaw the need for considerable coordinated international assistance in the future. The National Research Council of Brazil has already established a special committee to coordinate research activities and the Mission hopes that any requests for assistance in the Amazon area will receive a careful and sympathetic scrutiny. The need for an integrated approach to development, including agriculture, forestry and conservation activities is stressed, and the development, through research, of suitable farming systems should be given high priority in development programmes. An encouraging start has been made by the Amazon Development Authority (SUDAM) which has developed a plan for zonal settlement, based on concentric rings of agricultural and forestry land; this and other integrated systems should form the basis of future programmes.

ii) The Savannah lands

186. Although for many years it has been considered potentially feasible to increase the carrying capacity of the vast areas of the Llanos, only slight increases in utilization have been effected recently. One of the principal factors would appear to be lack of accessibility and consequent reluctance to form settlements. Secondly, poor management practices, often with "absentee" managers and owners, have led to overgrazing in the more productive areas and neglect of wide areas of range utilizable at least through part of the year. Suggestions are made below for a seminar or symposium on research problems facing the beef cattle industry at which it is suggested that the problems of improving natural grasslands should be thoroughly reviewed.

iii) Semi-arid areas

187. The most important of the semi-arid zones from a development point of view was felt by the Mission to be that of the interior of North-eastern Brazil. Rainfall

is low and erratic and frequent droughts cause periodic population migrations, which in turn aggravate the problems of the already densely settled coastal strip. Although specific recommendations can not be made by the Mission the importance of the area is emphasized and attention is called (para. 218) to the need for due consideration of any requests for bilateral or international assistance which might be forthcoming in the future.

Research Organization

188. Research organizations in the countries visited (Chapter Three) was generally found to be sound. National level policy making was in the hands of national agricultural research councils or their equivalents, and with the exception of some Central American countries nationally coordinated commodity research programmes had been established.

189. Two major constraints to the better conduct of research, particularly apparent in Brazil and Central America, were the very wide dispersion of effort, with too many small stations having only a single professional research worker in charge, and the relatively low academic status of a considerable proportion of research workers.

190. In Brazil the situation may be improved by the current reorganization of the research system and the special programme of assistance (PEPA) which includes a strong training element. Nevertheless the Mission was informed that additional technical and financial assistance from outside sources would be welcomed and it would therefore draw the attention of potential donors to the particular needs of the Amazon zone and the North-eastern zone.

191. The situation in Central America is more serious than elsewhere. Nevertheless this region has the great advantage of having the Tropical Training and Research Centre (IICA/CTEIA) situated at Turrialba in Costa Rica.

192. The Mission is strongly of the opinion that the future of this station should be assured, even though it feels unable to recommend the specific support sought for the livestock and legume programmes for Central America as originally requested by IICA, in the light of similar work being carried out elsewhere. The whole of this work, the Mission believes, should eventually be integrated into two or more coordinated programmes as indicated below.

193. The Mission would propose the following roles for the Turrialba Centre:

- i) As a major participant in any coordinated regional programme on food legumes which may be established, with specific reference to work in Central America.
- ii) As a similar major participant in regional livestock work with specific responsibility for dairying and beef production problems of the low country humid tropics.
- iii) By participation as a major regional centre in a global network of germ plasm conservation and resource centres with specific responsibility for cacao, tropical fruits, coffee (in association with Campinas), legume and cassava working collections (in association with CIAT and with zonal responsibility for Central America), and eventually for tropical forestry germ plasm. In addition the Mission believes that the Turrialba Centre, with its excellent teaching facilities, could play a major role in the practical training of staff for any global genetic resources network which might be established, and in the continued provision of post graduate facilities for Central America.
- iv) Turrialba should be borne in mind as a suitable site for the conduct of research on any tropical commodity for which centralized work may be proposed

in the future. Amongst these the Mission would draw particular attention to industrial crops such as cacao, palms and tropical fruits for commercial use. In addition its use as a centre for tropical forestry research may be considered.

194. The exact role of CTETI in the proposed regional networks for legumes and livestock production should be investigated in depth by appropriate working groups.

195. The recommendations of the TAC with respect to CIAT will be made at an appropriate time when the Centre's programme is reviewed. The Mission therefore wishes to emphasize to the Committee the probable need for further strengthening of the bean programme of CIAT in order to enable it to play its full contributory role, as leader in field bean research programmes, in any regional network which may be established.

196. Such a role has already been adopted by CIAT with respect to cassava and that programme should continue to be strongly supported.

197. A recommendation is made below which it is hoped will encourage leadership being assumed by CIAT in a regional beef cattle production research network. The impressive work being undertaken by CIAT, especially in the Llanos and the availability of a nucleus of CIAT trained personnel in many countries of the region, lead the Mission to the belief that such a network should form a subject for discussion at a proposed regional seminar on cattle production.

198. The future role of the legume activities of the Cooperative Food Crop Programme of Central America (PCCMCA) is dealt with in more detail in para. 213 below. The Mission emphasizes the success of this programme, operated with minimal resources and regards it as a model, following which similar research networks could be organized.

199. The initiative taken by Brazil, in establishing a Sub-regional Soils Research Programme, on the basis of bi-lateral assistance, impressed the Mission as an example of intra-regional cooperation which could well form a model to be followed by others of the more developed countries of the region.

Specific topics

A. Beef Cattle Research

200. The Mission reached the conclusion that feeding was the most important of all the constraints to cattle improvement in tropical America (Chapter Four A). Whilst such factors as increase in herd size, improvement in fertility and reproductive rate, reduction in calf mortality, increased off-take rates and increased weight of animals going to slaughter were all contributory to overall increased production they were, to a large extent, dependant on improved basic nutritional levels and assured feed supply throughout the year. Other contributory factors were felt to be improved animal health services, better management and a better infrastructure (marketing, communications, extension services etc.)

201. Throughout the areas visited the Mission found considerable duplication in research activities, and lack of sufficient contacts between people working on the same problems. The level of research effort was quite high and the current state of knowledge appeared in some places to be well in advance of application.

202. The Mission believes therefore that there is an adequate basis for the organization of a regional cooperative programme in beef cattle research, with the participation of national, regional and international institutions, aimed at achieving the maximum efficiency from the present widely scattered efforts and ensuring the fullest possible sharing of research results.

203. The Mission was firmly of the opinion that CIAT should be requested to take the lead in such a programme and therefore recommends that CIAT be requested to organize a seminar or working group, similar to that held on field beans in February 1973 to examine the status of and to discuss how best to coordinate, the present beef cattle research in tropical America, and that adequate financial provision be made for this purpose.

204. It further recommends that the TAC again appoint one or two of its members to follow up the above recommendation, if adopted, and to assist in the preparation of the agenda for such a seminar or working group.

205. The Mission believes that the seminar should provide for multi-disciplinary participation, including livestock and pasture specialists, veterinarians and economists and should address itself, ab initio, to the possibility of establishing a regional programme, or programmes, on the various aspects of beef cattle research.

206. The following topics are suggested as providing suitable guidelines for wide discussion during the seminar. It will be noted that the Mission again gives great importance to the various approaches to animal feeding, although agreeing that all aspects of beef production should be examined. No attempt at an exhaustive list of topics has been made.

207. i) Economically feasible methods of improving natural grasslands. To include discussion of such techniques as controlled burning; surface seeding (possibly aerial) of improved legumes and grasses to improve the sward; concomitant selection, breeding and multiplication of promising legume and grass species; the establishment of breeding and selection centres and germ plasm banks within the tropical zone, through strengthening of existing international and national efforts with the highest priority assigned to the ongoing work at CIAT.
- ii) Improving sown pastures. To include discussion on the selection, regionally and locally, of the best adapted species composition for artificial pastures, and their economic establishment.
- iii) Improved management systems. To discuss the best adapted management systems, for optimum animal output, for range, sown pastures or a combination of both under diverse local conditions.
- iv) Supplementary feeding. To include discussion of the various means of supplying additional feeds required to bridge periods of feed shortage, through conservation, (hay, silage etc.) and the use of specially grown feeds or by-products, in feed lots. The economics of grass/legume or fertilized grass feed lots should be examined in some detail. Attention should also be given to the use of nitrogenous supplements such as urea and mineral additives.
- v) Breeding techniques, including consideration of the upgrading of local races and the judicious use of exotic breeds to meet specific needs such as earlier maturity etc.
- vi) The improvement of veterinary services.
- vii) The improvement of the infrastructure of the industry, including questions of transport, marketing, provision of credit services, extension and advisory services etc.

208. Recognizing the breadth of the problems facing the livestock industry the Mission suggests that it might be appropriate to establish individual working groups, within the

seminar, to prepare recommendations for cooperative work on specific topics.

B. Field Bean Research

209. Reviewing the disappointing results of field bean research in tropical America relative to the considerable input to various national and regional programmes, the Mission reached the conclusion that this resulted from dispersion of effort, lack of communication and information exchange and, with some marked exceptions, to the somewhat low level of academic training of many of the workers.

210. The Mission was unanimously of the opinion that the better orientation and coordination of research programmes could be achieved through the establishment of a regional cooperative research network on field beans, discussion on which was to be held during a CIAT sponsored seminar scheduled for February, 1973.

211. When the Mission first reported briefly to the TAC in January 1973, it recommended the establishment of a working group to follow up closely the activities of the proposed CIAT seminar and to prepare a definitive outline for a regional cooperative programme. The Committee however recommended the attendance of only one member of its new Sub-Committee on Grain Protein and requested him to report on the findings of the Seminar.

212. The Mission has since learned that the seminar appointed a team of three, including one member of the Mission, to prepare a plan for the establishment of a cooperative bean research programme in tropical America. It is expected that this plan will be made available to the TAC.

213. The Mission members have not had an opportunity to examine the proposals made but it is their understanding that these are in line with the opinion, expressed earlier by the Mission, that a regional cooperative research programme for beans could be modelled on the existing IICA Central American Programme. Furthermore it is understood that CIAT has been recognized as the research base for such a cooperative programme and has taken steps to increase the budget for its bean research programme.

214. The Mission recommends strongly the establishment of such a regional cooperative research programme, utilizing the services of both IICA and CIAT, and would urge that every effort be made to obtain financial support for this activity.

215. It further recommends therefore the detailed study by the TAC of the proposals to be presented by the working group appointed at the CIAT seminar, if necessary seeking the advice and assistance of its Sub-Committee on Grain Legumes.

C. Cassava Research

216. In view of the importance of cassava in tropical America, both as a foodstuff and as the basic raw material for various manufacturing processes, the Mission examined the research programme of CIAT, including the collaborative and outreach activities with the countries of the region. It was greatly impressed by the programme and whilst not recommending any specific action emphasizes the need for the TAC to recommend continued support for this programme.

D. North-eastern Brazil

217. The specific problems of North-eastern Brazil, especially those of the semi-arid interior, covering the whole or parts of six states, are both ecological and socio-economic in nature. Agricultural research is still in a somewhat confused condition, having to reconcile national priorities with regional priorities stemming from development programmes. The national reorganization of research was still in progress at the time

of the Mission's visit and although tentative proposals had been made for a special programme for the North-east nothing had been finalized. Considerable international and bilateral assistance was being given to research and development in the area but pending the finalization of national plans, within which coordination could be effected, the Mission felt unable to recommend specific additional assistance at the international level.

218. Nevertheless the Mission believes that the various crop and livestock improvement programmes should participate to the fullest extent possible in assistance available from the existing international institutes. Programmes on rice, beans, corn, cassava and beef could, for example, benefit from closer contact with CIAT. The Mission also expresses the hope that as soon as possible the area may be able to participate in outreach programmes of ICRISAT, with respect to sorghum, and of IITA with respect to cowpea and farming systems.

218. It is possible that specific requests for assistance may be developed when the priorities for the region have been classified at the national level, and the Mission would urge their very careful consideration.

APPENDIX 1

ITINERARY, INSTITUTIONS VISITED AND PERSONS CONSULTED

19 November Recife, Brazil

- a. IPEANE (Instituto de Pesquisas Agronomicas do Nord Este)
Director General Eng. Agr. S. Gomes da Fonseca.
Senior Staff of the Institute.

20 November b. Universidade Federal Rural de Pernambuco
Rector Prof. A. Erasmo de Azevedo.
Senior Staff of the University.

- 21 November c. IPA (Instituto de Pesquisas Agronomicas, Penambuco)
Director General Dr. Paulo Emami Siqueira.
Senior Staff of the Institute.
- d. SUDENE Depto. de Agricultura e Abastecimento
 - i) Director Dr. J. de J. Moreira de Moraes Reyó.
Senior Staff of the Department.
 - ii) Dr. F. Esio de Souza,
Chefe de Divisao de Pesquisas e Experimentação Agropecuaria.
Senior staff of the Division.

22 November Belém

- a. IPEANE (Instituto de Pesquisas Agropecuarias do Nord)
Director Eng. Agr. Italo Falesi.
Deputy Director Eng. Agr. Adilson Serrao.

23 November b. SUDAM

- i) Ec. Dr. Pedro Melo, Chefe, Depto. de Incentivas
 - ii) Eng. Agr. David Ferreira, Chefe, Divisao de Projectos Agropecuarios.
 - iii) Ec. F.H. Savaira Martins, Chefe, Divisao de Promocão de Investimentos.
 - iv) Dr. Osvaldo Vera Cruz, Chefe Substituto, Depto. de Recursos Naturais.
 - v) Dr. Francisco Guerra, Chefe da Secaõ de Politica Florestal
- c. Mr. D.C. Allan, Director, Agrocere, S.A.

- d. Dr. John N. Landers, Director, Instituto de Pesquisas, IRI (formerly IBEC Research Institute), Matao, Sao Paolo.
- e. Dr. Eduardo Venezian, Agricultural representative of the Ford Foundation in Brazil, Rio de Janeiro.

24 November

Brasilia

- a. DNPEA
 - i) Dr. Roberto Meirelles de Miranda, Director General, Depto. Nacional de Pesquisas e Experimentação Agropecuario (DNPEA).
 - ii) Dr. Otto Lyra Schrader, Director, Agronomy Division.
 - iii) Dr. Vicente de Paula Mendes Peloso, Director, Animal Science Division.
 - iv) Dr. Ivo Torturella, Director, Veterinary Science Division.
 - v) Dr. Nataniel Broomfield, Director, Soils Division.
 - vi) Dr. José Virginio Lyra, Director, Agricultural Engineering Division.
 - vii) Dr. J. Murdoch, Special Programs Advisor, (PEPA), University of Wisconsin, USAID.
- b. IPEACO, Estação Experimental de Brasilia.
Director, Eng. Agr. Wilson Serrão.

25 November

Rio de Janeiro

- a. Dr. Addi Raoul da Silva (IPEACS),
Coordinator National Wheat Improvement Programme.
- b. Dr. Luis Fonseca, ABCAR (Associação Brasileira do Credito e Assistencia Rural), Rural Sociologist.

26 November

- c. IPEACS (Km. 47)
Instituto de Pesquisas e Experimentação do Centro-Sud
Dr. H. Gustavo Guida, Director
Senior staff of the Institute.

28 November

Sao Paolo

- a. Instituto do Zootecnia, Sao Paolo
Director General, Dr. A. Alves Santiago
Senior staff of the Institute.

- b. Instituto Agronomico do Estado do San Paolo, Campinas.
Director General, Dr. Pompeiu Cavallieri.
Senior staff of the Institute.
- c. Prof. Guido Ranzani, Director
Centro de Estudos de Solas, Piracicaba
- d. Dr. Carlos Krug, National Research Council Member
(Former FAO Country Representative - Brazil).
- e. Instituto de Zootecnia, Nova Odessa
Director, Dr. Geraldo Leme da Rocha.
Senior staff of the Institute.

30 November

Cali, Colombia

- a. CIAT
Dr. U.J. Grant, Director General.
Senior staff of the Centre.
- b. Dr. E.J. Johnson, FAO Pasture and Forage Agronomist.
- c. Dr. F. Suarez de Castro, Regional Director,
Andean Zone, IICA.
- d. Dr. A. Cardozo, Coordinator, Regional Cooperative
Pastures Programme, IICA.

1 December

Carimagua

Experimental Station. I.C.A.
Dr. J.M. Spain, Soils Specialist, CIAT.
Senior staff of the Station

Bogota

- a. Dr. V. Davila, Director General, ICA.
- b. Dr. Alvaro Gardner, Deputy Director General,
Research, ICA.

3 December

Bogota

Dr. Dr. J. Tauber, Senior Agricultura Adviser
and FAO Country Representative.

4 December

Maracay, Venezuela

- a. Centro de Investigaciones Veterinarias
Dr. R. Martinez Rueda, Director.
Senior staff of the Centre.

- b. Centro de Investigaciones Agronomicas
Dr. Alfredo Rivas Vasquez, Director.
Senior staff of the Centre.
- c. Facultad de Agronomia, UCV
Dr. Pompeyo Rios, Dean.

5 December

Cagua

Estacion Experimental, Fundacion Servicio para
el Agricultor.
Dr. Jesus Silva Calvo, Director.
Senior staff of the Station.

6 December

Calabozo

Estacion Experimental, CIA/MAC.
Dr. F. Morillo, Director General, Agricultural
Research Division, MAC.
Dr. G. Paéz, Director.
Senior staff of the Station

Pariaquan

Centro de Recria del MAC.
Sr. Dario Montone, Officer-in-Charge, Chief of
the Programme.

7 December

San Jose, Costa Rica

- a. Instituto Inter-Americano de Ciencias Agricolas (IICA)
Dr. José Emilio G. Aruajo, Director-General.
Dr. Carlos Madrid, Sub-Director General
Dr. Enrique Blair, Director, Agrarian Reform
Programme.
Senior staff of the Institute.
- b. Facultad de Agronomia, U.C.R.
Dr. A. Rodriguez, Rector
Dr. R. Echandi, Coordinator, Grain Legume Programme
Dr. R. Gamez, Virologist
- c. Ministerio de Agricultura
Ing. Ag. Alvaro Rojas, Deputy Minister
Ing. Ag. Vargas, Agronomist.

8-10 December

Turrialba

Centro Tropical de Enseñanza e Investigación
(CTEI/IICA)

Dr. Manuel Elgueta, Director and Vice-Dean

Dr. Jorge Soria, Chief, Crops and Soils Division.

Dr. H. Muñoz, Chief, Livestock Division.

Senior staff of the Centre.

APPENDIX II

SELECTED REFERENCES

- Eiten, G., 1972: The cerrado vegetation of Brazil
Bot. Rev. 38, 201-341
- Elqueta, M., 1972: The extrapolation of Agroclimatic conditions throughout
Central America. Report to the mission.
- Klages, K.H.W., 1949: Ecological crop geography, Macmillan Co., New York
- Papadakis, J., 1960: Chapter 14 in Geographia Agricola Mundial, Salvat
Editors, S.A. Barcelona-Madrid-, First Edition.
- Papadakis, J., 1970: Climates of the world, Bueno Aires
- Roberts, L.M. and Hardin, L.S., 1966: A proposal for creating an international
institute for agricultural research and training to serve the
lowland tropical regions of the Americas. Report
- Robinson, H., 1961: Latin America, Mac Donald & Evans Ltd, London
- Sioli, H., 1968: Zur Ökologie des Amazonas-Gebietes, in E.J. Fittkau et al.:
Biography and Ecology in South America, Dr. W. Junk N.V.,
The Hague
- Coelho, M. (Ed.), 1972: Nordeste. Realidade 7, No. 80
- Roberts, L.M. 1970: The Food Legumes. Report.
- Lombardo, H.A. 1969: Research on Agricultural Development in Central America.
The Agricultural Development Council Inc. New York.
- Banco Interamericano de Desarrollo, 1971: Estaciones Experimentales Agrícolas
de America Latina. BID. Washington D.C.
- Inter-American Development Bank, 1971: Report on Latin American Agricultural
Research Institutes. IDB. Washington D.C.
- Hutton, E.M., Undated: Establishing Research Priorities for Latin America:
Pasture and Forage Aspects. Report. CSIRO. Brisbane.
- CIAT, 1972: Programme and Budget, 1973. CIAT. Cali.
- CIAT, 1972: Annual Report, 1971. CIAT. Cali.
- FAO, 1968: Report of the FAO/UNDP Central American Livestock Mission. Rome.
- FAO, 1970: FAO/UNDP Project Reg. 8. Inter-American Institute of Agricultural
Sciences, Turrialba. Report on Project Results, Conclusions and
Recommendations. FAO. Rome.

- FAO, 1971: Suggestions for a Regional Research Network for Tropical and Sub-tropical Pastures in Latin America. Draft proposal.
- FAO, 1971: Suggestions for a Regional Research Network for Food Legumes in Latin America. Draft proposal.
- FAO, 1972: Perspective Study of Agricultural Development for South America. Draft. Rome.
- FAO, 1972: Production Yearbook. Vol.25. 1971. Rome.
- FAO, 1972: Report of the Twelfth FAO Regional Conference for Latin America. Rome.
- IICA, 1967: Las Ciencias Agrícolas in America Latina. IICA. San José
- IICA, 1970: Estaciones Experimentales Agrícolas de la Zona Andina. Publicación Miscelanea No. 72. IICA, Zona Andina. Lima.
- IICA, 1972: Proyecto de Programa-Presupuesto 1972-1973, IICA, San José.
- IICA, 1972: Sintesis del Programa Operativo 1972-1973. IICA, San José.
- IICA, 1972: Integral Plan for Research, Training and Technical Assistance for Protein Food Production in Central America and the Caribbean. IICA, San José.
- IICA/CTEI, 1972: Research Projects of the Tropical Training and Research Centre, 1972-1973. IICA/CTEI. Turrialba.
- IICA, 1972: Annual Report - 1971. IICA. San José.
- Departamento Nacional de Pesquisa Agropecuaria, 1972: Programa Especial de Pesquisa Agropecuaria, 1972-1976. DNPEA. Brasilia.
- DNPEA/IICA, 1971: Instituições de Pesquisas Agropecuarias do Brasil. DNPEA. Brasilia.
- DNPEA, 1971: Programa Nacional de Pesquisa Agropecuaria 1972. IPEAO. Campo Grande.
- Instituto de Zootecnia, 1971: Boletim de Industria Animal Vol. 27-28. Sao Paolo.
- Santiago, Alberto A, 1970: Pecuária de corte no Brasil Central. Instituto de Zootecnia. Sao Paolo.
- DNPEA, 1972: Pesquisas Prioritárias em Zootecnia e Agrostologia. Ministerio da Agricultura, Brasilia.
- SUDENE, 1972: Departamento de Agricultura e Abastacimento, Programa de Trabalho. Recife.

APPENDIX III

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