

AGENCY FOR INTERNATIONAL DEVELOPMENT
 WASHINGTON, D. C. 20523
 BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

Batch 64

1. SUBJECT CLASSIFICATION	A. PRIMARY Food production and nutrition	AA50-0000-0000
	B. SECONDARY Research	

2. TITLE AND SUBTITLE
 Final report; CGIAR (Consultative Group on International Agricultural Research) Review Committee

3. AUTHOR(S)
 (101) CGIAR

4. DOCUMENT DATE 1976	5. NUMBER OF PAGES 256p.	6. ARC NUMBER ARC
--------------------------	-----------------------------	----------------------

7. REFERENCE ORGANIZATION NAME AND ADDRESS
 AID/TA

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
 (In CGIAR RevCom 3)

9. ABSTRACT

The Consultative Group on International Agricultural Research (CGIAR) was established in 1971 to stimulate and coordinate research for increasing the production of food in less developed countries. CGIAR currently receives \$70 million per year from 28 donor organizations, including the Ford and Rockefeller Foundations, and distributes it among 17 international research centers and other organizations in as many countries. In 1975 the CGIAR established a review committee to assess its activities and recommend its future role in promoting research for the development of agriculture in developing countries. This report presents the results of the review committee's work, along with 22 recommendations. These include: The current focus of the CGIAR on research on foods widely consumed in the developing world is appropriate. The CGIAR could assist in analyses of key issues by organizing forums. No major additional financial commitments should be undertaken by CGIAR for the next three years. CGIAR-supported research centers should continue to develop their cooperation with national programs, insofar as this is essential to accomplish their research mandate. All support to a center other than that provided through the CGIAR should be classified as extra-core funding. A proposal for such a new project should be forwarded for review by the CGIAR Technical Advisory Committee when there is a question whether the activity lies within the center's mandate or whether it might put undue strain on center management or might have implications for future core support.

10. CONTROL NUMBER PN-AIE-143	11. PRICE OF DOCUMENT
12. DESCRIPTIONS Cooperation Development Organizations Technical assistance	13. PROJECT NUMBER
	14. CONTRACT NUMBER AID/TA/AGR
	15. TYPE OF DOCUMENT

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

Final Report
CGIAR Review Committee
October 1976
Washington, D.C.

CGIAR RevCom 3

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

1818 H St., N.W. Washington, D.C. 20433 U.S.A.
Telephone (Area Code 202) 477-3592
Cable Address - INTBAFRAD

TO: Members of the Consultative Group on International Agricultural Research

The Consultative Group on International Agricultural Research was established in 1971, and since that time has experienced dramatic growth in terms of membership, the size and number of activities supported by it, and the resources provided by its members to fund them. In 1975 the Group decided to review the scope of its activities and the programs supported by it so as to plan its future role in promoting research for the development of agriculture, particularly food production, in developing countries.

A Review Committee was established to carry out this task. The Committee members, fifteen altogether including their chairman, each serving in his individual capacity, were chosen for their understanding and experience of the various aspects of the CGIAR system and the several constituencies--developing countries, research centers and CG members--served by it. The members were:

Warren C. Baum, Chairman of the CGIAR and Vice President,
Projects Staff, World Bank

David E. Bell, Executive Vice-President, The Ford
Foundation

Dieter F. R. Bommer, Assistant Director-General,
Agriculture Department, FAO

Sir John Crawford, Chancellor of the Australian
National University, Chairman of TAC

Ralph W. Cummings, Director of ICRISAT

*Robert K. Cunningham, Principal Agricultural Research
Adviser, Ministry of Overseas Development, United
Kingdom

Gerrit de Bakker, Permanent Representative of the
Kingdom of the Netherlands to the Food and Agriculture
Organization and the World Food Program

*Dr. Cunningham was unable to attend the final meeting of the Committee.
His place was taken by W. Denis Maniece, Ministry of Overseas Development.

Curtis Farrar, Assistant Administrator for Technical Assistance, United States Agency for International Development

W. David Hopper, President, International Development Research Centre, Canada

Hidetsugu Ishikura, Director-General, Japan Marine Science and Technical Center

William T. Mashler, Senior Director, Division for Global and Inter-Regional Projects, United Nations Development Programme

Hussein Mirheydar, Deputy Minister, Ministry of Agriculture and Natural Resources, Iran

Armando Samper, former Chairman of the Board, Centro Internacional de Agricultura Tropical, Colombia

Bukar Shaib, former Chairman of the Board, International Institute of Tropical Agriculture; Permanent Secretary, Federal Ministry of Water Resources, Nigeria

Alfred Wolf, Program Adviser to the President, Inter-American Development Bank.

To serve the Committee as staff, a four-man Study Team was appointed. It began its work early this year and, with the issuance of this report, completed its task at the end of September. Members of this Study Team were:

Dr. Alex McCalla, Study Director
Professor of Agricultural Economics,
University of California at Davis

Dr. Ewert Åberg
Professor, Department of Plant Husbandry,
Agricultural College of Sweden
Uppsala
Sweden

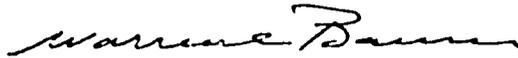
Dr. James McWilliam
Professor and Head of the Department of
Agronomy and Soil Science,
University of New England, Australia

Dr. Arthur Mosher, formerly President of
the Agricultural Development Council (ADC)
and now consultant to ADC.

The terms of reference of the Committee were broadly established by the Consultative Group at its October meeting in 1975, and subsequently refined by the Committee itself. They are set out in the introduction to this report.

This is the report of the Review Committee--which accepts full responsibility for it--but it is very much the outcome of the work of the Study Team. We of the Committee are heavily indebted to the Study Team for their untiring efforts and sound advice. Purposely, they were selected from outside the CGIAR system. In the short time available for their task, they have acquired a comprehensive understanding of the system and a firm grasp of its aims and problems. The Committee has been served outstandingly well.

On behalf of the Review Committee, I herewith transmit to the Consultative Group the report of the Committee.



Warren C. Baum
Chairman

October 1976

CONTENTS

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS	i
Context and Background	i
Conclusions and Recommendations	ii
Scope of the CGIAR	ii
Center Issues	v
CGIAR Planning, Evaluation, Allocation and Management	x
INTRODUCTION	1
PART A. CONTEXT AND BACKGROUND OF ISSUES	5
I. THE WORLD FOOD PROBLEM TO 1985 AND 2000 A.D.	5
II. NECESSARY AND SUFFICIENT CONDITIONS FOR EXPANDING FOOD OUTPUT	13
Technical Ceilings, Economic Ceilings, and Achievement Distributions	13
Conditions for Agricultural Growth	15
The Theory of Induced Innovation	18
III. SOME IMPORTANT CHARACTERISTICS OF AGRICULTURAL RESEARCH AND ITS ADMINISTRATIVE NEEDS	19
Some Characteristics of Agricultural Research	19
Need for an Appropriate Research Approach	19
Time Lags Between Recognition, Application, and Adoption	19
Uncertainty and Serendipity in Research	20
Character of Research Progress and Expectations	20
Characteristics of a Successful Researcher	20

A Suitable Research Environment	20
Priorities, Planning, Evaluation, and Management	21
IV. AGRICULTURAL RESEARCH ORGANIZATIONS SERVING DEVELOPING COUNTRIES	23
Major Components	23
National Research	23
Regional Research	24
International Research	24
Research in Developed Countries	26
Links and Interaction	26
Sources of Funds and the Deployment of Resources for Agricultural Research in Developing Countries	27
Special Problems in Developing Strong National Agricultural Research Organizations	30
V. THE CGIAR FAMILY OF ACTIVITIES	32
Origin and History of the CGIAR: A Narrative Sketch	32
Objectives of the CGIAR	32
Influences of Its Origin	35
Present CGIAR Activities	35
Evolution of the Research Centers	37
Current Form and Function	39
Arrangements for Financing Centers	39
The Technical Advisory Committee	41
Fiscal History of the CGIAR Family of Activities	43
Growth of Center Expenditures: 1972-1977	43
Trends in Donor Contributions: 1972-1976	44

PART B. ISSUES AND CONCLUSIONS	57
VI. SCOPE AND BOUNDARIES OF THE CGIAR	58
Geographic and Commodity Focus of the CGIAR	58
Types of CGIAR Activities	61
Modes of Operation in Research and Technology Development	63
Centers	63
Consortia (Networks)	64
Direct Support of National Programs	65
Interfaces with Other Agencies	65
Financial Magnitude of CGIAR Program	66
Procedures for Future Decisions about New Programs	66
Projection of Costs Under Alternative Assumptions	67
Future Funding Potential	71
VII. SCOPE, BOUNDARIES, AND MANAGEMENT OF CENTERS	75
Concept of a Fully Integrated Program	75
Program Complementarity and Balance	76
Cooperation with National Programs	79
Interaction with Advanced Research Institutions	83
Multiple Sources of Funding	84
Desirable Size of Centers	86
Longevity of Individual Research Programs	87
Forward Planning and Program Development	88
Interaction Among Centers	89

Boards of Trustees	91
Staffing Issues	92
VIII. PLANNING, EVALUATION, ALLOCATION AND MANAGEMENT FOR THE CGIAR AND ITS FAMILY OF ACTIVITIES	95
Structure of the CGIAR	95
Evaluation and Long-Range Planning	96
Mechanisms for Budget Planning and Development	98
Mechanisms for Budget Allocation, Including Distribution of Shortfalls	100
Technical and Management Needs	102
ANNEX 1: Questions in Staff Papers 2 and 3 with Responses	
ANNEX 2: List of People Interviewed	
ANNEX 3: "World Food Needs: Food Gaps and Performance," N.M. Koffsky	
ANNEX 4: "Priorities for International Support to Agricultural Research in Developing Countries," TAC Secretariat	

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of a review of the Consultative Group on International Agricultural Research (CGIAR) and its family of activities. The review was conducted by an ad hoc committee with staff assistance provided by a study team. The report is in two parts. This section presents a summary of Part A of the report and the conclusions and recommendations resulting from the analysis in Part B of the report. The problem setting, the analysis and more complete conclusions are presented in the main body of the report.

CONTEXT AND BACKGROUND

Part A of this report concludes, on the evidence of the Koffsky^{1/} findings and other analyses of the world food needs, that there is an urgent need to increase food production in those developing countries where large food shortages threaten over the next decade and beyond.

Agricultural research represents only one of the important approaches among the universe of activities that are necessarily involved in expanding food production. It represents the most important way of raising the technical ceiling, but alone is not a sufficient means of meeting the world's food problem as there are many other interacting factors involved.

With respect to agricultural research, it is important to recognize the highly interactive and dynamic nature of the problem and the desirability of adopting an interdisciplinary approach. Goals must

1/ See Annex 3.

be defined clearly and a sufficient degree of freedom and independence allowed in choosing them and the approaches to be used in solving the associated problems.

The present status of international agricultural research is characterized by the diversity of organizations and funding sources involved including national and regional organizations and bilateral donors and by the wide scope of their activities. The International centers and other activities supported through the CGIAR represent only a small component of this effort, but although the scope of their activity may be limited, they are of great significance.

There is a high degree of complementarity between the centers' research and that of other agencies in the field. The centers face pressures and inducements to become involved in a wider range of activities such as technology transfer and extension. However, we support the view that the centers should continue to concentrate on what they do best and should not try to do too much.

Finally the development and fiscal history of the CGIAR were reviewed. The important observations are that the Group is still only five years old and is developing rapidly both in the number of activities it supports and in terms of its financial needs. Five relatively new centers will not be completed and staffed for several years and the four oldest centers are still evolving.

CONCLUSIONS AND RECOMMENDATIONS

SCOPE OF THE CGIAR

It is against this background that the future need for and scope of the CGIAR is analyzed. There is need for increased efforts to improve

world food production. Research will continue to play a crucial role. Therefore the CGIAR is an important element in that process and will continue to be needed for the foreseeable future. The CGIAR currently focuses on research and technology development related to food commodities which are widely consumed in the developing world. We conclude that the focus is appropriate and that the commodity coverage is broad, though obviously not fully inclusive of all needs. This focus should be continued and the CGIAR should be cautious about assuming responsibility for major new activities, such as direct support of extension efforts or national programs. Many of the centers, as well as the CGIAR itself, are still in the formative stages and there is need to bring existing centers to maturity and to limit the administrative load on the CGIAR.

We do believe, however, that the CGIAR could make a useful contribution to better articulation of its and others' efforts if it were to engage in analysis of key issues and promote the exchange of information by organizing fora under its auspices.

We have analyzed potential costs of current activities supported through the CGIAR for the next five years under alternative assumptions. Costs will continue to grow, though at a less rapid rate than in the past, provided no new major financial commitments are undertaken. This analysis, coupled with a review of potential fund availability, suggests that the rate of cost increase for the next few years necessarily must be moderate.

We therefore conclude for all of these reasons -- the appropriateness of the current focus, the need to bring centers to maturity, the potential limitations on the administrative capacity of an informal

organization such as the CGIAR and financial realities -- that the next three years should be considered as a period of consolidation. However, during that period TAC should continue to explore needs for modifications in existing programs and for potential new programs, and should make such recommendations to the group as it seems appropriate.

The following recommendations are based on this analysis and the conclusions resulting therefrom.

Recommendation 1: *The need for a sustained research effort to increase food availability in developing countries will continue and is likely to increase. Therefore, we recommend that the Consultative Group on International Agricultural Research proceed on the basis that it should continue to function for the foreseeable future (pp. 58-60).*

Recommendation 2: *We recommend that the CGIAR should continue to endorse TAC's conclusion that the primary focus of the CGIAR should be to support research and technology development that can potentially increase food production in the food-deficit countries of the world. The research activities supported by the CGIAR are appropriately focused on food commodities which are widely consumed and collectively represent the majority of the food sources of the developing world and no major changes or additions are called for at this time (pp. 61-63).*

Recommendation 3: *We recommend that the next three years should be viewed by the CGIAR as a period of consolidation. During this period continued support should be provided for the current set of centers and related activities. We caution against undertaking initiatives requiring major financial commitments. TAC should continue during this period of*

consolidation to explore the need for new initiatives and changes in existing programs (pp. 61-74).

Recommendation 4: *In addition to the current practice of receiving reports from related activities such as IFDC, IFPRI, AVRDC, and CGFPI, we recommend that the CGIAR should support fora for information exchange among members of the Group, technical personnel from their agencies, centers, other aid agencies and national programs in developing countries. In this connection the CGIAR should consider two specific activities (1) commissioning papers as a basis for discussions of CGIAR issues of interest to donors and research beneficiaries and (2) explicitly seeking to foster increased information exchange among CGIAR donors and related agencies about other activities in which they are jointly involved (pp. 61-63).*

CENTER ISSUES

Scope, Balance and Boundaries of Center Programs

The research program of a center or related activity should achieve a functional balance between the major program thrusts. For most centers these include commodity research, often framed within a systems approach, cooperation with national programs in LDC's in both commodity and socioeconomic research, other off-campus activities involving interactions with advanced research institutions, training, and conferences. These components are interdependent and it is essential that all the projects undertaken by centers be regarded as components of their total integrated program.

A number of factors can potentially distort the balance and integration of components of the program. One of these is cooperation with

national programs (formerly known as outreach). Although this cooperation is a vital component of the research mandate of all centers, the demand on the centers to help strengthen national programs throughout the developing world greatly exceeds the capacity of the system to respond. Extensive involvement can distract a center from its primary research mission and place an undue burden on center management. Another factor is the existence of two sources of funds for center programs, one derived under the aegis of the CGIAR and the other from independent bilateral contributions. This has led to the practice of identifying programs by the source of funds which can have a divisive effect on center programs. Our conclusion is that these influences can be contained by adopting appropriate boundaries for cooperative work with national programs and implementing the concept of an integrated program. The entire program should be covered by the centers' program and budget papers and subject to general review procedures adopted by the CGIAR. To achieve appropriate program balance and integration we make these recommendations.

Recommendation 5: *We recommend that all projects undertaken by a center be regarded as components of its total integrated program regardless of sources of funds and that the entire program be subject to the review procedure as outlined in this report (pp. 75-76).*

Recommendation 6: *We recommend that each center develop an objective set of criteria for program choice and periodically reassess the balance of its program with respect to: (1) research and technology development, (2) training, (3) cooperation with national programs and advanced research institutions; and (4) communication and exchange of information*

between center scientists and others in related fields (pp. 76-79).

Recommendation 7: *We recommend that centers continue to develop and strengthen their cooperation with national programs, insofar as this is essential to accomplish their research mandate. Beyond this centers should remain alert and responsive to additional opportunities for cooperation to the extent that extra-core funds are available, that these activities do not compromise or distort the central research mission of the center and that they are within the centers' capacity to staff and manage (pp. 79-84).*

Recommendation 8: *We recommend that all support to a center other than that provided through the CGIAR be classified as extra-core funding. Further, we recommend that these funds be used to supplement activities supported by core funds and/or to finance activities that the center may wish to undertake primarily to benefit a particular country (pp. 84-86).*

Recommendation 9: *We recommend that any proposal for a new project to be supported by extra-core funds should be forwarded by the center to TAC for review when (1) there is a question as to whether the purpose of the activity lies within the center's mandate, (2) acceptance has implications for future core support, (3) the proposed activity might put undue additional strain on center management, or (4) the extra-core funding is particularly large (pp. 84-86).*

Recommendation 10: *We recommend that all centers develop more effective forward research program planning procedures and include as advisors international scientists with competence in the appropriate areas (pp. 88-89).*

Inter-center Relationships

As centers become more active in cooperating with research agencies in developing countries, opportunities for inter-center collaboration have increased. This is highly desirable and will enhance the effectiveness of the centers' programs and enlarge the impact of their technology in these countries. Because a number of these centers work with the same commodity and have interests in the same regions of the developing world, it is important that they avoid competition. To this end, the special strengths that centers may have in particular activities or commodities and their location in relation to the target areas should be taken into consideration in developing formal agreements between the centers concerned.

We believe that the initiative to develop such linkages and the fiscal and administrative arrangements are a matter for the center director and the respective boards of trustees. TAC and the CGIAR should be available to assist in resolving disputes should this be necessary.

Recommendation 11: *We recommend that centers should be encouraged to collaborate wherever possible in executing their cooperative research activities with national programs when working in the same region or with the same commodity. The negotiation and administration of these linkages should be the responsibility of center directors and the respective boards of trustees. TAC or the CGIAR should serve only to advise and assist in reaching a solution in the case of disputes that cannot be resolved by the centers. Further, we recommend that agreements and arrangements between centers be formally recorded in writing and a copy of all such agreements be sent to the CGIAR Secretariat (pp. 89-90).*

Center Management

The board of trustees perform a valuable role in conjunction with the director and his staff in developing and reviewing the programs and budgets of the centers. They are an essential element in the maintenance of the quality and independence of the centers.

To preserve the high caliber of board membership, we conclude that boards should define their own criteria for the selection and appointment of board members and that these should contain provision for: balanced representation of expertise in relevant fields, openness and vitality of boards, and for expanded efforts to broaden the search for new members, including more active participation by donors.

In relation to staffing issues, the reputation and success of the CGIAR and the individual centers is largely a reflection of the caliber and performance of the scientific staff. Every effort should be made to maintain staff vitality through sound leadership, regular contact with scientists in similar fields, increased opportunities to publish and enlightened personnel policies. Further, recruitment policies should be more open and every effort made to identify new staff from the widest possible cross section of potential applicants. With these issues in mind, the following recommendations are made.

Recommendation 12: *We recommend that each board of trustees define criteria and procedures for the selection and appointment of its own members and that these be made available to the CGIAR. Further, we recommend that each board of trustees broaden its membership by including, when appropriate and consistent with national laws, three members selected in conjunction with and ratified by the CGIAR (pp. 21-22).*

Recommendation 13: *Since quality of the staff is a central factor in the success of the program, we recommend that: (1) center directors advertise as widely and openly as possible in seeking candidates for staff positions, (2) every effort be made to maintain staff vitality, and (3) outposted staff receive the same sabbatical privileges as staff posted at headquarters regardless of source of funds supporting the scientist (pp. 92-94).*

CGIAR PLANNING, EVALUATION, ALLOCATION AND MANAGEMENT

Long Range Planning and Evaluation

Every effort should be made to retain the present informal character of the CGIAR and the activities it supports. These characteristics include: the consultative nature of the CGIAR, membership mainly comprised of donors, the right of each donor to designate how its contribution is to be used, the support of independent research centers and related activities, and minimum bureaucratic structure.

TAC should continue to play a major role in providing the CGIAR with advice about future needs as well as evaluating ongoing activities. TAC's responsibility should include quinquennial reviews, across center analysis of particular topics (stripe analysis), and periodic reassessment of CGIAR priorities.

We also conclude that the CGIAR is a highly dynamic entity. The centers and related activities supported by the CGIAR will continue to mature, national research programs will increase their own capacities and research needs will change. Therefore, the program and procedures of the CGIAR should be reviewed frequently.

Because of the dynamic nature of the CGIAR, we have made specific recommendations only for the next three to five years. Beyond that we present possible criteria to use in making future judgments and recommend a mechanism for periodic evaluation.

The following recommendations provide additional specific mechanisms needed for long range planning and evaluation of the CGIAR.

Recommendation 14: *We recommend that the CGIAR review its overall program and operation every three to five years. The CGIAR should appoint an ad hoc committee to conduct a review of the substantive program of the CGIAR as well as review those policies, procedures, and management mechanisms which require attention. TAC should provide a major input into this long term forward look at the substantive program (pp. 96-98).*

Recommendation 15: *We recommend continuation of the TAC quinquennial reviews for evaluation of scientific quality, scope, and balance of current programs, and to evaluate future plans, including explicit review of center proposals to continue projects of long standing. We also recommend that the TAC give greater emphasis to periodic, across center analysis of particular topics (stripe analysis) (p. 98-99).*

Mechanism for Budget Planning and Development

The character of the CGIAR and of the centers and related activities, respectively, poses a problem for planning and coordinating financial needs and fund availability. There are several elements in the problem: (1) the annual budgets of centers and related activities are developed with few guidelines and contain projections of variable quality with respect to future programs, directions, and financial needs; (2) a large number of

independent donors who contribute to centers on an annual basis leading to potential funding instability; (3) there is no mechanism to manage the situation when total donor resources fall short of center requests; and (4) integrated program and fiscal analysis is not carried out.

Part of the solution to this problem lies in limiting the number and size of CGIAR supported activities primarily for program rather than financial reasons. Another part of the solution lies in (1) combining program and budget reviews more completely and (2) making more realistic projections so that both centers and donor-members of the CGIAR may be able to plan ahead.

We conclude that annual budgeting and the lack of effective forward planning of budget needs is potentially a serious problem. We further conclude that one way to increase the stability of future funding is to develop a mechanism for improving forward budget planning for centers. Because of the interdisciplinary mode of centers, the need to maintain a sharp focus on the primary mission of the center, and because of potential financial constraints, we conclude that there is a desirable size range for centers. Each center should be requested to propose a desired size (in terms of number of senior scientists and total budget) and then use this as a central element in developing its future plans.

We conclude that biennial budgets, with an additional two year indicative plan which emphasizes staff needs, major proposed program changes and capital requirements, should be prepared by centers. TAC should review the indicative plans and recommend to the CGIAR reasonable program growth patterns for each center. These growth patterns would then become guidelines for future budget development.

In the process of reviewing these biennial budgets and the additional two-year indicative plans, TAC would be in a position to comment on current programs. These conclusions lead to the following recommendations.

Recommendation 16: We recommend that the concept of a desirable size range for centers be adopted. We further recommend that centers be asked to propose their desired size based on the number of senior scientists translated into financial terms. Until these plans are developed, we recommend that any proposed increase in senior staff numbers that would take centers above the size of the largest existing centers should be closely scrutinized (pp. 86-87 and 98-100).

Recommendation 17: We recommend that a biennial budget cycle be adopted for centers and related activities. In addition, a further indicative plan for the two years beyond the biennium should be developed. These budgets and indicative plans to be developed by centers should be consistent with their proposed desired size (pp. 98-100).

Recommendation 18: We recommend that the desired size and indicative plan proposals from centers be reviewed by TAC. TAC should make appropriate recommendations to the CGIAR, after the discussion of any proposed adjustments with the centers. The CGIAR approved plans would then form the guidelines for the preparation of the center's next biennial budget. Until this process is in operation, centers should recognize that proposals for budget increases will be reviewed very carefully in the spirit of our recommended period of consolidation (pp. 98-100).

Mechanism for Budget Allocation

These budgets and indicative plans would greatly enhance the information available to donors about the future financial magnitude of CGIAR needs. Parallel with longer horizons in center planning, we conclude that donors should be encouraged to expand the time horizon of their own commitments by agreeing on several guidelines regarding their own behavior.

It is our judgment that, if forward planning by centers and longer potential obligations by donors are possible, the likelihood of serious annual shortfalls will be minimized. However, the possibility of such shortfalls is not fully eliminated. We therefore conclude, that a standby committee of the CGIAR should be available to advise the group if shortfalls appear imminent.

Recommendation 19: *We recommend that within the framework of the following guidelines, donor autonomy be preserved and that center budgets result from the sum of independent donor decisions. The guidelines are: (1) donors be encouraged to increase the flexibility of their pledges, (2) donors be encouraged to continue support for a reasonable period of time to allow centers to produce research results, (3) donors be encouraged to precede any substantial reduction in support by two years' notice, (4) that donors agree to cooperate to assure that no center or other CGIAR supported activity receives greater support than its budget request, including supplemental requests, and (5) donor(s) of last resort fund a center that is seriously underfunded, but if that situation continues for two or three years the future of the center should be reviewed by the CGIAR (pp. 100-101).*

Recommendation 20: *We recommend that a standby committee of the CGIAR be authorized. Its membership should include the chairman of the TAC and the executive secretary. We suggest the committee stand ready to advise on how the Group should deal with significant shortfalls in funding. The committee could also be activated by the CGIAR or the Chairman of the CGIAR for advice should other policy issues or circumstances arise (pp. 101-102).*

Budget Analysis and Management

Regardless of whether shortfalls occur there needs to be more integrated program and budget analysis of current budget proposals. This should be provided by closer coordination of the TAC and CGIAR Secretariats. An assurance is needed that adequate budget and staff are available to do the job. The independence, integrity and effectiveness of these secretariats are essential to donors in justifying continued support to the CGIAR.

Finally, we comment on the seriousness of the cash flow problem in certain centers. The obvious solution is for donors to make greater efforts to provide their contributions to centers and related activities as early in the fiscal year as possible.

Recommendation 21: *We recommend that steps be taken to ensure closer coordination between the TAC and CGIAR secretariats to enable them to jointly produce integrated program and budget analysis for the CGIAR. Certain additional points of organization and procedure should be agreed upon:*

- (1) *Adequate staff and financial resources must be provided for the work of each of the secretariats.*

- (2) *The co-sponsors should report to the Group at its July meeting on the budgets of the secretariats for the coming year. If sufficient resources cannot be provided by them, donors should be asked to make additional funds available.*
- (3) *Each secretariat should recognize that it reports only to the Group, through its respective chairman.*

We further recommend that the co-sponsors report to the Group at the forthcoming meeting (October 1976) whether they foresee any difficulty in meeting these considerations (pp. 102-103).

Recommendation 22: We recommend that donors be strongly encouraged to provide their pledged funds as early in the fiscal year as possible. Further, we recommend that the CGIAR Secretariat provide donors and centers with a time schedule of center budgetary needs and availability of donors' funds. If these two mechanisms do not solve the cash flow problem, we recommend that the World Bank explore alternative solutions (pp. 103-104).

INTRODUCTION

The Consultative Group on International Agricultural Research (CGIAR) was founded in 1971 partly to facilitate adequate funding for the International Agricultural Research Centers launched earlier by the Rockefeller and Ford Foundations and partly to consider establishing additional and/or other international agricultural research activities.

There were four International Centers in existence in 1971. The new CGIAR soon decided to add five more; by 1976 there were a total of nine such centers although all are not yet operating. In addition, certain other activities, e.g., WARDA, CARIS, were supported by the CGIAR. All of these organizations are at various stages of maturity in terms of staff, physical facilities, and program development. In addition to growth in the number of CGIAR supported activities, the number of members of the CGIAR doubled in the same period.

Those developments led to rapidly increasing financial requirements and to a question of how long the increasing financial needs could continue to be fully funded. If they could not be, then some rational means of establishing priorities among current and potential research activities (or at least of allocating insufficient funds among established activities) would have to be devised.

Because the CGIAR is five years old; because it has grown at a rapid rate, both monetarily and organizationally, and because it has increased in complexity and has been called upon to contribute more support toward the solution of the food problem, it seemed appropriate to re-examine its scope and direction.

Thus in October 1975, the CGIAR began a review of its future role by establishing a Review Committee which in turn selected a four person study team to assist in this analysis. The Review Committee adopted the following Terms of Reference. This document is formulated around issues raised in the Terms of Reference.

Final Terms of Reference 1/

I. The committee will review available projections until the year 2000 A.D. of probable production of major food commodities, and trends in economic demand and in nutritional needs, especially in the areas most severely pressed. It will also review existing expert opinion as to rates of yield and production **increase** that are considered feasible over the next 10 years as a result of research and its application.

1/ Approved by the CGIAR Review Committee, March 18, 1976.

II. The Committee will review available information on the effort devoted to, and the objectives and promise of, major research programs already in progress that are relevant to the principal food crops, animal products, and related farming systems.

III. In the light of information obtained from I and II the Committee will review existing expert opinion as to needs for expanded applied and basic research relevant to the principal food crops, animal products and related farming systems noting particularly those areas of research that could appropriately be undertaken either by international centers or through other activities cooperatively financed by members of the CGIAR.

IV. Having regard to the existing and prospective state of development of national research and extension efforts in the LDCs, the Committee will suggest appropriate boundaries for the responsibilities of the Centers with respect to their own research programs, collaborative research with the developed countries, training, strengthening national research programs, facilitating the effective transfer of technology to beneficiary countries and its use there.

V. The Committee will suggest boundaries for the activities and responsibilities of the CGIAR itself with respect to the international Centers, other forms of CGIAR international agricultural research programs, national research and production programs and/or other activities in which various groupings of its members may have a common interest.

VI. The Committee will examine the statements of priorities recommended by the TAC, and consider whether it wishes to suggest any change in those priorities for CGIAR activities. It may, in addition, suggest special priorities and/or an overall size for the Centers, individually or collectively, for the next five years.

VII. The Committee will estimate the level of financing required by the international Centers and other CGIAR-supported activities over the next five years based on different assumptions with respect to programs. It will seek to ascertain the likelihood of availability of funds for the system as a whole under those program assumptions. If a shortfall seems likely it will recommend mechanisms, including means of establishing priorities among programs, for bringing resources and program needs into balance, should that become necessary.

VIII. The Committee will consider what measures may be necessary and practicable to insure that manpower and money devoted

to the CGIAR's international research are efficiently used. It may also suggest ways in which the procedures of the CGIAR, the TAC, and the Centers may need to be modified either individually or in relation to each other.

Scope of the Report

The report focuses primarily on issues of future possible scopes, mechanisms, and magnitudes of the CGIAR and of its activities.

As a necessary background for future analysis, Part A presents information against which the issues discussed in Part B can be considered. This background includes: (1) a summary review of projected world food needs, (2) a review of the potential contribution of research in meeting those needs, (3) a review of the character and nature of agricultural research, (4) a description of current research efforts addressing the food problem especially in developing countries, and (5) a review of the evolution of the CGIAR and of its current activities. Thus Part A attempts to set in perspective the current situation of the CGIAR.

The report then considers three major issues in Part B. These issues are: (1) the future scope and boundaries of the CGIAR including some indication of the cost of different options; (2) the scope and boundaries of individual CGIAR activities (centers, etc.); and (3) mechanisms for planning, evaluation, allocation, and management.

It is also appropriate to state what the report does not attempt. It is not a review of the scientific content and quality of current CGIAR activities, nor does it attempt to make judgments about future program emphases. It is not a full-scale independent review of the world food situation nor a review of all research devoted to agricultural production. Finally, it is not an evaluation of the effective scope of national research programs.

More information about the work sponsored by the CGIAR (the purpose, function, and operation) can be obtained in International Research in Agriculture published by the Consultative Group on International Agricultural Research.

Method of Approach

Donor-members of the CGIAR, center directors and board chairmen of centers were interviewed on the range of issues contained in the Terms of Reference. As a prelude to those interviews, two documents

labeled Staff Paper 2, "Questions for CGIAR Members" and Staff Paper 3, "Questions for Centers and Their Boards" were prepared. Questions outlined in these papers along with brief summaries of responses are attached as Annex 1. These interviews included visits to the eight existing centers and some of the other CGIAR supported operations. The opinion of 26 donors was sought. In addition, several other people knowledgeable about the CGIAR were interviewed. These interviews were conducted in most cases by at least two members of the Study Team selected by the Review Committee. A list of the people interviewed is attached as Annex 2.

A paper on world food needs was commissioned. The paper prepared by Nathan Koffsky titled "World Food Needs: Food Gaps and Performance" is included as Annex 3. It has formed the basis for Chapter I.

Many documents related to the issues addressed in this report, including the TAC priorities paper (Annex 4), were extensively reviewed.

PART A. CONTEXT AND BACKGROUND OF ISSUES

I. THE WORLD FOOD PROBLEM TO 1985 AND 2000 A.D.

The CGIAR grew out of concern about the world food problem, especially as it affects people in the less developed, low income countries. Nathan M. Koffsky was commissioned to summarize the current magnitude and character of the problem in "World Food Needs: Food Gaps and Performance"; a copy is annexed to this report. 1/ This chapter is based primarily on the Koffsky paper.

Despite the gains in productivity that have been made in recent years, the problem is growing, and with expected increases in population levels, it seems likely to grow still more. If recent production and yield trends were to continue, the deficit in cereal production in Asia, Africa, and much of Latin America is likely to rise from about 17 million metric tons in 1969-71 to between 65 million and 83 million tons in 1985-86; and it might grow by another 30 to 35 million tons by 2000 A.D. Similar increases in deficits are likely in root and tuber crops, and grain legumes.

Those projections alone are sufficient to call for intensified efforts to increase farm production.

Global and aggregate figures similar to those just cited are insufficient as a guide to action. To formulate guidelines, a clearer picture of current production, potential increases in production, specific food commodities needs, by countries or geographically associated groups of countries are needed.

Such a breakdown is depicted in visual terms in Chart I-1 on the next page which portrays in juxtaposition (a) the percentage of cropland devoted to each major crop in 1974, by country or groups of countries; and (b) the projected 1985 population of each country or group of countries. The width of each vertical band is proportional to the percentage of cropland devoted to each crop. The width of each horizontal band is proportional to the projected 1985 population of each country or group of countries. As a consequence, the chart shows the location in which each crop is important, its importance in terms of the number of people affected, and its relative importance among major crops in each region.

1/ Some of the studies used by Koffsky in preparing his paper were conducted by the U.S. Department of Agriculture, the Food and Agriculture Organization of the U.N., and the International Food Policy Research Institute.

Chart I-1

Source: Nathan M. Koffsky, "World Food Needs; Food Gaps and Performances," prepared for CGIAR Review Committee Study Team (Washington, D.C., May, 1976).

Regions, scaled by projected 1985 populations		Relative Importance of Food Crops in Acreages by Regions in 1974												
LOW INCOME REGIONS	India	Rice Wheat Maize Sorghum Millets B Pulses C												
	Sub-Sahara; Low Income	R	Ma	S	Mi	C	Po	SP	Y	Pu	G			
	Indonesia	R				Ma			C	SP	Pu	G		
	Bangladesh	R											SP	G
	Nigeria	S		Mi			C	Y	Pu			SP	G	
	Other Low Income, Asia	R							Ma	SP	Pu	G		
	North Africa/Middle East	R	W			Ma	S	Mi	B			SP	Pu	G
MIDDLE INCOME REGIONS	South America	R	W		Ma			B	C	Po	Pu	G		
	Mexico	W	Ma					S		Pu		S	B	
	Sub-Sahara, high income	R	Ma	S	Mi	C	Po	SP	Pu	G				
	Philippines	R				Ma					C	SP	Pu	
	Central America/Caribbean	R	Ma				S	Mi	C	SP	Pu	G		
	Turkey	W			Ma		S	Mi	C	SP	Pu	G		
	N. Africa/Middle East, non-OPEC	W			B				Po	Pu	G			
Egypt	R	W			Ma					Po	Pu	G		

Cereals

- R Rice
- W Wheat
- Ma Maize
- S Sorghum
- Mi Millets
- B Barley

Roots and Tubers

- C Cassava
- Po Potatoes
- SP Sweet Potatoes
- Y Yams

Grain Legumes

- Pu Pulses
- SB Soybeans
- G Groundnuts

The coverage of countries in Chart I-1 is limited in three ways. First, only low income countries with a GNP per capita of under \$200 and middle income countries with a GNP per capita of \$200 to \$400 are listed. Second, it is further limited to those regions faced with food deficits and foreign exchange constraints, thereby eliminating OPEC countries and a few others like Korea, Taiwan, Malaysia, Thailand, and Pakistan, that are predicted to be food exporters by 1985. Third, only countries having market economies are included. The Peoples Republic of China and other Asian centrally planned economies are, therefore, omitted. Even with these omissions, the chart includes the countries about which the CGIAR has been, and needs to be most concerned. For example, by 1985 it is projected that 40 percent of all the people in the low and middle income countries will be in India.

Current acreages in major food crops in India consist of 30 percent in rice, 15 percent in wheat, 5 percent in maize, 14 percent in sorghum, 15 percent in millet, 2 percent in barley, 18 percent in pulses and 1 percent in groundnuts. No root or tuber crop occupies as much as 1 percent of India's acreage in major food crops. In contrast, in low income countries in sub-Saharan Africa, 53 percent of the acreage is in maize, sorghum or millet, and 11 percent is in cassava (see Table I-1).

Both Chart I-1 and Table I-1 reflect the predominant importance of cereals in the diets of the low and middle income countries covered in Koffsky's review; neither refers to animal products as a foodstuff in those countries. Those, however, are covered in a table in Koffsky's paper, which is reproduced as Table I-2.

In Table I-2 it will be noted that the percentage of calories derived from meat and eggs is particularly low in all Asian, low income countries and in Nigeria. A relatively greater consumption of milk and milk products in the Indian subcontinent and Nigeria slightly increases this percentage.

The prospects for meeting the food gaps by 1985 or 2000 A.D. are not bright. Those projections assume that production trends of the recent past of 2 percent to 3 percent per year will continue. Those rates are similar to rates achieved in developed countries. It has been estimated that to close the gap by the year 2000 would require maintaining a growth rate of 4 percent to 4.5 percent, a rate that has never been achieved in the past, except for a brief period, in South Korea. 1/

Current information suggests that substantial increases are most likely in the yields of maize, sorghum, millets, and cassava 2/ in the near future if research in these areas is continued and perhaps

1/ "Meeting Food Needs in the Developing World: The Location and Magnitude of the Task in the Next Decade," Research Report No. 1, International Food Policy Research Institute (Washington, D.C., February, 1976).

2/ Cassava also has propagation problems, but its use is largely restricted to two major continents, South America and Africa.

Table I-1

Percentages of Total Food Crop Acres, by Major Crops

Country Grouping	Cereals						Roots and Tubers				Grain Legumes		
	Rice	Wheat	Maize	Sorghum	Millet	Barley	Cassava	Potatoes	Sweet Potatoes	Yams	Pulses	Soy Beans	Groundnuts
LOW INCOME:													
India	30	15	5	14	15	2					18		1
Sub-Sahara Africa	9		22	12	19		11	1	3	1	14		8
Indonesia	59		20				10		2		4		5
Bangladesh	95							1	1		3		
Nigeria				30	26		5			7	24	1	6
Other Asian	77		7				1	1	1		6		7
N. Africa/Middle East (non-OPEC)	2	50	7	9	4	19	1	1			4		3
MIDDLE INCOME:													
South America	12	24	29			8	5	10			10		2
Mexico		7	65	10							16	2	
Sub-Sahara Africa	6		24	7	20		14	2	3		6		18
Philippines	53		42				2		2		1		
Central America/ Caribbean	15		52	7	7		4		1		12		2
Turkey		68	5			21			1		5		
North Africa/Middle East (non-OPEC)		53				36			1		10		
Egypt	25	30	34						2		8		1

Source: Derived from Nathan M. Koffsky, "World Food Needs: Food Gaps and Performance," prepared for the CGLAR Review Committee Study Team (Washington, D.C., May, 1976)..

Table I-2

Sources of Calories Consumed Per Capita^{1/} by IFPRI Country Categories

(Percent of Total Consumed)

Country Country/Grouping	Total per capita Calories/per day	Cereals %	Starchy Foods %	Pulses, Nuts, Seeds %	Sugar %	Vegetables %	Fruit %	Meat %	Eggs %	Milk %	Fish %	Oils and Fats %
Food Deficit Low Income												
India	1964	64.4	1.5	10.3	10.3	1.4	1.4	.3	.1	4.0	.2	5.8
Bangladesh	1995	70.9	.9	2.9	8.3	1.4	1.3	.8	.1	6.9	.6	5.9
Indonesia	1760	60.4	19.2	6.9	4.1	.7	1.0	1.1	.2	.1	1.1	4.8
Other Asia	2066	72.7	1.8	6.3	4.8	1.3	1.3	1.3	.3	2.2	1.2	6.3
NA/ME Non-OPEC Low	2071	65.2	9.9	3.9	4.2	1.0	2.0	4.0	.1	4.9	.2	4.6
Nigeria	2166	51.5	30.2	7.1	.8	.4	.6	1.4	.1	.7	.3	6.8
Sub Sahara Low	2133	53.8	22.6	10.0	2.6	.6	.8	3.5	.2	1.7	.5	3.6
Food Deficit Middle Income												
Philippines	1911	62.7	5.6	2.8	9.5	.8	3.8	5.1	.5	1.1	2.7	4.7
Egypt	2639	69.6	1.0	3.1	8.1	2.7	3.3	2.3	.2	2.8	.3	6.6
Turkey	2769	61.9	2.8	5.0	5.8	2.0	5.8	2.7	.3	3.9	.2	9.4
NA/ME Non-OPEC High	2248	60.0	.9	3.6	10.6	1.5	4.1	3.4	.4	3.4	.4	11.6
Sub Sahara High	2208	47.1	30.5	6.3	4.0	.6	1.0	2.6	.1	1.3	1.1	5.3
Mexico	2624	52.0	1.5	8.6	16.0	.3	3.7	5.3	.6	3.7	.2	7.7
Other NA/Carit.	2156	45.9	8.7	6.1	15.8	.8	3.0	4.6	1.2	4.6	.7	7.2
Ecuador	1848	31.3	15.3	7.0	16.0	1.6	6.1	7.7	.4	6.4	.5	7.2
Other Latin America	2302	40.5	12.5	2.7	16.2	1.1	2.6	8.6	.5	6.0	.8	7.6
Food Deficit High Income												
Asia Group High	2329	69.5	7.2	3.3	5.0	1.8	1.6	4.5	.4	.8	1.6	3.8
NA/ME OPEC	2007	63.6	1.7	2.6	11.8	1.2	4.1	3.3	.2	3.3	.1	7.8
Venezuela	2367	37.6	13.4	3.7	15.4	.4	2.0	9.1	.8	6.4	1.6	9.1
Food Exporters												
Pakistan	1995	70.9	.9	2.9	8.3	1.4	1.3	.8	.1	6.9	.6	5.9
Thailand	2226	72.1	3.0	5.8	5.3	.9	3.3	3.7	.7	.8	2.2	1.9
Argentina	2885	34.6	6.2	.8	13.1	1.0	3.0	21.3	.8	7.1	.4	11.3
Brazil	2541	33.9	16.1	12.2	15.8	.4	1.9	8.0	.7	5.3	.5	5.1

^{1/} Computed from Food Balance Sheets 1964-66 FAO, Rome 1971

expanded. Potato yields can be increased, and the range of climates within which they can be grown extended, but due to dependence on vegetative propagation and quarantine restrictions, the rate at which aggregate potato production can increase will be much slower than in the case of cereals.

The food situation will be most severe in the coming decades in low income countries with foreign exchange constraints. It will be less severe in countries that also face food deficits and foreign exchange constraints but are somewhat better off economically. 1/ Domestic food deficits alone need not mean undernourishment if, through international trade, a country can afford to import food. However, there must be enough food produced in the aggregate if global food needs are to be met.

Koffsky's conclusions about global needs have implications for total research priorities. While the present relative importance of different food crops and their geographic distribution are important factors to be considered in research planning, they should not be the sole criterion used to decide which activities the CGIAR should support. Many additional factors should be considered including: use of particular crops in farming systems, other agencies' research programs, and comparative advantage of national research programs versus international research programs. A number of these issues are discussed in subsequent sections of this report.

Koffsky's findings and implications for research: 2/

1. There is a clear case for urgent attention to the needs of the low income countries (i.e., GNP per capita less than \$200) where large food shortfalls threaten over the next decade and beyond. Most importantly, these include India, Bangladesh, Indonesia (probably), Nigeria and most other low income sub-Saharan Africa countries. This group also contains most of the malnourished people in the developing world. Food crop yields are generally low and performance in improving them is poor. This is especially a matter of concern in Asian countries where additional cultivable land is a constraint.

2. Next are those countries, somewhat better off economically and in food production, but which also face substantial food deficits and financial constraints to purchase needed food supplies. These include the rest of the sub-Saharan countries, the non-OPEC North Africa/Middle East countries, the Mid-America/Caribbean group (except Mexico) and the Andean countries of South America, especially Peru and Bolivia.

1/ National averages conceal the fact that substantial differences exist between various segments of the economy.

2/ Koffsky, "World Food Needs."

3. This does not mean that others, where improved crop yields are a major determinant of higher incomes and levels of living should be denied attention. But the major focus should be directed to the groups above if the food problem in developing countries is to be resolved.
4. While attention should continue directed toward improving yields of the major cereals -- rice, wheat and maize -- there is need also for emphasis on millets and sorghum which are associated with the dry land cultivation prevalent in many food deficit countries. The same is true for root crops and for pulses and groundnuts.
5. In Asia, the primary need continues to be improvement of rice yields, the major food. Performance in this respect appears to be more or less adequate only in Pakistan and Indonesia. In India, additionally, poor performance in sorghum, millets and pulses also contributes substantially to the food problem. In Indonesia, where cassava is important, yields are on a declining trend. The situation for maize and groundnuts is generally unsatisfactory throughout the region.
6. In sub-Saharan Africa, yield performance of the major cereals -- maize, millets and sorghum -- is poor, particularly for the latter two where yields are declining. Root crops -- cassava, yams and sweet potatoes -- which rank with cereals as a major food source in much of the region, are having difficulty in maintaining historical yield levels. Yields of pulses and groundnuts are on a declining trend.
7. In North Africa/Middle East, the major problems in food crops remain wheat and barley, although in the low income countries of Sudan, they involve sorghum, cassava and pulses and, in Afghanistan, millets as well as wheat.
8. In Latin America, where maize is the dominant food, the main problem countries are in the Mid-America/Caribbean area (except Mexico) and in Bolivia and Peru. Maize yields in the former group have not changed much in the past and have risen only slowly in the latter two countries. Cassava and sweet potatoes are important in Haiti (a low income country), but yields show no significant change historically. In Bolivia and Peru, yields of wheat are low and declining in the latter country. Yields of potatoes in Peru are low and also show no tendency to improve. In most of Latin America, production of pulses lags behind population growth.

9. It should be noted that there is an immediate and urgent need to improve food production in low income food deficit countries. This places added emphasis on accelerating and exploiting research on those commodities where the potential exists to make a significant impact in the next 5 to 10 years.

10. At the same time, it is recognized that there are other constraints -- inappropriate food policies, lack of incentives, inadequate institutions and management, lack of inputs, etc. -- which impede the adoption of available research and technology by the ultimate cultivator. To narrow this gap, more intensive research is needed to identify and to help overcome such constraints.

II. NECESSARY AND SUFFICIENT CONDITIONS FOR EXPANDING FOOD OUTPUT

The food problem in the less economically developed countries is severe, and is likely to become more so. The activities supported by the CGIAR are intended to help alleviate that problem. In order to identify those activities all efforts that could increase food production should be surveyed before decisions about which activities the CGIAR should support are made.

There are two ways in which agricultural production can be increased: 1) expand the area under cultivation, 2) increase production per hectare per unit of time.

Both approaches to increasing production are constrained by natural resources: by the nature of the soil, by topography and altitude, by moisture availability and ranges of temperatures. In both cases, sustained and increased productivity depend on protecting and improving the character of the soil. The soil should not be depleted to achieve quick increases in productivity, instead long-run and increasing productivity should be sought.

Again, in both instances, increased production requires investment. To expand acreage, land may have to be cleared, but in addition in many cases irrigation and/or drainage may be needed. In agricultural development, increasing production per hectare per unit of time requires investments of many different forms. Among those, investment in research is essential, but it is not the only approach.

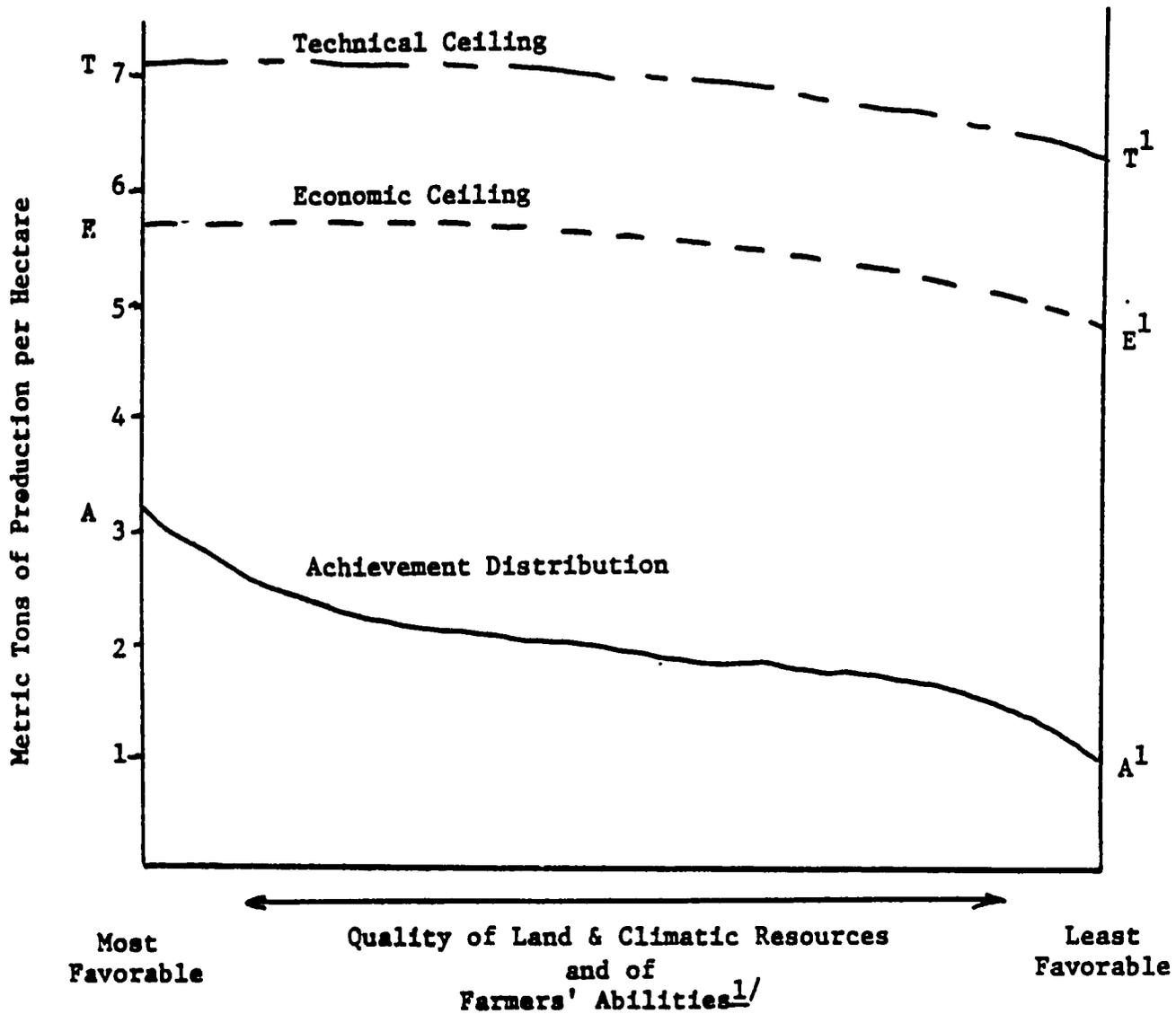
In order to better understand the role of research in this process, we review many conditions that must be met to achieve agricultural growth. Key factors that influence the necessary and sufficient conditions for agricultural growth are: technical ceilings, economic ceilings, achievement distributions, and the specific measures that affect them. Another key factor is the "theory of induced innovation."

Technical Ceilings, Economic Ceilings, and Achievement Distributions

A technical ceiling is the maximum physical production that can be achieved per unit area of land using the most productive set of technologies and services available, given the existing land quality. The highest technical ceiling is achieved on maximum yield plots at experiment stations, including those of the International Centers. It is represented by line T T¹ in Chart II-I on the next page. The fact that the technical ceiling drifts lower toward the right in the chart reflects what happens to yields when the same technologies are applied on progressively less productive land.

Corresponding to each technical ceiling is an economic ceiling, which represents maximum farm output possible with perfect information and astute economic sense. The economic ceiling is always considerably

Chart II-1



below the technical ceiling because farmers stop applying purchased inputs when marginal cost equals marginal returns, even though additional inputs could increase physical production.

^{1/} Only differences in land quality enter into the downward drift toward the right of a technical ceiling in Chart II-I. Two factors are responsible for the downward trend toward the right of achievement distribution. One is land quality. The other is differences in the abilities of farmers. Some of those differences can be removed by various types of education and training, but even with equal opportunities, significant differences in farmers' abilities always persist.

The achievement distribution represents the actual achievement of farmers. It always lies considerably below the economic ceiling because of imperfect information, aversion to risk and uncertainty, habit, and imprecise economic decision making. Achievement distributions rise close to the economic ceiling under economically stable conditions with few purchased inputs, in an agricultural system that is technologically stagnant.

Achievement distributions represent the actual accomplishment of farmers; therefore, raising achievement distributions must be the ultimate aim of efforts to raise production.

Conditions for Agricultural Growth

How can the two ceilings and the achievement distribution be raised?

Six activities are essential to keep technical and economic ceilings and achievement distributions moving upward:

- (1) Research focused on food production and protection, farm management, and improving the other five activities;
- (2) Manufacture or Importation of Farm Inputs: fertilizers, pesticides, tools, implements, etc.;
- (3) A Rural Infrastructure of Agri-Support Service: rural roads and local service centers to make information, farm inputs, and production credit readily accessible to farmers; and to move their products to market;
- (4) Adequate Production Incentives: primarily favorable price relationships and conditions of land tenure; 1/

1/ Relative prices of inputs and products can affect overall production in two ways. One is as an incentive to use an optimum combination of types and amounts of inputs in producing individual crops. The other is by influencing shifts in the use of land among different crops. Where local conditions allow several crops to compete for the same land areas, the land will be used for the most part, to produce those crops which are currently most profitable. Consequently, when research produces a crop variety and associated cultural practices that make that crop more profitable, the acreage devoted to it is likely to expand at the expense of the area devoted to other crops, which may also be in short supply, and may or may not be nutritionally important.

- (5) Land Improvement through irrigation, drainage, land-shaping, and appropriate cultural practices; and
- (6) Training Agricultural Technicians to operate all of these essential activities effectively.

Taken together, these six constitute the necessary and sufficient conditions for agricultural growth. All are related to technical and economic ceilings and achievement distributions in various ways.

As depicted in Chart II-2, a technical ceiling can be raised through (1) biological and engineering research and (2) through land improvement.

An economic ceiling can be raised by (1) raising the technical ceiling and (2) increasing the number of farming localities served by markets, and the efficiency of markets for farm products, local outlets for farm supplies and equipment, farm to market roads, favorable price relationships, and favorable tenure relations. 1/

An achievement distribution can be raised by (1) raising the economic ceiling and (2) improving the abilities and skills of farmers and their desire to increase production (e.g., through an efficient extension service).

A substantial gap between an economic ceiling and an achievement distribution is often viewed as a signal that effort be concentrated on extension, rather than research, to raise the achievement distribution.

That would be a major mistake. Instead, it is important to raise the technical ceiling as rapidly as possible, while also raising the economic ceiling. A constantly raising economic ceiling is a powerful incentive to farmers to increase production. As stated earlier, there is always a gap between an economic ceiling and its associated achievement distribution, and that gap is greater in less developed economics. Efforts to raise achievement distributions are important and need to be intensified. However, raising the technical and economic ceiling should be the primary focus.

1/ Parenthetically, the International Centers are proving that they can raise technical ceilings and, to a lesser degree, raise economic ceilings by breeding for responses and resistances that contribute to yield stability. They can find cultural practices that economize on the use of purchased inputs. Meanwhile, center scientists are haunted by lagging achievement distributions and are constantly tempted to give direct attention to them.

Chart II-2

Agricultural Development Activities Appropriate
to Raising Technical and Economic Ceilings and
Achievement Distributions

Raising the Technical Ceiling
is accomplished through:

- Biological and engineering research, and
- Land improvement

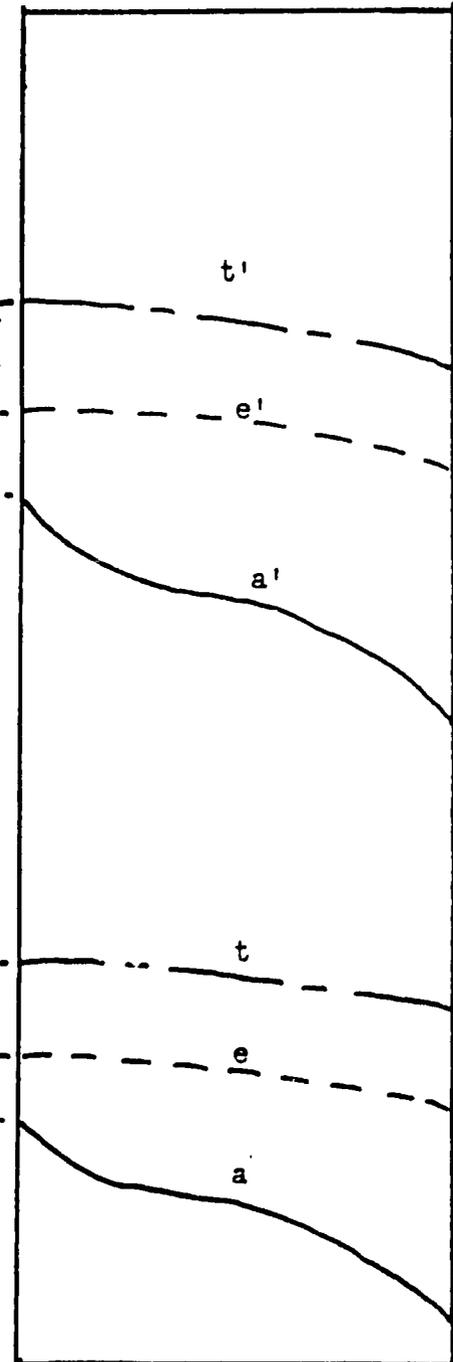
Raising the Economic Ceiling
can be accomplished by:

- Raising the technical ceiling
- Increasing the number of localities served by, and the efficiency of:
 - 1) Markets for farm products
 - 2) Outlets for farm supplies and equipment
 - 3) Production credit facilities
 - 4) Farm to market roads
 - 5) Favorable price relationships
 - 6) Favorable tenure relationships

Raising the Achievement Distribution
is accomplished:

- Primarily by raising the economic ceiling, but it can be accelerated by:

An efficient extension service and other means of increasing farmers' abilities, skills, and enthusiastic eagerness to increase production



The Theory of Induced Innovation

Technical and economic ceilings, achievement distributions, and the necessary and sufficient conditions for agricultural growth, as, agricultural research are a few of many factors that contribute to growth. The "theory of induced innovation" offers an additional explanation of agricultural growth. 1/

The key points that explain the role of induced innovation in agricultural growth are (1) that the relative abundance or scarcity of different factors of production in any economy induce a search for new technologies that are appropriate to those factor endowments, and (2) that the availability of new technologies induces development of the other innovations (including organizations and services) that are essential to exploit fully these technologies.

The theory implies that the crucial step in agricultural growth is to develop biological and engineering technologies that are appropriate to the resource endowments of each region. Once these technologies are available, they will help induce the development of organizations and services essential to their use.

Although most of the present centers were functioning before that theory was formally presented and verified from historical materials, it is precisely the reasoning that led to the creation of the older centers. Their founders believed that if more highly productive technologies more developed and made available, these technologies would stimulate leaders of national research and production programs to build up the other activities that would take full advantage of the new technologies.

Thus, agricultural research is a necessary but not a sufficient means of meeting the world's food problem. It is the most important contributor to raising technical ceilings. It is one contributor to raising economic ceilings, but many other activities are involved that include improving the rural infrastructure of agri-support services and price and land tenure policies. The influence agricultural research has on achievement distributions is primarily through its effect on technical and economic ceilings and farmer behavior that may be changed by expanding opportunities.

1/ Y. Hayami and V. W. Ruttan, Agricultural Development: An International Perspective (Baltimore: Johns Hopkins University Press).

III. SOME IMPORTANT CHARACTERISTICS OF AGRICULTURAL RESEARCH AND ITS ADMINISTRATIVE NEEDS

Research is one of six interacting activities, referred to in the preceding chapter that in combination can lead to agricultural growth. Each of these six requires distinctive procedures and administration. This chapter is a review of some salient characteristics of agricultural research and a brief description of the type of administration it requires.

Some Characteristics of Agricultural Research

Agricultural research focuses on problems that arise in highly interactive and dynamic ecosystems operating within a complex economic and social framework. Crop improvement involves interaction between the genetic composition and developmental processes of plants and other environmental, biological and social factors such as: (1) soils of varying composition, (2) differing patterns of moisture availability, (3) varying insect populations, (4) plant disease organisms, (5) human decisions about crop cultivation, and (6) social customs, such as those governing the division of farm labor. Problems of livestock production involve a similar set of interacting factors.

Need for an Appropriate Research Approach. Relatively simplistic "single-limiting-factor" approaches have limited value in solving these highly dynamic and interactive agricultural problems. These complex problems demand a more comprehensive systems approach to problem solving, employing the combined skills of researchers from many disciplines.

Adopting this more holistic approach to agricultural problems does not lessen the importance of the individual specialist in studying particular components of the system. To maximize their contribution, scientists from varied disciplines must jointly focus on particular problems and exchange scientific ideas. This interdisciplinary approach runs counter to the more traditional disciplinary approach which characterized so much agricultural research effort in the past. Interdisciplinary cooperation has proven to be a successful research approach and a more effective use of manpower.

Time Lags Between Recognition, Application, and Adoption. A common feature of most biological research is the several time lags that are involved. One is the long delay which often occurs between the discovery of a new concept or technology and the recognition of its practical value. The Japanese wheat variety Norin 10 was developed many years before Orville Vogel began using it in experimental trials in the U. S. in 1949. It was several years later when it, in combination with the U. S. variety Brevor, became the progenitor of most of the high-yielding semi-dwarf wheats that have emerged from CIMMYT's program in Mexico.

A second lag is the period between that recognition and completion of research based on the new concept. Third is the inevitable time lag involved in the adoption of a new technology by farmers.

Uncertainty and Serendipity in Research. Another characteristic of research is the uncertainty which makes it very difficult to predict the outcome of a particular project. The very fact that a problem requires research implies that there are some unknowns in the system. Often a solution is found, partially through luck or a chance discovery. This serendipity has been a feature of many important research developments in agriculture. For example, the discovery of zinc as an important key trace element in soils arose out of the use of galvanized containers in experiments with fertilizer treatments. These are the chance occurrences that make quantum jumps possible in science, but to achieve these, it also requires the right person to recognize the situation and exploit it.

Character of Research Progress and Expectations. Agricultural research history suggests that most progress has been cumulative and incremental, eventually leading to a more complete understanding and a gradual improvement in technology. Only occasionally does research progress by quantum jumps or breakthroughs, thereby resulting in the emergence of a new concept, genotype, or technique, which in turn creates new opportunities for further research. The publicity from this sort of rare occurrence can be a mixed blessing. It builds up the reputation and credibility of the research organization and makes it easier to attract support. However, it can also lead to undue pressure and sometimes a reaction from donors if similar breakthroughs are not forthcoming at fairly regular intervals. New breakthroughs will occur, but these are not predictable. Meanwhile, most progress in agricultural research will continue to be of the cumulative, incremental type.

Characteristics of a Successful Researcher. Attributes required to be a successful agricultural scientist are varied. Formal training is important, but intelligence, ability, and motivation are equally valuable. Many successful agricultural scientists have moved into agricultural research following rigorous training in a more specialized biological field or from different but related fields such as mathematics, physics, or biochemistry. Such scientists often bring new insights and ways of approaching problems which can be valuable in an interdisciplinary team approach. Above all, agricultural researchers need to be able to bring a conceptual approach to problem solving.

The choice of first rate scientists with these attributes is critical. They represent the most important component of any research program and largely determine its outcome.

A Suitable Research Environment. A productive research environment for the scientific staff requires good leadership, adequate equipment and facilities, independence, opportunities to interact with other scientific colleagues, and adequate rewards and recognition.

Priorities, Planning, Evaluation, and Management

The preceding brief discussion of the character of agricultural research makes it clear that the research enterprise is atypical; it is unlike many other types of agricultural development activities. For that reason, issues relating to priority setting, planning, evaluation, and management of research require additional brief comment.

The process of identifying priorities and translating them into specific goals -- a responsibility of any agricultural research organization -- requires a delicate balance between generality and specificity. Further, that balance is going to be different at each level in a research organization. Clearly, problem-oriented, interdisciplinary agricultural research requires clear choices about the geographic target area and the problems on which to focus. The criteria for these choices should include: (1) geographic importance of different food sources, (2) importance of particular food sources in the diets of target populations, (3) the limitation of agroclimatic conditions, (4) the magnitude and character of ongoing research, (5) the existing state of research knowledge, and (6) some estimate of the impact research might have in raising technical and economic ceilings. Integration of these and other factors to make quantitative priority choices is virtually impossible; and therefore, the choice of priorities must come from subjective judgment about the potential impact that a sustained research effort might have on levels of food output. Thus at the general level (e.g., CGIAR), these priorities need to be specific, constantly evaluated, and continuously emphasized. However, these goals should be generally outlined for the research unit, providing adequate leeway for the research unit to develop an appropriate strategy.

Given that research is interrelated, long term, chancy, and has an unknown specific outcome, the development of a research strategy is a critical element in the success of a research program. That strategy must allow maximum freedom for the researcher and the research institute to decide the best approach and proceed to direct its research activities toward the general goal.

Researchers must be experienced and highly qualified. To maintain their quality, researchers should have the opportunity and encouragement for continuous self-renewal. They must be able to work in a stable environment with maximum opportunity for scientific interchange. They must be provided with excellent equipment, laboratory and field facilities. They must have dynamic and enlightened leaders who constantly keep the goal before them and who have frequent, direct contact with problems under attack. They must have a feeling of personal and resource security that permits maximum sustained effort on a specific problem without bureaucratic interference.

In summary, a successful research strategy is one that involves clearly defined goals, the best possible inputs in the correct combination, and maximum freedom to pursue promising avenues within the general

goal. Therefore, it is inherently difficult to predict outcomes and apply traditional evaluative measures, such as, rates of return or cost-benefit analysis.

The above strategy should be pursued long enough to permit the possibility of substantial progress towards the goal. This time period will vary depending on the nature of the goal. However, once an institution is operating, periodic ex post progress reviews are essential. These reviews should involve internal program evaluation by the researcher and the research team (internal peer review), review by other members of the research institution, periodic external review by knowledgeable people outside of the institute, and review by potential users and donors.

This chapter presents a general description of agricultural research and its management needs. It will be noted that there is a good deal of harmony between what good research requires and what the International Centers now exemplify.

IV. AGRICULTURAL RESEARCH ORGANIZATIONS SERVING DEVELOPING COUNTRIES

The International Agricultural Research Centers sponsored by the CGIAR represent one among many research efforts serving the needs of developing countries. This chapter briefly reviews the kinds of research organizations that are involved, the interrelationships among them, the magnitudes of the resources devoted to them, and some of the problems involved in improving national programs.

Major Components

There are four major types of agricultural research serving the developing countries: national, regional, international research (the centers), and research conducted in developed countries.

National Research. Within developing countries, most agricultural research is supported by public funds (in some cases augmented by direct grants from bilateral and other aid agencies) and is conducted by or under the auspices of ministries or departments of agriculture. A limited amount of research is also conducted by universities and colleges of agriculture, who often have well qualified graduates on their staffs but because of limited facilities and funds some of them contribute little to national research efforts.

Two influences from the past may have inhibited the development of productive national research programs. The heritage of single-crop research institutions focused on export crops, established in colonial times and financed by a tax on exports has probably delayed adequate financing for research on other crops financed out of general revenues. Second, there has been a tendency to scatter research efforts on non-export crops among a large number of small experiment stations, thus failing to achieve a critical mass of high quality staff in particular places.

In an effort to overcome these problems, some countries have created central National Agricultural Research Institutes that group all the main research areas under an umbrella. These institutes have sufficient strength and flexibility for research on specific commodities or problems to be conducted, either within disciplines, or on a multidisciplinary basis. Examples of this approach are the Indian Council of Agricultural Research (ICAR) with its All-India Coordinated Research Programs in particular commodities, the Malaysian Agricultural Research and Development Institute (MARDI) and the quasi-government corporation (EMBRAPA) in Brazil.

In addition to central research organizations, an important task facing any national research effort is to create decentralized programs

that can adequately serve the localized social, economic, and environmental problems without excessive fragmentation and dissipation of scarce resources.

Regional Research. Another component of the research system in the developing world is regional multi-country research programs. These are fairly recent and have developed on a modest scale in Africa, the Middle East, Central America, and Southeast Asia. Some examples of these organizations and the scope of their activities are listed on the next page (Table IV-1).

Among the regional programs, those supported through the Office de la Recherche Scientifique de Technique d'Outre-Mer (ORSTOM), and the Groupement d'Etudes et de Recherches Pour la Developpement de l'Agronomie Tropical (GERDAT) both operating in francophone Africa, are probably the most extensive and well supported. Both organizations have central stations or research institutions supported by a network of secondary research centers distributed through the region. In the case of GERDAT the organization is further subdivided into a number of commodity research institutes with their own substations (e.g., IRAT, Institute de Recherches Agronomiques Tropicales et des Cultures Vivrieres).

The other regional organizations listed obtain funds from host countries, in addition to those received from sources outside the region, e.g., U.K. in the case of East Africa, The Ford Foundation and FAO in the Middle East, U.S.A. for Central America, and France and the CGIAR in the case of WARDA in West Africa.

Agricultural research in regional programs covers the spectrum of research activities. With some exceptions, (e.g., ORSTOM) it is largely mission oriented. Some of it involves longer term investigations that have regional implications.

International Research. The International Agricultural Research Centers (IARCs) constitute a third tier in the research structure of the LDCs.

Most of them are located in developing countries in the low latitude belt around the world and have a strong commodity focus, usually developed within a farming system context. The majority of the International Centers are under the collective sponsorship of the CGIAR. The history and development of this organization and details of the program and support for the centers are reviewed in Chapter V.

Some of the special advantages of the IARCs are their ability to attract a critical mass of talented scientists and provide them with adequate funding and facilities; their independence, flexibility, and interdisciplinary approach to problem solving; their strong focus on issues that are central to the problems of food production in developing countries; and their ability to interact with national and regional research programs through a global network of collaborative research efforts.

Table IV-1
 Some Examples of
 Regional Research Organizations
Operating in Developing Countries

<u>Organization</u>	<u>Region</u>	<u>Activity</u>
ORSTOM Office de la Recherche Technique d'Outre-Mer	Former French Colonies in West Africa	Basic research agri- culture
GERDAT Groupement d'Etudes et de Recherches Pour la Developpement de l'Agronomie Tropical	Former French Colonies in West Africa	Applied research agriculture
WARDA West African Rice Development Association	West African Region	Applied rice research
EAAFRO East African Agricul- ture and Forestry Re- search Organization	East Africa (Kenya, Uganda, Tanzania)	Research in agricul- culture and forestry
EAVRO East African Veteri- nary Research Organi- zation	East Africa (Kenya, Uganda, Tanzania)	Veterinary research
OAU/STRC Scientific Technical and Research Commis- sion of the Organi- zation of African Unity	--	--
CATIE Centro Agronomico Tropical de Investi- gacion y Ensenanza	Central America and Caribbean region	Dairy, beef, food cropping and forestry
SEARCA Southeast Asian Reg- ional Center for Graduate Study and Research in Agriculture	Southeast Asia	Wide range of activi- ties: water resources, food technology, ex- tension, agribusiness, economics, also post- graduate training
ALAD Arid Lands Agricul- tural Development	North Africa and Near East	Research and develop- ment of basic food crops, winter cereals, food legumes, and work on summer cereals, maize millet and sorghum.

Research in Developed Countries. The fourth agricultural research component serving developing countries is research in developed countries conducted by research institutions, universities, and private business firms. That research contributes in a number of ways:

First, it provides the scientific resource base: the accumulation of past research results and fruitful research techniques.

Second, it provides a number of models for research organization. These vary by country of origin and need to be adapted to the needs of developing countries. They do, however, exemplify: (1) effective combinations of central research institutes and branch experiment stations, (2) fundamental and applied research with technology development, (3) cooperation between universities and governmental research agencies, and (4) quickly mounted efforts to solve emerging problems.

Third, in some cases developed country research is aimed directly at current problems in the developing countries. Concern about the world food problem is worldwide and much of the research in developed countries is now being funded to tackle such basic problems as nitrogen-fixation, photosynthetic efficiency, etc. In addition, research organizations in developed countries are willing to study particular problems referred to them from developing countries, witness the several research contracts CIP has made with organizations in developed countries.

Links and Interaction

A major current need is to foster effective links and interaction among the four research components just discussed.

These links may involve joint research projects, pooling and exchange of research materials and results (including broadly based genetic materials), priority setting and program coordination, training, exchange visits, information sharing services, or other kinds of reinforcing activity. The IARCs have a pivotal role to play in this process. They are in continuous contact and collaboration with national programs in the process of carrying on their own research. They are in a position to work together with regional programs. They operate at the interface of research and technology in the developed world and its application to the problems of increasing food production in the developing world.

The mechanism for collaboration in the past has been largely dependent on voluntary cooperation among scientists and organizations sharing common interests and problems. Now, the cooperative regional and national programs of centers (such as CIMMYT, IRRI, IITA, and ICRISAT) are initiating interaction, and coupled with centers' training activities, are making a significant contribution to the strengthening of national research programs.

The UNDP/FAO Regional Research Cooperation Program in the Near East 1/ is another good example of integrated research activities. It involves an integrated approach, covering the majority of food crops of the region, agronomic work, and problems of both irrigated and dry land farming, embracing a total of 22 countries. It involves cooperation between FAO and national programs, and it is serving increasingly as a vehicle for collaboration with IARCs, regional programs (ALAD) and developed country research institutions that are active in the region.

Sources of Funds and the Deployment of Resources for Agricultural Research in Developing Countries

International aid funds have been a major input in the development of many of the agricultural research systems in developing countries over the last 25 years. In the 1950's international aid probably accounted for 40 percent to 50 percent of the total investment in research in developing countries and although that figure has now been reduced, it is still substantial, approximately 20 percent. The support comes from a number of sources. For example, the French government has provided substantial support for research mainly in francophone Africa. International agencies such as FAO/UNDP have been major contributors to the support of research and training. Aid for research has also flowed directly through bilateral government agencies such as the United States Agency for International Development (USAID), the U.K. Ministry for Overseas Development (ODM), the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC), from international organizations such as the World Bank (IBRD) and the InterAmerican Development Bank (IDB), and from private foundations.

This support for agricultural research in developing countries has taken a number of forms, including direct grants as loans to governments, provision of expatriate technical and scientific staff, and graduate training.

Although the details about the deployment of these funds in developing countries are not available, some impression of the overall pattern of distribution can be inferred from the global picture of the investment in agricultural research presented in Table IV-2 for the period 1951-1974.

These data show that investment in agricultural research has increased at a rapid pace in all regions, although in the last three years the rate has slowed considerably. The share of the investment in agricultural research in the developing countries has increased from approximately 10 percent in the 1950's to 16 percent in 1971, and has remained fairly constant since that time. Within these countries the contribution to agricultural research from the private industrial sector has been

1/ Project REM-71/293. FAO, Rome 1975.

limited because of the stage of development. In the more basic agriculturally related scientific research, there again the contribution has been limited because of the slow development of research in universities.

Table IV-2

Expenditure on Agricultural Research by Region /1

<u>Region</u>	<u>Total Annual Expenditure in Millions of Constant 1971 U.S. Dollars</u>		
	<u>1951</u>	<u>1971</u>	<u>1974</u>
Western Europe	130	671	733
Eastern Europe & USSR	132	818	861
North America & Oceania	366	1203	1289
Latin America	30	146	170
Africa	41	139	141
Asia	<u>70</u>	<u>610</u>	<u>646</u>
World Total	<u>769</u>	<u>3587</u>	<u>3840</u>

/1 Includes all agricultural and agriculturally related scientific research supported by public and private funds (does not include agricultural extension).

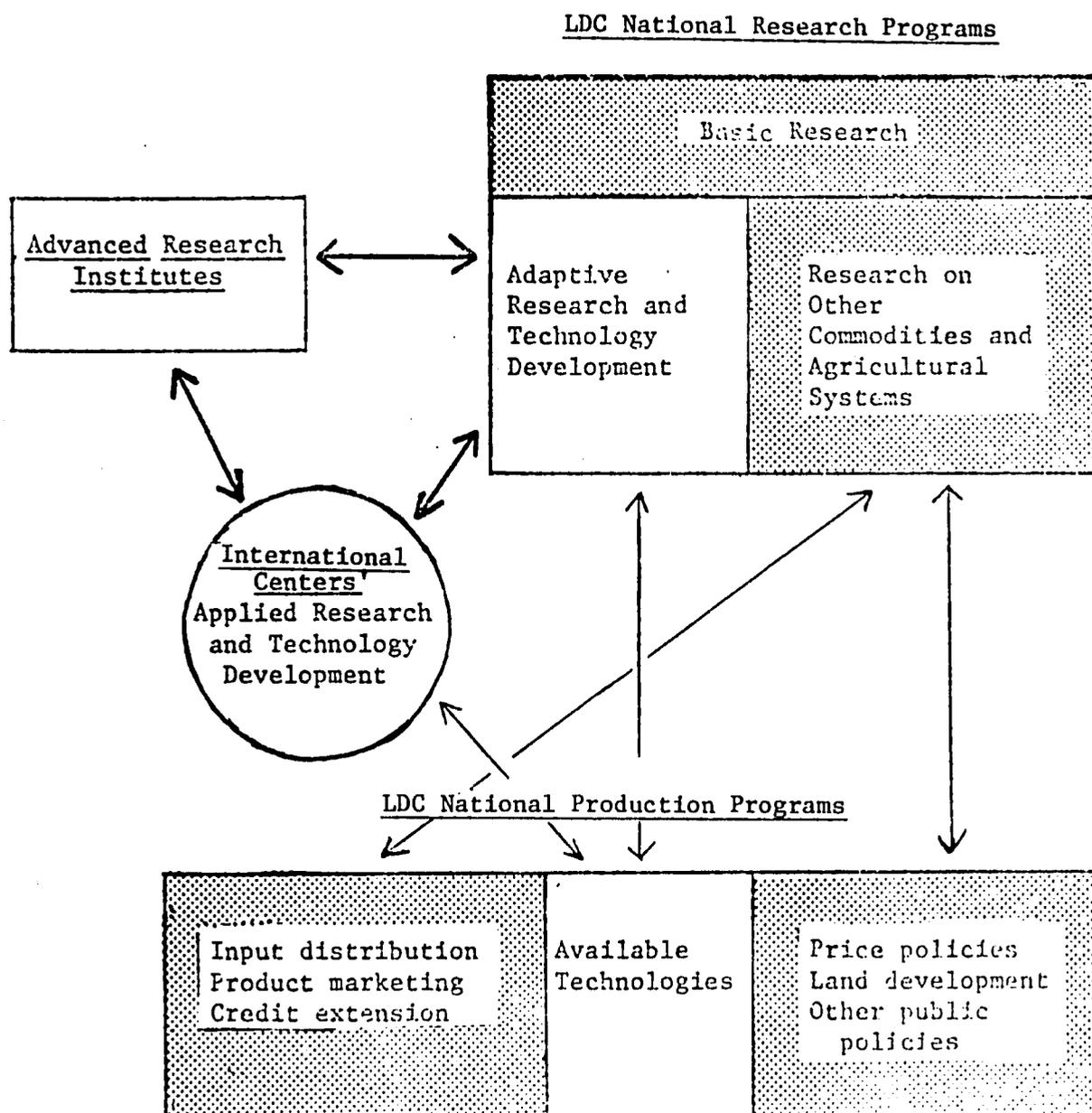
Source: J. K. Boyce and R. E. Evenson. "National and International Agricultural Research and Extension Programs," Agricultural Development Council (New York, 1975).

Despite the widespread efforts since World War II to improve agricultural research and extension programs in the developing world, the investment in these activities is still far short of that achieved in the developed western world.

To assist in the future planning of agricultural research and development in the LDCs, there is an urgent need to obtain more reliable data, on a country by country basis, of the current investment in agricultural research. The data should include the contributions of individual donors, the manner in which these funds are invested in national programs, and the nature and quality of the research they support. The statistical data currently available are not sufficiently reliable to use for this purpose.

International Centers must now operate within a very complex set of circumstances. They must find their place among, and establish optimum cooperative relationships with other international agencies, advanced research institutes, and national research and production systems in LDCs.

These interrelationships are indicated in the following diagram.



In this diagram, the shaded extensions of the box representing national research programs are intended to indicate other responsibilities than just interaction with international technology development. They engage in technology development themselves, not only on crops on which the centers work but on other crops as well. As they mature, they are likely to engage in some basic research, as well.

The shaded extensions of the box national production programs indicate that many factors other than available technologies also affect actual production levels in each country. All of these factors enter into the technology-policy-organizational packages on which national production programs need to be based.

Special Problems in Developing Strong National Agricultural Research Organizations

Given the seriousness of the food problem and the acknowledged importance of research as an essential activity in agricultural development, it is clear that every food deficit, low income country with appreciable agricultural potential needs a strong agricultural research program.

Some agricultural research is now conducted in most of the developing countries, but it varies greatly in both quality and quantity. Some programs are small, others quite substantial. A few are quite effective, many are not. A prime question is: why are these programs not more productive? In large measure it is because of the many severe constraints that must be faced.

One major constraint is the lack of well trained and imaginative research scientists and support staff. Competition for trained scientists is great; many are attracted to more highly paid administrative posts and other ministries. Often seniority considerations in promotion restrict the opportunities of young, talented scientists long enough for them to lose their drive and enthusiasm.

Other constraints relate to the availability and facilities for servicing and repairing complex equipment, and administrative difficulties causing delays in transportation, communication, and in the provision of logistic support for research programs involving growing plants, where timeliness is essential.

Those well trained, young research workers who do remain in agriculture tend to continue working on the more basic research topics that constituted the thrust of their own theses or the thrust of the research institute in which they worked. This is partly due to scientific inertia and also to the desire to obtain scientific recognition by publishing in international journals. Another factor is the reluctance by many scientists in developing countries to participate personally in field research. Many prefer to direct rather than participate, and without talented support staff this is often ineffective. What their countries need most is a strong interdisciplinary team approach to develop appropriate technologies to solve local problems, rather than contributions to the burgeoning growth of journal articles.

Finally, there is the constraint of inadequate funds. Good research can be highly productive, but it does need an adequate and sustained source of funds. Since developing countries need to finance many activities, research must compete with many other urgent demands in the planning and budgeting processes. In the past, agriculture in general, and agricultural research activities in particular, have not had a high priority in the allocation of limited budgetary funds in many developing countries.

Not all of the constraints mentioned here are peculiar to research programs. Some of them are found whenever a new activity designed to further agricultural growth in a developing country is started. They also interact; the demand for a strong national research program is likely to be greatest when the other elements of a successful national production effort (credit, extension, price incentives, etc.) are also in place.

To lessen these constraints, political and administrative leaders must appreciate the importance of research and understand the kinds of research needed and the contingencies necessary to benefit from it. Secondly, it involves many types of changes in personnel policies and administrative procedures, not only within research organizations, but throughout the many governmental departments with which research organizations must deal.

V. THE CGIAR FAMILY OF ACTIVITIES

In earlier chapters we have reviewed:

- the world food problem;
- the variety of activities that are essential to agricultural growth, and within them, the specialized role of agricultural research;
- the characteristics of agricultural research that need to be considered in conducting research (by whatever agency); and
- the many organizations, national, regional, and international, that are currently conducting research for the benefit of developing countries.

The focus of this study is stated in the question: what should the CGIAR do, and how? This final chapter in Part A, therefore, is a review of the history, and present nature of the CGIAR and the major activities it supports, the International Centers. The chapter is divided into two sections. The first is a narrative sketch describing the CGIAR and the existing centers. The second is a fiscal history, discussing the growth of center budgets and the corresponding trend in donor contributions.

Origin and History of the CGIAR: A Narrative Sketch

The Consultative Group on International Agricultural Research was established in 1971. It was an outgrowth of two earlier conferences of donor-agency administrators at Bellagio, who agreed on the need to broaden the base of financial support for four International Centers established earlier by the Rockefeller and Ford Foundations. The mechanism agreed upon was a "consultative group," patterned along the lines of others previously established by the World Bank.

Objectives of the CGIAR

The objectives of the CGIAR, adopted at its first meeting, are worth quoting in full. They are listed on the next page.

It will be noted that "centers," as such, are not mentioned in this statement of CGIAR objectives. Nor is there any restriction to food

Objectives of the CGIAR *

The main objectives of the Consultative Group (assisted as necessary by its Technical Advisory Committee ...) are:

- (i) On the basis of a review of existing national, regional and international research activities, to examine the needs of developing countries for special effort in agricultural research at the international and regional levels in critical subject sectors unlikely otherwise to be adequately covered by existing research facilities, and to consider how these needs could be met; 1/
- (ii) to attempt to ensure maximum complementarity of international and regional efforts with national efforts in financing and undertaking agricultural research in the future and to encourage full exchange of information among national, regional and international agricultural research centers;
- (iii) to review the financial and other requirements of those international and regional research activities which the Group considers of high priority, and to consider the provision of finance for those activities, 2/ taking into account the need to ensure continuity of research over a substantial period;
- (iv) to undertake a continuing review of priorities and research networks related to the needs of developing countries, to enable the Group to adjust its support policies to changing needs, and to achieve economy of effort; and
- (v) to suggest feasibility studies of specific proposals, to reach mutual agreement on how these studies should be undertaken and financed, and to exchange information on the results.

1/ Research is used in this document in a broad sense to include not only the development and testing of improved production technology, but also training and other activities designed to facilitate and speed effective and widespread use of improved technology.

2/ Final decisions of funding remain a responsibility of each member in connection with specific proposals.

crops as the proper focus of CGIAR concern. Instead, the objectives speak of "examining the needs of developing countries for special effort(s) in agricultural research at the international and regional levels in critical subject sectors unlikely otherwise to be adequately covered by existing research facilities, and to consider how these needs could be met," and of "reviewing the financial and other requirements of those international and regional research activities which the CGIAR considers of high priority."

In addition, the statement of CGIAR objectives contemplated "undertaking a continuous review of priorities and research networks related to the needs of developing countries, to enable the Group to adjust its support policies to changing needs, and to achieve economy of effort." 1/ It speaks also of attempting "to secure maximum complementarity of international and regional efforts with national efforts in financing and undertaking agricultural research in the future and to encourage full interchange of information among national, regional and international research centers." 2/

In other words, the objectives of the CGIAR are precisely what its name states: a consultative group comprised of representatives from donor-agencies concerned with the broad field of international agricultural research, that consult on meeting the financial needs of selected activities that the CGIAR had jointly agreed to launch and/or financially support, "taking into account the need to ensure continuity of research over a substantial period." 3/

The first footnote to the CGIAR Terms of Reference on the previous page should be particularly noted. It defines research in an unusual way: to include "not only the development and testing of improved production technology, but also training and other activities designed to facilitate and speed effective and widespread use of improved technology." 4/ In adopting that broad definition, the CGIAR recognized the actual nature of the centers then in existence, and their nature and objectives have continued to characterize both the older and the newer centers. It leads, in fact, to one of the questions we shall examine later about the balance in center programs, i.e., to what extent should they concentrate on raising technical and economic ceilings, and to what extent and in what ways is it appropriate for them to seek to raise achievement distributions by other means.

1/ Consultative Group on International Agricultural Research, (AGR 71/3) Annex III.

2/ Ibid.

3/ Ibid.

4/ Ibid.

Influences of Its Origin

Four International Centers predated the formation of the CGIAR. Those were established earlier by the Rockefeller and Ford Foundations. They were operating centers, with a full set of objectives and operating procedures. As the CGIAR later established five new centers organized along the same lines, it is important both to review the nature of the earlier centers and to note some of the problems in management that necessitated changes as a consequence of the shift from foundation to CGIAR sponsorship.

First, IRRI, CIMMYT, CIAT, and IITA had engaged in applied research and technology development, using interdisciplinary teams of scientists backed up by all of the physical facilities needed for first class performance by highly qualified scientists. The emphasis was on solving particular problems, rather than on pushing back the frontiers of knowledge. For two of those centers, the problem was to raise the technical ceiling for the production of particular commodities: rice in the case of IRRI, wheat and maize in the case of CIMMYT. For the other two centers the problem was to try to find more productive ways to use the resource endowments of particular agroclimatic zones: the humid lowland tropics of Central Africa (IITA), and the tropical areas of South America (CIAT).

Second, each of the four centers was administered by its own international board of trustees, but the resources of the sponsoring foundations were available to them. Those resources were financial, and they were also administrative. In the latter case, the foundations, according to their normal administrative procedures, provided a mechanism for (1) adjusting budgets to available funds, (2) encouraging uniform administrative procedures, and (3) technical review by foundation personnel or the consultants they might enlist. When the CGIAR was established, responsibility for fulfilling those functions no longer lay with the foundations. Financing became a function of the CGIAR. The TAC and the CGIAR Secretariat replaced the foundations as far as technical and administrative support were concerned, developing procedures as they went along.

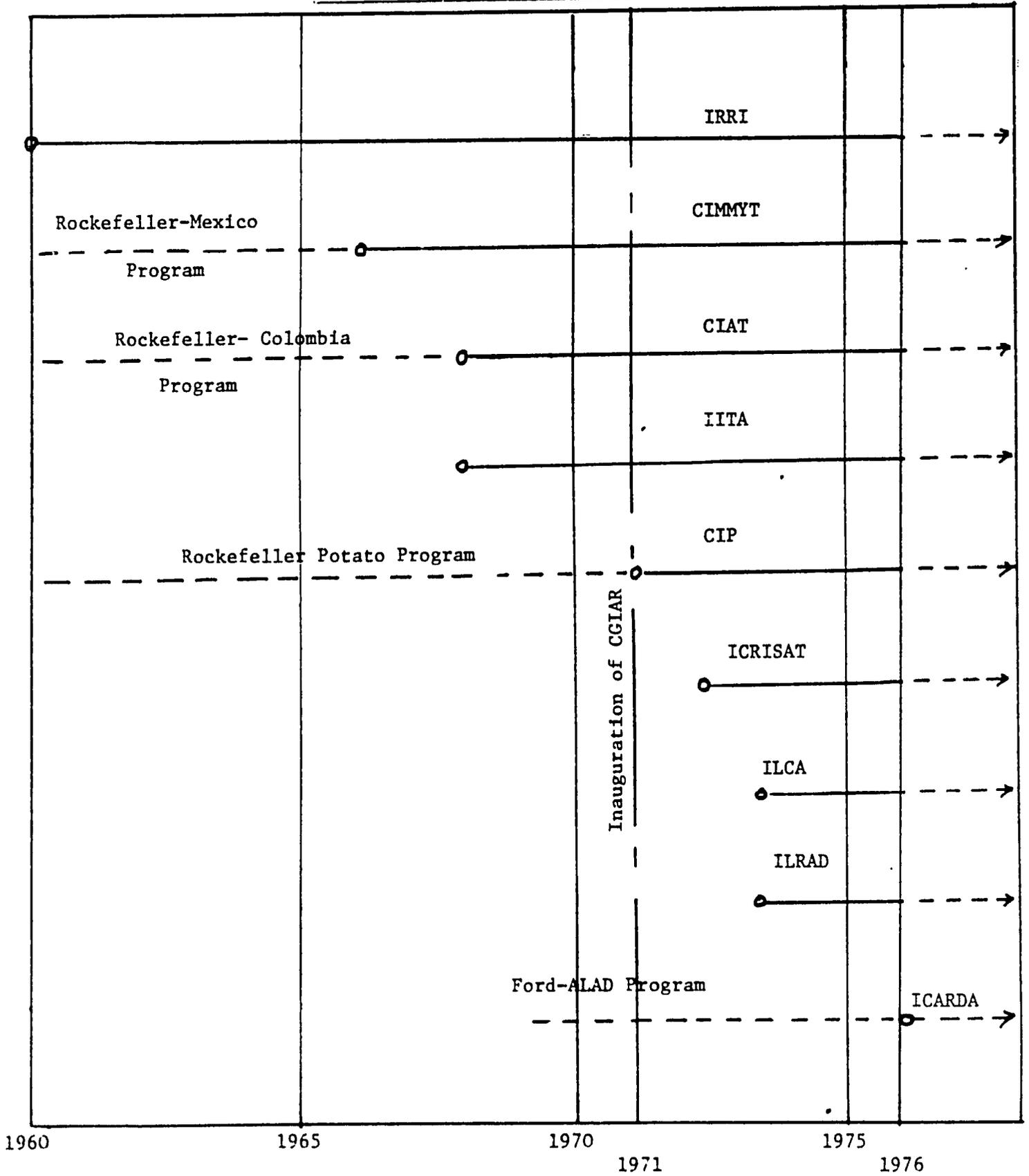
Third, a "major breakthrough mentality" was encouraged by the notable achievements of CIMMYT and IRRI in the late 1960's. It was those accomplishments, to the creators of the CGIAR, that legitimized both expanded support of existing centers and the possible creation of new ones. Despite these accomplishments foundation administrators realized and pointed out, that the problems tackled by CIAT and IITA were unlikely to be solved within a short time and that future advances in rice and wheat were much more likely to be of the cumulative, incremental type, rather than the quantum jumps experienced in the late 1960's.

Present CGIAR Activities

Today there are nine International Centers, including ICARDA which is still in its formative stage. ICARDA is to be built on the base

Chart V-1

Age of International Research Centers



of ALAD, established in 1967 by the Ford Foundation. In addition to the initial four, CIP is an outgrowth and expansion of a previous Rockefeller Foundation program of long standing. Moreover, we have been told by participants at the Bellagio conference that in 1971 initiatives about arid and semi-arid areas and livestock in Africa were considered. Thus, ICRISAT, IRAD, and ILCA were contemplated by 1971, although not approved by the TAC, the CGIAR, or launched until later. It should be noted that from the beginning centers could cooperate with national research programs already in existence when centers, through international efforts, were organized.

The other activities that have been supported by the CGIAR within the past five years are diverse in character. WARDA, based in Liberia, is a cooperative program in 13 West African countries dealing with rice research and development. The International Board for Plant Genetic Resources seeks to stimulate and coordinate the collection and exchange of materials of potential interest to plant breeders in developing countries. The Current Agricultural Research Information System (CARIS), managed by FAO, has received financial help through the CGIAR, but the support is currently expected to terminate at the end of 1976.

Including these in the CGIAR family of activities illustrates the willingness of the CGIAR to support international research that is not cast in the normal center mode; this is further exemplified by several proposals that the TAC is currently considering.

Evolution of the Research Centers

Over the past five years, the older centers have remained relatively unchanged in certain respects while undergoing considerable change in others. Each remains highly problem oriented with its emphasis on applied research and technology development, and with an associated training program. Each mounts interdisciplinary teams to tackle specific problems. Each is located in the tropical or low latitude subtropics. Each has, or plans soon to have a well-equipped set of science laboratories, experimental fields, a technical library, documentation center, and training and conference facilities at its headquarters. Each is international in its staff, financing, and management. Each operates under a charter that allows a broader program than is currently being conducted, and that charter can be amended by its board of trustees.

At the same time, there have been significant evolutionary developments in the past five years.

1. Increasingly, each of several centers (IRRI, CIMMYT, and CIP) has moved away from doing most of their research at or near their headquarters and is becoming an organization for widespread coordinated research activities in many countries. In their plant breeding activities, a major technique of the centers is to gather germ plasm from diverse regions, recombine it in many different ways, then test the resulting crosses over a wide range of contrasting environments for yield stability

and pest tolerance, etc. That requires testing in many countries. Moreover, nationally developed varieties are becoming important sources of materials for such international testing.

The core research of ILCA is to be conducted in four regional centers, two in East Africa and two in West Africa. ICRISAT has established one regional research program in West Africa and plans others in East Africa and South America to sample more adequately the semi-arid tropical world.

In addition, IRRI, CIMMYT, and CIP are placing regional teams in a number of different countries, partly to monitor international testing, but also to encourage and aid national in-country training activities and national production programs.

Frequently, one hears it said that "IRRI is at Los Banos" and "CIP is at Lima." Their headquarters are there but their research, and that of other centers is carried on at many places, in many countries.

2. There is a movement toward each of several centers undertaking research on more crops than were initially intended. Thus, CIMMYT now has programs concerning both bread and durum wheats, maize, barley, triticale, and cold-tolerant sorghum. Groundnuts research has been added at ICRISAT. IRRI has recognized that it must deal separately with shallow-water irrigated rice, rainfed "upland" rice and deep-water rice.

3. Farming systems (cropping systems) are receiving increased attention since the way in which a crop, or a variety of crops, fits into a combination of different crops or into sequential cultivation of the same crop vitally affects both its acceptability and its potential contribution to aggregate production.

4. There is an increasing tendency to get involved in a certain amount of basic or fundamental research and to contract for such research. IRRI and CIMMYT had the advantage of being able to draw on an enormous amount of previous research related to the commodities with which they deal. The same is not true for millet, cassava, potatoes, and several other crops grown under tropical conditions. This means some basic research will have to be undertaken by centers. CIP, for example, has been contracting with a number of research agencies in developed countries where the facilities and expert research manpower already exist to undertake basic investigations relevant to its program.

5. Over the past five years, centers have become involved in an increasing number of single-country (or regional) technical assistance projects. Some of these are projects to help develop research programs; others involve assisting national production programs as well.

Such projects are peripheral activities as far as the research purposes of centers are concerned, but they may be helpful in accelerating the strengthening of national research capacities and/or accelerating national increases in food production.

All centers are eager to see national research capacity increase, and they are impatient for their own research results to show up promptly in rising achievement distributions in individual countries. In addition, as centers demonstrate research competence they are courted both by national governments and by donor-agencies interested in more rapid agricultural development in particular countries or groups of countries.

6. Administratively, there has been a change in the method of selecting members of boards of trustees. The older centers' boards have places reserved for members from host countries, foundation representatives, and are otherwise self-perpetuating. On boards of centers more recently established, places are not reserved for foundation representatives and some or all members (in the case of ICARDA and IBPGR) are appointed by the CGIAR.

7. Also administratively, the increases in the number of centers, in the widespread international testing of planting materials, in the number of commodities with which various centers deal, and in the number of single-country technical assistance projects in which centers are involved, have led to questions regarding the jurisdictions of different centers, particularly where they are involved in different capacities in the same countries. Up to now, such problems have been worked out, case by case, by the center directors and boards of trustees of the centers involved.

Current Form and Function

With the formation of the CGIAR, it became necessary to make new provisions for functions previously performed by the foundations. One of those is embodied in the arrangements and procedures for financing centers. Another is the activities of the Technical Advisory Committee (TAC).

Arrangements for Financing Centers. The ways in which the activities sponsored by the CGIAR are financed constitute an adjustment to the policies and legislative constraints of the various donor-members of the CGIAR. Some donors can commit funds more than one year in advance; some cannot. Some can give to the overall programs of international agencies; others can only support particular activities of an international agency, but not its overall program; still others can give only to, or to programs on behalf of, individual developing countries. Some can operate in any of these ways, making grants of each type out of a separate division of their own budgets.

Corresponding to those different situations, centers can accept three types of contributions. One is "unrestricted core" funds that can be used by a center for any part of its program. Another is "restricted core" funds that can be used only for that part of a center's program as it is designated by the donor. The third is "extra-core" (special project) funds that are bilaterally negotiated between a center and donor for special purposes.

Each center, annually in July, presents to the CGIAR a proposed program and budget for the coming calendar year. Individual donor-members of the CGIAR, at that meeting (Centers' Week) give a preliminary indication of how much they are willing to contribute in support of the centers for the coming year.

It would be sheer coincidence if the preliminary financing indications of donor-members matched, even approximately, the budget requests of centers and other activities financed through the CGIAR. At the end of Centers' Week the budgets of some centers may be oversubscribed and others undersubscribed, and the total of all subscriptions may be (and usually is) less than the total needed for all CGIAR supported activities.

Between Centers' Week and the Pledging Meeting, held usually in October, each donor-agency reconsiders what it will do, frequently in consultation with the CGIAR Secretariat, about programs that are under- or oversubscribed. In addition, the CGIAR Secretariat frequently takes the initiative to discuss with different donors helpful ways in which their contributions might be reallocated. Many donors are quite flexible in making such readjustments even though they may still be constrained from pooling their contributions for allocation by the CGIAR Secretariat itself.

Once donors have made their firm subscriptions in the Pledging Meeting, the CGIAR Secretariat recommends allocation of funds that have been made available by those donors who do not specify to which CGIAR activities they are to be applied.

In fact, arranging for the financing of CGIAR activities is a major responsibility of the CGIAR Secretariat. It encourages centers to present their budget figures in a standardized form easily comprehensible by participants in meetings of the CGIAR. It prepares "integrative reports" and comments on the program and budget submissions of all centers and other CGIAR supported activities, suggesting topics that may merit discussion. It helps negotiate shifts in contributions to insure that all budget requests are fully covered. It handles requests of centers for supplementary contributions within each year to meet unforeseen needs.

In addition to its central program and budget, most centers also have several special projects and their associated budgets. The chief substantive difference is that, whereas, the central programs and budgets are considered simultaneously and by all members of the CGIAR, special projects are negotiated separately between a single center and a single donor-agency. They are not reviewed by the CGIAR as a whole although each center now reports to the CGIAR, ex post, all special projects it is initiating.

Special projects are dominantly three types. The most numerous are technical assistance projects to strengthen research and/or production programs in individual countries or groups of countries. The second type is special projects to augment activities within the central program. The third type is special project funding of additional physical facilities and equipment.

The Technical Advisory Committee. Recognizing that representatives of donor-agencies on the CGIAR are not necessarily agricultural scientists, and that they are, in any case, quite busy people, the CGIAR took early steps to establish a Technical Advisory Committee composed of agricultural scientists or research administrators selected for their personal professional capacity and without regard to their organizational affiliations.

The Terms of Reference of the TAC, which are reproduced in full on the next page, delineate three basic tasks: (1) to consider the desirability and technical feasibility of adding new areas of research to those already being supported under the aegis of the CGIAR; (2) to suggest an appropriate organizational mechanism for each type of recommended new research; and (3) periodically to review, from a technical standpoint, the CGIAR sponsored research already underway.

Meeting two or three times a year in five-day sessions, the TAC makes liberal use of task forces and subcommittees, which usually include people from outside the TAC because of the special topic under review, to prepare agenda papers for its consideration. After the TAC has deliberated, its conclusions are formulated by its chairman, with the aid of the Executive Secretary of the TAC Secretariat and submitted to the CGIAR for consideration.

It is understandable, in view of the youth of the CGIAR and of most centers, that most of the attention of the TAC up to now has been devoted to considering new research initiatives for the CGIAR, and appropriate organizational mechanisms for each. That has been a major task in itself, and few of the centers have been mature enough, until recently, for formal evaluative review of ongoing programs to be merited.

Reviews of ongoing programs were begun in 1975, in the form of quinquennial reviews, each conducted by a special team selected for the purpose by the TAC.

In reaching its conclusions about what new types of research should be initiated, the TAC gives first priority to research on basic staple food crops, favoring those that can benefit large numbers of people, but it also considers regional needs. ^{1/} At any one time it has a large number of possible activities under review. No matter how important a field may be judged to be, it appears that TAC does not recommend it until

^{1/} In its February, 1976, meeting, the Chairman, Sir John Crawford, stated: "TAC has always been flexible in its criteria, recognizing that there is a need for a balanced view of regional needs. Poverty and malnutrition exist everywhere, and all resources should not be directed to one area even if the population served was very large, to the complete neglect of other research of vital importance to people elsewhere." (That statement was made in response to a member's query as to why a center is supported just to work on potatoes).

TERMS OF REFERENCETECHNICAL ADVISORY COMMITTEE 1/

The TAC will, acting either upon reference from the Consultative Group or on its own initiative:

- (i) advise the Consultative Group on the main gaps and priorities in agricultural research related to the problems of the developing countries, both in the technical and socio-economic fields, based on a continuing review of existing national, regional and international research activities;
- (ii) recommend to the Consultative Group feasibility studies designed to explore in depth how best to organize and conduct agricultural research on priority problems, particularly those calling for international or regional efforts;
- (iii) examine the results of these or other feasibility studies and present its views and recommendations for action for the guidance of the Consultative Group;
- (iv) advise the Consultative Group on the effectiveness of specific existing international research programmes; and
- (v) in other ways encourage the creation of an international network of research institutions and the effective interchange of information among them.

These Terms of Reference may be amended from time to time by the Consultative Group.

1/ CGIAR, (AGR 71/3) Annex III.

it is satisfied (1) that the kind of organizational arrangements for conducting research are the most effective and (2) that existing research in that field is inadequate.

This means that its priorities are basically time priorities. Research efforts that need to be put forth now because of their intrinsic importance and because the appropriate research mechanisms are clear are given a higher order of priority. Thus, for a field of research to be ascribed a lower order of priority by TAC does not necessarily mean that it is considered intrinsically less important.

The TAC has stated that it does not contemplate proposing any additional centers in the near future, but maintains the prerogative to suggest additional areas of research using other organizational mechanisms, or to add new programs to existing centers.

Fiscal History of the CGIAR Family of Activities

In addition to reviewing the narrative history, it is instructive to review briefly the fiscal developments of the CGIAR for the period 1972-1977. This six-year period has seen rapid growth in center budget requests which have been matched by growth in the number of donors and their contributions. The character of the increases in budgetary expenditures of CGIAR supported activities is treated first. It is followed by a review of donor sources.

Growth of Center Expenditures: 1972-1977

Table V-1 displays total expenditures of CGIAR activities from 1972 through 1976. It also displays requested budget levels for 1977. Including special projects, annual expenditures in the five year period have risen from 22 million dollars to 84 million dollars. To complete the picture of CGIAR costs, it is necessary to identify the costs of the two secretariats serving the CGIAR. These costs were 550 thousand dollars in 1974, 750 thousand dollars in 1975, and one million dollars in 1976. 1/

Part A of Table V-1 shows the growth in budgetary cost for each CGIAR supported activity. The same figures are graphically shown in Chart V-2. Chart V-2 clearly shows the rapid rate of budget increase in all centers over the past three years. All rates of increase have been about the same except for CIMMYT (1974-76) and ILCA (1975-77).

1/ Source: CGIAR Secretariat. These costs include quinquennial review expenditures.

Part B of Table V-1 shows expenditures for capital from 1972 through 1976 and amounts requested for 1977.

Three comments on these figures are in order. First, the nearly 77 million dollars spent on capital significantly understates the capital costs of all CGIAR activities because it does not include the major capital investment at the original four centers before the CGIAR was established. Second, capital expenditures have escalated very rapidly in the past three years largely because the CGIAR established four new centers, each involving a major building program. Third, unless new centers are approved, capital costs should decline substantially after 1977.

Part C of Table V-1 shows the patterns of centers' expenditures from special project sources. Until 1976, special project funding increased slowly (or declined as in 1975) in monetary terms and declined in relative importance. In 1976 special project funding increased 2 1/2 times and represented in that year nearly 20 percent of annual expenditures. Two centers (CIP and IRRI) received special project funding equivalent to more than 40 percent of core budgets. On the other hand, two centers (ILCA and ILRAD) received very little or no support via this route. The major reason for this increase appears to be the rapid development of regional and other off-campus programs funded via the special project route. Chart V-3 shows the trends in the above factors.

Tables V-2 and 3, based on center program and budget papers, attempt to show the distribution of increased costs among four categories: (1) maintenance of previous programs, (2) new programs and expansion of previous programs, (3) inflation, and (4) capital. These tables show the distribution of annual operating expenditures by centers. They show that, in each of the two years for which this kind of data is available, maintenance of previous programs uses about 75 percent of budgets; new programs 15 percent and inflation 10 percent. Table V-4 shows that, if one looks at the distribution of total budgetary expenditures for eight centers in the years 1975 and 1976 the cost of maintaining ongoing programs represented 55 percent of total cost when capital expenditures are included. Obviously, as new centers mature (assuming no new centers are established) the relative importance of program maintenance will rise and that of capital expenditure and of new program cost will decline.

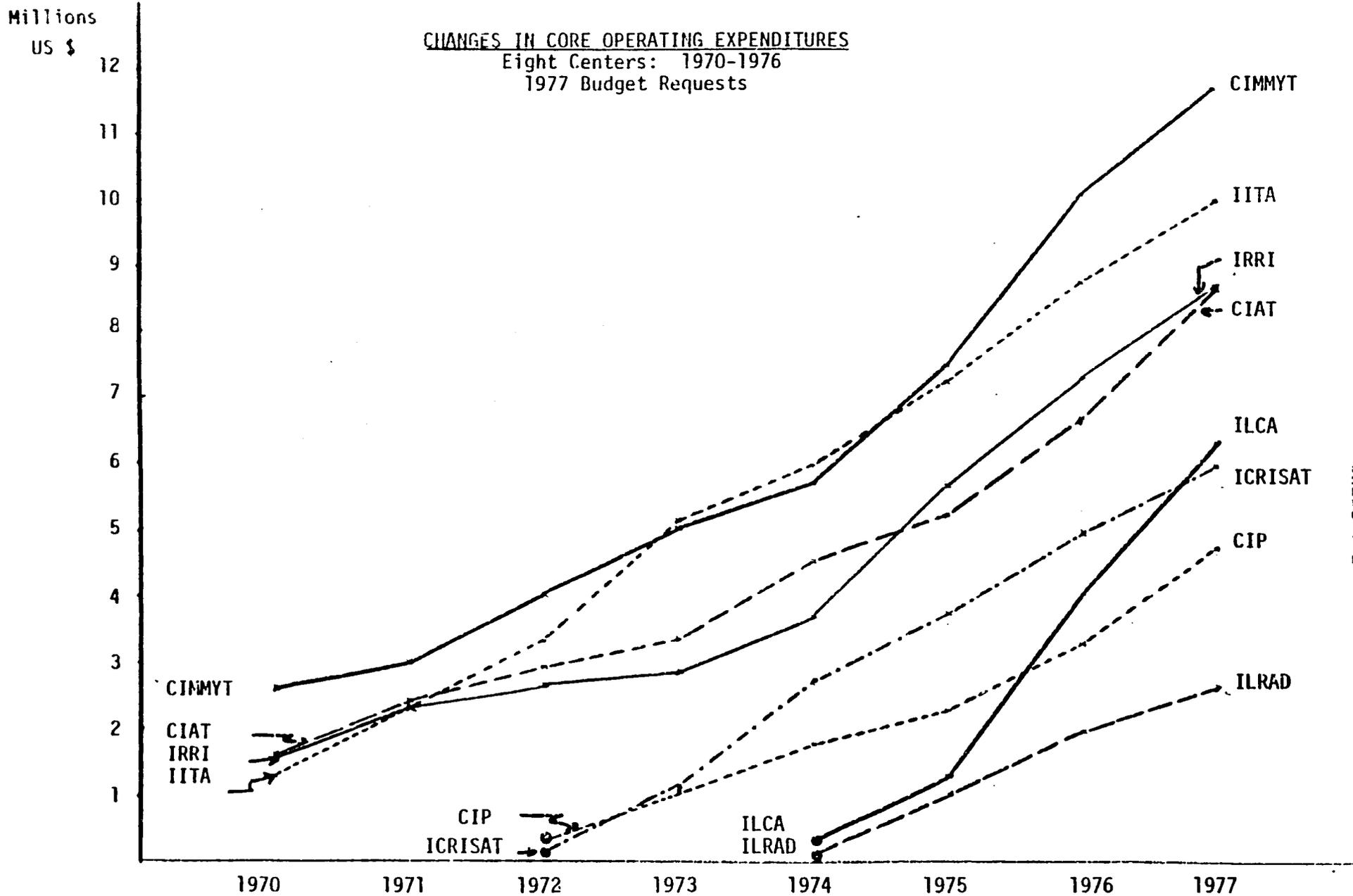
Trends in Donor Contributions: 1972-1976

Table V-5, prepared by the CGIAR Secretariat, provides basic information on all donor contribution to core funded programs since 1972. In 1972 there were 16 donors who contributed \$20.06 million. Three donors joined and one dropped out in 1973 and total contributions rose 28 percent to \$25.705 million. In 1974, two more donors joined and contributions rose 34 percent to \$34.525 million. Three more donors joined in 1975 and total contributions increased 37 percent to \$47.345 million. Four new donors joined in 1976 and donations rose 36 percent to \$64.390 million. Thus, in five years total contributions have increased more than fourfold and the number of donors have increased from 16 to 26.

Table V- 1

CGIAR - Total Expenditures: 1972 - 1977
(Thousands of \$)

	1972 actual	1973 actual	1974 actual	1975 estimated	1976 budgeted	1977 requested
<u>A. Operating Expenditures</u>						
CIAT	2,891	3,363	4,503	5,270	6,682	8,614
CIMMYT	4,084	5,023	5,714	7,472	10,197	11,663
CIP	352	1,024	1,768	2,265	3,297	4,754
IITA	3,270	4,898	5,959	7,201	8,789	9,999
IRRI	2,607	2,800	3,692	5,479	7,292	8,694
ICRISAT	184	1,140	2,700	3,750	4,900	5,900
ILCA			260	1,272	4,002	6,247
ILRAD			142	520	1,921	2,592
ICARDA				100	1,700	3,300
WARDA			445	555	760	1,500
GENES				555	845	1,100
CARIS				280	350	0
Total Operating	13,388	18,248	25,183	34,719	50,735	64,363
<u>B. Capital Expenditures</u>						
CIAT	1,557	2,700	1,000	825	900	1,400
CIMMYT	975	1,200	600	286	500	1,500
CIP		200	437	306	747	1,200
IITA	3,100	1,700	500	675	2,000	1,400
IRRI	353	284	1,100	3,409	2,200	3,200
ICRISAT		1,700	1,900	6,500	8,900	4,300
ILCA			42	306	2,398	5,400
ILRAD			600	1,886	2,650	2,900
ICARDA					1,000	3,000
Total Capital	5,985	7,784	6,179	14,193	21,295	24,300
Total Expenditure	19,373	26,032	31,362	48,912	72,030	88,663
<u>C. Special Projects</u>						
CIAT	98	404	632	593	902	na
CIMMYT	1,263	1,808	1,385	1,419	2,901	na
CIP			739	39	1,805	na
IITA	45	442	755	951	2,074	na
IRRI	1,323	1,982	2,040	2,185	3,508	na
ICRISAT				190	1,035	na
ILCA			25	159	184	na
ILRAD						na
ICARDA						na
Total Special Project	2,729	4,636	5,576	5,486	12,225	



Source: CGIAR Secretariat and Table V-1.

Chart V-2

Table V-2

Sources of Increase in Expenditures - 1975

	<u>Maintenance of Previous Programs</u>	<u>New Programs & Expansion of Previous Programs</u>	<u>Inflation</u>	<u>Total Operating</u>	<u>Capital</u>	<u>Total</u>
CIDMYT	\$ 5,654,000 81%	\$ 140,000 2%	\$ 1,159,000 17%	\$ 6,953,000 100%	\$ 286,000	\$ 7,239,000
IRRI	3,527,000 69%	1,054,900 21%	529,100 10%	5,111,000 100%	3,409,000	8,520,000
IITA	6,134,000 91%	361,000 5%	235,000 4%	6,730,000 100%	675,000	7,405,000
GIAT	4,778,000 88%	231,000 4%	444,000 8%	5,453,000 100%	825,000	6,278,000
CIP	1,880,000 86%	109,000 5%	192,000 9%	2,181,000 100%	190,000	2,371,000
ICRISAT	2,650,000 71%	717,000 19%	383,000 10%	3,750,000 100%	6,500,000	10,250,000
IICA	700,000 41%	996,000 59%	n.a.	1,696,000 100%	569,000	2,265,000
ILRAD	142,000 16%	732,000 84%		874,000 100%	2,222,000	3,096,000
Totals	\$25,465,000	\$ 4,340,900	\$ 2,942,100	\$32,748,000	\$14,676,000	\$47,424,000
Percentages	78%	13%	9%	100%		

47

Source: Annual Center Program and Budget Reviews.

Table V-3

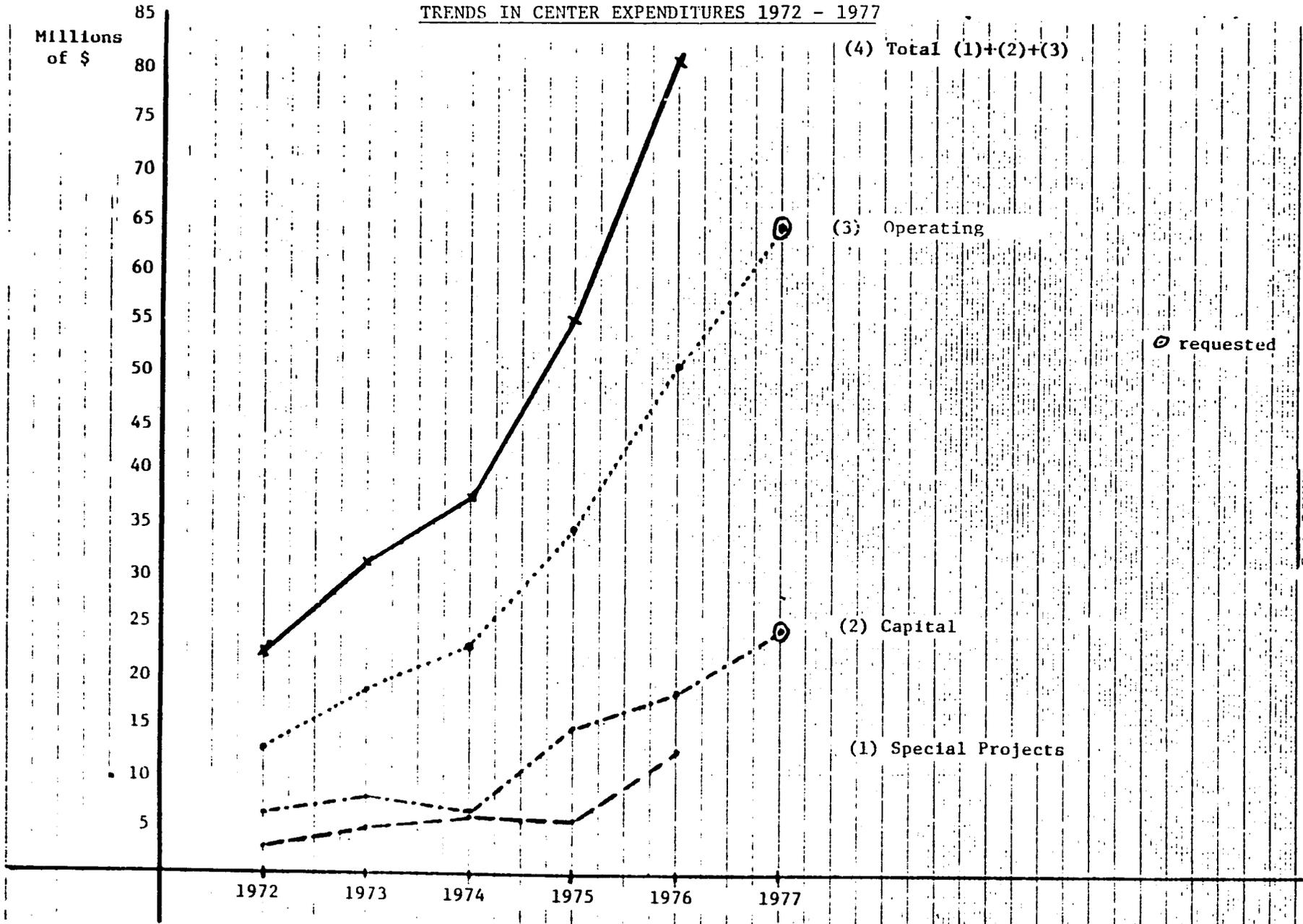
Sources of Increase in Expenditures - 1976

	<u>Maintenance of Previous Programs</u>	<u>New Programs & Expansion of Previous Programs</u>	<u>Inflation</u>	<u>Total Operating</u>	<u>Capital</u>	<u>Total</u>
CIMMYT	\$ 7,995,000 70%	\$ 1,990,000 17%	\$ 1,498,000 13%	\$11,483,000 100%	\$ 509,000	\$11,992,000
IRRI	5,497,000 80%	526,000 8%	854,000 ^{1/} 12%	6,877,000 100%	2,273,000	9,150,000
IITA	7,638,000 90%	413,000 5%	472,000 ^{2/} 5%	8,523,000 100%	1,995,000	10,518,000
CIAT	5,617,000 81%	623,000 9%	654,000 10%	6,894,000 100%	992,000	7,886,000
CIP	2,606,000 81%	260,000 8%	360,000 11%	3,226,000 100%	472,000	3,698,000
ICRISAT	3,925,000 80%	600,000 ^{3/} 12%	375,000 ^{3/} 8%	4,900,000 100%	5,500,000	10,400,000
ILCA	1,696,000 41%	2,396,000 59%	n.a.	4,092,000 100%	1,988,000	6,080,000
ILRAD	874,000 41%	1,256,000 59%	n.a.	2,130,000 100%	2,833,000	4,963,000
Totals	\$35,848,000	8,064,000	\$ 4,213,000	\$48,125,000	\$16,562,000	\$64,687,000
Percentages	74%	17%	9%	100%		
ICARDA				2,600,000	1,000,000	3,600,000
WARDA				800,000		800,000
Genes Board				1,100,000		1,100,000

^{1/} Includes salary adjustments.^{2/} Includes merit increases.^{3/} There are arbitrary allocations; they are not shown separately in ICRISAT figures.

Source: Annual Center Program and Budget Reviews.

TRENDS IN CENTER EXPENDITURES 1972 - 1977



* Eight centers included

Source: Table V-1.

⊙ requested

Chart V-3

Table V-4

Components of Budget Costs - Summary
(Eight Centers only)

(Thousands of \$)

	<u>Maintenance of Previous Programs</u>	<u>New Programs and Expansion of Old</u>	<u>Inflation</u>	<u>Capital</u>	<u>Total</u>
1975	25,465 54%	4,341 9%	2,942 6%	14,678 31%	47,424 100%
1976	35,848 55%	8,064 12%	4,213 7%	16,562 26%	64,687 100%

Source: Table V-2 and V-3.

Table V-5

CGIAR Contributions (1972-1976)
(US \$ Millions)

<u>Donor</u>	<u>Actual</u>				<u>Estimate</u>	<u>Total</u>
	1972	1973	1974	1975	1976	
Asian Development Bank				.300		.300
Australia		.005	1.015	1.210	1.755	3.985
Belgium	.140	.600	.380	.620	1.765	3.505
Canada	1.160	2.530	4.675	4.340	5.735	18.440
Denmark	.250	.225	.370	.400	.465	1.710
Ford Foundation	5.315	3.675	3.000	2.800	2.000	16.790
France			.130	.410	.520	1.060
Germany		1.805	3.040	3.960	4.730	13.535
Inter-American Bank			2.030	4.120	5.000	11.150
IDRC	.175	.345	.645	.985	1.790	3.940
Iran					1.975	1.975
Italy					.100	.100
Japan	.105	.230	.265	.675	1.200	2.475
Kellogg Foundation	.155	.290	.280	.290	.300	1.315
Netherlands	.375	.430	.555	1.235	1.500	4.095
New Zealand					.100	.100
Nigeria				.645	.640	1.285
Norway	.075	.185	.445	.805	1.090	2.600
Rockefeller Foundation	3.990	4.545	3.500	2.800	2.150	16.985
Saudi Arabia					1.000	1.000
Sweden	1.000	.150	1.490	2.275	2.190	7.105
Switzerland		.410	.140	.460	.855	1.865
United Kingdom	.690	1.110	1.920	2.425	2.970	9.115
UNDP	.850	1.000	1.465	1.930	2.360	7.605
UNEP				.600	.300	.900
United States	3.770	5.390	6.805	10.835	15.100	41.900
World Bank	1.260	2.780	2.375	3.225	6.800	16.440
Kresge	.750					.750
Total	20.060	25.705	34.525	47.345¹	64.390	192.025

^{1/} Contributions to WARDA, Genes and CARIS, amounting to \$1.390 million, are still estimates.

Source: Consultative Group and the International Research System -- An Integrative Report, 1976, Annex II, Table I.

Table V-6 presents a breakdown of the trends in core and restricted core contributions. For purposes of analysis we have divided the donors into two groups. "Initial donors" are those that have continuously contributed since 1972. (They are identified in footnote 1 of the table). The remaining donors who have joined the Group since 1972 we have called "additional donors." Chart V-4 shows graphically the trend in total contributions and those components of the total contributions accounted for by initial donors and additional donors. The proportion of the total accounted for by initial donors has declined from 100 percent in 1972 to 74 percent in 1976 showing that an increasing proportion of the rising costs of the CGIAR have been provided for by additional donors. Percent of total contribution in each year provided by first time donors in that year are shown in Table V-7.

Table V-8 presents data for special project funding by donor source for the period 1972-76.

In summary, these last four tables provide a perspective on the source of CGIAR contributions, whereas tables in earlier parts of this section provide expenditure data. Differences between the totals are explained in part by year to year carry-overs and earned income at centers.

Table V-6

CGIAR Contributions - Analysis
 1972-1976 (Core and Restricted Core)
 (Millions US \$)

	<u>ACTUAL</u>				<u>ESTIMATE</u>	<u>TOTAL</u>
	1972	1973	1974	1975	1976	
All Donors	20.060	25.705	34.525	47.345	64.390	192.025
% change		(+28)	(+34)	(+37)	(+36)	
"Initial" Donors <u>/1</u>	20.060	23.483	28.170	35.640	47.415	
% of total	100	91	81	75	74	
"Additional" Donors <u>/2</u>	0	2.222	6.355	11.705	16.975	
% of total	0	9	19	25	26	

/1 Donors who contributed continuously from 1972--Belgium, Canada, Denmark, Ford Foundation, IDRC, Japan, Kellogg Foundation, Netherlands, Rockefeller Foundation, Sweden, United Kingdom, UNDP, USA, World Bank.

/2 Donors who have joined since 1972--Asian Development Bank, Australia, France, Germany, IDB, Iran, New Zealand, Nigeria, Saudi Arabia, Switzerland, UNEP.

Source: Table V-5.

Table V-7New Donors Contributions, Annually 1973 - 1976

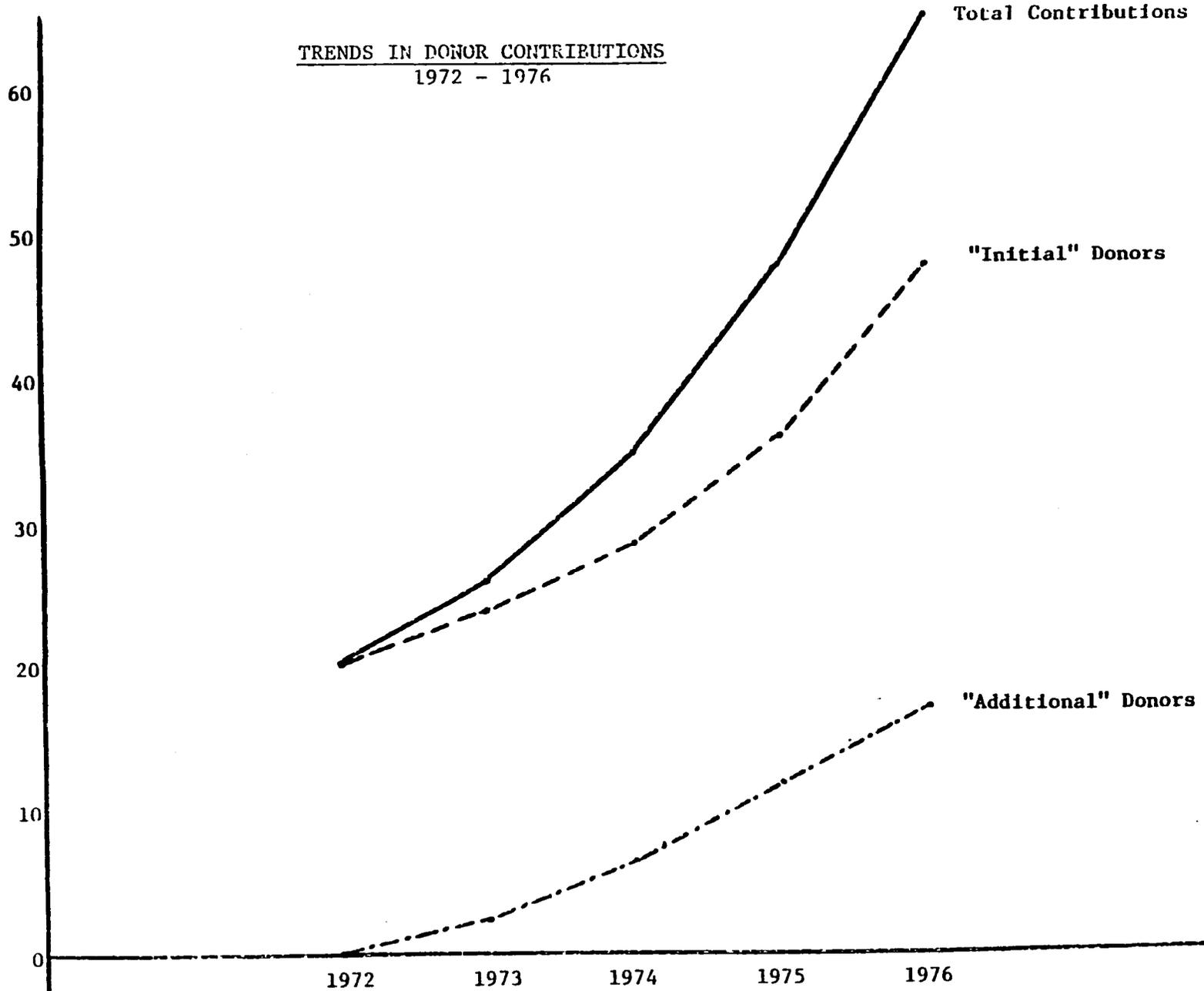
(in millions US \$)

	1973	1974	1975	1976
Total new contribution	2.220	2.160	1.545	3.175
Previous donors	23.485	32.365	45.800	61.215
Total contributions	25.705	34.525	47.345	64.390
% New donors contribution	9%	6%	3%	5%

Source: Consultative Group and the International Research System -- An Integrative Report, 1976, Annex II, Table I.

Millions of
US \$

TRENDS IN DONOR CONTRIBUTIONS
1972 - 1976



Source: Based on Table V-6.

Table V-8

Special Project Contributions by Source
1972-1976
(US \$ million)

Donor	1972	1973	1974	1975	1976	Total
Asian Development Bank	--	--	--	--	.325	.325
Australia	--	--	--	.135	.145	.280
Belgium	--	.101	.107	.079	.127	.414
Canada	--	--	--	--	1.426	1.426
Ford Foundation	.987	1.801	1.658	1.544	1.225	7.215
Germany	--	--	.052	.206	.130	.388
IDB	.050	.161	.748	.273	.938	2.170
IDRC	.087	.068	.448	.319	.914	1.836
Kellogg Foundation	.030	.077	--	--	--	.107
Netherlands	.091	.100	.093	.130	.409	.823
Rockefeller Foundation	.263	.307	.372	.317	.148	1.407
Switzerland	--	--	--	--	.225	.225
United Kingdom	--	.107	.071	.079	0	.257
UNDP	--	--	.050	.248	.976	1.274
USA	.656	.934	.968	1.230	2.826	6.614
Other						
FAO	--	.033	.059	.106	.173	.371
IMC Foundation	--	--	.015	.065	0	.080
Thailand	--	--	--	.011	.010	.021
IMP	--	--	--	.021	--	.021
Indonesia	--	.344	.142	.156	.600	1.242
N.I.H.	.050	.056	.051	--	--	.157
Zaire Government	.286	.219	.244	.111	.418	1.278
Genes Board	--	--	--	.050	--	.050
CIP	--	--	--	.075	.070	.145
IITA	--	--	--	.049	.076	.125
Unidentified ^{1/}	.229	.328	.458	.282	1.064	2.361
	2.729	4.636	5.536	5.486	12.225	30.612

^{1/} This component contains contribution from NFAC, NIH, CIDA, and Australia which were under negotiation at the time of the preparation of the budgets of the centers.

Source: CGIAR Secretariat.

PART B. ISSUES AND CONCLUSIONS

INTRODUCTION

The preceding Part A of this report has been devoted to a survey of the nature and dimensions of the task of increasing world food production and a brief account of the activities undertaken by the CGIAR in the past to help meet that problem.

In Part B, we turn to the key issues which are the concern of this review. These are presented and analyzed in three chapters:

- VI. Scope and Boundaries of the CGIAR
- VII. Scope, Boundaries, and Management of Centers
- VIII. Planning, Evaluation, Allocation, and Management for the CGIAR and Its Family of Activities

It will be noted that some of the issues discussed in these chapters were not specifically included in the Terms of Reference. The reason is that as the review proceeded it became obvious that in many cases topics not mentioned in the Terms of Reference were important to understand those that were. For this reason they have been included in Part B.

VI. SCOPE AND BOUNDARIES OF THE CGIAR

Although the initial impulse in establishing the CGIAR was to assure adequate financing for a set of International Agricultural Research Centers, the Terms of Reference adopted for the CGIAR were much broader ^{1/}. Subsequently, the TAC has recommended that several activities other than centers be financed through the CGIAR. In addition, suggestions have been made by various donors about direct financing of national research programs, endorsing certain activities as worthy of bilateral support (without trying to arrange direct funding through the CGIAR), and the CGIAR serving as a forum for the discussion of various topics related to strengthening agricultural research to benefit the food-deficit countries of the developing world.

The question of appropriate scope and boundaries for the activities of the CGIAR was included in the Terms of Reference for the present review and is the topic of this chapter.

Five basic questions encompass the issues involved:

1. What should be the geographic and commodity focus of the research financed through the CGIAR?
2. In what types of activities, including but not limited to research, should the CGIAR become involved?
3. What modes of operation, e.g., centers, consortia (networks), fora, should the CGIAR support?
4. How should the CGIAR interface with other agencies active in the same or complementary activities?
5. What should be the financial magnitude of the program of the CGIAR?

Geographic and Commodity Focus of the CGIAR

The serious state of the world food problem was one of the major factors leading to the establishment of the CGIAR. This concern has continued to dominate discussions about the future focus of the CGIAR.

In any approach to increasing food production, it must be recognized that crop and livestock improvement is only one component of

^{1/} See Chapter V.

a more complex food production system and that other key elements, especially land and water resources, must also be considered. It is essential that this resource base be studied and improved if the latent yield potential of new crop varieties is to be realized. Crop improvement must not be an end in itself but should be considered one component in the improvement of the total system.

Because of its present structure and size, the CGIAR cannot possibly be responsible for the total efforts required to solve the food production problems and should therefore be highly selective in what it chooses to support. For this reason it has deliberately concentrated its efforts on the improvement of specific foods and cropping systems within defined geographic regions of the developing world and within ecological zones in those regions. As the organization enters its sixth year, we raise the question: Is the work of the CGIAR focused in the most relevant areas? And in these areas are the most important food commodities being studied?

Criteria for selecting the most important food-deficit regions in which to focus the work should include analysis of demographic and nutritional factors contributing to the food demand, the extent and likely duration of the deficit, the trends in yields per hectare, and total production of major food commodities. This information, together with an understanding of the prospects for increased food production or availability through imports, can give a measure of a region's likely food deficit and need for assistance in the future.

This procedure may well identify major food target areas but may miss important subregions such as the high altitude tropics or sections of the population in the lower socioeconomic groups that face serious and chronic food deficits.

Having identified the most important region, the next task is to identify the most important or potentially important foods. Importance of food sources could be judged by their contribution to the diet, their nutritional significance, especially their protein levels and other important dietary constituents, and their popularity and widespread adaptation in food-deficit regions.

Another factor to consider is the probability of changes in the demand for particular foods stemming from shifts in food preferences resulting from rising incomes of the expanding urban populations in poor countries.

Considered from the point of view of suitability for CGIAR support one could ask, will improvement in the commodity increase food availability and improve income distribution? Will it be transferable and is it likely to be adopted? And, what is the likely scale of impact on production? Other important aspects include the potential for significant improvement and the time involved.

It should be emphasized that many donors are increasingly concerned about the problems of the small farmer and the rural poor. Both

groups have tended to receive less emphasis in previous agricultural development efforts. It must be recognized that the economic problems of these groups cannot be solved by agricultural technology alone. However, research supported by the CGIAR should take special cognizance of their needs.

The Koffsky 1/ report commissioned for this study and summarized in Chapter I concluded that emphasis should be given to the major sources of food in food-deficit, low income countries with shortages of foreign exchange. As shown in Chart I-1 and Table I-2, these important sources of food are the major cereals, roots and tubers, and grain legumes. Koffsky's conclusions are similar to those of TAC in their revised priorities paper.2/ TAC, using a comparable set of criteria to those previously listed, has recommended research on the major cereals, roots and tubers, grain legumes and ruminant livestock all of which are widely consumed and which collectively represent 80 percent of the food supply of the developing world.3/ On the basis of our criteria, Koffsky's analysis, and other recent studies of the world food situation,4/ it is apparent that the CGIAR has been making good choices regarding geographic regions and food sources.

Some important food crops, and also some non-food crops which can contribute to food availability of rural populations through the increased income they can generate have not been recommended by TAC at this stage. The reasons for not recommending them at this time appear soundly based, but they should not be excluded from consideration in the future.

Conclusion. The Koffsky analysis as summarized in Chapter I clearly points out the need for increased food output. In fact, his study in conjunction with the analysis in Chapters II, III, and IV indicate that there is an overwhelming need for research in the future and therefore a need to continue activities supported by the CGIAR. We conclude that the present CGIAR coverage of geographic areas and food commodities is appropriate and that there appear to be no major gaps. In addition to the issue of coverage, the fact that several center programs are not yet fully developed and that there is a reduced likelihood of major increases in fund availability (which is

1/ Koffsky, "World Food Needs."

2/ See Annex 4.

3/ Food and Agriculture Organization, "Agricultural Commodity Projections, 1970-80," Vol. II (FAO, Rome) 1971.

4/ "Meeting Food Needs in the Developing World," IFPRI; and "NRC Study on World Food and Nutrition," Report of the Steering Committee of the Commission on International Relations, National Research Council, National Academy of Sciences (Washington, D.C., 1975).

discussed later in this chapter), suggest that there are good reasons for not considering significant expansion of this coverage in the near future. However, TAC should continue to be active in exploring needs.

Types of CGIAR Activities

From the beginning, the centers supported through the CGIAR have concentrated primarily on research and technology development related to specific food commodities or to particular ecological zones. In conjunction with that major emphasis they have conducted a considerable amount of training. They have participated in efforts to get their technologies adopted in individual countries (technology transfer). They have arranged for information collection and exchange.

The current issue is to what extent the CGIAR should support additional activities whose primary focus is different from those presently supported. For example, should the CGIAR engage in direct support of national programs or extension activities?

In analyzing this issue we have considered four questions:

(1) Is an international effort the best approach to the problem or would national activities, perhaps supported by external aid, be preferable?

(2) Does the CGIAR have a comparative advantage regarding particular activities or are there other agencies that might deal equally well with the problems?

(3) Could a particular investment have a direct impact on food production, or are other intermediate links needed before the technology can be used? For example, the development of a new fertilizer technology might depend on substantial national or international investment before the results of the technology could be useful to farmers in increasing food output. On the other hand, an agronomic package requiring no complementary infrastructure or investment might be directly useable.

(4) Would supporting additional activities unduly complicate administration or divert resources from existing CGIAR activities?

It is understandable that individual donors may wish to undertake additional research activities under the aegis of the CGIAR, using the unique mechanism which it provides. We are fully sympathetic with the desire in the long run but, for the next three years we counsel against it because of the need to bring present centers to maturity and to limit the administrative load on the CGIAR instrumentalities during their formative years.

Although the existing centers have many characteristics in common, they also have unique characteristics related to their respective mandates. ILCA, ILRAD, and IITA have distinctive mandates that require the application of different criteria to evaluate and fund their programs. The same is true of WARDA and IBPGR. Increasing heterogeneity of CGIAR activities makes it increasingly difficult for a consultative, informal organization with funding designated independently by donor-members to keep its activities in perspective.

Consequently, it is our judgement that quite apart from questions of available funds, the CGIAR's capacity to add new activities and bring them to maturity is limited. Therefore, any suggestion for taking on activities different from those now supported should be carefully reviewed with regard to their potential impact on existing activities and on the CGIAR mechanism.

The one activity that we would advise adding is a formal forum function. Establishing the CGIAR resulted in representatives of a large number of donor-agencies meeting twice annually, thereby creating a situation that makes it easier for them to confer, not only about international agricultural research and activities of the CGIAR, but informally about many other matters in which they have mutual interests; i.e., research activities other than those of the CGIAR, bilateral aid to various types of national programs, etc. Discussions of CGIAR activities at these meetings tend to be focused on individual centers. With proper preparation, they could provide opportunities to discuss specific issues and program components that characterize most or all centers as well as other problems relating to research and technology in developing countries. These meetings should include researchers from developing countries.

We suggest that a program of forum discussions be organized by the CGIAR. Some discussions would be designed for representatives of donor-agencies to participate; others would be more appropriate for technical personnel from those agencies, from the centers, from other aid agencies, and from national programs in the developing countries. Topics for such discussions might include problems of developing national research activities; the impact of centers on national programs; the magnitude, nature and quality of research in selected developing countries, etc. There will need to be careful planning of these discussions. We suggest the TAC or other agencies be asked to commission discussion papers about specific aspects of research programs, both national and international to be presented at these fora.

Conclusion. We conclude that the CGIAR should limit its efforts for the next three years to the support of its present activities which concentrate largely on research and technology development. Other agencies, including donor-members of the CGIAR, now engage directly in activities, other than research, funded both bilaterally and multilaterally. We believe it would be both confusing and competitive for the CGIAR, apart from its support of centers, to mount programs in these other fields, important as they are.

The only new activity we recommend for the CGIAR is the organization of fora to discuss issues of relevance to the CGIAR, donors, and developing countries.

After the next three years, we suggest that the four questions discussed above would still be appropriate when considering new activities that the CGIAR might contemplate undertaking.

Modes of Operation in Research and Technology Development

Supporting research and technology development to raise technical and economic ceilings for food production has been the focus of CGIAR activities from the beginning, and we recommend that this continue. To accomplish that, the CGIAR has chosen to establish and support centers and other activities mandated to do so. However, the kind of center supported has not been, and need not be, homogeneous. Centers could have a global, regional, or ecological zone focus, and they could be focused on a commodity or systems approach or some combination of the above. They also could have an interdisciplinary production, factor, or disciplinary focus. To date, the CGIAR has focused primarily on the interdisciplinary production approach. Other modes of operation have been proposed, and the CGIAR has, in certain instances, such as WARDA, IBPGR and CARIS, adopted them.

The choice of method is necessarily a pragmatic one and has to be based on experience and the particular circumstances.

Centers. International Centers, the dominant mode of the CGIAR, are in many respects unique institutions.

Their strength and comparative advantage is that they have a great deal of independence, are strongly mission oriented, and have a sharp focus on applied research and technology development in relation to commodities that are of crucial importance in increasing food production in low-income food-deficit countries of the world. Members of centers work in interdisciplinary teams which permit direct personal interaction and maximize the potential for increasing production of specific food commodities. Simultaneously, this approach has an important demonstration effect for national programs that have, heretofore, been strongly discipline oriented.

Because of the ethos and excellent reputation of the centers, the emoluments, and good working facilities, each center has been able to attract a critical mass of first class scientists from all parts of the world. The mode of operation of the centers has provided those scientists with a stable and well-equipped research environment.

Because of their international status, the centers have been able to assemble and recombine extensive gene pools of the crops on which they concentrate and to maximize the genetic variability in these for use in breeding programs.

Largely on the basis of the early success with wheat and rice, the centers have developed a global reputation that allows them freedom in scientific exchange that no national program could hope to achieve. As a result, they can assemble and subject to testing in many countries new technology built around improved genetic material at a faster rate and on a greater scale than any national program. This results in a greater potential impact of the new technology and a considerable saving in time in its development.

As a byproduct of the centers' special character and their commodity or activity focus, the quality of the staff, equipment and facilities, emphasis on an interdisciplinary team approach, and their ability and willingness to develop cooperative working links with appropriate research groups in national programs, they have excellent possibilities for training technicians and scientists from developing countries. Although there is a limit to the amount of time and effort that the centers can put into training, it clearly contributes to the strengthening of national research programs and the building of a collegiate network of scientists and technicians who cooperate in the breeding work at the centers.

In summary the centers have already demonstrated their capacity for success and have identified areas in which they are uniquely successful. It is our judgment that this uniqueness applies particularly to commodity or systems oriented centers whose forte is the interdisciplinary team approach. It is less clear that these characteristics could apply to factor or discipline oriented centers that are more comparable to traditional developed country research approaches. Therefore, we conclude that the center approach has much merit and is uniquely fitted to the character of the CGIAR.

Consortia (Networks). The consortium approach (sometimes referred to as the network approach) to supporting international research has many attractive features. It attempts to build on existing institutions rather than creating new ones. It is, therefore, significantly cheaper than the center approach, to the extent that it need not involve major capital expenditures. Finally, it appears to involve the intended users of the research more directly in the process.

However, there are also potential weaknesses. First, a consortium is only as good as the quality of its components. Creating a cooperative research consortium to work on a commodity is unlikely to succeed unless the prerequisite of established research institutions has already been met. Here the situation in various countries of the developing world is very uneven. Second, the allocation of research funds by a committee of potential recipients of research funds is likely to lead more to political allocations than to hard programmatic judgments. While this defect might be overcome

by some other arrangements for fund allocation, there are few examples of success. History should not be allowed to rule out promising new proposals, but past experience suggests caution with respect to using consortia as a major mode of operation.

Direct Support of National Programs. Centers, as an integral part of their research methodology, have considerable interaction with national research programs. One purpose of their training activities is to strengthen national programs; a major focus of their seminars, conferences, and of the exchange of scientific personnel is similar.

Important as they are, such activities are confined largely to the commodities on which each center works, and the competence of center staff by no means covers the manifold problems to be faced in strengthening national research programs.^{1/}

Strengthening national research programs is a topic of concern to many other bilateral and multilateral agencies, and there is widespread recognition that this critical issue does not receive nearly the emphasis that it deserves. For that reason there have been proposals that the CGIAR adopt direct support of national research programs as an additional major activity. However, the magnitude and geographic dispersion of needed support for national research programs is so overwhelming that it would overburden the CGIAR approach to such an extent that other activities would suffer.

Conclusion. We conclude that, for the next three years the CGIAR should continue to concentrate on the support of centers and the current set of related activities and caution against undertaking any major new activities. This does not preclude continuing exploration by TAC of possible additional activities. Beyond that period, careful analysis should precede expansion of CGIAR activities.

Interfaces with Other Agencies

It is important that the CGIAR be constantly aware of what is being done by other agencies in the same or related field. It is our judgment that the centers by and large are quite well informed about complementary activities that relate to their mandates. The procedure of having related activities, e.g., IFPRI, IFDC, AVRDC, etc., report on their activities to the CGIAR is also valuable. Finally, the forum role discussed in the preceding section, if adopted by the CGIAR, could further increase interaction among agencies if some personnel from other agencies are invited to participate.

^{1/} See Chapter IV and VII.

Conclusion. If the CGIAR continues to restrict activities to those where it has a strong comparative advantage, we see the question of relating to other organizations as not presently a serious problem. We, therefore, conclude that no formal mechanism for dealing with interfaces need be developed.

Financial Magnitude of CGIAR Program

As shown above in Chapter V the cost of the CGIAR program has risen rapidly, matched thus far by equally rapid increases in donor support. As key question for the future is whether donor funding can be expected to continue to rise as rapidly as it has in the past.

Donor opinions on the rate of cost increase and availability of support vary. Some are relatively optimistic and feel that the fund availability need not be a constraining factor if the research programs continue to be highly productive and useful. Others feel that the total annual cost of the program is approaching a limit and that some way must be found to control future growth.

What is needed are (1) suggestions about procedures to be followed in considering new activities in the future; (2) better estimates of the probable cost of present activities over the next five years, based on different assumptions about program; and (3) some indication of potential fund availability.

Procedures for Future Decisions About New Programs. First, there is need for a careful analysis of the magnitude of commitments in terms of both initial costs (primarily capital investment) and anticipated annual program costs. One of the factors often overlooked in assessing the rapid increase in costs these past three years has been the fact that they have included a large component of capital costs because several centers are still in the developmental phase. If no new activities are undertaken in the next five years that component of costs will decline.

Second, an estimate of the minimum length of required time commitment to a center or related activity is needed. The CGIAR is supporting research enterprises whose life before payoff can be expected to be long because of the incremental nature of research results as discussed in Part A. Thus, the time horizons of commitments need careful attention.

Third, as a minimum, some qualitative judgment is needed about the potential payoff in terms of expected results and the length of time required to produce those results. We have pointed out in Chapter III the difficulties of quantitative cost-benefit ratio or rate of return analysis being applied to research activities. This does not, however, obviate the need for paying continuing attention to the goals of research enterprises, to the costs of reaching them and to the progress being made.

Projection of Costs Under Alternative Assumptions. Item VII of the Terms of Reference for this review state in part -- "The Committee will estimate the level of financing required by the international centers and other CGIAR supported activities over the next five years based on different assumptions with respect to programs." 1/

The projections that follow are restricted to a limited set of alternative models, all of which assume that the recommendations outlined earlier in this chapter are accepted. At the end, we give some examples of additional costs that would be added in case of CGIAR should decide to undertake additional activities.

The estimates of cost through the five-year period 1977-1981 are presented in terms of constant 1977 dollars and also in terms of current monetary value for each year assuming a 10 percent per year inflation rate. The advantage of presenting both estimates is that it allows the substitution of alternative inflation rates to ascertain their effects on total costs. It should also be borne in mind that while the constant dollars cost estimates are more reassuring in terms of magnitudes, when the financing occurs, the actual cost will be in terms of that year's dollars.

Four alternative levels of cost are presented. Each is described in turn.

Model I: The "Austerity" model assumes that once a center has reached maturity, it will receive no new funds for fixed capital or new programs. Budget increases would reflect only inflationary and normal non-cost-of-living salary increases. This model is perceived to represent the minimum that the current system would cost with no new centers or activities and without a real decline in existing programs. This model is based on the following assumptions: (1) no new activities are added, (2) present activities are continued at existing levels to maintain approved programs, and (3) the newer incomplete centers are completed to originally planned staff and physical size.

IRRI, CIMMYT, IITA, and CIAT were classified as mature centers, and their 1976 budgets were used as the base. For budgets 1977 through 1981 their core operating budgets were increased by 3 percent per year for non-cost-of-living related salary increases such as merit increases and promotion. 2/ For these centers no fixed capital expenditures were included.

1/ See Introduction.

2/ The 3 percent is based on the fact that for most established centers salary costs are approximately 60 percent of operating budget, and that merit and promotion increases in some comparable research institutions average about 5 percent of salary costs.

Second, maturity dates for the remaining centers were assigned as follows: CIP, 1977; ILRAD and ICRISAT, 1978; and ICARDA and ILCA 1980. In the years prior to maturity the centers own projected costs for both staff and capital were used. The one exception was ILCA where their budgeted inflation estimates were deflated beyond 1977. For the years after maturity, we allowed the same 3 percent per year for salary increases as for the mature centers. Also, after maturity no capital expenditures were included.

Regarding other activities, the 1976 budgets of WARDA and IBPGR were increased by 3 percent per year. No funding beyond 1976 for CARIS was included. After the basic projections, 10 percent inflation per year was added to core operating budgets to get monetary totals.

Model II "Normal": This model accepts budget costs as projected by the centers until 1980 and increases budgets beyond 1980 with allowances for increased salary costs and modest increases for new programs and capital. It probably indicates lower annual costs that would prevail with unrestrained growth because the levels of increase in new programs and capital it indicates are below the actual averages of the last several years. The model is based on the assumptions: that no new activities are added and all existing activities are funded at projected levels until 1980 with allowance for modest program growth for 1981.

For all centers their projected core operating and capital costs through 1980 were used as presented in their 1977 program and budget proposals. Beyond 1980 we increased core operating budgets by 8 percent per year on the basis of 3 percent salary costs and 5 percent new program growth. Capital budgets were increased by 5 percent of the previous year's core operating budgets.

For IBPGR and WARDA, which have not projected budgets beyond 1977, their subsequent core budgets were increased by 3 percent per year. Again current (monetary) dollar cost were derived by using a 10 percent per year inflation rate.

Model III "Limit on Senior Scientists": Model III is a modification of Model II in that senior scientists were frozen at the 1976 level if that exceeded 60 or were frozen at 60 when that number was reached. The only center affected is IITA and as a result there is little cost difference between this model and Model II.

Model IV "Budgetary Growth Paths": It is recommended later in the report that centers be requested to develop budgetary growth paths using the concept of a desirable size for centers. The model presented here is a preliminary estimate of what these growth paths might look like.

Four centers are now at least seven years old and can be presumed to be at a stage of maturity where they might level off either in number of staff or in the size of their core budgets if the principle of a maximum reasonable size of center is to be adopted. They are IRRI, CIMMYT, CIAT, and IITA.

For the other centers, it seems reasonable to presume that ICRISAT, ILCA, and ICARDA may ultimately be comparable in size to the four older centers and that they should be allowed (for the next three years) to grow toward that size as rapidly as is (a) prudent internally and (b) supportable by the overall level of donor financing likely to be available. CIP and ILRAD, because of the nature of their current mandates, should probably have a smaller ultimate size.

Taking all of the of the above factors into account, it is assumed that for the next three years, a maximum size of core operating budgets be set at \$12 million (in 1977 dollars) and that the permissible rate of growth of individual centers be as shown in Chart VI-1. This model sets as an upper limit an amount just above that requested for CIMMYT in 1977 which, excluding inflation, is only slightly above its budget in 1976. It sets growth paths for the other three older centers, IRRI, CIAT, and IITA, that begin to level off but continue to grow at a modest rate toward CIMMYT's size in the period 1977-79. This is done in order to give some priority to the needs of newer centers that are younger and should now be growing rapidly.

It would allow the operating budgets of ICRISAT, ILCA, and ICARDA to grow at the rate of \$1 million annually, in real terms. Historically, that is approximately the rate at which the older centers grow at similar periods in their development. It would allow CIP and ILRAD to grow slightly less rapidly than other centers in the next three years, in anticipation that an ultimate size for each of them might be set somewhere in the range of \$7.5 million for CIP and \$5.5 million for ILRAD.

It is recognized that these assumptions are somewhat arbitrary and can be criticized from many standpoints. However, they are workable; they would allow forward planning by both centers and donors; they would leave substantive allocations within centers to the centers and their trustees.

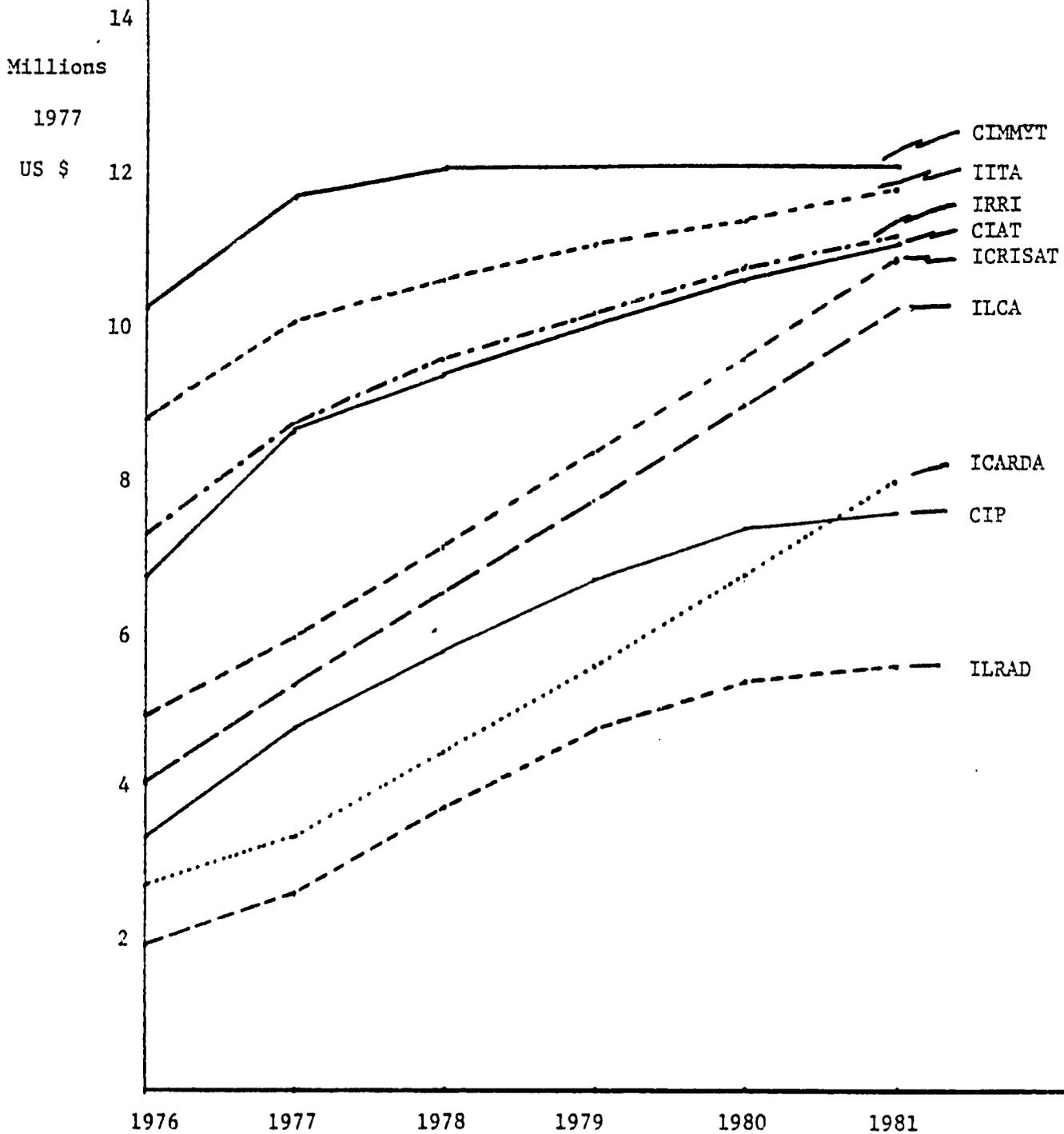
Under these assumptions the requested core operating budgets for 1977 as presented at centers week were used except for ILCA, which was reduced from the \$6.247 million requested to \$5 million. This still is an increase of \$1.246 million over estimated expenditures in 1976.

All other budgets lie within, or reasonably near, the amounts the proposed growth paths would indicate if the base year had been 1976.

Capital estimates in this model are generated by excluding working capital items in the 1977 budget and by deferring \$3.5 million of capital expenditures requested for 1977 to 1978.

The results of the four models are presented in Table VI-1. The range of projected costs in 1981 is from \$73.5 million to \$95.1 million in 1977 dollars. Comparable monetary (current) dollar figures range from \$108.7 million to \$131.3 million. The lower figure is the Austerity Model, the higher the Growth Path Model. The so-called Normal Model is \$88.5 million in real terms and \$121.4 in current monetary terms.

Chart VI-1

Model IV Growth Paths - Core Operating Budgets

It should be noted that the Normal Model is still very conservative even though center projections are accepted. In many instances, centers project no increase in budget in real terms beyond 1978. This is unrealistic. All models show a leveling between 1977 and 1978, because capital programs at the newer centers will be largely completed and any contemplated new activities would not yet be on stream. The Austerity Model is perhaps unrealistic in the sense that it allows no replacement of equipment or capital in mature centers. Finally, all estimates in current dollars, especially as we approach 1981 are uncertain because of the allowances for inflation.

The above four models assumed no additional new activities. If the CGIAR were to take on additional activities it would simply have to add the additional cost to any one of the models presented above in 1977. As examples, the water buffalo proposal discussed by TAC and the IDRC. post harvest proposal are used in Table VI-2. The estimates for the water buffalo program presented to TAC through 1980 were used. The 1981 budget simply increased by 3 percent. For the Post Harvest Technology Project we began with a basic cost of \$600,000 based on \$100,000 per year total cost per member of a five-person technical committee and \$100,000 per year for administrative and advisory committee costs. In years beyond 1977, we increased the previous year's budget by 3 percent. In both cases no capital costs were included. The detailed projections are in the upper portion of Table VI-2.

If the CGIAR chose to add one or more new centers, the potential costs are presented in the lower part of Table VI-2.

The actual costs of ICRISAT and projected costs at ICARDA were used as general guidelines. ICRISAT had capital costs of \$21.150 million and core costs of \$18.149 million for the years 1973 to 1977. ICARDA is projected to have capital costs of \$17.9 million and core costs of \$26.756 million for the years 1976-80.

We assumed that a new center beginning in 1978 would have four-year capital costs of \$14 million and core costs of \$16 million. For a second center beginning in 1979, we assumed a three-year cost of \$6 million for capital and \$9 million for core for the years 1979-81. In both cases the full start-up cost would not be incurred by the end of 1981. We estimate full capital costs of new centers of the scope of ICRISAT and ICARDA would exceed \$25 million.

In summary, if the CGIAR were to adopt the Normal Model, add two new activities and two new centers the total current monetary cost of the CGIAR family by 1981 would be \$148.8 million. It is left to the reader to compute other combinations.

Future Funding Potential. The Terms of Reference also requested that some estimate be made of future fund availability. Our basic view is that projecting future fund availability is even more hazardous than projecting costs. Almost every donor interviewed reported that if they had been asked three years ago if their contributions would be at the level they are for 1976 they would have answered emphatically "no" Thus to some extent demand creates its own supply.

TABLE VI-I
FUTURE COSTS OF CGIAR ALTERNATIVES PROJECTED
TO 1981 ^{1/}

A. PROJECTIONS IN CONSTANT 1977 DOLLARS						
	1976	1977	1978	1979	1980	1981
	Estim.	PROJECTED				
(millions of constant 1977 dollars)						
MODEL I: AUSTERITY						
Capital	15.9	16.7	7.3	5.9	6.0	0.0
Operating	51.0	57.9	63.2	67.7	71.3	73.5
TOTAL	66.9	74.6	70.5	73.6	77.3	73.5
MODEL II: NORMAL						
Capital	15.9	24.7	12.3	10.5	8.7	4.8
Operating	51.0	62.2	67.8	72.8	76.6	83.7
TOTAL	66.9	86.9	80.1	83.3	85.3	88.5
MODEL III: NORMAL WITH MAXIMUM SIZE (IITA 1976, CIMMYT 1977)						
Capital	15.9	24.7	12.3	10.5	8.7	4.8
Operating	51.0	61.3	66.7	72.0	76.2	82.6
TOTAL	66.9	86.0	79.0	82.5	84.9	87.6
MODEL IV: INTERIM BUDGETARY GROWTH PATHS						
Capital	15.9	18.9	13.3	7.6	5.7	4.5
Operating	51.0	62.4	70.9	78.3	85.2	90.6
TOTAL	66.9	81.3	84.2	85.9	90.9	95.1

B. PROJECTIONS INCLUDING 10% INFLATION PER YEAR (millions of current dollars)						
MODEL I: AUSTERITY						
TOTAL	66.9	78.2	80.9	90.7	102.3	108.7
MODEL II: NORMAL						
TOTAL	66.9	88.8	89.0	99.4	109.0	121.4
MODEL III: SIZE LIMIT						
TOTAL	66.9	88.2	88.4	93.8	108.8	120.4
MODEL IV: GROWTH PATHS						
TOTAL	66.9	81.3	91.3	101.6	116.4	131.3

^{1/} Does not include costs of secretariats.

TABLE VI-2

Future Potential Costs for CGIAR with New Activities Included

A - New Activities B - New Center(s)

	1977	1978	1979	1980	1981
	millions of constant 1977 dollars				
A. New Activities					
Water buffalo-core	.3	1.5	1.8	2.1	2.4
Post harvest-core	<u>.6</u>	<u>.7</u>	<u>.8</u>	<u>.8</u>	<u>1.0</u>
Total	<u>.9</u>	<u>2.2</u>	<u>2.6</u>	<u>2.9</u>	<u>3.4</u>
B. New Center(s)					
(1) 1978 Capital			2.0	4.0	8.0
Core operating		<u>1.0</u>	<u>3.0</u>	<u>5.0</u>	<u>7.0</u>
Total		<u>1.0</u>	<u>5.0</u>	<u>9.0</u>	<u>15.0</u>
(2) 1979 Capital				2.0	4.0
Core operating			<u>1.0</u>	<u>3.0</u>	<u>5.0</u>
Total			<u>1.0</u>	<u>5.0</u>	<u>9.0</u>
With both centers added		<u>1.0</u>	<u>6.0</u>	<u>14.0</u>	<u>24.0</u>

Donors we interviewed mainly anticipated continued support of the CGIAR with modest increases in real terms and, as a minimum, increased contributions to cover inflation. A few project significant real increases. Few if any project declines. Most donors, however, are firm in the view that the rate of increase of CGIAR costs over the past four years cannot be sustained.

Practically all donors tie possibilities of increases to the practical achievements of the CGIAR centers and other activities. Many emphasize strongly that the possibilities for increased contributions depend on the extent to which the results of CGIAR research activities appear in practical farming in developing countries.

We have consulted with the CGIAR Secretariat and others regarding the potential for new donors. It appears that the obvious pool of potential donors is smaller than in previous years. The EEC and IFAD are seen as possibilities. With a lesser degree of certainty, some additional OPEC countries and regional banks are also suggested. One thing is clear however, that potential new donors are likely to have more regional or special interests in supporting activities than previous donors. Thus, as in the past, future contributions to the CGIAR will depend on established donors maintaining or increasing their contributions.

Conclusion. On the basis of discussions with donors about future fund availability, and analysis of potential new donors, we conclude that the CGIAR will be able to finance modest real growth in the existing centers for the next three to five years. However, we doubt that the climate is right for undertaking major new activities. This conclusion coupled with the previous conclusions in this chapter argue strongly that the next three years should be a period of consolidation. While we conclude that only modest real growth of the centers as a group is realistic in the near future, we recognize that the rate of growth should vary among centers because several of them are young and need to reach maturity.

VII. SCOPE, BOUNDARIES, AND MANAGEMENT OF CENTERS

Our analysis so far has concluded that the CGIAR should support, as its primary focus, research and technology development on important food sources primarily through international centers. The next task is to discuss issues that arise in conjunction with the scope, boundaries, and management of center programs.^{1/}

The chapter begins with the concept of an integrated program because it is our conclusion that defining programs by source of funds or as on-campus or outreach is misleading and does an injustice to the necessarily integrated way in which centers approach their tasks. We, therefore, discuss only those factors that potentially distort a center's program. Within this context of an integrated program we discuss the question of program balance, the thorny question of cooperation with LDC national programs, interfaces with advanced research institutes, and the issues relating to the different sources of funding (the so called special projects issue). We then proceed to a discussion of the desirable size of centers and the longevity of programs within centers and the necessity for developing more effective forward planning procedures. Finally, issues of center management are addressed, including the problems of inter-center relationships, the selection and appointment of board members, and the maintenance of the vigor and quality of the staff.

Concept of a Fully Integrated Program

As discussed in Chapter V, centers are involved in a range of research activities in many countries. The program of a center is multifaceted and is influenced by a number of factors. It is influenced by the mandate of the center, the location of the center, the geography of its crop or crops, the research strategy adopted, the mix of activities undertaken, the necessity for cooperation with national programs, the desirability for interaction with advanced country research institutes, and by the sources of funds. The first three of these factors are determined when the center is created and the fourth is clearly specific to the center. The latter four are of relevance to this discussion.

A center in developing its program attempts to achieve a rational balance between the various research projects and other related activities in which it is engaged, but a number of factors can distort this balance. The most serious have been the existence of two independent sources of funds, the practice of defining programs by the source of the funds and the lack of any attempt by centers to describe and

^{1/} We have deliberately focused our analysis on centers because they account for over 95 percent of cost of the system. However, most of the principles expressed in this chapter apply equally well to the other activities supported by the Group.

present an integrated program for review. The funds derived from individual donors, independent of the CGIAR, have been used to fund a range of projects especially those involving support for cooperative programs in LDCs and other off-campus activities involving interactions with advanced research institutions and training. These are the so called special projects which are discussed in greater detail later in this chapter. In the absence of any agreed upon principles to guide centers in the acceptance of special projects and the lack of integration between these and the projects funded through the CGIAR, there is a real danger that the balance of the center program can be severely distorted and deflected from the primary research objective. The task of the center, given these multiple influences, is to create and maintain an internally consistent, integrated program.

Conclusion. Our purpose in this section has been to draw together a set of apparently different components into the concept of a holistic program. It is essential that a center's program be considered as an integrated whole. To recognize the interdependence of these factors underscores the importance of balance, and the need for integrated use of multiple sources of funds. It also explains why it is difficult to deal with these factors in any crisp policy manner. Our overall judgment is that the centers and their boards are best qualified to make the ultimate decision on these important issues. What we are proposing in the subsequent sections are some possible guidelines for making these decisions.

Program Complementarity and Balance

The character and composition of different centers' programs rightly vary in accordance with their mandates and the ecological zones in which they operate. Some research programs are commodity oriented with a strong emphasis on genetic improvement. Others are cropping systems oriented. Increasingly, however, centers do both, and in addition are involved in socioeconomic research and training.

Some idea of the relative emphasis given to these various programs by different centers in 1976 is indicated in Table VII-1.

These data confirm that interdisciplinary commodity research, including off-campus cooperative research with national programs is the dominant activity at the developed centers. IITA and IRRI are currently spending about 25 percent of their core funds on cropping systems research which is closely integrated with their commodity programs. The figures quoted for training are probably underestimated. Much of the cooperative research with national programs has a training component

Table VII-1

Proportion of Core Operating Funds Devoted to
Various Aspects of Research and Training in 1976

	<u>Commodity Research</u> ^{1/} <u>including cooperation with</u> <u>national programs</u>	<u>Systems</u> <u>Research</u>	<u>Socioeconomic</u> <u>Research</u>	<u>Training and</u> <u>Conferences</u>	<u>Support</u> <u>Services</u> <u>Operating</u>	<u>General</u> <u>Administration</u>	<u>Total</u>
CIAT	54	-- ^{2/}	-- ^{2/}	12	24	10	100
CIMMYT	53	--	3	16	18	10	100
CIP	56	--	3	13	17	11	100
IITA	34 ^{4/}	28	-- ^{3/}	6	21	11	100
IRRI	34	26	4	5	23	9	100

1/ Cooperative research involves a training component.

2/ Economic and systems research integrated with commodity programs. No separate budget item.

3/ Economic research integrated with systems research.

4/ Research support allocated to commodity and systems research in proportion 3.2.

Source: 1977 Program and Budget Proposals of centers.

that has not been identified. A similar analysis of cooperative research (country) programs supported by special project funds for these same centers in 1976 indicates that approximately 30 percent of the funds were devoted to cooperative commodity research and 20 percent to training^{1/}.

The integration and balance between the major thrusts in a center's program is important and the only issue would appear to be, what constitutes a desirable balance and how is this judgment made?

Below four major program thrusts are summarized which complement the central commodity program of the centers. Significant over-expansion of any of these could unbalance the center's total integrated program.

Cropping and animal production systems research has been adopted by a number of centers as the most effective framework in which to develop its research program. Frequently the approach has been to identify the most critical underlying constraint in the ecological zone involved, such as water or soil management in the case of IITA and ICRISAT, and then tailor particular crops or cropping systems to meet these major constraints. There is no evidence that current investment by centers in such activities is excessive or out of balance with the remainder of the program.

Cooperation with national programs is an integral component of the research activities of all centers. It is essential to their international testing programs. It is also necessary to ensure that the technology developed at the centers is transferable, suitably adapted, and useable in target areas. Investment in this activity has grown as centers have matured, and there is no reason why this may not continue, provided the projects are appropriate and in balance with the centers' research program.

All centers (except ILRAD) now conduct some socioeconomic research. In some centers much of it is separately organized and conducted. In others it is integrated into commodity and cropping systems research. Whichever route is followed, a prominent part of it is the identification of technical, economic, and social constraints to the adoption of specific new technologies in target countries. This approach, coupled with research on the consequences of adopting new technologies, has pioneered an important new field which will help to sharpen research objectives both in the programs of the centers and in the countries which they serve.

The training and conference activities of centers are vitally important to assist in strengthening national research programs. Training by centers at technical and professional levels provides scientists in these countries with highly relevant on-the-job experience and provides

^{1/} From conversations of the study team with center directors.

the centers with trained cooperators in future collaborative research programs. Since the investment in training varies between centers, depending on the stage of growth, and over periods of time at any one center, it is not possible to recommend desirable investment guidelines for all centers.

Conclusion. All of the program activities discussed are highly complementary elements in each center's program. Each center makes decisions about the balance among them in preparing its budget, but the criteria used in arriving at those decisions are seldom made explicit. It is important that the centers retain flexibility in developing center programs and the CGIAR should simply monitor shifts in emphasis and seek explanations of these rather than attempt to set firm guidelines.

We conclude that each center should draft a set of criteria for its own use both in selecting research projects and in determining how much to allot to each of its other activities. Such a set of criteria would be useful in any center reviews that may be undertaken. It would also demonstrate to donors that programs are in fact determined on the basis of objective criteria in order to maintain the most productive balance among the center's activities.

Cooperation with National Programs

As noted above, cooperation with national programs, or outreach as it has been called in the past, constitutes an important and necessary component of the research programs of all centers. It extends the scope of the center's own research program and at the same time, through example and training, is helping to strengthen national research capacity.

Some of this cooperative research is carried out through frequent visits by center scientists. In other cases, formal cooperative projects are arranged with resident center scientists participating. Investment in cooperative projects of this latter type has increased as centers have developed new technologies and have acquired sufficient staff and the capability to extend to more areas.

One important feature of cooperative research is the potential it offers for centers to play a catalytic role in building a collegial network of competent national scientists. This is a dynamic process and with the strengthening of the national research capability, the opportunities for a two-way flow of ideas and technology are enhanced.

The question, therefore, is not whether cooperation with national research programs is a legitimate activity, but rather, how far centers should go in this activity. What are the boundaries, and how can these be defined in broad terms to guide centers, while allowing them to retain their flexibility to assist countries with widely different levels of development and available expertise?

In considering this question it is necessary to see the problem from a number of different angles.

Donors tend to be ambivalent about this issue. They are eager that centers not become too ingrown in their research, but they are concerned also that the centers may deploy their limited resources too widely, causing their programs to become unbalanced and their efforts dissipated over too broad a range of activities.

It is not difficult to state an appropriate principle for centers. The central thrust of each center should be to engage in research and technology development and to cooperate with national research and production programs to the extent necessary to further the center's own research activities. (Although this may be a conservative view, it leaves scope for interpretation, and centers will vary in setting their boundaries.) In general most outposted staff whose primary responsibility is in research, do inevitably become involved in some extension and production activities as a result of their normal research commitment.

The research staff in the national programs are the clients, and they do not believe that cooperation should be limited to assisting the centers' research programs. They see the centers as valuable resources they can tap to help strengthen their own adaptive research and production programs even though the centers' competence may be restricted to particular commodities.

The result of these varying viewpoints is that centers are under considerable pressure to cooperate with national programs beyond the needs required by the center's own research program. This pressure comes from the national country programs and also from the donor-agencies eager to assist programs in particular countries. In this regard, donor-members should not feel that centers have an obligation to accept such projects just because the same donor-agency also contributes to the center's central program.

Another reason for center involvement in national programs stems from some centers' belief that they have a global mandate not just with respect to research but a global mandate to raise national production of their particular commodities all over the low latitude world. The terminology in which the mandates of some centers are couched justifies that attitude. We believe that to be a mistake. To succeed, centers would have to become active in the whole range of necessary and sufficient conditions to increase production, described in Chapter II. If the term global mandate is to continue to be used at all, it should

be interpreted to mean global leadership among centers in research on a particular commodity or commodities. It should not be interpreted to imply a responsibility with respect to national yields or national production. Nevertheless the centers should remain vitally concerned with yield and production levels and must continuously be in touch with what is happening in farmers' fields.

In any analysis of the problem it is obvious that the technology available in international research centers is far ahead of that currently practiced in the developing world and that there is an urgent need to raise the achievement distributions of the small farmers in these countries. The centers are very conscious of this need and are anxious to help in strengthening national programs and in particular to see their technology used. However, the general strengthening of national programs requires major changes in national administrative procedures, to forge effective links between research and training research workers. Many other kinds of research in addition to that engaged in by centers are required to strengthen national programs. Moreover, the dimensions of the problem throughout the developing world far exceeds the capacity of the centers to respond. If they tried to respond they could readily be swamped with a volume of requests that would divert them from their principal and essential mandate.

Thus the problem for the centers is not the existence of this need or their obvious desire to help, but the magnitude of the effort required to bridge this gap. In approaching this problem we believe that centers should be receptive and responsive to opportunities to assist with this task, provided funds are available and their boards of trustees approve. At the same time they should be mindful of the areas in which they are adept and in which they have a comparative advantage. The extent of their involvement in cooperative programs should also be determined by the need to avoid distorting their central research thrust, the need to maintain a balanced program, and not to overreach their managerial capacity.

Our study of this problem has led to the conclusion that the definition of discrete boundaries to delineate the appropriate range of cooperative activities for a center is very difficult and probably not useful. Flexibility is needed in this respect because the appropriate boundary will vary to some extent with the type of commodity, its stage of development, the strength of the national research program, and the availability of staff and resources at the center to conduct the program.

A list of the types of activities that might be considered appropriate, sometimes appropriate and inappropriate, depending on the circumstances, are listed on the next page.

Conclusion. We conclude that cooperation with national programs is a vital component to the research activities of all centers. As a general rule the primary purpose of such cooperation should be research to advance the central mission of the

Range of Cooperative Activities with National Programs

Appropriate

Participation in national research programs to further the centers' research mandate and to assist in the development of the national research capacity. Such activities might include:

Evaluation of promising new breeding material for adaptation, productivity, and pest tolerance

Two-way exchange of superior breeding lines from international and local testing programs

On site evaluation of biological and socioeconomic constraints to farm production and studies of the consequences of new technology

Testing key components of farming systems and evaluating farm machines suited to the needs of small farmers

Identifying potential trainees and training trainers in research and production at regional centers or in conjunction with country programs

Staff visits and sponsorship of workshops and conferences at regional and country centers to disseminate results and technical information

Sometimes Appropriate

On-farm trials to demonstrate the applicability of a center's new technology

In-country training of production personnel and advice on production systems

Consultation on problems relating to regional or country production problems

Assistance in the development of a national research institute involved in research and extension in a commodity or technology of direct relevance to center

Advice on research organization staff recruitment, personnel policies and equipment

Inappropriate

Management of national research organizations

Participation in full time extension and delivery activities

Management of national agricultural production programs

Responsibility for general technical assistance projects

Making recommendations to national governments on agricultural economic policy and related issues

center. However, centers should be alert and responsive to opportunities for additional cooperation with national programs, provided extra-core funds are available, the project is appropriate, it does not distort their central research thrust or place an undue burden on the center's administrative personnel, and the review procedures enunciated on pages 96 - 98 are met. If the project does not conform to these guidelines, the center should question its involvement and suggest that the requests for assistance be channeled to another donor or agency.

Interactions with Advanced Research Institutions

Although centers by design are primarily concerned with applied research, it must be remembered that elements of basic research are essential components of all good applied research. Without this component of basic research and the capacity to communicate and draw on relevant research findings from all over the world, centers will rapidly lose their special character and become regular field experiment stations.

Thus the question is, how can centers, while retaining their primary mission orientation and focus on applied objectives, remain actively involved in basic research to keep abreast of the latest scientific developments and serve the basic research needs of their principal crops?

Two recent developments have increased the opportunities for centers to link with relevant research programs in advanced research institutions.

One of these is the opportunity for a center to contract specific research projects that are deemed important for the progress of the center's research. CIP is making considerable use of such contracts in lieu of enlarging its own staff and acquiring the necessary equipment. Such arrangements are sometimes financed from core funds or from external sources. One donor in 1977 is designating 10 percent of its 1977 contribution to centers in the form of restricted core expressly for this purpose.

The other new development is the availability of special funds for research in North America and in Europe to support research relevant to problems of food production in developing countries. Scientists in advanced research institutions are eager to work cooperatively with the centers and several major donors are particularly keen to increase the opportunities for their countries' scientists to collaborate with the centers. The only danger with this approach might be that centers could be overwhelmed by requests for cooperation and in the process they could

be diverted from their main research purpose.

To avoid this, in any arrangements for research to be done by or in collaboration with advanced research institutions, it is important that the work be of significance to the center's program as seen by the center itself, and that there be an effective return for the investment of time devoted to the project. Centers must be protected from being swamped by requests for cooperation or for certification of projects submitted as part of an application to granting agencies. Also, they must be protected from donor pressure to undertake projects that are of little direct interest. Finally, there should be a minimum of formality and maximum contact between the scientists participating in the research. Opportunities for reciprocal visits and periodic reviews of programs involving staff from both the center and the external institute are important and necessary to ensure the success of such projects. It may be preferable that funding for such projects go directly to the advanced institution and not through the center, provided the above conditions are honored.

Conclusion. Interaction between centers and advanced research institutions is important for centers (1) to sustain interest and activity in basic research in the center's program, and (2) to gain access through contracted research to the special professional qualifications and equipment resources of other research agencies. Centers should also take advantage of the increasing interest and funds available for scientists in advanced countries for research of relevance to LDCs, provided this does not divert them from their ongoing research.

Multiple Sources of Funding

Two sources of funds are available to centers. The first is those provided under the aegis of the CGIAR which are known as core funds. Their application can be unrestricted or restricted in accordance with the wishes of the donor. The other source comes in the form of bilateral contributions, obtained independently from donor agencies, many of whom are also substantial donors within the CGIAR. These have been used to fund what have been called special projects, however, in the future we propose to designate all funds from these sources as extra-core. The rationale for this nomenclature is that those funds generated by the CGIAR from its donor-members are seen as the core funds of the group, either freely allocated by a center or restricted to particular projects, whereas those flowing to the centers independently of the CGIAR are categorized as outside the core funds, or extra-core.

Core funds, and to a large degree restricted core funds, because of their greater reliability, are used to support the central and critical components of each center's program. The only difference in these two

categories is that restricted core, as the name suggests, is used to fund specific aspects of a center's central program.

Extra-core funds represent a valuable additional source of funds for centers. They can be used to supplement the central thrust of the program or to finance additional activities which, nevertheless, are relevant and contribute to the center's approved goals. One of the most common uses of these funds has been to finance cooperation with national programs in individual countries.

Extra-core funds provide centers with a greater degree of flexibility in developing their programs because they can be negotiated at any time and because they provide a way of obtaining additional money from donors who may have funds available for single-country or regional projects that are not available to support the program conducted at the center. In the past, as a general rule, projects supported by extra-core funds have not been reviewed by TAC or the CGIAR Secretariat.

The availability of extra-core funds can encourage centers to undertake tasks that may be inappropriate to their mandate. Centers also can be placed in a delicate position if approached by a donor with a proposal for a particular project which is also a major contributor to the center's core budget.

One of the main problems associated with multiple sources of funds is that programs have frequently become identified more with the source of funds than with the activities involved. Also, the acceptance of a large number of extra-core projects may unbalance a center's program and distort its emphasis. This same criticism could also apply to the excessive use of restricted core funds by donors. Both of these factors can also impose additional strain on the center's administration and may have long term implications for expenditures on maintenance and personnel. This is particularly relevant if the responsibility for funding these projects is subsequently transferred to the CGIAR and becomes a charge against core funds.

In the past, projects funded from extra-core sources were not reported in the program and budget proposals of centers (as of 1976 this is now done) and thus, donors were not certain how much of a center's actual program was being reported at Centers' Week.

Conclusion. To help meet the problems caused by multiple sources of funding, we urge that each center's legitimate activities be viewed as a single integrated program, and judgments about the activities each center should undertake should be made by its board of trustees on that basis.

To implement the concept, we suggest that all activities of centers be covered in their program papers, regardless of the source or sources of funds. Their

budgets should identify all sources of funds whether core, restricted core, or extra-core. All activities should be subject to the review procedures adopted by the CGIAR.

Desirable Size of Centers

Maturing centers have grown rapidly in recent years (see Chapter V) both in terms of their staffs and budgets. Because of the concern about the resources for the future, one question being asked is, how large should centers become?

Our perception about the desirable size for centers, supported by the CGIAR, grows directly out of three considerations. One is the special nature of centers' research methodology. The second is their location in developing countries. The third is the fact that there are a number of centers still to be completed at a time when the availability of additional funds is in some doubt.

The research methodology of the centers includes interdisciplinary teams of scientists tackling specific problems. For such teams to work effectively, each must be big enough to provide a critical mass of research talent and small enough to permit continuous and intimate interaction. After extensive sampling of the opinions of center directors and other experts, there appears to be a consensus that the optimum size of an interdisciplinary team varies between five and ten people, depending on the problem. The number of such teams that can be combined effectively in a single center, without losing the interaction between them, is about six.

In addition, the locations of centers in the developing world should be taken into consideration. Centers do not have a primary responsibility to assist in the development of national research programs, but because of their locations they can serve as patterns that national programs may tend to copy. Few national programs fully meet these principles of critical mass and of close interaction among scientists of different disciplines, and therefore, centers and programs of reasonable size may be a suitable pattern for national governments to follow.

Finally, for the next few years it is more important to fully develop the newer centers than it is to enlarge the budgets and programs of the older centers. Even if it is financially possible to do both, we believe that a modest amount of budgetary restraint for more mature centers has advantages. It would encourage them to consider eliminating activities that have outgrown their usefulness, and it would encourage general economy of operations.

These factors appear to be more important than the possible economies of scale that can sometimes be achieved in providing support services for larger institutions.

In many ways the number of senior scientists ^{1/} would appear to be a useful criterion by which to decide on the maximum size for centers, because of the central need for close interaction. That number obviously should not be the same for all centers because of differences among centers' mandates, the number of commodities involved, and the mixture of research activities undertaken. Translating such a measure into budgetary terms is difficult because of the wide differences in salaries and wage rates for research support staff, clerical staff and field workers among the countries in which centers are located. However, it is the size of centers in budgetary terms that presses on the availability of funds for all centers collectively. For these reasons both these criteria should be considered.

Conclusion. We conclude that there is a desirable size range for centers, and that each center's board of trustees should propose to TAC and the CGIAR such a size, taking into account the foregoing considerations and the nature of its own task. That size should be used to develop a growth path for the center's budget and in turn be used as a financial guideline for determining the subsequent growth of the center.

In our judgment some of the older centers are approaching a desired size. Because of the current fiscal constraints and the need to complete the development of the newer centers, the largest centers should not be encouraged to grow much further. Any significant growth beyond their present size should be questioned and accepted only after adequate justification.

Longevity of Individual Research Programs

Generally speaking, some programs of centers should be continued indefinitely while others should not.

Those which should be continued indefinitely are the programs with international implications, such as the widespread testing of promising breeding lines, the exchange and recombination of genetic materials, and the development and maintenance of major collections of important food crops.

Other activities and projects may be appropriate for centers temporarily, until national programs become competent to handle them. It is these that need to be periodically re-examined and perhaps discontinued, either because they have fulfilled their original objectives or

^{1/} Senior scientists might be classified as those experienced research scientists, irrespective of their location or source of funds, who are actively engaged in research and responsible for a program or

because they have become unproductive or redundant, or because national programs can now handle them effectively.

Up to now, new programs have been financed out of additional funding. From now on, resources for new activities should come primarily from funds that have been diverted from other activities or programs that were terminated or contracted because they did not hold strong promise of future productivity.

Most centers are still young and flexible, but they may not remain so indefinitely. Building in provisions for a periodic appraisal and reconsideration of all activities could help to ensure that center programs retain their vitality and ability to respond to new initiatives.

Conclusion. This model of a relatively permanent center of moderate size with programs evolving and changing in response to new initiatives and research demands is the type of flexible organization we view as the most appropriate for support through the CGIAR. Opportunities to develop in this way should be built into all centers, using periodic reviews as occasions to terminate or to rejustify the continuance of particular programs.

Forward Planning and Program Development

With annual budgets and minimum resource constraints, there has been little incentive for centers to devote much time to long-range planning. Most centers conduct annual in-house program reviews, along with the development of the budget for following years, but these budgets tend to have a limited time horizon.

The need for centers to remain innovative and flexible in terms of program development has made many persons skeptical about the value of long-range program planning; however, the need for forward planning will become more urgent if centers adopt longer range indicative plans as recommended later in this report.

The only issue is the definition of the most desirable mechanism for centers to use in longer range program development. This requires that a center should begin with the planning of individual center projects or program thrusts. One of the most effective ways to approach this is to invite several independent authorities in the particular field to join the staff at the center and work together on formulating priorities and developing a realistic program for the next three to five years. It may not be necessary to review all of the centers' programs in this way. The visits should be informal and could be spread over a six month period. This approach has been used by CIP in developing priorities for individual program thrusts and has much to recommend it.

Once plans for individual program thrusts are developed and budgetary implications determined, these can be integrated into the total center program using a type of in-house review procedure. Participants in such a program development exercise should include center staff, the program committee of the board, TAC representatives and other invited participants (e.g., representatives from other centers who could make a useful contribution). If such internal program reviews were scheduled during the last year of a center's budget cycle, it would enable the center to update its existing program and extend it to cover a further cycle.

Conclusion. All centers need to develop more effective forward program planning and development procedures in conjunction with the formulation of their long-range indicative plans. The use of independent authorities to assist the center staff in this exercise is strongly supported.

Interaction Among Centers

In recent years all centers have become more active in cooperating with national programs in developing countries. Because much of this cooperative research is concerned with commodities which are widely adapted in the low latitude tropics, it is not surprising that two or more centers may wish to work in the same region or with the same commodity in different regions. In Kenya, for example, the base for ILRAD, two other centers, CIMMYT and CIP, have cooperative programs with wheat and potatoes respectively, and ICRISAT is planning a program involving millet and sorghum. Also, with rice, IITA, CIAT, and WARDA all draw on the materials and expertise available from IRRI and in some cases draw direct support in the operation of their own breeding and regional testing programs. The responsibilities for the staff of a center involved in an inter-center cooperative program and the costs involved may be the responsibility of either center depending on the particular circumstances.

Close coordination among centers is desirable because this can have a synergistic effect on their cooperative programs. Overlapping efforts and programs related to commodities and regional activities are the natural outcome of the centers' desire to extend their research into food-deficit regions and is evidence that centers are evolving their own informal networks with respect to their commodity research.

The other important considerations in the inter-center issue are the clients, the national research organizations. Although it is important that the relationships among the centers are well organized it is equally important that they are effective in jointly serving the interests of the national research programs.

The main issues that arise as a consequence of these interactions are (1) problems of competition when centers choose to work inde-

pendently in the same region, and (2) territorial disputes that can arise concerning the major responsibility for a particular commodity in specific countries or regions.

When two or more centers are involved in the same region, regardless of the commodities, it is desirable for them to share an operational base, preferably an International Center if it is available in the region. By doing so they can maintain closer contact and avoid duplication of logistic and administrative support. Operating from a center provides the added advantage of established links with national governments, contact with other research teams, and adequate support facilities.

Where two or more centers are working on the same commodity program, as is the case with rice, maize, wheat, cassava, and chickpea, it would be desirable if the center that has been given the major responsibility for that crop were to be considered the "lead center." This would involve the responsibility for a major breeding program, collection and maintenance of a germ plasm bank, and the recombination and distribution of genetic resources for other breeding and testing programs. Other centers working with the same commodity involving regional testing or even breeding work could be designated as "relay centers." The resources and assistance provided by the lead center and the reciprocal exchange of materials and information in this type of arrangement can be very productive. The recent major increase in the yields and total production of rice in Colombia is a good example of this type of collaboration between IRRI, acting as the lead center, and with CIAT and ICA (the Colombian Institute of Agriculture) acting in a relay capacity.

The initiative to undertake such joint ventures and the details of the financial and other personnel and administrative arrangements are matters for the respective centers and their boards. Center directors should collectively identify the principles underlying the achievement of effective cooperation between centers and national programs. Territorial disputes with respect to regions or commodities that cannot be resolved by the centers should be referred to TAC for assistance and ultimately, if necessary, to the CGIAR. Finally because there is every indication that interactions between centers to assist in developing cooperative research with national programs are likely to increase, it is important that centers make formal records of these agreements and file a copy with the CGIAR Secretariat.

Conclusion. Centers should collaborate whenever necessary in executing their cooperative research activities with national programs when working in the same region or with the same commodity. This can be enhanced by sharing the same working facilities and participating in joint research programs. Organization and administration of these informal links is the responsibility of the centers and their boards. TAC or the CGIAR should serve only to advise and assist in reaching a settlement in disputes that cannot be resolved by the centers.

Boards of Trustees

Boards of trustees are an important component in the structure of the CGIAR and an essential element in maintaining the quality and independence of centers. The principal issues that arise in connection with them are those concerned with the qualifications of the members and the criteria and procedures for their selection and appointment.

These issues have been raised in discussions with donors who express concern about the competence of some boards, and in particular, about their ability to develop realistic budgets when they do not have full responsibility for mobilizing the funds that they use. There are also some misgivings about how board members are selected, a concern that boards through their election and replacement procedures tend to become closed, and a desire to see more extensive advertising among CGIAR members regarding forthcoming board vacancies.

In raising these issues, there is no reflection on the quality or effectiveness of any of the boards; in fact our general impression is that they are performing a valuable role in conjunction with the director and his staff in developing and reviewing the programs and budgets of the centers.

Because of the need to maintain the autonomy and freedom of boards and their critical role in planning and decision making, it is important that each board define its own guidelines for the selection and appointment of members. These might include:

- (1) Personal competence, and professional understanding of the field.
- (2) Balanced representation of expertise in relevant scientific discipline, research management, business experience, and familiarity with the problems of developing agriculture.
- (3) Members, with the exception of those representing the host countries, elected not as national representatives but as members in their own right to ensure the nonpolitical character of the board. In making such nominations, the candidates' governments should be fully informed to ensure cooperation.
- (4) Host country and ex officio membership kept to a minimum. Foundations and aid agencies should not be given reserved seats on boards, although it is hoped that the invaluable professional contribution of these organizations will continue to be available through membership on boards.

- (5) More effective donor participation achieved by having on each board at least three members selected in conjunction with and ratified by the CGIAR. Older boards that do not have this provision may have to move slowly in this respect because of the legal and constitutional obstacles in the original charters of these centers.
- (6) Boards should thoroughly canvass all CGIAR members, LDC countries, and pertinent research organizations before selecting new members. Lists of potential candidates could be maintained by the CGIAR secretariat. The boards and the CGIAR (when appropriate) should be given ample time to consider candidates before making recommendations.
- (7) Staggered appointments are recommended to avoid loss of continuity and to avoid any tendency to become closed. A fixed term of office is desirable (three years is suggested) with the provision that no member can be elected for more than two consecutive terms.

Conclusion: Boards of trustees are of central importance in the development and planning of center programs. Each board should define its own criteria and procedures for the selection and appointments of boards members. It would be appropriate for those boards without CGIAR representation to broaden their membership by their inclusion.

Staffing Issues

The reputation and success of the CGIAR and its individual centers is largely a reflection of the motivation, vigor, and high caliber of the scientific staff, the excellent facilities and working conditions at the centers, and the enlightened personnel policies that have helped bring this about. It is essential that these be maintained to attract and retain good scientific staff since they collectively represent the organization's most valuable resource. It is also important that the centers have access to good leadership, and ways to develop this potential in the younger staff members should be explored.

Although the general conditions are good, there are some issues that require consideration in the interests of improving conditions for existing staff and also to ensure that the centers continue to retain an advantage in attracting new staff of the highest quality.

Most of the issues listed here are matters that are the direct concern of center management, and as such are outside the purview of the

present review. The only justification for including them is because any matter that influences the performance of a center is also inevitably the concern of the CGIAR.

- (1) Many senior scientists claim that they have little opportunity to publish in reputable international journals because of the nature of their research commitment and the time constraints under which they work. This limitation has had a negative influence on the recruitment of younger scientists and can restrict the ability of center scientists to re-enter national research institutes and universities in developed countries.
- (2) Some outposted staff, especially those appointed to cooperative country programs on extra-core funds, lack any form of tenure and often feel insecure. Also, under present policies, they have few opportunities to return regularly to the center to exchange scientific ideas and information. They tend to feel isolated from the mainstream of center activities.
- (3) Although the scientific staff at most centers are still young and highly motivated, every research institution ultimately faces the problem of aging staff. This might be avoided by continual investment in postdoctoral students and sabbatical visitors, regular sabbaticals for senior scientists, including outposted staff regardless of source of funds; greater opportunity for center scientists to transfer to other centers and obtain renewed stimulus from new problems; rotation of staff from LDCs to share the experience of working in International Centers; and more active interfacing with basic research programs in advanced research institutions to maintain a strong scientific competence in the center's program.
- (4) The disparity in salaries and working conditions of scientists at the centers, in comparison with other scientists living and working in these same countries, presents a problem which is not restricted to the CGIAR centers. All centers are well aware of this and have attempted to reduce the visible disparity in living standards. Despite these problems, it is essential that incentives be maintained to attract talented scientists and their families to live and work in LDCs.
- (5) Recruitment policies for centers should be made more open and every opportunity should be taken to identify

new staff from the widest possible cross section of potential applicants.

Conclusion. All of these issues are germane to the central problem of the quality and performance of center staff, and for this reason they should be treated as a matter of high priority by center management. The periodic meetings of center directors provide an appropriate forum for the discussion of these and other issues of common concern such as length of tenure and perquisites. Specifically, attention needs to be given to the issues of open recruiting, maintenance of the vitality of staff, and sabbatical privileges of outposted staff.

VIII. PLANNING, EVALUATION, ALLOCATION, AND MANAGEMENT
FOR THE CGIAR AND ITS FAMILY OF ACTIVITIES

The CGIAR has experienced rapid growth and change over the past five years. Five new centers plus two additional activities have been added; budgetary costs have increased fourfold; and the number of donors has nearly doubled. This growth has occurred within the formal structure of the CGIAR with minimal problems. The next three to five years promise to be a period of further growth. The newly approved centers will be crystalizing their programs, older centers will continue to adjust their programs to changing needs, and as projected in Chapter VI, financial requirements will continue to grow. Thus, the basic question is whether any changes in the CGIAR's structure or mechanisms for planning, evaluation, allocation, and management should occur. Our analysis of this question is divided into five topics: (1) structure of the CGIAR, (2) mechanisms for long-range planning and evaluation, (3) mechanisms for budget planning and development, (4) mechanisms for budget allocation including the distribution of shortfalls, and (5) technical and management needs of the CGIAR.

Structure of the CGIAR

The overall structure of the CGIAR necessarily came within the purview of the review. In looking at it, the question was asked whether any major changes were necessary.

The "structure" of the CGIAR has the following characteristics: (1) it is a consultative group made up of independent donors who in the final analysis make individual allocative decisions regarding distribution of resources to centers and related activities, (2) it supports independent research institutes, constituted under national law with international boards of trustees, (3) it receives its technical advice from an independent Technical Advisory Committee (TAC) composed of internationally recognized scientists and science administrators from both developed and developing countries, (4) membership in the CGIAR is gained mainly by participating as a donor, (5) acting through group consensus, it makes rules for its own conduct as it deems appropriate, and (6) its administrative functions are provided by two secretariats.

Two of these structural characteristics, donor independence and center independence, represent an inherent contradiction if both are pursued to the extreme. To date the CGIAR has operated by pragmatic modifications of these characteristics to avoid irreconcilable differences. Our conclusions and recommendations seek mechanisms which retain as much of this independence as is consistent with effective operation of the CGIAR and minimizes bureaucratic formalization as the solution.

The only structural issue arising is the need for more effective participation in the affairs of the CGIAR by users and potential beneficiaries of CGIAR research. The provision for regional representation on the CGIAR offers one opportunity. In addition representation on TAC and Center Boards provide other opportunities. Finally, if the forum activities recommended in this report are implemented, this mechanism can be used for increased participation. It is our judgment that if all of these avenues are fully utilized, the desired objectives would be achieved.

Conclusion. No basic changes should be made in the CGIAR's structure, including the composition of its membership. However, several changes in mechanisms employed within that structure are needed and are addressed in subsequent sections.

Evaluation and Long-Range Planning

The CGIAR has relied on TAC for advice on both the future directions of the CGIAR and for evaluation of ongoing activities. To date, TAC has dealt predominantly with proposed initiatives in a sequential fashion, however, always within the context of the priorities as stated in the TAC priorities paper. Evaluation of ongoing programs has begun recently through the initiation of quinquennial reviews. The basic issue is whether these procedures are sufficient to maintain continuing surveillance of future needs and current activities in an integrated fashion within the broader context of food needs.

If the conclusions of this review about the number and size of centers are accepted, then in the future the balance of CGIAR activities will shift more toward maintenance of already approved activities. Thus a mechanism which provides for a periodic overview of the family of CGIAR centers, can identify new needs, monitor gaps and overlaps in CGIAR activities, can establish fiscal requirements and availabilities, and assign priorities within and between programs is very important. Our analysis is that, to date, TAC has done a good job in its assigned tasks and we see no reason why TAC cannot continue to provide similar services to the CGIAR.

It may, however, be appropriate to spell out in more detail the mechanisms TAC might use to maintain an overview of the activities of the CGIAR family in the broader context of food research needs. These mechanisms are: (1) review of proposed initiatives, (2) quinquennial reviews, (3) "stripe" analysis, (4) review of indicative plans of centers, (5) periodic priority reviews, (6) continuing interaction with center programs.

TAC should continue to play the major role in reviewing proposed initiatives. These would include completely new proposals that could involve establishing new research activities and reviews of new

or large initiatives within existing center programs. All new or large activities being proposed by centers, regardless of the source of funds, should be reviewed by TAC regarding their appropriateness to the center mandate, implications for administration, and implications for future commitment of CGIAR resources.

The quinquennial reviews initiated this past year show much promise. With experience it may be appropriate to sharpen the definition of the purpose of the reviews. The reviews should be concerned with three principal tasks: (1) to evaluate the scientific quality of current programs, (2) to comment on the scope and balance of current programs, and (3) to evaluate future plans including the explicit review of center proposals to continue projects of long standing. Clearly, the onus should be on centers to justify continuance. This latter function of reviewing future plans is particularly important for TAC and the CGIAR. The quinquennial reviews should be planned well in advance, giving the TAC time to establish a high quality review committee which can be briefed well in advance and allow centers time to carefully develop their long-range future plans. The reviews should be analytic and probing in their treatment of programs, particularly regarding the relative distribution of efforts within center programs. A concise summary of the report should be prepared for the CGIAR. To date, reviews have tended to focus on current programs and generally have recommended more of everything. In addition to these main areas of investigation, common to all centers, specific questions for review could be posed by TAC, the CGIAR, or individual donors.

TAC should continue periodic across-center analysis of particular internal program components such as training, documentation, cropping systems research, etc. These "stripe" analyses would be useful to TAC and the CGIAR in maintaining an overview of the system and also would provide a useful mechanism for centers to compare their different program components and learn from each other. They are termed analyses rather than reviews because we would not like to see them become mechanisms that encourage conformity.

In the next section, a longer term budget cycle is proposed including two-year (biennial) budgets and an additional two-year indicative or perspective program plan. TAC's role would be to review the indicative plans in the context of budget proposals, modify them if necessary after discussion with the centers and recommend to the CGIAR for approval the center's budgetary growth path. Each center would develop its next biennial budget within that plan.

Using the above procedures, TAC in time could be in an excellent position to reassess the program of the CGIAR periodically (every five years) and to recommend priorities for the future.

Finally, TAC needs to have members who are knowledgeable about particular center programs. One possible approach TAC may want

to consider would be if subsets of TAC members were specifically responsible for knowing about particular centers. If TAC member A were assigned specific responsibilities for centers 1, 3 and 5; B for centers 1, 2 and 4; etc., then three members of TAC would be particularly familiar with three centers, but no two members would have common responsibilities for more than one center. TAC members could develop this knowledge by attending in-house program development reviews and possibly participating in quinquennial reviews.

The redefinition of TAC's role apparently implies an expanded set of responsibilities. However, TAC is already involved in priorities, quinquennial reviews, stripe analysis, reviews of proposed initiatives, and reviews of center budgets. With effective staff work from more closely coordinated secretariats, we believe the task is manageable.

In addition to reviews undertaken by the TAC, there is need for periodic review of the overall CGIAR program and of the mechanisms and management of the CGIAR by the CGIAR itself. The current approach of constituting a review committee within the CGIAR has merit. A similar review should be conducted within three to five year intervals. The review committee could have the option of commissioning a study team or teams, if it saw the need. TAC's recommendations on future program priorities would be a major input into that review.

Conclusion. We conclude that TAC with an appropriate redefinition of its role should provide the mechanism for continuing review of ongoing programs in the context of changing broader needs. TAC should be asked periodically (every five years) to produce an updated broad program perspective for the CGIAR. This review as a part of a quinquennial review of the CGIAR itself would provide adequate mechanisms for long-range planning and evaluation for the CGIAR and its family of activities.

Mechanisms for Budget Planning and Development

The preceding section discussed the need for and proposed mechanisms for long-range forward planning in conjunction with substantive reviews of ongoing programs. There are also intermediate-term planning issues related to budgetary forward planning for centers. These plans have implications for total CGIAR financial commitments. At the moment, financial arrangements are made mainly on an annual basis between donors and centers. The basic issue is whether or not there is a need for better intermediate-range budget planning and development.

We are convinced that the annual budget process, in the absence of regular, comparative formal consideration by the CGIAR of longer range plans of centers will constitute a critical problem in the

future, particularly if resource shortfalls occur. The centers are long-term research institutes that must in their internal operations look further than one year ahead. Therefore, to assure greater resource stability over a long period some mechanisms seem needed as far as centers are concerned. Many centers and their boards have developed, for their own planning purposes, longer range program plans using different approaches and time horizons. However, analysis suggests that the three-year projections now made by the centers lack reality. The conclusion is reached by comparing both actual budget requests in subsequent years with previous projections and by evaluating 1977 program and budget projections to 1980. Most of these are completely static with only variable allowances for price increases included. It would be in the centers' interest (as well as the CGIAR's) to have longer range budgets. Discussions with centers suggest a receptiveness to longer term budgets provided that they are used in the allocation process. This would require that centers develop an improved capacity to do long-range planning.

Discussions with donors also led to the conclusion that many donors would prefer longer range plans even though some donors may not be able to commit resources beyond one year. All donors would like, for planning purposes, some longer range perspective of potential financial demands of the CGIAR supported activities.

We have reviewed approaches to longer range budget planning used by some other research institutions and find persuasive arguments for considering at least two-year budgets, with indicative plans for an additional two years. If centers were asked to use the concept of a maximum desirable size (discussed in Chapter VII) as a beginning point, realistic biennial budgets, plus additional two-year indicative plans, could be developed.

Projections for the second two years would necessarily be more general, but could identify future staffing needs, proposed major adjustments in programs, anticipated major capital needs, requirements for equipment replacement and such other major changes as the expansion of regional activities that the center contemplates.

Conclusion. Each center should be asked immediately to define its desirable size and then to use that size in developing a biennial budget and a further two-year indicative plan. The biennial budget and the indicative plan, after analysis by the secretariats and review by TAC, in consultation with the centers, would serve two purposes. First, it would constitute a formal budget proposal to the CGIAR and, second, it would provide a framework (budgetary growth path) within which the centers' next biennial budget could be prepared. A necessary component for such a plan would be an explicit and reasonable system for centers to define and forecast

price increases.^{1/}

Some donors cannot commit funds beyond one year. However, there is nothing inconsistent between annual pledges and biennial budgets. If after some experience with biennial budgets and two-year indicative plans they work well, then triennial budgets might well be considered. If half of the centers were budgeted each year it would equalize the work load for TAC, the secretariats, the CGIAR, and the centers, and would perhaps allow for more meaningful interchanges at Centers' Week on past program performance and future plans.

Mechanisms for Budget Allocation Including the Distribution of Shortfalls

The particular character of the CGIAR creates two potential problems that would not occur in a centralized or hierarchical, unitized organization. These are: 1) the potential for between-year instability in center support resulting from a large number of independent fund sources, and 2) the absence of a formal decision-making mechanism to allocate resources among CGIAR activities. The latter issue becomes very important if resource shortfalls occur.

The problem of between-year instability could occur even if total resources available were sufficient to meet total budget requests, if some centers were oversubscribed and others undersubscribed and if the donor of last resort chose not to make up the difference. However, the problem would become more serious if an overall shortfall did occur. For long-term research institutions to have to depend on 20 or more donors for resources pledged, on an annual basis, late in the previous year, poses potentially serious problems of instability. This potential instability results mainly from annual provision of funds by donors but the centers' dependence on a multitude of independent donors also contributes to the instability. That element, however, has additional potential implications in periods of shortfall, when the donor of last resort cannot cover the deficit. With complete retention of donor autonomy, some centers could, when the columns are added up, suffer severe budget cut-backs on short notice, and thus be incapacitated. At the other extreme, other centers might receive more support than they really require.

If the CGIAR is going to adopt longer range planning for centers, it is reasonable that it adopt some minimal policy guidelines that would give longer term stability to program funding.

^{1/} The definition and application of this system to deal with inflation is an appropriate task for the CGIAR Secretariat.

Conclusion. It is our conclusion that donor autonomy with the following modifications be retained rather than resorting to a pooling arrangement. Donors should be encouraged to accept the following guidelines: (1) that donors designate a portion of their contribution as flexible or unspecified funds; (2) that when donors undertake support of a center they accept an obligation longer than one year; (3) that donors provide two years' notice before discontinuing support of a center or one of its activities; (4) that donors agree to cooperate so that no center or activity is overfunded, including supplementary requests; and (5) that the donor(s) of last resort should fund a seriously underfunded center, but if that situation persists for two or three years, the future of the center should be reviewed by the CGIAR.

The second problem relating to resource allocation stems directly from the consultative nature of the CGIAR composed of many autonomous donors. The problem is that no mechanism for making collective budget decisions exists. Given that we have recommended that the character of the CGIAR be retained with modification, a binding mechanism for decision making is not recommended. However, it is clear that some mechanism for collective advice should be available in the event shortfalls occur.

A standby committee of the CGIAR should be authorized to give such advice. The committee is proposed as "standby" because it is our judgment that if growth paths are well defined within the limits of potential resource availability, and if the guidelines on donor behavior suggested previously are adopted, the likelihood of annual shortfalls will be minimized. In the event a shortfall is likely, the committee should be called on to recommend a course of action to the CGIAR. The following guidelines could be followed: in the event of a shortfall the lowest priority should be given to capital requests of mature centers that can be deferred; requests for additional funds for new program proposals at mature centers; and significant additions to original plans at maturing centers. If the reductions implied by these guidelines are not sufficient to cover the shortfall, the committee should review center budgets and make recommendations for adjustments, recognizing the stage of development at maturing centers and the need to maintain ongoing activities of all CGIAR activities. To the extent that donors, in addition to the donor of last resort, designate portions of their funds as flexible, the advice of the standby committee could be used in the allocation of these flexible funds.

It is appropriate for donor representatives to be involved in the process of budget reduction. Further, increased participation of donors in the direct affairs of the CGIAR would be useful to sustain donor commitment. The alternative would be for TAC to be the primary budget advisor. Because of the expanded role assigned to TAC, the additional work load would be difficult to handle. More important, TAC's main role

should be forward program planning and program evaluation. Further, it is our judgment that to mix the roles of scientific advisor and fiscal decision maker is not necessarily desirable. TAC and the two secretariats would provide invaluable analysis and input to the committee. In the following section a mechanism for this is proposed.

The existence of a committee of this sort would also provide a possible mechanism for the CGIAR, or the chairman of the CGIAR, to use if other pressing policy issues arise.

Conclusion. A standby committee of the CGIAR should be established to consider and give advice on center budget requests in the event of a serious shortfall. Its membership should include the chairman of TAC and the Executive Secretary, as well as other members that the CGIAR might designate. Having the chairman of TAC on the committee is a mechanism to get a TAC input without formally involving TAC in short-term fiscal issues. The committee could also be called on for advice on such other policy issues as deemed important by the CGIAR.

Once the allocative decisions are made on the basis of donor allocations with advice from the committee, TAC and the CGIAR Secretariat, the allocation of budget shortfalls within each center or other CGIAR activity should be the responsibility of the board of trustees and the director-general.

Technical and Management Needs

In this section two topics are discussed. These are: (1) the staffing and budgetary analysis requirements of the CGIAR and TAC, and (2) the problem of cash flows.

Despite the preceding conclusions that the informal nature of the CGIAR be preserved, there are administrative and analytic functions that must be performed. Currently, these functions are provided by two separate secretariats -- the TAC Secretariat attached to FAO and the CGIAR Secretariat provided by the World Bank. Increasingly, donors are requesting integrated program and fiscal analysis both of current budget requests and of longer term financial needs. The Integrative Reports and center commentaries are useful documents as far as fiscal and budgetary matters are concerned. Similarly, the TAC minutes and the TAC chairman's reports to the CGIAR are useful inputs as far as program content is concerned. Both suffer from the deficiency of focusing on only a part of the total picture which encompasses both program and fiscal issues.

When the two secretariats were initially established, it was to draw upon the technical and professional skills of the two organiza-

tions concerned (FAO and IBRD), despite obvious inconveniences of having separate staffs.

Implementation of the recommendations of this report will require closer coordination between the two secretariats and a functional integration of some of their work. This closer cooperation is essential if the two secretariats are to serve the Group effectively, and the situation should be watched carefully to ensure that it takes place.

The TAC and CGIAR secretariats exist to serve the needs of the CGIAR and its agencies. Their independence and integrity are critical in assuring donors of effective use of their funds. It must be clearly recognized that the secretariats exist to serve the Group and that they report to the Group through their respective chairmen. To fulfill all their functions, including reviews, the secretariats must be adequately funded and staffed. It is in the Group's interest to assure that the funding and staffing requirements of the secretariats are adequately met. Therefore, an annual report of the proposed budget and staffing for the secretariats, accompanied by a statement from the co-sponsors about their capacity to support the secretariats is needed. In the event the co-sponsors cannot fund the full needs of the secretariats, donors should be prepared to make the necessary funds available.

Given the urgency of this issue, the co-sponsors should report at the meeting of the CGIAR in October 1976, as to whether they foresee difficulty in meeting these obligations.

Conclusion. The effective review of current (biennial) program and budget proposals of centers and related activities requires integrated fiscal and program analysis, particularly as it relates to significant changes and trends in budget proposals. This will require coordinated inputs from TAC and its Secretariat and the CGIAR Secretariat. The Group should ensure the functional integration of the secretariats and their adequate support. It must also be agreed that the secretariats report to the Group through their respective chairmen.

The final management issue discussed is that of short-term funding difficulties. Multiple sources of funding and varying fiscal years are creating very serious short run cash flow problems for some centers. The cash flow problem primarily results because some donors provide funds late in the fiscal year causing early year cash flow problems for some centers. The most obvious and easiest solution is for donors to make their contributions earlier. Failing this, better information about when funds will actually be provided would also help. The CGIAR Secretariat could make this information available to the donors or centers. If this is not sufficient, an option to seriously explore is asking the World Bank (IBRD) to handle it, perhaps by rotating its residual contribution among cash short centers prior to final allocation. In our judgment, independently expanding working capital at each center or creating a separate fund to meet cash flow problems are both inefficient and unnecessarily complicated.

Conclusion. The cash flow problem is serious and needs attention. The easiest solution would be for donors to provide their funds early in the fiscal year. Failing this, alternative solutions need to be sought.

Addendum to Staff Paper No. 2

Summary of Responses From CGIAR Members to Staff Paper No. 2

1. What is your perception of the purposes, objectives, and scope of the CGIAR and its activities? What should be its scope in the future?

Most agree the CGIAR should focus on activities (for most research) to enhance production of major food crops in food deficit countries. A few believe that non-food crops should be included as parts of farming systems. The major issue is what, within this general scope, to concentrate on given the limited resources of the CGIAR. The CGIAR must constantly keep in mind that national programs use the research it supports.

2. Should the CGIAR limit its activities to the International Centers, or embrace other international agricultural research programs as well? Should the CGIAR endorse certain activities that it does not finance?

There is a wide range of opinion on the question. A few believe the CGIAR should limit itself to "global commodity centers"; some favor primary emphasis on "centers"; some favor centers plus alternative support of any kind of unique research efforts plus the CGIAR as a forum for discussion and exchange of information about broader research issues; and a few favor the CGIAR as a forum for identifying global and regional research needs, as well as, coordinating them. Most feel that the CGIAR should not endorse what it does not fund, but could encourage important activities.

Staff Paper No. 2QUESTIONS FOR CGIAR MEMBERS

The Consultative Group on International Agricultural Research has been in operation now for just five years. During that time its activities -- including but not limited to the international Centers that it supports -- have grown rapidly. In addition, the composition of the CGIAR has changed. The number of participating members has increased, and many of the original representatives have been replaced by other people.

Many of the materials needed for the present review of the CGIAR can be gleaned from existing documents. But documents do not tell the whole story. We need, in addition, to know how those closest to the CGIAR perceive the organization, its problems, and the respective roles of its components. Consequently, the Study Team needs the benefit of your knowledge, experience, and insights.

In order to help make sure we do not miss important points we have framed this set of questions for discussion. They refer to, but do not completely cover, four topics:

- I. Objectives and Scope of the CGIAR
- II. Operational Procedures
- III. Interrelationships with Other Agencies
- IV. Funding and Financial Allocation Problems.

In addition to helping us with these questions, we urge you to raise any others you believe merit attention.

The questions posed in the original staff paper are reproduced below prior to each summary response.

Following these are excerpts from (AGR 71/3) Annex III giving CGIAR Objectives and Supporting services.

3. What is your perception of the longevity and performance of
1) the CGIAR? 2) individual centers?

Most agree that the CGIAR will be needed "for the foreseeable future." Some believe centers should have a definite life span, others do not. Most agree that programs within centers should have a definite life span with the obligation on the program to justify its existence beyond that point.

4. The Terms of Reference for the CGIAR and for its Technical Advisory Committee (TAC) are attached. Do they reflect your views of the current roles of the CGIAR and of the TAC? Their future roles?

All feel the Terms of Reference of the CGIAR are acceptable as they stand. They are sufficiently broad to embrace almost anything the CGIAR wishes to undertake. The Terms of Reference for TAC also seem appropriate though there is some question whether the operational mechanisms of TAC are as clearly spelled out as they might be. A few feel that within the terms of reference more attention should be devoted to the needs of national programs and their relation to the CGIAR.

5. Do you feel that you receive sufficient information and/or justification of current and proposed CGIAR activities to allow your country or organization to make rational decisions? Would biennial or triennial budget requests cause you any problems?

All feel that the written information received is sufficient for decision making; most say this information is supplemented by people in their own organizations. A few think the material should be better edited and more efficiently distributed. Some would prefer greater interaction between their national

5. (Continued)

scientists and center personnel as a mechanism of improving information flows and scientific interaction.

The concept of going to biennial or triennial budgeting is supported by almost all respondents. Most say that biennial budget pledges would present no organizational or legislative problems. Fewer would be able to commit for three years in advance.

6. What is your view of the scope and utility of the centers' annual Program and Budget Reviews and of the annual Integrative Papers prepared by the CGIAR Secretariat?

Annual center Program and Budget Reviews are viewed by most as adequate and useful. Few suggest the need for further information. The Integrative Report gets very good marks. A few suggest that it should be more concise and include a narrative summary of major research accomplishments across the CGIAR family but most agree it's about right as it is.

7. To what extent is it important that decisions about programs, or relative emphasis accorded to different programs be made by centers and their boards? How should decisions regarding programs that involve two or more centers be made?

All agree that centers and their boards should make the final decisions on matters within a center's mandate. The role of boards will become critical if resource limitations occur. Therefore, it is essential that no efforts be spared to make

7. (Continued)

sure boards are of high quality. On matters of inter-center relationships, all would prefer centers to work out the matters to their mutual satisfaction. If it cannot be settled between centers, most feel TAC should attempt to solve the problem. The CGIAR would have to be the final arbiter in the cases of serious dispute.

8. Please comment on the following questions, regarding the relationships of centers to the CGIAR and TAC:

- a) What role should the TAC quinquennial review play relative to (a) center internal planning and evaluation?
(b) CGIAR funding decisions?
 - b) What role, if any, should TAC and the CGIAR play regarding activities outside of the core program founded as special projects, or contracted with client countries?
 - c) Should individual centers be able, without external involvement, to seek additional funds from CGIAR DONORS or from others?
- (a) *Most express the view that the quinquennial review ought to be useful to centers and the CGIAR in planning, evaluation and budget matters but that it is too early to judge the exact usefulness. Most are not sure how the various quinquennial reviews can be integrated to give an overview of the family.*
- (b) *Special projects are a particularly sensitive issue. Not an insignificant number of donors react negatively to them. Some other donors see them as a mechanism to enhance overall*

8. (Continued)

funding for centers. Most everyone agrees that full disclosure of the substance and magnitude of ongoing and proposed special projects, should be fully integrated into the annual Program and Budget Review at Centers' Week.

- (c) Opinion on the opportunity of a center to seek additional funds outside the CGIAR is sharply divided. A majority interviewed respond very negatively because it could create problems of development for a center within its program and damage trust. Some respond positively, provided the CGIAR is fully informed. A few give an unqualified yes.*

9. Please give your view on the current and future roles of the following components in the system:

- a) donors as individual entities
- b) the Consultative Group on International Agricultural Research
- c) the co-sponsors (FAO, UNDP, IBRD)
- d) the CGIAR Secretariat
- e) the Technical Advisory Committee (TAC)
- f) the TAC Secretariat
- g) the centers' boards of trustees
- h) the directors-general of centers
- i) center staffs

- (a) See answer to Question 13.*

9. (Continued)

- (b) *Most responses about the role of the CGIAR are similar to the answers to Questions 1 and 2 which reflect a wide range of opinion. Two additional issues were raised here by a number of donors. The first relates to what role the users or potential beneficiaries of the research should have in the CGIAR. The second relates to the issue of the capacity of the CGIAR to make allocative decisions.*
- (c) *Most people are confused about what the role of the co-sponsors is or ought to be. Some see them as a necessary element, because they represent three members of the U.N. family.*
- (d) *Views on the role of the CGIAR Secretariat are sharply divided. Some donors see the current role of the CGIAR Secretariat as an intermediary for information exchange between donors and centers as sufficient and that any expansion of that role could lead to centralization and bureaucratization which are greatly feared. Other donors agree that the role of the CGIAR Secretariat should be expanded, and its scientific capacity strengthened. Almost all agree that the Secretariat should not assume a decision making or management function in the CGIAR.*

9. (Continued)

- (e) *All agree on the need for some scientific advice for the CGIAR. TAC provides such a mechanism. Most think that in the future TAC will devote more time to the review and evaluation of existing activities rather than to the review of new initiatives. Most see an important role for TAC in keeping the larger perspective in sight. They are not certain that, as currently structured, TAC has sufficient time or staff input to do that job in addition to other activities.*
- (f) *The TAC Secretariat is viewed as useful. Its role is dependent on what TAC does. Quite a number of donors feel that the question of combining the TAC Secretariat and the CGIAR Secretariat should be explored. Some others feel they should be separate.*
- (g) *See answer to Question 7 above.*
- (h) *Center directors should play a strong role and be free to direct. If they do not perform, boards should take appropriate action. There is no suggestion for any change in the role of directors.*
- (i) *Only a few commented at all. Most comments were concerned with the mechanisms for advertisement for and selection of center staff.*

10. How should CGIAR activities interface with the totality of international agricultural research, supported by or conducted in countries which are members of the CGIAR, to benefit developing countries?

There is a wide diversity of opinion, as there was in response to Question 2. Those who feel that the CGIAR should restrict itself to center-type research are not concerned about interfaces. "The CGIAR should have no ambitions for total responsibility." Their concern is that the CGIAR keep itself informed about what others are doing. Those who support a forum role see the CGIAR as a minimum, providing members with the opportunity to exchange information about their activities outside the CGIAR. A few would see the CGIAR play a coordinating role, and therefore, take a lead in dealing with interfaces. One donor thinks there should be special TAC situation papers by region and/or TAC compendiums on ongoing research.

11. How should the CGIAR relate to such other international programs as the Consultative Group on Food Production and Investment (CGFPI); the International Fertilizer Development Center (IFDC); the International Food Policy Research Institute (IFPRI); or the International Soybean Program (INTSOY)?

Most felt we had mixed apples and oranges in this question. Most view the CGFPI as a different type of organization from the other listed. Regarding the CGFPI, most express uncertainty because it is not yet clear as to what CGFPI's role will be. Regarding the other types of activities, the CGIAR should keep itself informed about their activities.

12. How would you feel about some form of pooling of resources distribution among CGIAR activities? Would this create legal, management, or other problems?

This question elicited more strongly held views than any other one. A majority of donors interviewed strongly opposed pooling, citing legal, legislative, and conceptual difficulties. On the other extreme, a few donors favor pooling. Many would consider partial pooling if others did so.

13. To what extent is it either advisable or imperative that individual donors have the right to assign their funds bilaterally to centers, programs, and projects of their choice?

Again similar to the response to Question 12, a majority of donors feel the right to assign funds to centers of their choice is imperative. A great many more believe it is strongly desirable to be able to support specific program components. Most, however, agree that the CGIAR will need flexibility particularly if aggregate resources become limited.

14. Does your country or organization allocate money to international agricultural research through mechanisms other than the CGIAR? If so, how are allocative decisions among such activities made?

Most donors bilaterally allocate money that does in many instances support agricultural research. In most cases, these allocations are not competitive with CGIAR contributions. Mechanisms for allocative decision making vary greatly.

15. One of the issues that led to this review is the possibility of available resources (money) falling short of center budget requests. What criteria and mechanisms could be used to make allocative choices? Who should participate in the process? Who should have the final decision?

Most agree this is a critical question. Most agree that there currently is no mechanism in the CGIAR to deal with the question. Many think that there cannot be or should not be a mechanism. The final decision, after advice and counsel, should be that of the sum of individual donor decisions. Many would have TAC involved, but the mode of involvement and criteria to be used are not specified. Less than a majority favor the CGIAR as an entity making the final decision but do not know how such a process could be structured. Most donors recognize that if resources become short, the "let donors decide" mechanism could produce severe shortfalls at some less popular centers and instability for all. But most are reluctant to yield on total donor independence.

16. What is your view about adding additional centers or programs to the system in the next five years, other than the ones already approved? How about adding new programs at existing centers?

Most donors believe there should be a moratorium on establishing new centers for three to five years. The remainder would not be categorical but would "favor a presumption against" new centers unless they appear to be really exciting. A cautious approach to adding new

16. (Continued)

prohibition for many donors although some would apply a "no new program rule" as with new centers.

17. Should any limit be set on the rate of growth of CGIAR funded activities as a whole?

Most would agree that no formal nonquantitative limit should be placed on budget growth. However, everyone agrees that the rate of budgetary growth of the CGIAR over the past five years cannot continue. Most favor a period of consolidation and budget growth stabilization. One way to better deal with growth would be to move to multi-year budgeting and longer range planning.

18. What other issues should the Review Committee be studying?

Other issues:

- (a) Many do not want the CGIAR to become bureaucratic and rigid. Informality is its strength.*
- (b) There should be a better mechanism for long-range planning.*
- (c) A number expressed the need to pay more attention to leadership development and training.*
- (d) A number requested a better definition of outreach.*
- (e) A number said more attention should be paid to training.*
- (f) Some expressed concern about the lack of specificity in centers concerning their target groups.*
- (g) More should be done to clarify the contributions made by international activities and to publish this information.*

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH*

First Meeting
May 19, 1971
Washington, D. C.

A. Objectives

1. The main objectives of the Consultative Group (assisted as necessary by its Technical Advisory Committee (TAC) described in Part C below) are:

- (i) on the basis of a review of existing national, regional and international research activities, to examine the needs of developing countries for special effort in agricultural research at the international and regional levels in critical subject sectors unlikely otherwise to be adequately covered by existing research facilities, and to consider how these needs could be met; 1/
- (ii) to attempt to ensure maximum complementarity of international and regional efforts with national efforts in financing and undertaking agricultural research in the future and to encourage full exchange of information among national, regional and international agricultural research centers;
- (iii) to review the financial and other requirements of those international and regional research activities which the Group considers of high priority, and to consider the provision of finance for those activities, 2/ taking into account the need to ensure continuity of research over a substantial period;
- (iv) to undertake a continuing review of priorities and research networks related to the needs of developing countries, to enable the Group to adjust its support policies to changing needs, and to achieve economy of effort; and

1/ Research is used in this document in a broad sense to include not only the development and testing of improved production technology, but also training and other activities designed to facilitate and speed effective and widespread use of improved technology.

2/ Final decisions on funding remain a responsibility of each member in connection with specific proposals.

* Excerpts from (AGR 71/3) Annex III.

- (v) to suggest feasibility studies of specific proposals to reach mutual agreement on how these studies should be undertaken and financed, and to exchange information on the results.

C. Supporting Services

Technical Advisory Committee

7. A small Technical Advisory Committee (TAC) will be created by the Consultative Group, composed of distinguished international experts from developed and developing countries, nominated by the co-sponsors and appointed by the Group. Appointments will be for three years* except that in the case of the first appointees (other than the chairman) four, similarly selected, will have two-year appointments. The TAC will report to the Consultative Group.

8. TAC will, acting either upon reference from the Consultative Group or on its own initiative:

- (i) advise the Consultative Group on the main gaps and priorities in agricultural research related to the problems of the developing countries, both in the technical and socio-economic fields, based on a continuing review of existing national, regional and international research activities;
- (ii) recommend to the Consultative Group feasibility studies designed to explore in depth how best to organize and conduct agricultural research on priority problems, particularly those calling for international or regional effort;
- (iii) examine the results of these or other feasibility studies and present its views and recommendations for action for the guidance of the Consultative Group;
- (iv) advise the Consultative Group on the effectiveness of specific existing international research programs; and
- (v) in other ways encourage the creation of an international network of research institutions and the effective interchange of information among them.

These terms of reference may be amended from time to time by the Consultative Group.

* Later it was decided that TAC members would serve for two years and be eligible for a second two-year term.

Staff Paper No. 3

QUESTIONS FOR CENTERS AND THEIR BOARDS

From our consultations to date, the major impulses leading to the present review appear to be the following:

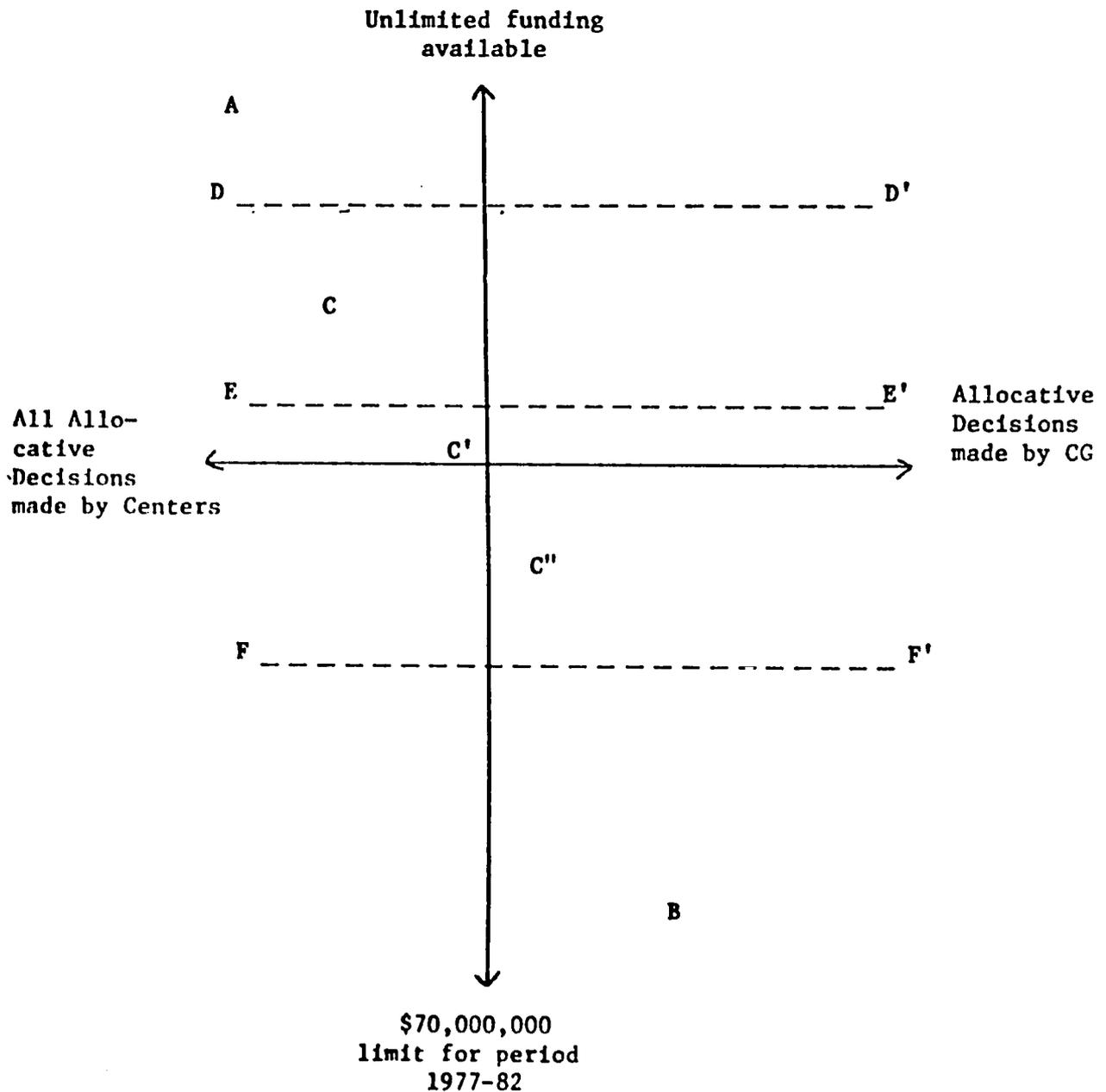
1. A concern about the recent rapid rate of growth of center budgets and uncertainty about whether donors will be willing to continue to fully meet those budget requests.
2. The question of how choices that could bring programs and financial support into balance are to be made, if financial needs cannot be met in full.
3. A concern that as the number of centers and the size of the CGIAR grows it becomes more difficult for donors to consider all budget requests in perspective.
4. A concern about whether the system as a whole, as it now is, meets the commodity research needs it should and whether its comparative attention to different commodities is reasonable.
5. Misgivings that the rapid growth of outreach programs, especially financed as special projects, and therefore, not subject to overall review procedures, may be throwing the overall program out of balance.

Along with those concerns, there is widespread agreement that any changes proposed in response to these concerns should retain the operating autonomy of each center as completely as possible; and CGIAR donor member freedom to choose what specific parts of the program they support financially.

Faced with those concerns and constraints, the task of the Study Team, as we see it, is to explore the options open to the centers and the CGIAR. We see those options as lying at different points along two different continua. One of those continua represents different assumptions with respect to fund availability; it ranges from an assumption of the current level of funding (\$70 million) per year for the years 1977-82, at one extreme, to almost unlimited fund availability to finance centers with continuously increasing programs, at the other.

The other continuum has to do with who makes major allocative decisions. It ranges from having nearly all such decisions made by individual centers, at one extreme, to having a large number of such decisions made by some agency of the CGIAR, at the other.

The situation is represented graphically by the drawing reproduced below. If fund availability is unlimited, then it may be acceptable for most allocative choices to be made by the centers, and this situation would be represented by some point in the vicinity of A on the drawing. However, if available funds are to be limited, increasing the burden of allocating them among centers and increasing the pressures for efficiency in the use of funds, a solution somewhere in the vicinity of B on the drawing may seem to be indicated.



As the Study Team sees its task, it is either to recommend a particular set of internally compatible propositions corresponding to a particular point, for example, as C, C', or C" or to suggest options consistent with some particular level of fund availability, such as D D', E E', and F F'.

At this stage in our task, we are interested in collecting as much information and expert opinion as we can that bears on the problem. To that end, we are submitting a set of questions for discussion under five headings:

- I. The Central Purpose of Centers
- II. Allocative Issues
- III. Interfaces or Relationships with National Programs, and with International or Developed Country Research Programs
- IV. Problems Regarding Resource Limitation
- V. Issues of Management.

Some of these questions address the issue of what the centers should be trying to do and with what magnitude. Others address the capacities of centers for allocative decision making.

The list of questions is not exhaustive and we welcome having other relevant topics brought into our discussions.

The questions posed in the original staff paper are reproduced below prior to each summary response.

Addendum Summary of Responses to Staff Paper No. 3

The following are the Study Team's brief summaries of center and center board chairmen responses to Staff Paper No. 3. Their brevity does not imply that much more was not said. We do not claim that the summary is necessarily complete but we developed it so that the Review Committee might have some flavor of the response.

I. The Central Purposes of Centers

1. What is your perception of the central purpose of your center?

To contribute to increasing food production, primarily through commodity focused crop improvement research, except at ILCA where the research is more oriented to socioeconomic systems of livestock rearing, and ILRAD, where it is concentrated on animal diseases.

2. Should the following components of a center's program be viewed as equally important? If not, which should be a center's primary task or tasks and which should be considered of lesser priority?

(a) Conducting applied research and technology development.

(b) Conducting or contracting for fundamental or basic research.

(c) Helping increase the capacity of national research programs.

(d) Helping accelerate the adoption of improved technologies in individual countries.

(e) Training activities of various types.

Research -- usually applied research and technology development but not excluding basic research if it is essential to its program -- is seen as a center's most

2. (Continued)

important function. Training -- partially in order to create component collaborators -- is rated second in most places. Developing national research programs is more a by-product than a primary objective, except in some of the special projects. Efforts to accelerate adoption of technologies in individual countries are ranked lowest as a center responsibility, except possibly for CIMMYT.

3. Would your replies to the foregoing questions be conditioned by such factors as the stage of development of a center, or the stage of development of national programs, or the state of scientific knowledge and available technologies regarding commodities with which the center deals? Should any other factors be taken into account?

Judgments about the degree to which a center's stage of development should affect the priorities vary widely among centers, but in general they are not considered controlling except at ILCA and ILRAD.

4. Does it seem to you that changes in national total production, or in national average yields of a crop that a center is researching, are legitimate measures of the success or failure of that research program?

CIMMYT is the only center to state, without qualification, that what happens to national crop yields is a measure of a center's success or failure (with Sprague dissenting). Other centers hold that too many factors, other than available technologies, are involved to make national yields a measure of a center's success.

5. Do you anticipate that future center accomplishments will be more of the "major breakthrough" variety or of the "cumulative, incremental" variety?

Centers view advances as coming, for the most part, through incremental improvements, and with increasing emphasis on yield stability rather than on maximum yields. At the same time, they anticipate that there will be breakthroughs from time to time, citing such indications regarding triticale, cassava, cold and heat tolerant potatoes, and perhaps maize. If ILRAD is successful it will be a breakthrough by definition.

6. Under what circumstances should a center engage in, or contract for, projects of fundamental or basic research?

In general, centers favor contracting for basic research only when (a) it is essential to performing a center's applied tasks and (b) the center does not have the personnel and/or equipment to do it. CIP goes further and prefers to contract research rather than enlarge the CIP staff.

7. Should the decisions that a center makes about the kind of technologies to be developed be conditioned by whether those can be applied by individual farm operators, on the one hand, or by governments, associations of farmers, agri-business firms, on the other?

The centers should concentrate primarily on technologies to be applied by farmers. Larger scale infrastructures may be needed to provide farmers with inputs and to process output but these are not the responsibility of centers.

8. How should a center deal with the current widespread concern about the relevance of farm technologies to the needs of operators of small farms?

Centers should be concerned about appropriateness of technology for small farms but should not develop inefficient technologies just to accommodate small farmers. Most of their technologies are scale neutral, but small farmers are especially vulnerable to weak national infrastructures; however, these are not the responsibility of the centers.

9. Should a center continue indefinitely or are there some limits to its life?

Centers should have definite finite objectives that are periodically reviewed but not within too short a time period. There will be a permanent need for the GEU type of activity. Further, each major commodity will continue having new and different problems.*

** Genetic Improvement and Utilization*

II. Allocative Issues

10. How should a center decide how much of its core budget to devote to:
- various types of research activities?
 - various types of training at the center?
 - developing interaction among scientists of different countries (conferences, seminars, cooperative projects-publications, etc.)?

The allocation of a core budget among major activities should be made by staff discussion, director's input,

10. (Continued)

and the action of the trustees' program committee. These allocations need to keep changing. CIAT suggests that division between (a) research and (b) measures to transfer technology to countries, including training, should be roughly 2/3 and 1/3.

11. What are the arguments for and against the practice of special projects being financed outside of a center's core budget?

Special projects are useful to:

- a) provide a center with some involvement in problems of single countries;*
- b) tap resources of some donors who cannot fund international activities without some form of specific identification;*
- c) allow some strengthening of individual activities;*
- d) thus give some flexibility to a center's program.*

But they should not be accepted, except when clearly within a center's main task. Too many of them can involve too much administrative burden and unduly slow a program. ILCA does not favor special projects at all.

12. Would it be advisable for some limit to be set on the number and/or size of such special projects, or on the total budget value of such projects in proportion to the size of the center's core program?

12. (Continued)

Setting a limit on number and size of special projects is generally acceptable. ILCA suggested 30% of core budget. CIP suggested 60% on-campus and 40% off. IITA sets no limit, but the CGIAR could resolve the question if the situation gets out of hand.

III. Interfaces or Relationships with National Programs, and with International or Developed Country Research Programs

13. Should a center's involvement with national research and production programs be limited to that needed for the success of the center's own applied research and technology development or should it go beyond what the center needs and include helping individual country research programs?

In general, there is a strong consensus that involvement in national programs should be limited to provide field testing and guide a center's own research with two strong exceptions. CIMMYT feels they must go further to help develop national research programs. ILCA because of its organization feels that the only way it can accomplish its objective is by building capacity in the national programs through which it must work.

14. How could a center most effectively help to strength national research programs?

Centers can help to build national capacity through training in research methods, professional interchange among LDC scientists and center personnel, and collaborative research. Some centers would go further, e.g.,

14. (Continued)

by providing for information and documentation exchange. In general, the building of collegiate relationships and a network of competent scientists is viewed as high priority.

15. What guidelines should be used in determining the types and amount of center involvement in developing operational links with research programs of other international agencies and/or with research programs in developed countries?

Interchange with other international and DC research is not seen as a general problem. Most centers feel they have adequate access through existing means to exchange information. But some feel a need to intensify this exchange to prevent duplication of effort.

16. Considering that increasing production involves many factors in addition to available technology, is a center competent to advise or participate in designing or operating national production programs?

Opinion about how much centers should involve themselves in national production programs varies widely. All agree that they should not be involved in operating them. A majority agree that giving advice when asked may be appropriate. Fewer agree that a center legitimately can participate in designing programs. Two centers indicate they should not be involved at all (CIAT and IRRI).

17. Which of the following types of specific center involvement in national production programs seem to you to be appropriate?

- training production specialists at the center's headquarters.
- home country training of production specialists.
- center personnel stationed in a country to assist a production program.
- a center employee taking administrative leadership of a production program.

All centers agree that training of production specialists at headquarters is appropriate. Five centers agree that in-country training of production specialists is appropriate in conjunction with center field research programs. Four centers agree that center personnel stationed in countries may assist as a by-product of their research responsibility. Four others definitely say no. All centers oppose center employees taking administrative leadership of a production program.

IV. Problems Regarding Resource Limitations

18. Do you feel it would be advisable to consider setting an upper limit to the size of individual center core program budgets.

There is agreement that some limit on the size of centers is desirable. Most would agree that it should be in the number of senior scientists rather than budget. Two centers propose the development of five year plans within which centers would have to live (CIP, ILCA).

19. If such limits were to be set, what criteria should be used to establish them?

In addition to comments in Question 18, most centers propose specific numbers of senior scientists. These range from 25 (ILRAD) to 60 (IITA). Additional criteria suggested by some centers were:

- 1) Size of physical facilities*
- 2) Administrative simplicity*
- 3) Required levels of support staff and research support. Three centers gave importance to the priority of their research on a global basis (IRRI, ILRAD, ILCA).*

20. How much, if any, attention should be given to the demonstration effect of centers as a guide for planning the size, scope, physical plant, and modus operandi of centers?

The question refers to three possible types of demonstration effect: (a) the physical plant size; (b) the method of research approach and (c) the mode of center operation.

Effective use of interdisciplinary research approaches and mechanisms for organizing and operating research teams are two areas in which the demonstration effect of centers is important. Only two centers see the size and character of the physical plant as being important to the demonstration. The other six see it as an unimportant issue.

V. Issues of Management

21. Is maintaining the professional vitality of center scientists a problem? If so, what steps are now taken or might be taken to alleviate it?

Maintaining professional vitality has not become a problem at any center. Having many visiting scientists and a number of post-doctoral fellows, in addition to the challenge of the job, contributes both information and enthusiasm. However, it becomes increasingly difficult for center scientists in some fields, e.g., agricultural economics, to reintegrate themselves into the professions in developed countries. The general problem may already be emerging with outposted staff.

22. What is the process within your center for making up the annual budget request?

The annual budgeting procedure is quite similar in most or all centers. Budget proposals are made by program leaders, reviewed and adjusted by the director-general, reviewed and modified by the program committee of the board of trustees and then considered by the full board. Executive and program committees of boards of trustees are getting stronger and playing a decisive role though we are not clear about their roles at CIMMYT and ILCA.

23. What criteria do you currently use in deciding what proportion of your center's resources to devote to different research activities: e.g., among commodities, within a given commodity program, etc.?

23. (Continued)

Most centers have no well articulated criteria for allocating resources among research activities. IITA depends on two criteria: likelihood of significant success and relative importance among the commodities with which it deals. IIRRI mentions availability of competent staff. In general, the judgment of the director-general plays a major role.

24. What procedures does your center have for periodic program evaluation reviews?

- internally.
- involving external evaluators.

Arrangements for internal program evaluation range from none at all to formal reviews of several days duration annually with members of the trustees' program committee present, the tendency at most centers being in the latter direction.

CIP has the most elaborate arrangements for external evaluation in its triennial planning conference for each of its programs.

Ad hoc external reviews of aspects of programs at the center come about from time to time but are not normally stressed by the centers themselves.

25. What do you understand the role of the TAC to be with respect to program evaluation? Should it be changed in any way?

Centers directors are generally critical of TAC's capacity to carry out program evaluations, partly because of lack of time. The quinquennial reviews are seen as useful primarily because of the internal evaluation implicit in the advance preparation for them. They do not show promise of critically evaluating the balance of various activities within a center or between centers.

26. What is the process within your center by which special projects are proposed, accepted, and approved?

The usual pattern for approval of special projects is that the director-general carries out preliminary negotiations, then submit the project for approval to the executive committee of trustees. IITA has no fixed procedure. ILRAD has no special projects. (It appears that special projects are not given the same internal staff review as the normal budgeting procedure suggests.)

27. Is it your understanding that new types of activity allowed by your charter can be authorized by the board of your center without reference to the TAC or CGIAR?

Most of the directors feel that any genuinely new type of activity should be submitted to TAC and the CGIAR for approval, especially if it is one the center may later wish to consider expanding. The dominant view is

27. (Continued)

that centers have the authority to adopt new programs that are within their respective mandates without prior reference to TAC, but that, in the interest of retaining CGIAR support, it is better not to exercise that right.

28. What role does your governing board play in general, and specifically, what role does it play regarding program and budget formulation and in taking on new activities?

Boards of trustees are increasingly active in budget formulation and in considering new programs, frequently modifying or rejecting proposals recommended to them.

29. How should relations be organized between two or more centers:

- engaged in programs related to the same crop?
- Engaged in work on different crops but in the same country or region?

Arrangements for accommodation between two or more centers working (a) on the same crop(s) or (b) within the same country should be worked out between their respective directors-general. Any unresolved conflicts regarding research on a particular crop at two or more centers should be taken to TAC for its judgment (ICRISAT). IITA argues that each center should have primary in contacts with national governments within its general geographical vicinity.

30. What issues are involved (and who should be involved) if a program initiated as a special project is subsequently proposed for transfer to the core budget?

There is a general consensus that no special project should become part of the core budget without prior consideration by the TAC. Only IITA feels its trustees can adopt any special project or initiate any new core activity that lies within its mandate, and that it also has the authority to change that mandate.

List of People Interviewed ^{1/}Co-sponsors

Food and Agriculture Organization (FAO), Rome	Dieter Bommer J. P. Huyser P. J. Mahler A. Molle Peter Oram Brian Webster J. F. Yriart
FAO, Egypt	M. Nour
FAO, Thailand	D. Umali
United Nations Development Programme (UNDP), New York	William Mashler
International Bank for Reconstruction and Development (IBRD), Washington, D. C.	Warren C. Baum Bruce M. Cheek John Coulter W. A. Green Michael Lejeune Robert S. McNamara Daniel Ritchie Montague Yudelman

^{1/} Co-sponsors, donors, centers and other CGIAR activities, and others are alphabetically listed within these four categories. The names of the individuals interviewed are listed alphabetically according to institutional affiliation.

Centers and Other CGIAR Activities

Centro Internazionale de Agricultura Tropical (CIAT), Colombia	Eduardo Alvarez-Luna Luis Crouch John Nickel Kenneth Rachie and staff
Centro International de Mejoramiento de Maiz y Trigo (CIMMYT), Mexico	Virgilio Barco Norman Borlaug Keith W. Finlay Haldore Hanson Ernest Sprague and staff
CIMMYT, Algeria	G. Varughese
CIMMYT, Egypt	W. Haag
CIMMYT, Kenya	G. Kingma
CIMMYT, Tunisia	J. Doolett
CIMMYT, Turkey	E. Saari
Centro International de la Papa (CIP), Peru	Orville T. Page Richard L. Sawyer Mariano Segura and staff
CIP, Mexico	John Niederhauser
International Board for Plant Genetic Resources (IBPGR), Rome	Richard H. Demuth R. Pichel and staff
International Center for Agricultural Research in Dry Areas (ICARDA)	H. Graves Robert Havener
International Crop Research Institute for Semi-Arid Tropics (ICRISAT), India	C. F. Bentley R. W. Cummings J. S. Kanwar and staff
International Institute for Tropical Agriculture (IITA), Nigeria	W. K. Gamble D. J. Greenland Thomas R. Odhiambo and staff

International Livestock
Center for Africa (ILCA),
Ethiopia

Jean Pagot
Georges Tacher
Shenkute Tessema
and staff

International Laboratory
for Research on Animal
Diseases (ILRAD), Kenya

James Henson
John Pino
Ordway Starnes
and staff

International Rice Research
Institute (IRRI),
The Philippines

D. S. Athwal
N. C. Brady
F. F. Hill
and staff

IRRI, Indonesia

R. A. Morris
and staff

Donors

Asian Development Bank (ADB)	Sam Hsieh	
Australia	Bruce M. Cheek M. D. Mentz and staff	IBRD Australian Development Aid Agency
Belgium	Edmond De Langhe Albert Ramboux	Ministry of Foreign Affairs Development Cooperation Department, Ministry of Foreign Affairs
Canada	H. George Dion Paul Ladouceur Franc Mes	CIDA CIDA CIDA
Denmark	Finn Jønck Bjørn Olsen	Ministry of Foreign Affairs Danida
Ford Foundation, New York	David Bell Norman Collins Lowell Hardin Robert Havener F. F. Hill	
Ford Foundation, Egypt	S. Bunker	
Ford Foundation, Tunisia	W. Le Melle	
France	Claude Bailly Roville d'Orfeuil Henri Vernede	Delegation General de la Recherche Scientifique et Technique Ministère Affaires Etrangère Ministère de la Cooperation
Germany	Werner Treitz	Federal Ministry of Economic Cooperation
Inter-American Development Bank (IDB), Washington, D. C.	Alfred C. Wolf	

International Development Research Centre (IDRC), Canada	D. Daniels W. D. Hopper J. H. Hulse J. Pfeifer B. Scott	
Iran	Hussein Mirheydar	Ministry of Agriculture
Italy	G. T. Scarascia- Mugnozza	University of Bari
Japan	Isao Imanishi Hidetsugu Ishikura Akio Suzuki Hisashi Suzuki Noboru Yamada	Ministry of Agriculture and Forestry Japan Marine Science and Technology Center Agriculture, Forestry and Fisheries Research Council Ministry of Agriculture and Forestry Tropical Agricultural Research Center
New Zealand	W. A. Green	IBRD
Netherlands	W. F. M. Albers G. de Bakker J. J. Hardon J. Koopman W. Oosterberg K. Soels	Ministry of Foreign Affairs Ministry of Agriculture Ministry of Agriculture Royal Tropical Institute International Agricultural Center Technical Assistance Department, Ministry of Foreign Affairs
Nigeria	B. S. Oloruntoba	Federal Ministry of Agriculture and Rural Development
Norway	Paal Bog Johan H. Dahl Dag Nissen Kristian Oland Lars Strand	Ministry of Foreign Affairs Ministry of Foreign Affairs Ministry of Foreign Affairs Agricultural College Agricultural College

Rockefeller Foundation, New York	Colin McClung John McKelvey, Jr. John Pino Sterling Wortman	
Rockefeller Foundation, Thailand	James Bell	
Sweden	Gun-Britt Andersson (Mrs.)	Swedish Agency for Research Cooperation with Developing Countries (SAREC)
	Björn Elmér	Ministry of Foreign Affairs
	Karl Eric Knutsson	Swedish Agency for Research Cooperation with Developing Countries (SAREC)
	Per Rydén	SIDA
Switzerland	Josef von Ah Kurt Burri	Division of Agriculture Office of Technical Cooperation
	Rolf Wilhelm	Office of Technical Cooperation
United Kingdom	S. Bunce	Ministry of Overseas Development
	A. H. Bunting	University of Reading
	R. K. Cunningham	Ministry of Overseas Development
	W. D. Maniece	Ministry of Overseas Development
	W. A. C. Mathieson	formerly Ministry of Overseas Development
	R. Melville	Ministry of Overseas Development
	R. Riley	Cambridge Plant Breeding Station
	D. Williams	Ministry of Overseas Development
United Nations Development Programme (UNDP)	See "Co-sponsors"	
United Nations Environment Programme (UNEP), Kenya	R. J. Olembo	
United States	Guy Baird Curtis Farrar	
IBRD	See "Co-sponsors"	

Others

Agriculture Development Council, Bangkok	Shao-er Ong
Arid Lands Agricultural Development (ALAD), Cairo, Egypt	Owen L. Brough
Center for Animal Research and Development, Bogor, Indonesia	Mr. Gurnett-Smith and staff
Colombian Institute of Agriculture (ICA), Bogota, Colombia	Dr. Quintero
Consultative Group on Food Production and Investment (CGFPI), Washington, D. C.	Edwin Martin
Corporacion Nacional de Investigacion y Fomento Forestal	Armando Samper
Development Cooperation Directorate, Organisation de Coopération et Développement Économiques, Paris	Nicole Massignon (Mrs.) Bevan B. Stein Francis Wells
Department of Agriculture, Cairo, Egypt	A. L. Fawzy S. Dessouki
European Economic Community (EEC), Brussels, Belgium	H. Eggers
Institute of Agriculture, Bogor, Indonesia	A. M. Satri and staff
The International Centre of Insect Physiology and Ecology (ICIPE), Nairobi, Kenya	Thomas R. Odhiambo
International Food Policy Research Institute (IFPRI), Washington, D. C.	Nathan M. Koffsky
Minister of Agriculture, Algiers	H. E. Nour-Eddine Boukli
National Academy of Sciences, Washington, D. C.	Joel Bernstein
Philippine Council of Agricultural Research, Manila	J. Madamba
Technical Advisory Committee (TAC), Rome	Sir John Crawford and other members
University of Illinois	M. B. Russell

WORLD FOOD NEEDS:
FOOD GAPS AND PERFORMANCE

Prepared by
Nathan M. Koffsky

Report to the CGIAR Review Committee Study Team
Washington, D.C.
May 1976

Report to the
CGIAR Review Committee Study Team

Findings and Implications for Research

In many countries of the developing world, performance in food production lags seriously, building up food shortfalls which could well become unmanageable. Thus, there is an urgent need to improve yields in most of the array of food crops as soon as possible. The findings which surface from this report suggest certain guidelines for directing attention as to research needs and priorities in terms of specific areas and specific food crops.

1. There is a clear case for urgent attention to the needs of the low income countries (i.e. GNP per capita less than \$200) where large food shortfalls threaten over the next decade and beyond. Most importantly, these include India, Bangladesh, Indonesia (probably), Nigeria and most other low income Sub-Sahara Africa countries. This group also contains most of the malnourished people in the developing world. Food crop yields are generally low and performance in improving them is poor. This is especially a matter of concern in Asian countries where additional cultivable land is a constraint.

2. Next are those countries, somewhat better off economically and in food production, but which also face substantial food deficits and financial constraints to purchase

needed food supplies. These include the rest of the Sub-Saharan countries, the non-OPEC North Africa/Middle East countries, the Mid-America/Caribbean group (except Mexico) and the Andean countries of South America, especially Peru and Bolivia.

3. This does not mean that others, where improved crop yields are a major determinant of higher incomes and levels of living should be denied attention. But the major focus should be directed to the groups above if the food problem in developing countries is to be resolved.

4. While attention should continue directed toward improving yields of the major cereals - rice, wheat and maize - there is need also for emphasis on millets and sorghum which are associated with the dry land cultivation prevalent in many food deficit countries. The same is true for root crops and for pulses and groundnuts.

5. In Asia, the primary need continues to be improvement of rice yields, the major food. Performance in this respect appears to be more or less adequate only in Pakistan and Indonesia. In India, additionally, poor performance in sorghum, millets and pulses also contributes substantially to the food problem. In Indonesia, where cassava is important, yields are on a declining trend. The situation for maize and groundnuts is generally unsatisfactory throughout the region.

6. In Sub-Saharan Africa, yield performance of the major cereals - maize, millets and sorghum - is poor, particularly for the latter two where yields are declining. Root crops - cassava, yams and sweet potatoes - which rank with cereals as a major food source in much of the region, are having difficulty in maintaining historical yield levels. Yields of pulses and groundnuts are on a declining trend.
7. In North Africa/Middle East, the major problem in food crops remain wheat and barley, although in the low income countries of Sudan, it involves sorghum, cassava and pulses, and in Afghanistan, millets as well as wheat.
8. In Latin America, where maize is the dominant food, the main problem countries are in the Mid America/Caribbean area (except Mexico) and in Bolivia and Peru. Maize yields in the former group have not changed much in the past and have risen only slowly in the latter two countries. Cassava and sweet potatoes are important in Haiti (a low income country), but yields show no significant change historically. In Bolivia and Peru, yields of wheat are low and declining in the latter country. Yields of potatoes in Peru are low and also show no tendency to improve. In most of Latin America, production of pulses lags behind population growth.
9. It should be noted that there is an immediate and urgent need to improve food production in low income food deficit

countries. This places added emphasis on accelerating and exploiting research on those commodities where the potential exists to make a significant impact in the next 5 to 10 years.

10. At the same time, it is recognized that there are other constraints - inappropriate food policies, lack of incentives, inadequate institutions and management, lack of inputs, etc. - which impede the adoption of available research and technology by the ultimate cultivator. To narrow this gap, more intensive research is needed to identify and to help overcome such constraints.

Introduction

This report is designed to provide background information on potential food shortfalls in developing market economies^{11/}; to sort out the countries and regions where the food problem is likely to be most difficult, and to identify the principal food crops which require attention if food needs are to be met.

Food shortages and poor performance in crop yields and production may reflect many constraints. Whether inadequate agricultural research either at the international level or in the national research system is a major factor does not come out of the analysis in this report. Rather it provides a framework in which to look in order to determine if that is the case in particular situations. To get closer to such an evaluation,

^{11/} This excludes the Peoples' Republic of China and other Asian Centrally Planned Economies.

it might be well to mobilize the expertise in the International Centers to determine if the varieties being developed and the directions of research are in accord with the specific agro-climatic and other requirements in the areas of greatest need.

Essentially, the food problem in the developing world is largely one of cereals. Generally, cereals provide the major source of calorie intake (Table 1). Further, recent findings suggest that consumption of enough cereals to satisfy minimum energy needs will provide enough of the other nutritional requirements as well. Thus, for most developing countries, particularly low income countries, the potential cereal deficit is a meaningful measure of their food problem.

Attention is also given to the starchy root crops. In Indonesia, Sub-Sahara Africa and South America, root crops are an important alternate source of energy. While experience indicates that over time cereals come to be preferred because they require less bulk to provide equivalent calories and are higher in protein content, root crops will continue as a substantial part of the diet, especially for subsistence cultivators. In these regions, lag of root crop production relative to population growth would increase the requirements for cereals.

Similarly, production performance of pulses, soybeans and groundnuts - major sources of vegetable protein - is evaluated. In most low income countries, vegetable protein is much more important in the diet than animal protein. Meat becomes important in the diet in higher income countries - beef in beef exporting countries of Latin America, pigs in Asia and sheep and goats imported

into Near East OPEC countries largely from Sub-Saharan Africa. These are not considered in this report since they are of relatively low priority in directly meeting overall food needs although they might well be important elements in development strategy in some countries, especially in Africa.

The Cereals

Cereal Deficits - 1985

Projections of the cereal deficits for 1985 (table 2) used in this report are those of the International Food Policy Research Institute. ^{1/} This is the only set of published projections which provides a complete breakdown of the incidence of cereal deficits by major countries and regional groupings. ^{2/}

The methodology for projecting the deficit employed by IFPRI, and used as well by FAO and the World Bank, basically involves projecting the gap which results from demand for cereals arising from population and income growth on the one hand and on the other projecting the historical trend of cereal production. Thus, the deficit indicates the amount which would be needed to satisfy demand for cereals if past production trends continued into the future.

^{1/} Meeting Food Needs in the Developing World: The Location and Magnitude of the Task in the Next Decade. Research Report No. 1, Washington, DC, February, 1976.

^{2/} Projections for a number of countries have been made by FAO and the World Bank for internal use. In general, those projections using approximately the same methodology as IFPRI yield about the same results. The major exception is Indonesia where FAO data indicate a much smaller deficit than the IFPRI projection which was based on USDA data. Other projections prepared by OECD, the Univ. of Calif., and Iowa State Univ. were not usable for various reasons, mostly because of lack of comparability in coverage of countries.

Such projections indicate the extent of adjustments countries face: whether to meet deficits by increased production, by commercial imports if foreign exchange is not constrained, or concessionary imports if it is; and/or by reducing per capita consumption either by higher prices or by rationing.

The ranges in IFPRI projections of consumption and cereal deficits are based on a high income growth assumption (more or less the historical trend in growth in GNP per capita) and a low income growth assumption which takes into account the slowdown stemming from the energy situation in many developing countries. Further, the countries were categorized according to their economic circumstances into three income groups; low income, middle income, and high income.

Table 3

Gross Cereal Deficits by Income Groups

(million tons)

Food Deficit Countries	1969/71 Ave.	1974/75 Ave.	Projected 1985/86	
			High Income Growth	Low Income Growth
Low Income	5.4*	12.6*	48.0	41.9
Middle Income	10.9	17.1	25.2	22.9
High Income	<u>9.3</u>	<u>13.0</u>	<u>34.8</u>	<u>29.7</u>
TOTAL	25.6*	42.7*	108.3	94.5

*Does not include deficits for Pakistan and Brazil which are projected to become exporters by 1985.

Low Income Food Deficit Countries

As noted in Table 3, the major cereal deficits are in the low income countries (i.e. those with less than \$200 per capita in 1972). These include the South Asian Countries, Indonesia, a few in North Africa/Middle East, and a large number of Sub-Saharan countries.^{1/} They are expected to contain about 1.5 billion people in 1985, some 60 percent of the total population in DME countries. Population growth is the main factor increasing food consumption. Their cereal crop yields are lower and rising more slowly than in the Middle Income Group, and generally are more subject to weather and other uncertainties. These countries have little option except to increase production more rapidly, inasmuch as the size of the deficit appears to be beyond the bounds of either commercial imports of food aid transfers. Further, since in most low income countries average diets are already deficient, there is little room for downward adjustment in that regard which generally would impact most severely on the poor who already are underfed.

According to FAO, some 440 million people, most of whom are in Asian low income countries, are underfed. If things go on as they are, their numbers will increase by 1985. FAO estimates that an additional 20 million tons of cereals, beyond the deficit shown for 1985, would be required to supplement their intake by 250 calories per day. This may be conservative. Other estimates place the additional requirement at 35-40 million tons.

^{1/} See Annex's A and B for countries included and expected population in 1985.

Middle Income Food Deficit Countries

This group (per capita GNP above \$200) includes the Philippines, Egypt, Turkey, most non-OPEC countries of North Africa/Middle East, some Sub-Sahara Africa countries containing about 1/6 of the region's population, and Latin America excluding Argentina and Brazil. In total, these countries contain about 20 percent of the population in DME countries. In recent years, the cereal deficit for this group has been larger than those for the other income groups but is projected to increase more slowly in the future than the others. While they are generally in a better position than the low income group, chronic food problems exist in Egypt, much of Mid America/Caribbean area and the Andean countries of South America.

High Income Food Deficit Countries

These countries have a high capacity to generate foreign exchange. They include the OPEC countries and diversified economies in Asia such as Taiwan and South Korea. With high income growth the demand for cereals, particularly for feeding livestock, rises rapidly. While the cereal deficit will increase rapidly, they have the resources to import commercially. Their population is only 8 percent of the total.

Cereal Exporters

Presently Argentina and Thailand are significant exporters. The projections indicate that Pakistan and Brazil will move into that category within the next 10 years. Population in these countries will account for 13 percent of total DME population at that

time. While cereal production for this group generally increases at a satisfactory rate, most of it comes from expansion of crop area in Thailand and Brazil whereas rising crop yields is the major factor in Pakistan and Argentina.

Cereal Deficits by Countries - 1985

The Secretariat of the U.N. World Food Council has identified those developing countries which it considers as Food Priority Countries. For the most part, this group substantially is in accord with the category of low income food deficit countries noted above. (It should be noted that Burundi, Togo and Zaire which are not listed under Food Priority Countries are in the opinion of the Secretariat at the margin and could well have been included.) Table 4 shows the upper end of the range of the deficits projected by IFPRI for Food Priority Countries as well as for all other countries. The accompanying data for each country on rates of growth in area, yield and production of cereals are from FAO.

Speculation on 1985-2000

According to U.N. medium projections, population of DME countries will increase from 2.5 billion in 1985 to 3.6 billion in 2000. The rate of population increase will slow in Asia, North Africa/Middle East and Latin America but is expected to increase slightly in Sub-Sahara Africa. Under an assumption of maintaining grain consumption per capita constant from 1985 to 2000 ^{1/} and

^{1/} This assumption would still leave most of the low income countries with inadequate cereal intake per capita

continuing the past production trend, the cereal deficit would increase by 30-35 million tons over 1985. Under such assumptions, which are only suggestive, the deficit in Asia would stabilize, increase slightly in Latin America, and rise substantially in Sub-Saharan Africa and North Africa/Mid East where population would outrun cereal production by substantial margins.

Under a more realistic assumption that incomes will continue to grow and add to demand, the total cereal deficit could well double between 1985 and 2000, reaching 200 million tons or more.

Performance of Cereal Crops - 1961-74

In order to determine the particular food crops in specific countries where performance needs to be improved, historical growth rates (1961-74) of area harvested, yield per hectare and production have been computed from data published by FAO for 6 cereals (wheat, rice paddy, barley, maize, sorghum, and millets), 4 root crops (cassava, yams, sweet potatoes and potatoes) and pulses, groundnuts and soybeans.

As can be seen in Tables 5 and 6, yields of all the grains are significantly lower in the low income food deficit countries than in the middle income group, and increases in yields have come at a much slower pace. Performance in the high income group is mixed with high yields of rice (paddy) in Asian countries such as Taiwan and South Korea and very low yields of wheat in OPEC countries of North Africa/Middle East. For food exporters, yields of maize average significantly higher but those of rice and wheat are relatively low. Increases in production in the exporting group have

come more from expansion of crop area than from yield increases.

Asia: Excluding the high income group, crop yields of rice - the major cereal in the region - have risen rapidly in Pakistan, Indonesia, the Philippines and Sri Lanka. They have lagged badly in Bangladesh, Thailand, Nepal and Burma. Yields in India have risen somewhat less than average. For India, Bangladesh, Nepal and Burma, there has been little growth in paddy area, indicating that in the future increases in production will have to come from higher yields per hectare.

Performance in wheat has been good in India and Pakistan, the main countries involved. For millet and sorghum which are important in dry areas of India, yields are low, rising for millet but not for sorghum. In the major countries concerned with maize - India, Indonesia, Philippines and Thailand - yields are less than 1 ton/ha except for Thailand, which exports most of its maize. Yields have risen significantly only in the Philippines.

Thus, the major concerns which come out of these data are to improve more rapidly yields of rice in India, Bangladesh, Nepal, and Burma; with Thailand close behind; yields of millet and sorghum in India; and yields of maize in India, Pakistan, Indonesia and Thailand.

North Africa/Middle East Non-OPEC: In this region, wheat and barley are the most important cereals, with additionally sorghum in Sudan and millet in Afghanistan, both low income countries.

In Egypt, where the land is largely cropped and irrigated, crop yields of wheat, rice and maize are about the highest in the developing

world. While wheat and maize yields have increased rapidly in the past, it seems unlikely that this will continue unchecked. In Turkey, where crop area is also limited, yields of wheat, barley and maize are somewhat above average, and increasing for wheat and maize but stagnant for barley.

For the rest of the higher income group - Jordan, Lebanon, Morocco, Syria, Tunisia and Cyprus - yields of wheat and barley are somewhat lower than in Turkey and in most countries the area of grain is declining. Except for Morocco and Tunisia, barley yields show a substantial downward trend, and for wheat, the trend in yield is slightly down.

For the low income countries, wheat area is expanding rapidly in the Sudan but yields are declining. To a lesser extent the same situation prevails in sorghum. In Afghanistan both wheat area and yield are rising slowly, but millet yields are declining.

As a matter of priority for low income countries, special attention should be given to reversing the downtrend in yields of sorghum in Sudan and of millet in Afghanistan. For the latter country, the slight uptrend in wheat yields needs to be accelerated. Viewing the region as a whole there is need for general improvement in wheat and barley yields, particularly in Jordan, Lebanon, Syria and Cyprus.

Sub-Saharan Africa: The important cereals in this region are maize, millet and sorghum. Maize yields averaged 1.1 tons/ha in 1974, whereas millet and sorghum averaged about 0.6 tons/ha. Nigeria, the country with the largest population, shows declining yields for all

three crops, particularly for sorghum. The countries in the low income category show a modest increase in yield trend for maize but a decline in millet yields. Low income countries experiencing little change or declines in yields include Malagasy, Tanzania, Chad, Ethiopia, Guinea, Mali, Niger, Rwanda, Upper Volta and Zaire. Yields are higher in the Sub-Saharan High Income group, and except for millets, yields are on an uptrend. Most countries in this group, including Ghana, the largest, record downtrends in millet yields.

It would appear that special emphasis should be directed to reversing the yield downtrends for millet and sorghum and to improving yields of maize faster, particularly for Nigeria and other low income countries.

Latin America: Yields of maize, the most important cereal in the region, vary significantly among countries ranging from 0.8 tons/ha in Haiti (a low income country) to 2.8 tons/ha in Argentina. Yields in Mexico average about 1 ton/ha, and although increasing, still fall short of population growth which is among the highest in the world.

The most difficult food problems are in the Middle America/Caribbean sub-region and in the Andean countries. In the former group, maize yields in most countries have not changed much in the past 15 years. The major exception is El Salvador where maize yields have increased substantially. Rice yields, on the other hand, average 2½ tons/ha and almost all countries in the sub-region show strong uptrends.

In Bolivia, Colombia and Peru, maize yields run 1¼ to 1½ tons/ha

and rising slowly. However, the maize area has remained more or less unchanged and maize production is lagging behind population growth and demand for cereals. In the case of wheat, which is important in Bolivia and Peru, yields are fairly low, running less than 1 ton/ha, the area harvested is declining and in Peru, yields are on a downtrend. In Colombia, rice (paddy) yields run 4 tons/ha and are on a strong uptrend.

The main need is to improve maize yields, primarily in the Middle America/Caribbean countries and in the Andean Group and for the latter group to improve wheat yields as well.

Recent Trends in Area and Yields (1967-74)

The recent seven-year period, particularly since it was a period with considerable variation in weather, is too short to provide a reliable indication of changes in trend. Nevertheless, the more recent data suggest as follows:

Asia: Wheat and rice appear to be maintaining historical trends in yields (1961-74). However, the expansion in rice area has slowed further, whereas the growth in wheat area has accelerated.

North Africa/Mid East Non-OPEC; The area in wheat has increased more rapidly than earlier, but an offsetting slowdown has occurred in yield. For barley, trends in both area and yield have turned down.

Sub-Saharan Africa: The uptrend in maize yields has come to a halt; yields of millets and sorghum continue to decline. While area in maize and sorghum continues to

rise, that of millets has turned slightly down.

Latin America: The growth in yields of maize has slowed but wheat and rice yields have risen more sharply than earlier. Expansion of area has slowed for all three.

This would appear to put added pressure on the need to improve yields of rice in Asia; wheat and barley in North Africa/Middle East; maize, millet and sorghum in Sub-Sahara Africa; and maize in Latin America.

Root Crops

As noted in Table 1, root crops make up an important part of the diet in cereal deficit countries including Indonesia, Sudan, Sub-Sahara Africa and in some countries in South America. A shortfall in root crop production relative to population growth places added burden on increasing the supply of cereals. Conversely, increasing root crop production may alleviate a situation where the supply of cereals is not forthcoming. Cassava is by far the most important root crop in the developing world, involving a total area harvested of 11.6 hectares in 1974 compared with 2.8 million in sweet potatoes and 2.0 million in yams. During 1961-74, average yields of cassava have increased only 0.6 percent a year, yams 1.0 percent, and potatoes 1.8 percent, while yields of sweet potatoes have declined 2.6 percent a year. Increases in production of cassava and sweet potatoes have come largely from expansion of area.

Although these crops contain only 20-30 percent of the caloric content of cereals and are negligible in protein, crop yields in the low income food deficit countries average about 7 times more

in tonnage per hectare relative to wheat, rice and maize and about 15 times more than sorghum and millet.

Performance 1961-74 (Tables 7 and 8)

Indonesia: Cassava and sweet potatoes are the main crops consumed, with the former accounting for about 80 percent of consumption of root crops. Yields are somewhat below the average for cassava in low income food deficit countries and above average for sweet potatoes. Population is projected to increase about 2.6 percent a year to 1985. The trends in both area and yields are negative for both cassava and sweet potatoes, thus operating to reinforce the prospect for a widening cereal deficit.

Sudan: Cassava represents 85 percent of root crop consumption with sweet potatoes most of the rest. Yields of cassava have shown little change historically while sweet potatoes have increased 1.4 percent a year. Production of root crops, largely from area expansion, increases 3.6 percent a year relative to 3.2 percent for population. Yields of both crops are among the lowest in the developing world.

Sub-Saharan Africa:

Nigeria: Cassava and yams are about equally important in the diet. Yields of both are higher than average, with

yields of cassava increasing 0.7 percent annually and yams 1.5 percent a year. However, the crop area in root crops has changed little so that annual production increases of 1.1 percent a year falls considerably short of projected population increases of 3.0 percent annually.

High Income: All countries in this group are projected to be in deficit for cereals. Cassava is most important generally, with, additionally, yams in Ghana and the Ivory Coast. Yields of both are relatively low. Cassava yields have increased historically about 1.2 percent a year but the major gains have occurred in Ghana and the Ivory Coast where cassava is relatively less important in the food supply. Other countries show little change or declines. For yam, yields declined 1.2 percent, mostly as a result of a substantial drop off in Ghana. Root crop production in Mozambique, Zambia, Liberia and Senegal has lagged appreciably behind population growth.

Low Income: Cassava and sweet potatoes are the major root crops. Yields also run below average. In most countries, yields of cassava have changed very little since the early 1960's. But production has increased substantially due to rapid expansion in area cropped. Yields of sweet potatoes have declined sharply throughout most of the countries but increases in area cropped have more than offset the drop in yields. The major cereal deficit countries

where root crop production lags seriously behind population growth are Benin (Dahomey), Guinea, Kenya, Mali, and Tanzania.

Mid America/Caribbean: Cassava and sweet potatoes are significant in the cereal deficit countries of Haiti and Dominican Republic. Yields are high in the latter country but quite low in Haiti. In the Dominican Republic where yields and area are rising, production of root crops lag slightly behind population growth. In Haiti, yields of cassava increase slowly while those of sweet potatoes tend to decline. Although area is expanding, production of root crops also lags slightly behind the rate of population growth which is quite low.

South America: Brazil is projected to become a cereal exporter. Thus, there is not likely to be a major concern over performance in cassava production, which has increased faster than population growth. In Venezuela, an OPEC country, the fact that root crop production is stable is also not of great moment considering that foreign exchange is not a constraint and a large part of its food supply is imported commercially.

The food problem in Bolivia, Colombia and Peru, all cereal deficit countries with foreign exchange constraints, is another matter. The important root crops in these countries are potatoes and cassava. Potato yields range from 5-6 tons/ha in Peru and Bolivia to over 12 tons/ha in Colombia. Cassava yields are 8-9 tons/ha in Peru and Colombia and

14 ton/ha in Bolivia.

In Bolivia, yields of potatoes have increased almost 3 percent a year, and of cassava almost 2 percent a year. With area of the latter expanding rapidly, root crop production exceeds population growth by a considerable margin. In Colombia, yields of potatoes have risen 1.6 percent a year and of cassava over 4 percent. Coupled with rapid expansion of area, root crop production also exceeds population by a wide margin. Peru, on the other hand, shows a slight negative trend in potato yields and a slight positive trend in cassava yields. With area cropped relatively unchanged, the trend of production of root crops is slightly negative.

It is evident that major emphasis should be given to increasing yields of cassava in Indonesia and much of Africa with subsidiary attention in Africa to sweet potatoes and yams in the countries noted earlier. The same applies to Haiti. The problem is less acute in South America except for Peru where performance in potatoes has been disappointing.

Pulses, Groundnuts, and Soybeans

This group of commodities provides about the same amount of calories per unit as cereals but roughly 2-3 times the protein content. Pulses and groundnuts are prevalent in most developing countries. Yields are relatively low, averaging about $\frac{1}{2}$ ton/ha for pulses and 0.8 tons/ha for groundnuts in the shell. Yields per

hectare have not changed much historically, in fact they show a slight downtrend. The trend of production particularly in the low income food deficit countries is also sidewise, thus on a per capita basis the supply of these food commodities is diminishing.

Most of the soybeans in the developing market economies are grown in Brazil, where a substantial export trade has developed. It is also taking hold rapidly in other Latin American countries. Yields average over 1½ tons/ha in this region and are rising about 2½ percent a year.

Performance 1961-74 (See Tables 8 and 9)

Asia: Excluding the Asia High Income Group, where performance has been quite good, yields of pulses have shown little change historically throughout the region. In India, which accounts for 90 percent of the area harvested in the region, pulses make up about 10 percent of the food grain supply. (Pulses have been included in computing the cereal deficit in India shown in Table 2.) Both yield and area have tended to decline historically, with production diminishing almost 1 percent a year. The result is an increasing gap between the supply of pulses and population. This situation is much the same throughout the region.

The trend in yields of groundnuts is only slightly better. With production rising less than 1 percent a year, there is also a widening gap relative to population growth.

Soybean production is relatively unimportant, except in Indonesia and Thailand. Yields in these countries are low and increa-

North Africa/Middle East: Yields of pulses have risen in most of the region except in the low income countries of Sudan, Yemen Arab Republic and Afghanistan. For the latter group, expansion of area have increased production about in line with population growth.

For groundnuts, yields show a sharp decline historically throughout the region, again, compensated by enlarging area. Production has risen faster than population.

Soybeans are negligible in the region.

Sub-Sahara Africa: Yields of pulses are substantially below average in Nigeria and show a rapid decline historically. However, large increases in area result in production exceeding population growth. Among the Higher Income Group, yields are about average but little changed historically. Production lags significantly behind population growth in most of the group, particularly in Mozambique, Ivory Coast and Senegal. In the Lower Income Group, yields are also about average and show a tendency to decline historically, with fairly sharp declines in Burundi, Chad, Gambia, Mali, and Niger. In most of this group, expanding area brings increasing production slightly in excess of population growth.

For groundnuts, yields are also significantly below average in Nigeria, with a rapidly declining trend. Together with sharp declines in area, production is also dropping rapidly. In the Higher Income Group, the trend in yields and production is also down, particularly in Angola and Senegal. In the Lower Income Group, yields are relatively low and show a moderate declining trend. Production also lags behind population growth, although less

have occurred in Chad, Mali, Niger, Tanzania, Togo, Upper Volta and Zaire.

There is very little soybean production in this region. Of what there is, yields are very low.

Latin America: Yields of pulses are somewhat higher in this region than average and show a modest uptrend historically. In Mexico, yields have risen close to 3 percent a year. Even so, production lags somewhat behind population growth. Pulses are also important in the diet in Middle America/Caribbean, where yields rise about 1 percent a year, and production increases fall short of population growth. Yields show little change or declines in Guatemala, Haiti, Honduras, and Nicaragua. In South America, yields show little change or declines, with production increasing slower than population in Brazil, Venezuela, Ecuador and Peru. Performance of yield and production in Bolivia and Colombia are more satisfactory. Peru has a sharp downtrend in yields with a slight decline in trend of production.

Groundnuts are of minor significance. Yields are on a declining trend throughout most of the region with increases in area somewhat more than offsetting.

Soybeans: Most of the soybean area is in Brazil, where yields are increasing about 3 percent annually with area expanding very rapidly. Performance in other Latin American countries, while not as high as in Brazil, shows yields rising over 1½ percent a year accompanied by fairly rapid increases in area. The major exception is Peru, where both yields and area have declined.

There is evidently a widespread and urgent need to improve yields of pulses and groundnuts throughout most of the developing world, particularly in the low income food deficit countries in Asia and Africa where the potential cereal deficits are expected to be large. Increasing yields of pulses in the Middle America/Caribbean countries can also contribute to alleviating the food situation in that area.

Soybeans appear to be performing quite well in Brazil and some other South American countries. At this time, their potential in other regions has hardly been tested.

DEVELOPING MARKET ECONOMIES
IFFRI COUNTRY CATEGORIES

A. DEVELOPING COUNTRIES WITH FOREIGN EXCHANGE

- | | | |
|-------------------------------------|-------------|--------------|
| 1. Asia Group | | |
| Brunei | Singapore | Macao |
| Hong Kong | South Korea | |
| Malaysia | Taiwan | |
| 2. North Africa - Middle East OPEC: | | |
| Iran | Algeria | Saudi Arabia |
| Iraq | Libya | Kuwait |
| Bahrain | Oman | Qatar |
| United Arab Emirates | | |

B. DEVELOPING COUNTRIES WITH FOREIGN EXCHANGE CONSTRAINTS

(Countries asterisked are oil exporters which are likely to improve reserve positions.)

- | | | |
|---|------------------------------------|--------------------|
| 1. Other Asia Market Economies: | | |
| a. India | e. Philippines | |
| b. Bangladesh | f. Thailand | |
| c. Pakistan | g. Other Asia: Bhutan, Nepal, | |
| *d. Indonesia | Sri Lanka, Burma, Pacific Islands, | |
| | Papua-New Guinea, Sikkim, Maldives | |
| | Islands | |
| 2. North Africa-Middle East (Non-OPEC): | | |
| a. Egypt | | |
| b. Turkey | | |
| c. Remaining Countries (from Afghanistan to Morocco): | | |
| (1) High Income (\$200+): | | |
| Jordan | Syria | |
| Lebanon | Tunisia | |
| Morocco | Cyprus | |
| (2) Low Income (less than \$200): | | |
| Sudan | Yemen (Aden) | |
| Yemen (Sana) | Afghanistan | |
| 3. Sub-Sahara Africa | | |
| *a. Nigeria | | |
| b. Remaining Sub-Sahara: | | |
| (1) High Income (\$200+): | | |
| Mozambique | Mauritius | |
| Rhodesia | Reunion | |
| Zambia | Senegal | |
| *Angola | Spanish Sahara | |
| Cameroon | French Terr. Afaro & Issas | |
| Congo | Guinea-Bissau | |
| *Gabon | Cape Verde Isles | |
| Ghana | Ceuta & Melilla | |
| Equatorial Guinea | Sao Tome & Principe | |
| Ivory Coast | Seychelles Islands | |
| Liberia | | |
| (2) Low Income (less than \$200): | | |
| Kenya | Mali | |
| Malagasy Republic | Mauritania | |
| Malawi | Niger | |
| Tanzania | Rwanda | |
| Uganda | Sierra Leone | |
| Burundi | Somalia | |
| Central Africa Rep. | Togo | |
| Chad | Upper Volta | |
| Dahomey | Zaire | |
| Ethiopia | Lesotho | |
| Gambia | Comoro Islands | |
| Guinea | | |
| 4. Latin America: | | |
| a. Argentina | | |
| b. Mexico | | |
| c. Brasil | | |
| *d. Venezuela | | |
| *e. Ecuador | | |
| f. Other Middle America and Caribbean: | | |
| Bahamas | Guatemala | Panama |
| Bermuda | Haiti | *Trinidad & Tobago |
| Costa Rica | Honduras | Other Caribbean |
| Cuba | British Honduras | Isles (Martinique, |
| Dominican Republic | Jamaica | etc.) |
| El Salvador | Nicaragua | |
| 5. Remaining Latin America: | | |
| Bolivia | French Guiana | Peru |
| Chile | Guyana | Surinam |
| Colombia | Paraguay | Uruguay |

**POPULATION IN IFPRI CATEGORIES
BY INCOME GROUPS, 1970 EST., 1985 AND 2000 PROJECTED**

Income Group	1970 Est. (millions)	1985 Proj. (millions)	2000 Proj. (millions)
Low Income-Food Deficit (under \$200 per capita):			
India	549.8	792.4	1,059.4
Bangladesh	68.3	99.4	144.3
Indonesia	121.0	177.7	237.5
Other Asia	52.1	73.7	99.4
NA/ME Non-OPEC Low Income	34.6	53.4	79.0
Nigeria	55.8	85.7	134.9
Sub-Sahara Low Income	<u>130.6</u>	<u>197.0</u>	<u>299.9</u>
Total Low Income	1,012.2	1,479.3	2,054.4
Middle Income-Food Deficit (\$200+ per capita):			
Philippines	38.2	61.8	89.7
Egypt	33.7	47.7	64.6
Turkey	35.7	52.4	72.6
NA/ME Non-OPEC High Income	32.3	50.7	75.4
Sub-Sahara High Income	48.3	72.5	110.6
Mexico	51.1	84.2	132.2
Other MA/Carib.	37.0	54.6	78.2
Ecuador	6.1	9.8	14.8
Other Latin America	<u>56.6</u>	<u>84.4</u>	<u>118.9</u>
Total Middle Income	339.0	518.1	759.0
High Income-Food Deficit (high foreign exchange capacity):			
Asia Group High Income	62.2	87.8	115.0
NA/ME OPEC	62.7	100.8	151.0
Venezuela	<u>10.7</u>	<u>16.6</u>	<u>23.6</u>
Total High Income	135.6	205.2	289.6
Total DME-Food Deficit	1,486.8	2,202.6	3,101.0
Grain Exporters:			
Pakistan	61.4	98.9	146.9
Thailand	36.3	58.7	85.6
Argentina	23.9	28.8	32.9
Brazil	<u>96.6</u>	<u>147.1</u>	<u>212.5</u>
Total Exporters	218.2	333.5	477.9
TOTAL DME	<u>1,705.0</u>	<u>2,536.1</u>	<u>3,578.9</u>

Source: United Nations Projections for 1985 and 2000 are U. N. medium-medium variant 1974.

Table 1

Sources of Calories Consumed Per Capita^{1/} by IFFRI Country Categories
(Percent of Total Consumed)

Country Country/Grouping	Total per capita Calories/per day	Cereals %	Starchy Foods %	Pulses, Nuts, Seeds %	Sugar %	Vegetables %	Fruit %	Meat %	Eggs %	Milk %	Fish %	Oils and Fats %
Food Deficit Low Income												
India	1964	64.4	1.5	10.3	10.3	1.4	1.4	.3	.1	4.0	.2	1.8
Bangladesh	1995	70.9	.9	2.9	8.3	1.4	1.3	.8	.1	6.9	.6	5.9
Indonesia	1760	60.4	19.2	6.9	4.1	.7	1.0	1.1	.2	.1	1.1	4.8
Other Asia	2066	72.7	1.8	6.3	4.8	1.3	1.3	1.3	.3	2.2	1.2	6.3
NA/ME Non-OPEC Low	2071	65.2	9.9	3.9	4.2	1.0	2.0	4.0	.1	4.9	.2	4.6
Nigeria	2166	51.5	30.2	7.1	.8	.4	.6	1.4	.1	.7	.3	6.8
Sub Sahara Low	2133	53.8	22.6	10.0	2.6	.6	.8	3.5	.2	1.7	.5	3.6
Food Deficit Middle Income												
Philippines	1911	62.7	5.6	2.8	9.5	.8	3.8	5.1	.5	1.1	2.7	4.7
Egypt	2639	69.6	1.0	3.1	8.1	2.7	3.3	2.3	.2	2.8	.3	6.6
Turkey	2769	61.9	2.8	5.0	5.8	2.0	5.8	2.7	.3	3.9	.2	9.4
NA/ME Non-OPEC High	2248	60.0	.9	3.6	10.6	1.5	4.1	3.4	.4	3.4	.4	11.6
Sub Sahara High	2208	47.1	30.5	6.3	4.0	.6	1.0	2.6	.1	1.3	1.1	5.3
Mexico	2624	32.0	1.5	8.6	16.0	.3	3.7	5.3	.6	3.7	.2	7.7
Other NA/Carib.	2156	46.9	8.7	6.1	13.8	.8	3.0	4.6	1.2	4.6	.7	7.2
Ecuador	1848	31.3	13.3	7.0	16.0	1.6	6.1	7.7	.4	6.4	.5	7.2
Other Latin America	2302	40.5	12.5	2.7	16.2	1.1	2.6	8.6	.5	6.0	.8	7.6
Food Deficit High Income												
Asia Group High	2329	69.5	7.2	3.3	5.0	1.8	1.6	4.5	.4	.8	1.6	3.8
NA/ME OPEC	2007	63.6	1.7	2.6	11.8	1.2	4.1	3.3	.2	3.3	.1	7.8
Venezuela	2367	37.6	13.4	3.7	15.4	.4	2.0	9.1	.8	6.4	1.6	9.1
Food Exporters												
Pakistan	1995	70.9	.9	2.9	8.3	1.4	1.3	.8	.1	6.9	.6	5.9
Thailand	2226	72.1	3.0	5.8	5.3	.9	3.3	3.7	.7	.8	2.2	1.9
Argentina	2883	34.6	6.2	.8	13.1	1.0	3.0	21.3	.8	7.1	.4	11.3
Brazil	2341	33.9	16.1	12.2	15.8	.4	1.9	8.0	.7	5.3	.5	5.1

^{1/} Computed from Food Balance Sheets 1964-66 FAO, Rome 1971

Table 2

Cereal Deficits 1969-71 and
1985/86 Projected by IFPRI Country Categories^{1/}

Country/Country Grouping	1969-71 Average (Mil. Met. Tons)	1985/86 Projected (Mil. Met. Tons)
<u>Asia High Income</u>	<u>-5.8</u>	<u>-16.8 to -20.4</u>
	-2.5	-20.0 to -25.5
	(-5.7)	(-29.4 to -34.4)
<u>Other Asia Market Economies</u>	<u>(+3.2)</u>	<u>(+9.0 to +9.4)</u>
India	-2.2	-14.2 to -16.8
Bangladesh	-0.7	-5.3 to -5.5
Pakistan	-0.8	+3.7 to +3.9
Indonesia	-1.3	-6.7 to -8.6 ^{2/}
Philippines	-0.7	-1.5 to -1.8
Thailand	+3.2	+5.3 to +5.6
<u>Other Asia</u>	<u>0.0</u>	<u>-1.7</u>
	-8.3	-36.8 to -45.9
	(-11.5)	(-46.2 to -54.8)
<u>Total Asia</u>	<u>(+3.2)</u>	<u>(+9.0 to +9.4)</u>
<u>N. Af./MidEast OPEC</u>	<u>-2.6</u>	<u>-10.7 to -11.4</u>
<u>NA/ME Non-OPEC</u>	<u>-5.3</u>	<u>-10.6 to -11.2</u>
Egypt	-2.0	-3.6
Turkey	-0.4	-2.0 to -2.2
NA/ME Hi Inc.	-2.4	-2.7 to -2.9
<u>NA/ME Lo Inc.</u>	<u>-0.4</u>	<u>-2.3 to -2.4</u>
<u>Total NA/ME</u>	<u>-7.9</u>	<u>-21.4 to -22.5</u>
Nigeria	-0.4	-7.6 to -8.1 ^{3/}
Sub-Sahara Hi Inc.	-0.8	-2.0
Sub-Sahara Lo Inc.	-0.3	-4.1 to -4.8
<u>Total Sub-Sahara</u>	<u>-1.5</u>	<u>-13.7 to -14.9</u>
Mexico	-0.1	-.8 to -2.2
Other Mid-Am./Carib.	-2.4	-4.2 to -4.4
Argentina	+8.2	+15.7 to +16.1
Brazil	-1.7	+1.1 to +3.4
Venezuela	-0.9	-2.1 to -3.1
Ecuador	-0.1	-.7 to -.8
Other Lat. Am.	-2.0	-5.4 to -5.6
	+1.0	+.7 to +6.4
	(-7.3)	(-13.2 to -16.1)
<u>Total Lat. Am.</u>	<u>(+8.3)</u>	<u>(+16.8 to +19.5)</u>
	-16.7	-65.5 to -82.6
	(-28.2)	(-94.5 to -108.3)
<u>Total DME</u>	<u>(+11.5)</u>	<u>(+25.7 to +29.0)</u>

Source: IFPRI Research Report #1

Note: Parenthesis sum deficits and surpluses separately. Net deficit or surplus shown without parenthesis.

^{1/} For listing of countries see Annex A. ^{2/} If recent production growth rates prevail, the deficit would be reduced to 1-3 million tons.

^{3/} Projected deficit from other sources ranges from 3-6 million tons.

Food Priority and Other Developing Countries
(Categorized by U.N. World Food Council Secretariat,
U.N. WFC/20 14 April 1976)

Table 4

Developing Market Economies	Population		Cereal Deficit (1971-76)		Cereal Growth Rates (FAO data) (1961-74)		
	1975 (millions)	Growth Rate 1975-85	1969/71 million tons	1985/86 proj. High Income Growth million tons	Area %	Yield %	Production %
Food Priority Countries							
Afghanistan	19.3	2.7	.1	1.1	0.2	1.0	1.2
Bangladesh	73.7	2.9	.7	5.5	1.0	0.4	1.5
Benin (Dahomey)	3.1	2.8	(1/)	.1	-1.2	2.2	1.0
Burma	31.2	2.4	.7	.5	0.4	0.4	0.8
Cameroon	6.4	2.3	1/	.3	1.8	0.1	1.9
Chad	4.0	2.2	0	1/	-2.3	-3.8	-6.1
Egypt	37.5	2.3	2.0	3.6	0.5	2.1	2.6
El Salvador	4.1	3.2	1/	1/	1.4	4.0	5.5
Ethiopia	28.0	2.5	1/	1.0	1.4	0.6	2.0
Guinea	4.4	2.6	1/	1/	3.0	-0.5	2.5
Haiti	4.6	1.8	1/	.2	0.9	1.8	2.8
Honduras	3.0	3.4	1/	.2	0.5	-0.1	0.4
India	613.2	2.5	2.2	16.8	0.8	1.8	2.6
Indonesia	136.0	2.6	1.3	8.62/	1.1	3.1	4.3/
Kenya	13.3	3.4	(1/)	.4	1.3	1.6	2.9
Madagascar	8.0	3.1	1/	.3	2.2	-0.6	1.6
Malawi	4.9	2.6	1/	(1/)	2.8	1.5	4.4
Mali	5.7	2.6	1/	.5	0.6	-2.5	-1.9
Mozambique	9.2	2.4	1/	.2	0.4	1.7	2.1
Nepal	12.6	2.6	(.2)	.4	1.4	-0.3	0.6
Niger	4.6	2.8	0	.3	0.2	-1.1	-0.8
Pakistan	70.6	3.3	.8	(3.7)	1.5	4.1	5.8
Philippines	44.4	3.2	.7	1.8	1.5	2.2	3.8
Rwanda	4.2	3.0	(.1)	1/	3.3	-1.9	1.4
Senegal	4.4	2.5	.2	.6	0.4	-0.7	-0.3
Sierra Leone	3.0	3.0	1/	.2	2.1	1.8	4.0
Somalia	3.2	2.9	N/A	N/A	N/A	N/A	N/A
Sri Lanka	14.0	1.9	.9	1.0	1.5	3.0	4.6
Sudan	18.3	3.2	.2	.7	5.0	-1.6	3.3
Tanzania	15.4	3.2	1/	1.1	3.0	0.2	3.2
Uganda	11.4	3.1	0	(1/)	1.6	1.8	3.4
Upper Volta	6.0	2.4	1/	.3	-0.1	-0.7	-0.8
Yemen A.R.	6.7	3.0	N/A	N/A	-1.2	1.9	0.7
Other Developing Countries							
Algeria	15.8	3.4	.6	3.1	.4	.8	1.2
Angola	6.4	2.6	(1/)	.1	0.2	-0.0	0.2
Argentina	25.4	1.2	(8.2)	(15.7)	1.5	2.1	3.6
Bolivia	5.4	2.6	.2	.4	0.5	1.3	1.9
Brazil	109.7	2.8	1.7	(1.1)	3.9	0.1	4.0
Burundi	3.5	2.7	0	(.2)	7.1	2.1	9.4
Chile	10.2	1.8	.8	2.0	-0.9	1.6	0.7
Colombia	25.9	3.1	.4	.9	0.4	3.6	4.0
Cuba	9.4	2.1	1.3	2.0	1.4	3.4	4.7
Dominican Republic	5.1	3.4	.1	.4	0.6	3.9	4.6
Ecuador	7.1	3.2	.1	.8	-0.5	2.9	2.3
Ghana	9.9	3.1	.2	1/	5.0	1.2	6.3
Guatemala	6.1	3.0	.1	.2	2.4	0.1	2.3
Hong Kong	4.2	1.4	.6	.8	-9.7	2.1	-7.8
Iran	32.9	3.4	.6	4.2	3.6	.2	3.8
Iraq	11.1	3.3	.5	1.9	-1.0	2.9	1.2
Ivory Coast	4.9	2.7	.2	.3	2.2	2.4	4.7
Korea (Republic)	33.9	2.0	2.6	6.0	-0.7	2.7	2.0
Malaysia	12.0	2.9	.7	.4	4.3	1.6	4.0
Mexico	59.2	3.4	.1	2.2	1.6	2.4	4.2
Morocco	17.5	3.1	.7	(.5)	2.0	3.1	5.2
Nigeria	69.9	3.0	.4	8.1	1.1	-1.6	-0.5
Peru	15.3	2.9	.7	1.9	0.7	0.7	1.4
Saudi Arabia	9.0	3.1	.5	1.0	3.3	-0.2	3.0
Syria	7.3	3.4	.3	1.1	-0.2	-1.6	-1.8
Thailand	42.1	3.2	(3.2)	(5.3)	2.2	.6	2.9
Tunisia	5.7	2.8	.4	.4	-0.4	6.1	5.7
Turkey	39.9	2.6	.4	2.2	0.4	1.6	2.0
Uruguay	3.1	3.0	1/	(.1)	-1.0	3.2	2.1
Venezuela	12.2	2.9	.9	3.1	1.8	1.4	3.2
Zaire	24.5	2.8	.4	.3	10.0	-2.0	7.8
Zambia	5.1	3.3	1/	1/	-0.1	0.7	0.6

Note: Figures in parentheses are exports
• Countries with over 1 million population
1/ Less than 100,000 tons

The data base makes the deficit for Indonesia subject to unusual uncertainty. Projections of deficit by other institutions range from 1 to 3 million tons.

Table 5

Average Yields of Principal Cereals in IFPRI Country Categories^{1/} - 1974
(metric tons per hectare)
(area harvested in million hectares in parentheses)

Country/Country Grouping	Wheat	Rice (paddy)	Barley	Maize	Sorghum	Millet
Asia High Income	1.36 (.1)	4.25 (2.6)	2.35 (.8)			
India	1.16 (19.1)	1.64 (37.5)	.89 (2.6)	.91 (5.8)	.47 (17.0)	.49 (18.5)
Bangladesh		1.74 (9.9)				
Pakistan	1.25 (6.1)	2.09 (1.6)		1.08 (.6)	.63 (.5)	.51 (.6)
Indonesia		2.68 (8.5)		.97 (2.8)		
Philippines		1.61 (3.5)		.83 (2.8)		
Thailand		1.70 (7.7)		2.14 (1.1)		
Other Asia		1.82 (6.9)		1.51 (.6)		
Other Asia Market Economies	1.18 (25.6)	1.80 (75.6)	.87 (2.9)	1.04 (13.8)	.49 (17.6)	.49 (19.3)
N. Af./MidEast OPEC	.74 (8.3)		.71 (2.7)			
Egypt	3.45 (.6)	4.90 (.5)		3.83 (.7)		
Turkey	1.29 (8.6)		1.28 (2.6)	1.72 (.6)		
NA/ME HI Inc.	.97 (4.8)		1.09 (3.2)			
NA/ME Lo Inc.	1.17 (3.8)				.84 (3.0)	.44 (1.3)
NA/ME Non-OPEC	1.25 (16.8)	4.01 (.8)	1.19 (6.4)	2.14 (2.3)	.84 (3.1)	1.02 (1.4)
Nigeria					.62 (5.6)	.57 (4.9)
Sub-Sahara HI Inc.		1.30 (.7)		1.66 (2.8)	.81 (.8)	.59 (2.3)
Sub-Sahara Lo Inc.		1.31 (2.9)		.96 (7.2)	.67 (3.9)	.56 (6.3)
Total Sub-Sahara		1.31 (3.9)		1.12 (12.3)	.65 (10.4)	.57 (22.5)
Mexico	3.55 (.78)			.79 (7.8)	2.31 (1.2)	
Other Mid-Am./Carib.		2.23 (.6)		.72 (2.1)	1.68 (.3)	.78 (.3)
Argentina	1.44 (3.9)			2.84 (3.5)	2.44 (2.5)	
Brazil	1.10 (2.5)	1.56 (4.4)		1.34 (12.0)		
Venezuela		2.86 (.1)		1.09 (.5)		
Ecuador		2.55 (.1)		.94 (.3)		
Other Lat. Am.	1.24 (1.4)	3.43 (.7)	1.18 (.5)	1.38 (1.7)		
Total Lat. Am.	1.49 (8.7)	1.94 (6.1)		1.39 (27.9)	2.32 (6.4)	
Low Income Deficit	1.1 (23.7)	1.8 (66.2)	.9 (5.0)	1.0 (18.3)	.6 (29.6)	.5 (31.1)
Middle Income Deficit	1.4 (16.4)	2.2 (6.3)	1.2 (6.6)	1.2 (19.2)	1.6 (2.6)	.9 (2.9)
High Income Deficit	.7 (2.0)	4.0 (3.2)	1.1 (3.5)	1.2 (4.6)	1.4 (7.2)	1.1 (7.2)
Total Food Deficit	1.1 (49.1)	1.9 (75.8)	.9 (15.1)	1.1 (38.2)	.7 (32.3)	.5 (34.2)
Food Exporters	1.3 (12.5)	1.7 (12.8)	.8 (.6)	1.7 (17.2)	2.2 (3.3)	.7 (.9)
Total DME	1.17 (61.6)	1.89 (89.5)	1.1 (15.7)	1.48 (55.4)	.8 (35.6)	.55 (34.9)

Source: FAO Production Yearbook 1974

^{1/} For listing of countries see Annex A.

Cereals: Growth Rates of Area, Yield and Production 1961-74 by IFPRI Categories
(Percent per year compounded)

Table 6

Country/Region	Total Cereals			Wheat			Rice (Paddy)			Barley			Maize			Sorghum			Millets			
	A	Y	P	A	Y	P	A	Y	P	A	Y	P	A	Y	P	A	Y	P	A	Y	P	
Asia High Income	0.02	2.14	2.15	-3.67	0.05	-3.63	0.86	1.30	2.16	-0.44	3.70	2.77										
Other Asia Market Economies	0.98	1.81	2.81	3.29	4.26	7.67	0.67	1.47	2.35		1/		2.14	0.73	2.89	-0.79	0.08	-0.71	0.26	1.56	1.82	
India	0.80	1.81	2.63	3.61	4.41	8.18	0.59	1.30	1.89	-1.72	1.30	-0.44	2.49	-0.02	2.47	-0.85	-0.16	-1.00	0.35	1.67	2.02	
Bangladesh	1.04	0.45	1.49				0.98	0.47	1.45													
Pakistan	1.57	4.14	5.78	2.17	4.01	6.26	1.85	5.20	7.14				2.81	0.80	3.64	0.11	2.35	2.47	-2.52	0.42	-2.11	
Indonesia	1.15	3.12	4.30				1.74	3.38	5.16				-0.40	-0.03	-0.43							
Philippines	1.50	2.25	3.76				0.62	2.58	3.22				2.77	2.44	5.28							
Thailand	2.21	0.63	2.86				1.46	0.48	1.95				10.20	0.55	10.80							
Other Asia	0.71	0.32	1.11				0.54	0.64	1.18				0.14	-0.52	-0.38							
N. Af./MIDEast OPEC	1.66	1.16	2.83	2.67	0.87	3.56				-1.23	1.00	-0.24										
NA/ME Non-OPEC	0.76	1.48	2.24	0.92	1.80	2.80		1/		-0.11	1.36	1.24	-0.30	2.29	1.98	0.91	0.48	1.39	4.85	-3.18	1.51	
Egypt	0.47	2.11	2.59	-0.32	2.13	1.80	3.92	-0.16	3.75				-0.45	3.30	2.83							
Turkey	0.37	1.62	2.00	1.03	1.97	3.02				-1.00	1.00	-0.02	-0.74	2.13	1.37							
NA/ME Non-OPEC HI Inc.	0.70	2.38	3.10	0.98	2.14	3.14				0.79	2.86	3.62										
NA/ME Non-OPEC Lo Inc.	1.55	0.19	1.74	1.09	1.00	2.10										1.19	0.32	1.52	7.61	-4.86	2.36	
Nigeria	1.04	-1.57	-0.51													0.91	-2.84	-1.95	1.29	-0.49	0.79	
Sub-Sahara HI Inc.	1.02	1.28	2.30				0.19	2.68	2.87				1.74	1.40	3.16	0.47	0.79	1.26	0.67	-0.60	0.07	
Sub-Sahara Lo Inc.	1.39	0.44	1.84				3.63	-0.68	2.92				2.53	0.89	3.44	0.98	-0.09	0.89	-0.37	-0.62	-0.98	
Total Sub-Sahara	1.24	0.11	1.35				2.96	0.14	3.10				2.09	0.94	3.05	0.89	-1.48	-0.61	0.38	-0.57	-0.19	
Mexico	1.65	2.45	4.15	-1.32	5.03	3.64							0.84	1.18	2.03	20.63	0.62	21.38				
Other Mid-Am./Carib.	1.18	1.71	2.90				1.98	4.03	6.09				1.00	0.59	1.60	1.70	1.31	3.07	0.72	0.91	1.63	
Argentina	1.47	2.10	3.60	-1.26	0.04	-1.22							2.58	3.16	5.82	9.99	2.27	12.49				
Brazil	3.94	0.07	4.02	10.60	2.57	13.44	2.59	-0.83	1.74				3.54	0.68	4.24							
Venezuela	1.80	1.37	3.19				3.22	3.81	7.15				1.32	0.19	1.51							
Ecuador	-0.53	2.86	2.22				-2.76	5.04	2.13				2.02	2.98	5.06							
Other Lat. Am.	0.28	2.09	2.38	-1.85	1.11	-0.76	1.31	2.29	4.64	1.35	-0.11	1.24	0.32	1.35	1.68							
Total Lat. Am.	2.18	1.43	3.64	0.52	0.52	1.04	2.31	0.53	2.86		1/		2.10	1.53	3.66	11.67	2.77	14.77			1/	
Total DME	1.19	1.50	2.70	2.04	2.14	4.18	1.05	1.34	2.40	-0.55	1.43	0.84	2.09	1.23	3.23	0.10	1.67	2.38	0.43	0.49	0.97	
Low Inc. Food Deficit	0.96	1.37	2.35	3.24	3.73	7.10	0.90	1.37	2.28	-0.64	0.89	0.24	1.70	0.26	1.96	-0.10	-0.46	-0.56	0.52	0.60	1.12	
Mid Inc. Food Deficit	0.87	1.96	2.85	0.58	2.06	2.65	0.93	2.67	3.62	-0.03	1.43	1.40	1.07	1.37	2.46	5.97	5.74	12.05	0.48	0.13	0.62	
High Inc. Food Deficit	1.28	1.36	2.47	2.53	0.65	3.22	1.21	1.35	2.51	-1.07	2.12	1.16	1.70	1.20	2.94	1.98	0.16	2.14	-2.29	3.95	1.46	
Total Food Deficit DME	0.96	1.31	2.45	2.13	2.16	4.59	0.91	1.42	2.38	-0.49	1.06	0.97	1.37	0.96	2.22	0.26	0.65	0.92	0.50	1.04	1.05	
Food Exporters	2.48	1.36	3.88	1.74	1.22	2.98	1.89	0.61	2.51	-1.66	0.31	-1.35	3.59	1.51	5.16	7.64	4.11	12.06	-1.95	0.32	1.64	

Data Source: FAO Production Yearbooks.

1/ Relatively unimportant in regional total.

Table 7

Average Yields of Major Root Crops in IFPRI Country Categories,^{1/} 1974
(metric tons per hectare)
(area harvested in thousand hectares in parentheses)

Country/Country Grouping	Cassava	Yam	Sweet Potatoes	Potatoes
			16.7	10.4
<u>Asia High Income</u>			<u>(105)</u>	<u>(45)</u>
India	17.3 (167)		7.8 (230)	8.7 (533)
Bangladesh			10.5 (61)	9.1 (80)
Pakistan			9.2 (17)	10.2 (23)
Indonesia	7.0 (1350)		6.2 (350)	
Philippines	5.4 (40)		4.8 (132)	
Thailand	19.7 ^{2/} (320)			
<u>Other Asia</u>	<u>5.4</u> <u>(129)</u>		<u>4.3</u> <u>(120)</u>	<u>5.8</u> <u>(66)</u>
Other Asia Market Economies	8.8 (2356)		6.6 (946)	8.27 (743)
<u>N. Af./MidEast OPEC</u>				7.7 (117)
Egypt				17.0 (44)
Turkey				12.2 (180)
NA/ME HI Inc.				11.4 (48)
NA/ME Lo Inc.	4.8 (230)		3.5 (141)	
NA/ME Non-OPEC	4.8 (230)		3.9 (144)	12.7 (284)
Nigeria	10.0 (1000)	11.1 (1350)		
Sub-Sahara HI Inc.	6.1 (1582)	6.3 (351)	4.9 (190)	
<u>Sub-Sahara Lo Inc.</u>	<u>7.2</u> <u>(3724)</u>	<u>7.0</u> <u>(186)</u>	<u>4.1</u> <u>(1051)^{2/}</u>	<u>5.4</u> <u>(191)</u>
Total Sub-Sahara	7.4 (6306)	9.8 (1886)	4.2 (1292) ^{2/}	
Mexico				11.2 (40)
Other Mid-Am./Carib.	6.3 (79)		6.7 (32)	
Argentina			6.3 (51)	16.2 (111)
Brazil	13.7 (2196)		11.9 (162)	9.8 (171)
Venezuela	8.6 (38)			10.1 (12)
Ecuador	9.2 (59)			9.2 (48)
<u>Other Lat. Am.</u>	<u>10.1</u> <u>(295)</u>			<u>7.2</u> <u>(322)</u>
Total Lat. Am.	12.8 (2692)		9.9 (319)	9.0 (974)
Low Income Food Deficit	8.0 (6801)	10.4 (1589)	5.2 (1964) ^{2/}	7.7 (919)
Middle Income Food Deficit	6.8 (2104)	6.6 (373)	5.9 (429)	8.2 (802)
High Income Food Deficit			16.6 (108)	8.6 (174)
Total Food Deficit	7.7 (8962)	9.7 (1970)	5.7 (2532) ^{2/}	8.0 (1896)
Food Exporters	12.9 (2642)		10.3 (266)	12.1 (307)
Total DME	8.9 (11604)	9.7 (1970)	6.2 (2783)(1971)	8.6 (2202)

Selected Food Crops: Growth Rates, Area, Yield and Production 1961-74 by IFPRI Categories
(Percent per year compounded)

Table 8

Country/Region	Root Crops			Cassava			Yams			Sweet Potatoes			Potatoes			Pulses			Soybeans			Groundnuts		
	A	Y	P	A	Y	P	A	Y	P	A	Y	P	A	Y	P	A	Y	P	A	Y	P	A	Y	P
Asia High Income	0.39	0.93	1.32							0.74	0.85	1.60	-0.67	1.39	0.70	1.15	2.11	3.28	0.97	3.31	4.31	7.60	2.47	10.26
Other Asia Market										0.03	0.78	0.81	2.79	2.58	5.44	-0.70	-0.00	-0.70	2.45	1.24	3.73	-0.07	0.88	0.81
Bromelias	0.95	1.73	2.70	0.85	1.80	2.66																		
India	3.30	4.18	7.61	3.52	7.24	11.01				4.69	1.05	6.42	2.63	2.29	4.97	-0.86	-0.13	-0.99				-0.31	0.63	0.31
Bangladesh	4.47	3.38	8.00							5.26	2.02	7.38	3.88	4.57	8.62	0.05	0.92	0.97				9.75	0.41	10.20
Pakistan	2.80	1.47	4.32							1.21	0.41	1.63	4.25	2.21	6.55	-1.41	0.03	-1.38				9.86	1.22	11.21
Indonesia	-1.47	-0.46	-1.93	-1.14	-0.47	-1.60				-3.06	-0.44	-3.49				4.04	-0.04	4.00	1.78	1.03	2.83	0.73	1.00	1.73
Philippines	-0.56	-0.79	-1.34	-0.13	-1.49	-1.62				-0.76	-0.38	-1.13				-2.11	-0.59	-2.68	-1.40	-0.62	-2.01	4.60	-1.72	2.80
Thailand	9.18	-0.08	9.09	10.22	-0.74	9.41										12.23	-1.65	10.96	11.82	0.44	12.32	4.90	1.33	6.30
Other Asia	3.31	0.90	4.24	7.44	-2.84	4.39				2.33	2.26	4.65	0.32	3.83	4.16	0.65	1.05	1.71	3.18	-0.09	3.16	0.41	2.36	2.78
NA/ME/MidEast OPEC	4.71	-0.85	3.82										4.71	-0.85	3.82	1.70	1.51	3.23	15.18	20.22	45.07	0.19	2.30	2.50
NA/ME Non-OPEC	2.44	0.60	4.06	1/						3.89	2.45	4.36	2.81	1.19	5.05	1.53	1.07	2.62	1.54	2.47	7.10	7.67	-1.70	5.86
Egypt	4.21	0.44	4.67										4.98	0.54	5.55	-2.86	3.12	0.18				-1.26	-0.94	-2.19
Turkey	2.22	1.14	3.40							2.22	1.14	3.40				0.77	0.22	0.99	1.54	5.47	7.10	6.33	-0.11	6.21
NA/ME HI Inc.	3.78	0.78	4.58							3.78	0.77	4.58				2.44	1.93	4.42				12.77	-1.57	11.00
NA/ME Lo Inc.	3.32	0.33	3.67	2.91	-0.04	2.86				4.09	1.43	5.58	0.85	3.28	4.16	3.18	-0.02	3.15				7.94	-1.60	6.20
Nigeria	-0.06	1.17	1.10	1.50	0.72	2.23	-1.05	1.49	0.42							8.12	-2.75	5.14				-2.94	-5.59	-8.37
Sub-Sahara HI Inc.	7.12	0.51	2.64	1.82	1.18	3.02	1.70	-1.17	0.51	5.26	-0.12	5.12				1.89	-0.37	1.52	-3.13	1.12	-2.05	1.23	-0.93	0.29
Sub-Sahara Lo Inc.	6.15	-1.70	4.35	5.14	-0.19	4.94	-0.23	2.79	2.56	8.02	-5.36	2.24	3.58	1.35	4.97	2.58	0.42	3.01	2.71	3.06	5.86	2.48	-0.45	2.01
Total Sub-Sahara	3.60	-0.84	2.74	3.53	0.31	3.84	-0.51	1.03	0.51	7.87	-4.85	2.64		1/		4.34	-0.96	3.33	0.06	1.15	1.21	0.63	-2.09	-1.47
Mexico	-0.95	3.88	2.89										-1.19	3.83	2.62	-0.21	2.96	2.74	25.93	-1.69	23.80	-3.84	0.62	-3.25
Other Mid-Am./Carib.	2.27	1.33	3.63	1.93	1.39	3.35				1.65	0.15	1.80				0.44	1.04	1.49				2.78	0.79	3.60
Argentina	-1.09	1.71	0.60							1.74	-0.99	0.73	-2.32	3.12	0.73	4.68	-1.79	2.81	32.98	3.01	36.98	1.62	-2.63	-1.06
Brazil	2.88	0.62	3.52	3.30	0.24	3.54				1.40	1.71	3.14	0.24	3.37	3.62	2.49	-0.45		24.82	3.03	28.60	1.67	-0.34	1.32
Venezuela	2.10	-1.98	0.09	3.56	-4.00	-0.57							-0.32	1.65	1.33	0.66	-2.26	-1.62				25.66	-2.11	23.01
Ecuador	3.95	2.04	6.07	6.65	0.66	7.36							2.76	2.80	5.63	0.38	-0.51	-0.13	67.46	-2.51	63.91	1.57	-1.85	-0.31
Other Lat. Am.	0.86	1.32	2.19	1.73	1.45	3.20							0.41	1.15	1.57	1.99	-0.15	1.84	18.94	1.65	20.90	1.26	0.10	1.37
Total Lat. Am.	2.02	1.02	3.09	3.09	0.36	3.47				1.19	1.23	2.43	0.03	1.97	1.99	1.47	0.64	2.13	24.74	2.47	27.82	1.67	-0.93	0.74
Total DME	2.67	0.16	2.84	2.80	0.62	3.44	-0.40	0.97	0.58	4.47	-2.60	1.76	1.54	1.85	3.41	0.67	-0.04	0.63	12.32	5.44	18.43	0.56	-0.27	0.29
Low Inc. Food Deficit	2.90	-0.33	2.56	2.75	0.41	3.17	-0.84	1.38	0.54	5.23	3.42	1.63	2.86	2.37	5.30	0.52	-0.41	0.10	1.41	-1.20	2.63	0.28	-0.24	0.04
Mid Inc. Food Deficit	1.63	0.88	2.52	1.81	1.17	3.00	1.68	-0.91	0.76	1.82	-0.15	1.67	1.05	1.55	2.61	0.66	1.49	2.16	20.85	0.61	21.59	1.28	-0.77	0.50
HI Inc. Food Deficit	1.86	-0.31	1.54	1/				1/		0.78	0.83	1.62	2.50	-0.06	2.42	1.46	1.11	2.59	1.28	3.59	4.92	9.64	-0.68	8.89
Total Food Deficit DME	2.59	-0.08	2.50	2.51	0.58	3.10	-0.40	0.97	0.58	4.67	-2.99	1.54	2.01	1.68	3.73	0.54	-0.07	0.47	3.48	3.82	7.43	0.44	-0.30	0.14
Food Exporters	3.06	0.75	3.84	3.92	0.19	4.12		1/		1.64	1.25	2.91	-0.61	2.87	2.25	1.58	-0.02	1.56	24.29	2.97	27.38	2.39	-0.65	1.73

Data Source: FAO Production Yearbook Tapes
1/ Relatively unimportant in regional total.

Table 9

Average Yields of Pulses, Soybeans, and Groundnuts
in IFPRI Country Categories, 1974
(metric tons per hectare)
(area harvested in thousand hectares in parentheses)

Country/Region	Pulses	Soybeans	Groundnuts in shell
<u>Asia High Income</u>	0.61 (52)	0.68 (381)	1.48 (12)
<u>Other Asia Market Economies</u>	0.44 (25167)	0.83 (811)	0.81 (7814)
India	0.42 (22016)	--	0.76 (656)
Bangladesh	0.75 (307)	--	1.38 (24)
Pakistan	0.51 (1588)	--	1.32 (38)
Indonesia	0.50 (572)	0.79 (700)	1.26 (420)
Philippines	0.47 (61)	0.76 (2)	0.37 (35)
Thailand	1.09 (250)	1.13 (102)	1.58 (145)
<u>Other Asia</u>	0.58 (574)	1.07 (3)	0.79 (611)
<u>NA, AC, and East OPEC</u>	0.70 (435)	1.55 (20)	2.09 (7)
<u>NA/ME Non-OPEC</u>	0.96 (1251)	1.23 (5)	1.25 (878)
Egypt	2.10 (163)	--	1.88 (16)
Turkey	1.12 (624)	1.23 (5)	2.19 (16)
NA/ME HI Inc.	0.73 (929)	--	1.25 (34)
<u>NA/ME Lo Inc.</u>	1.17 (159)	--	1.22 (811)
Nigeria	0.19 (4610)	0.38 (170)	0.50 (1200)
Sub-Sahara HI Inc.	0.51 (664)	0.60 (4)	0.86 (1955)
<u>Sub-Sahara Lo Inc.</u>	0.51 (5369)	0.49 (16)	0.61 (2685)
<u>Total Sub-Sahara</u>	0.37 (10161)	0.29 (186)	0.67 (3840)
Mexico	0.69 (1721)	1.67 (245)	1.27 (51)
Other Mid-Am./Carib.	0.74 (448)	--	0.80 (196)
Argentina	1.38 (135)	1.48 (134)	0.34 (344)
Brazil	0.61 (3688)	1.56 (4793)	1.37 (350)
Venezuela	0.29 (106)	--	0.85 (20)
Ecuador	0.54 (113)	1.19 (4)	0.92 (12)
<u>Other Lat. Am.</u>	0.77 (590)	1.98 (149)	0.88 (31)
<u>Total Lat. Am.</u>	0.66 (7431)	1.58 (5513)	1.08 (212)
Low Income Food Deficit	0.41 (33327)	0.71 (323)	1.75 (1312)
Middle Income Food Deficit	0.71 (4888)	1.78 (422)	0.88 (2261)
High Income Food Deficit	0.63 (594)	0.72 (80)	1.26 (38)
Total Food Deficit	0.66 (39809)	0.97 (1719)	1.77 (14611)
Food Exporters	0.62 (5461)	1.35 (529)	1.19 (974)
Total SME	0.43 (24479)	1.41 (4948)	0.89 (15489)

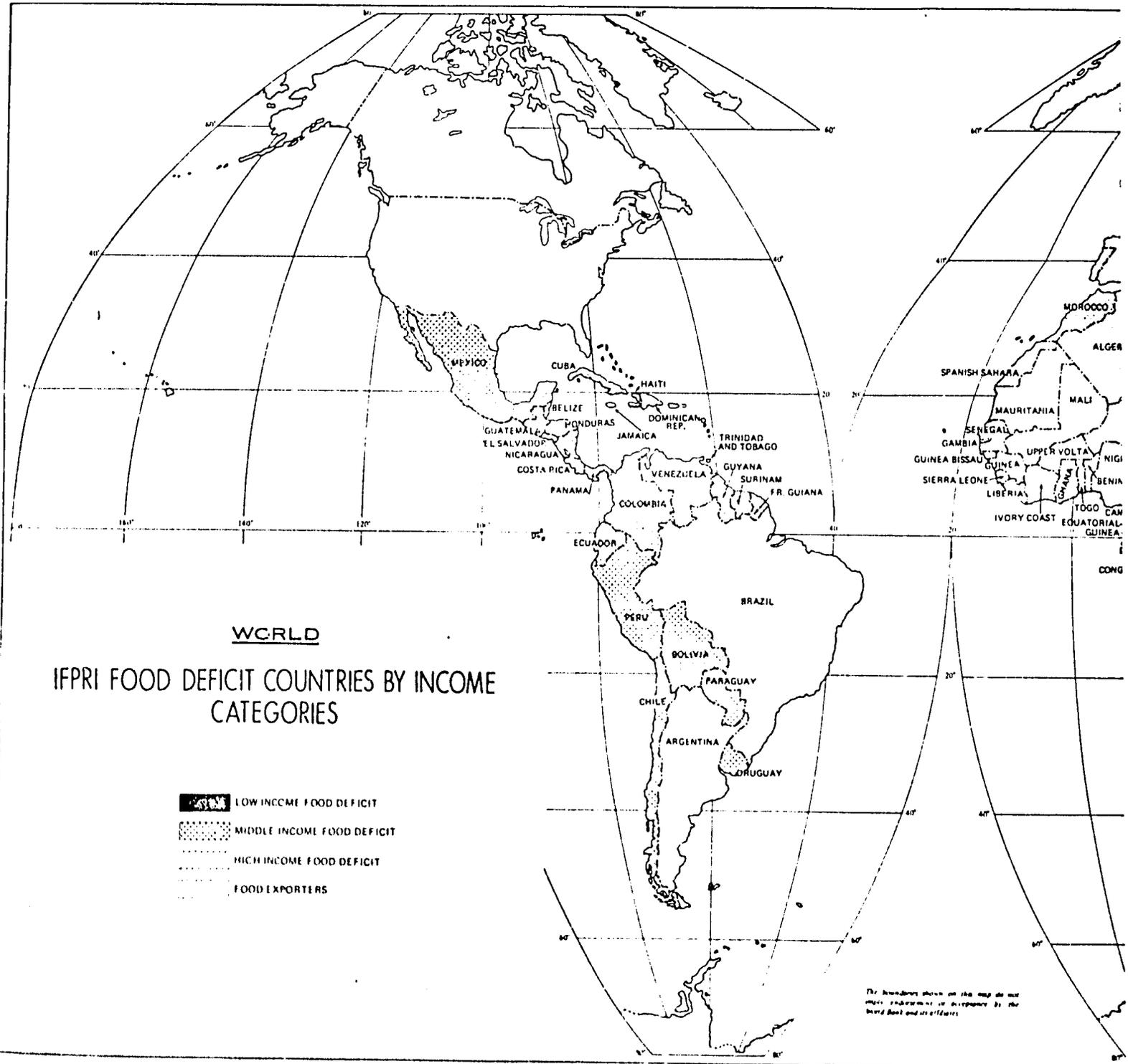
Source: FAO Production Yearbook 1974.

✓ For listing of countries see Annex A.

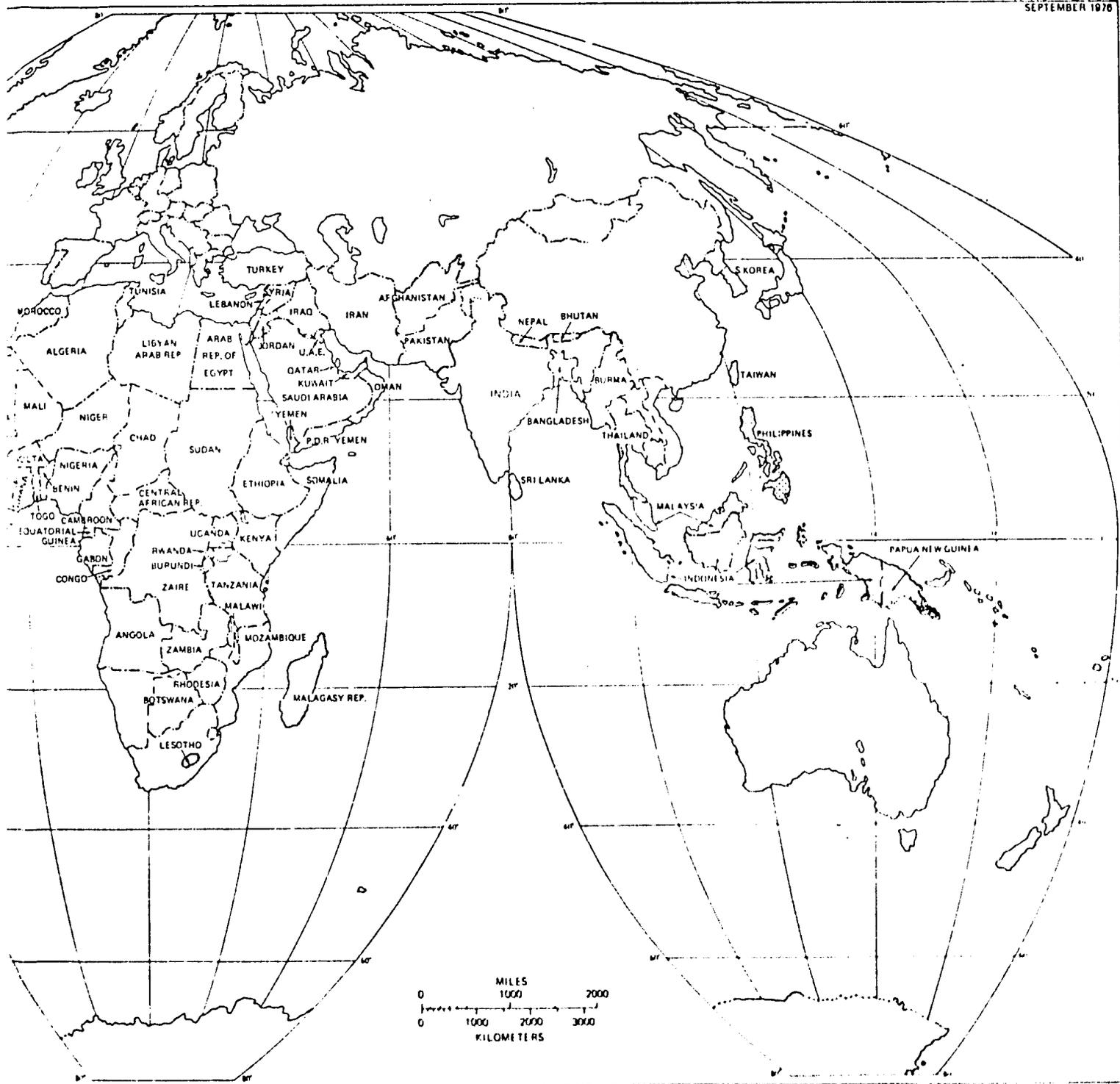
WORLD

IFPRI FOOD DEFICIT COUNTRIES BY INCOME CATEGORIES

-  LOW INCOME FOOD DEFICIT
-  MIDDLE INCOME FOOD DEFICIT
-  HIGH INCOME FOOD DEFICIT
-  FOOD EXPORTERS



The boundaries shown on this map do not imply endorsement or disapproval by the World Bank and its affiliates.



DDR:IAR/76/2 RESTRICTED
Revised 30.5.76

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH
TECHNICAL ADVISORY COMMITTEE

PRIORITIES FOR INTERNATIONAL SUPPORT TO AGRICULTURAL RESEARCH
IN DEVELOPING COUNTRIES

TAC SECRETARIAT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME 1976

W/K0610

TABLE OF CONTENTS

	<u>Page</u>
I. Introduction	1
II. The Priorities Summarized	3
III. First Order Priorities	4
(i) The cereals	4
(ii) Food legumes	6
(iii) Starchy products	8
(iv) Ruminant livestock	9
(v) Aquaculture	11
(vi) Intensification	12
(vii) Post-harvest technology	14
IV. Second Order Priorities	15
(i) Vegetable Research	17
(ii) Cotton	17
(iii) Oilseeds	18
V. Lower Priority Areas	19
(a) Tropical fruits	19
(b) Forestry	20
VI. Important Fields of Research Not Assigned Specific Priority	21
(a) Socio-economic research	21
(b) Factor-oriented research	22
VII. Institutional Considerations in Developing a Global Agricultural Research System	23
(a) Relations Between Applied and Basic Science	23
(b) Mechanisms for implementing international research programmes	26
(c) Strengthening National Research Institutions	27
VIII. Concluding Considerations	31

Statistical Annex

Tables 1-9
Figures 1-3

PRIORITIES FOR INTERNATIONAL SUPPORT TO AGRICULTURAL RESEARCH
IN DEVELOPING COUNTRIES

(Chairman's Position Paper)

I. INTRODUCTION

1. At the request of the Consultative Group on International Agricultural Research (CGIAR) the Technical Advisory Committee (TAC) submitted recommendations on priorities for support to international agricultural research in a paper prepared for consideration by the Group at its meeting in July 1973. (1) These recommendations were endorsed by the members of the Group and have represented its policy to date.

2. In the last three years expenditures on international agricultural research have risen rapidly both in real terms as a result of the expansion of existing programmes and the development of new international centres, and as a result of monetary inflation. This is highlighted in the integrative paper prepared by the Consultative Group Secretariat in 1975 (2). While the rapid growth of the international research system reflects both the urgency of the need and the value of the Consultative Group conceptually as a means of generating new international support for a priority field of action, it is natural that after five years of operation and a six-fold growth in monetary terms there should be some pause for reflection. It was therefore decided in August 1975 to undertake a review of the operations and future management of the whole system. (3) As a contribution to this review the TAC felt that it should re-examine its recommendations for priorities for support to international agricultural research in the light of progress made since 1973, and this paper sets out its conclusions. It is emphasized that these priorities relate to internationally supported research. Priorities for research and those for development do not necessarily coincide. Different priorities will apply to the application of research results to development, depending on the availability of technologies already developed and the objectives of national development plans.

3. In its discussion of priorities the TAC has always realized that funds for international research would not be unlimited and that any proposals for expanded activities, whether involving existing or new programmes, had to be viewed against the likelihood of a certain level of funding being available at a given point in time. Against a background of time the objective of assigning an order of priorities is therefore to indicate those activities which, in the light of certain criteria, ought to be given first attention within the level of funding which can reasonably be anticipated within a given time horizon. Others of recognized importance but outside this first category of immediacy should then be considered within that period only if funding was to become available more rapidly than had been expected, and if their inclusion did not appear to jeopardise or place an unreasonable restriction on a first priority activity.

Alternatively support from the CGIAR to activities originally considered by TAC to be of lower priority could be phased in over a longer period of time once the first priority group had been substantially dealt with, providing there was a continuing modest expansion of funding in real terms which admitted the inclusion of new proposals. In reviewing its priorities the TAC has worked on the assumption that this will be the situation, and this crucial point must be borne in mind in studying its recommendations. Clearly if the future level of funding were to be fixed at something like the 1976 level of \$65 million, the whole set of priorities which follow would have to be reconsidered.

5. A note concerning the criteria used by TAC in suggesting priorities for international support to agricultural research is relevant to the background of its work in this field. Certain of these criteria are explicit in the discussion of individual recommendations in this paper, for example in the case of cereals, where the importance of their contribution to the diet, particularly of lower income groups, their significance to the balance of payments of developing countries, the inter-relationships of increased output of cereals with progress in raising production and productivity of other key food commodities, and their importance to farm income and employment over a broad range of conditions in developing countries, are all brought out. These facts indicate that if research led to a successful advance in raising productivity of cereals, it would benefit a very large number of people economically, socially and nutritionally in many countries.

6. The latter is important in considering the justification for support from CGIAR; research on a given problem or commodity of benefit to only one or two countries could scarcely qualify for this, even if the number of people involved was quite large. Otherwise TAC's first priorities for action might all relate to Asia! This would not, of course, preclude the Committee from drawing attention to an urgent need for action to reinforce such research outside the CGIAR framework.

7. Similarly food is an extremely important priority but not all-embracing, since if rural people do not have work or land they may have no money to sustain an adequate diet, let alone obtain other necessities. The potential contribution of agricultural research to income and employment from agriculture is therefore also an important criterion, and here the end-use(s) of a crop, or the possibility of multiple uses must be taken into account. Such criteria may guide decisions both in respect of the priorities for research - cotton is an example, and concerning the objectives of the research to be undertaken in terms of its probable socio-economic impact, e.g. the mechanization of cotton production.

8. Of course, a need for research does not necessarily indicate that that research merits priority, nor because a commodity or problem is of widespread importance does it always mean that more research is likely to give a high pay-off. This is where there has to be a marriage of economic and scientific judgement. Thus the probability of a successful and even a rapid outcome from a piece of research would not justify awarding it a high priority for CGIAR support unless this was likely to have widespread benefits. The opposite case of

a problem whose solution would open up an enormous potential but which presents great technical difficulties with a consequently speculative outlook and probably a high cost is more challenging, but equally might call for the TAC to urge advanced countries to undertake it as part of their contribution to development rather than to recommend the CGIAR to fund it. Essentially, therefore, the TAC has directed its priorities to the more effective application of existing knowledge to solve identified agricultural problems of wide potential benefit to developing countries, rather than to adding to the stock of knowledge in basic scientific fields.

9. In approaching this task it has not worked to any rigid set of criteria or applied any mathematical formulae. Priorities are not immutable and the keynote has been flexibility both to enable it to cope with the very wide range of subjects which have come before it, and to cover changes over time. Again cotton offers an example, since the closure of the U.K. Cotton Research Corporation (CRC) may have introduced a new element of urgency for international support to research on a crop the wide importance of which has always been recognized by TAC but where there has been a question mark against the need for CGIAR action to reinforce ongoing research.

10. As time goes by and the costs of the whole CGIAR system rise, it may become increasingly necessary for the TAC to look at priorities within its priorities, for example between and even within individual cereals (e.g. between irrigated, rainfed, deepwater and upland rice). This would allow shifts in emphasis to meet changing circumstances to be made in good time, and in some cases might indicate the need to phase out an ongoing programme in order to allow resources to be re-allocated to a new line of research within the CGIAR system, either at the same institution or elsewhere. The quinquennial reviews of the International Agricultural Research Centres (IARCS) should be of considerable value here; whether any more sophisticated approach to the overall determination of priorities to cope with future exigencies is desirable or even feasible, is a matter which the CGIAR or its review committee might wish to discuss with the TAC.

II. THE PRIORITIES SUMMARIZED

First priority - Research on basic staple foods

11. Both in respect of support to existing programmes and to new research endeavours, the TAC places the highest importance on research directed to increasing the amount and quality of food produced. This policy has been consistent throughout the life of the CGIAR and it has been substantially endorsed not only by the actions of the CGIAR but by the conclusions and recommendations of the World Food Conference (4), the recent working conference on research to meet U.S. and world food needs sponsored by the U.S. Agricultural Research Policy Advisory Committee in July 1975 (5), and by the 18th FAO Conference in November 1975. (6) If anything the continuing uncertainties of the world food situation have enhanced this priority during the life of the TAC.

12. Within this overall first priority group primary emphasis is given to the cereals for the reasons set out below. Great importance is also attached to the food legumes (including the leguminous oilseeds - groundnuts and soyabeans), to the starchy roots and tubers, to ruminant livestock and to aquaculture. However, because their importance to the diet, as well as to agriculture in terms of the area they occupy and the income they provide to producers varies greatly on a regional and ecological zone basis (see Annex Tables 1 to 3), the TAC has not assigned a particular ranking between these other commodities.

13. Three other major and related fields of research to which the TAC accords very high priority are intensification of cropping, which could be the major source of growth after improved productivity of the major food staples has been soundly established, post-harvest technology, and socio-economic research both in respect of the individual commodities mentioned above and in connexion with the development of improved farming systems.

Second priority

14. Among the second priorities currently under examination are tropical vegetables, cotton (which provides both food and livestock feed as well as fibre), and the annual and perennial oilseeds. Support has also been recommended for single factor research in one field - the International Fertilizer Development Centre - and limited support for a specialized entomological institute, the International Centre of Insect Physiology and Ecology (ICIPE) is under study, as is the specialized field of water conservation and management.

III. FIRST ORDER PRIORITIES

(i) The cereals

15. Cereals are of first importance because they provide the mainstay of the diet in most developing countries, especially for the poorer people, both in terms of calories and of total protein, and although their significance varies between regions, a recent calculation suggests that their contribution to overall energy supplies is over 70 percent. (Annex Table I) Thus, for about two-thirds of the world's population, the future food problem will centre primarily around the availability and price of grain. (7)

16. Research to increase the yield and protein content of cereals is thus of fundamental nutritional importance. Upgrading their amino-acid composition could, at no extra cost to consumers, make a further improvement in the quality of the diet provided it did not lead to reduced yield.

17. However, despite the real successes in increasing wheat and rice output, cereal production in developing countries has barely kept pace with population and income growth during recent years, and experience in Asia and in the world as a whole since 1970 shows how fragile is the base on which these critical supplies rest. (8) (Annex Table 4)

18. Income elasticity of demand for cereals is still high in the poorer countries in which 90 percent of the world's population increase is concentrated, quite unlike the situation for food grains in the developed economies, and is an important indication that

food consumption levels are inadequate. (Annex Table 5) In a number of countries failure to increase production rapidly enough to meet domestic demand has led to increasing imports, draining foreign exchange required for social and economic development. The magnitudes of future imports, if production of staple cereals could not be increased more rapidly than past trends, were first pointed out in FAO's Indicative World Plan in 1970, and then received relatively little attention. (9) The fact that the situation had not significantly improved five years later was starkly highlighted at the World Food Conference (10), and recent studies by the University of California (11) and the USDA (7) indicate a high degree of uncertainty as to the prospects for the longer-term future. This is a second reason for accordng the highest priority to increasing cereal production in developing countries.

19. Third, a faster growth of production will be necessary if cereals are to become available in sufficient quantity at prices which will permit their economic use in livestock rations. It is relevant to note that the rapidly rising demand for feedgrains in the more affluent nations has contributed to the recent shortages and high prices of cereals and soya beans, affecting the availability of grains both on concessional and on normal trade terms to developing countries. This further emphasizes the need to increase output in those countries as rapidly as possible. (Annex Table 6)

20. Finally, cereals are the lynchpin of the cropping systems in many developing countries and thus contribute significantly to farm income and employment.

21. While these reasons in themselves offer compelling nutritional, economic and social arguments for devoting high priority to research on the cereals, there is another important consideration. In the past most developing countries increased their production (including that of cereals) largely by expanding the cultivated area. Certain are still fortunate enough to have reserves of good land which can be brought under the plough, but some are already pressing up against the limits of their land resources, or will be within a measurable timespan; and marginal land is already being cultivated with serious backlash effects on pastures and forests and consequent environmental degradation.

22. Although research is required (as well as other measures) to try to prevent further loss of arable land through erosion, salinization, desertification and pollution, and to identify the restraints and costs of bringing new, potentially arable land into use, the problem facing many developing countries is likely to be one of trying to produce more and more from a finite, or even shrinking resource. This particularly applies to the densely populated countries of South Asia, but also to much of the Near East and North Africa. (Annex Table 7)

23. It will be increasingly necessary to turn to raising yields and crop intensities as the major source of future growth, and since cereals occupy the largest share of the arable area in a wide range of environments, (see Annex Tables 1-3) they hold the key to the

more effective use of land and water resources. Unless their yields can be increased or their time to maturity reduced, it will be correspondingly more difficult to make significant progress with other crops and livestock since more and more land will have to be devoted to satisfying basic calorie requirements. The alternative - increasing imports - is open only to a few developing countries.

24. With the increased emphasis of IRRI on non-irrigated rice and of CIMMYT on durum wheats, and the establishment of ICRISAT and of ICARDA, significant progress will have been made since 1971 in covering the major gaps identified at the inception of the Consultative Group, which related especially to sorghum, millet; rainfed, deep flooded, and upland rice; barley, and durum wheat.

25. Nevertheless it may be open to question whether even now enough is being done in respect of cereals, and three aspects seem to merit special attention. The first is the nature and adequacy of linkages between the International Centres and national institutions, both in research and the application of its results; where the Centres' responsibilities should end; and how their efforts to work with countries could be supplemented by collaboration with other agencies such as FAO. The second is the improvement of nutritional quality of cereals; how this can be achieved without detriment to yield or consumer acceptability, and the respective roles of the Centres and other advanced scientific institutions in this. The third is the degree to which yield stability can be improved, particularly in the more difficult environments, by a better understanding of the fundamentals of plant physiology, tolerance of adverse climatic conditions, and the mechanisms of resistance to pests and diseases ^{1/}. For this further basic research is required, and this explains the high importance attached by TAC to the greater involvement of advanced laboratories of both developed and developing nations in collaborative research with the Centres, and its interest in some aspects of the new venture of ICIPE.

(ii) Food legumes

26. The food legumes are the second main source of total protein in the diet, and, at least for the lower income groups, the principal means of improving dietary quality, because they complement the unsatisfactory composition of most cereals in terms of the limiting amino-acids. They are also a potential source of simulated milk and meat products (soya bean is already being developed industrially for such purposes).

27. However, the low and unstable yields of most species of food legumes in developing countries give cause for concern because, despite their high nutritional value, slow progress in achieving any significant improvement in yield is leading to their progressive displacement in a number of countries by more profitable crops, especially where improved cereal varieties can be grown ^{2/}. (Annex Table 8)

^{1/} It is important to note that 75 percent of all cultivated land is rainfed and yield fluctuations due to unpredictable climatic stress act as a strong disincentive to innovation. This was referred to repeatedly at the FAO/UNDP "Travelling Seminar" on Rainfed Agriculture in Monsoon Asia. (12)

^{2/} This is referred to several times in the UNRISD study of the social and economic implications of the high-yielding cereal varieties. It has been compounded by government price support policies which are often directed to cereals but ignore other food crops.

28. For this reason the TAC sees a particular need for international support to research related to the grain legumes and has recommended that priority be given to six species: cowpea, chickpea, field bean (Phaseolus vulgaris), groundnut, pigeon pea, and soyabean. However, it has experienced difficulties in determining the best approach to such research in view of the large number of species involved, the very diverse range of environments over which they are cultivated with consequent problems of location specificity, and the apparent need for fundamental research to obtain a better understanding of the nature and physiological mechanisms limiting their yields which might argue for establishing some strong central facility.
29. In order to help resolve this problem the TAC convened a working group on the improvement of grain legumes at the IARI, New Delhi, in September 1974.(13)
30. While this group identified a number of aspects of fundamental research on the biology of yield of grain legumes for which additional resources are clearly needed, it did not conclude that there is some inherently low ceiling on yield improvement which puts an immediate restraint on the ability of national research and development programmes to help farmers to increase yields. Indeed it felt that there is strong evidence that substantial scope exists for increasing yields of existing varieties by applied research to improve cultural practices, plant populations, pest, disease and weed control, and by the use of disease-free seed, production of effective inoculants, appropriate fertilizer amendments and better agricultural practices.
31. While it saw the international agricultural research centres working on the main legume species together with national programmes as having an important role to play in applied research and training related to these problems, it pointed out that some of the measures which could improve yield and production in the short run are of an economic and policy nature and lie outside research.
32. A further measure which it felt could have an important bearing on the improvement of yields in the somewhat longer term is coordinated action to make the world's germ plasm of the major species of grain legumes more accessible to all countries and to evaluate these genetic resources for use in breeding programmes. It recommended that this should receive high priority in the work of the International Board of Plant Genetic Resources.
33. At the same time it recognized that there appear to be physiological obstacles to raising grain legume yields beyond those presently indicated by advanced applied experimental work, which are unlikely to be solved without additional sophisticated research. It did not consider that such work could be effectively undertaken at a single centre and concluded that a more satisfactory approach would be to reinforce ongoing work at identified centres of strength in relation to specific problems.
34. On the basis of this report and its subsequent discussion, the TAC has affirmed the need for continuing high priority to applied research to raise yields of the food legumes at

the International Centres in collaboration with the ICPGR and selected institutes in developed and developing countries. It recommends that the Centres be encouraged to prepare specific presentations for its consideration in respect of any additional activities and funds required.

35. In order to provide a mechanism for initial discussion of such requests, as well as to identify specific areas for further work and to decide how such work might best be carried out, the TAC has decided to keep in being its ad hoc committee on grain legumes as a Standing Committee. This will enable further meetings of fundamental and applied scientists to be convened periodically in respect of some of the more basic problems identified at the New Delhi meeting and to assist in formulating specific projects. A problem discussed by TAC in this respect and not yet fully resolved is how to develop more flexible means of funding such activities.

36. The TAC Working Group drew attention to the fact that the only widely grown food legume which will not be adequately covered by the work of the international centres once ICARDA is established will be the soya bean. It regretted that the CGIAR had not found it possible to support the INTSOY proposal which TAC had earlier recommended.

37. The TAC's subsequent discussions of how best to proceed with this matter have confirmed the widespread interest of developing countries in the potential of the soya bean both as a direct source of human food in various forms and for concentrate feed for livestock. However, there have also been some divisions of opinion as to the technical possibilities of translating this apparent potential into real terms. Attention has been drawn to the frequent failures of attempts to introduce this crop in many countries, particularly in the humid tropics, both because of low yields and other factors affecting production, some of which appear rather fundamental, as well as problems of utilization and consumer acceptance.

38. While still regarding this as a crop of high promise for developing countries, the TAC therefore wishes to be better informed as to the nature and significance of these problems (particularly as they seem likely to affect the value of soya bean as a means of improving human nutrition), before making a further recommendation to the CGIAR as to the priority it should be given and the type of additional support required. In making any recommendation for such support, TAC would also wish to indicate an appropriate and acceptable institutional machinery for its implementation (in which it sees INTSOY as the key resource base) and this too will be given further consideration.

(iii) Starchy products

39. The third major group of food crops to which the TAC accords high priority is the starchy foods, including roots and tubers. As was pointed out at the 5th TAC meeting in 1973, they have received much less concentrated research attention than the cereals, since they have been held to have low nutritional value by nutritionists and only the potato is of significance to developed countries. Yet, despite their low protein content, these crops are of great dietary importance in the developing world - for example, in tropical equatorial Africa where

Some 70 percent of the world area of yams, sweet potato and cassava is concentrated, they are the staple food of some 80 million people. Moreover they have a potential for producing an enormous output of energy per hectare, and their yield, nutritional quality, and range of ecological adaptation all appear capable of improvement. As the pressure on cultivable land increases it is conceivable that people will have to turn more and more to such crops as the basic source of energy compared to the relatively inefficient cereals. This has been a main reason for the TAC recommending support for CIP despite the somewhat limited importance of the potato to the developing world as a whole at the present time.

40. The TAC therefore recommends continuing support for work on cassava at CIAT and IITA, and yams and sweet potatoes at IITA; as well as the expansion of efforts on Irish potatoes at CIP, both for the high altitude areas of the tropics and sub-tropics, and for the humid lowland tropics. It is considered essential that their programmes cover not only production but also storage, conservation, and processing, since some of these crops, although capable of very high production, are poor keepers and suffer serious losses from spoilage.

41. The banana or plantain is now the only widely grown member of this group of crops remaining outside any major research programme, despite a proposal by IITA that exploratory work should be included in its programme for 1973. The TAC believes this to be a significant gap in the coverage of food crops in the humid tropics, since the genus Musa ^{1/} which is almost entirely located in the developing countries) is not only important at the moment as a source of food, employment and export earnings, but is believed to have a considerable potential for improvement of yields and for fitting into more intensive productive systems. It therefore proposes to explore this question further, possibly through a TAC-sponsored working group.

(iv) Ruminant livestock

42. In respect of livestock the TAC holds the view that priority should go to the ruminants, especially for meat production, since this offers opportunities for increasing food supplies through better resource utilization, which conflict only to a limited extent with requirements for land for direct production of human food. (The work of CIAT on developing beef production in the llanos of Latin America suggests that there are major untapped opportunities here). Moreover ruminants are of dominant social and economic significance in some of the poorest and most backward countries which have little scope for other agricultural development, for example in the Sahelian zone of Africa, and where knowledge acquired in developed countries cannot easily be transferred successfully. There are possibilities for expanding both meat and milk production, and provided marketing can be properly organized the latter may offer a new cash activity to small farmers as well as having important connotations for the improvement of nutrition. Nevertheless the TAC does not see research in dairying as a major priority for international support. However, both for technical and social reasons the achievement of the ruminant livestock potential will not be easy and

^{1/} This genus includes the vegetable plantain, the banana and ensete (grown mainly in Ethiopia)

there are difficult problems requiring research which cannot easily be tackled without an international multi-disciplinary effort.

43. By contrast, pig and poultry production can be increased relatively easily by the application of sophisticated, capital intensive technology, provided that rigorous control of disease can be achieved and entrepreneurship and sound managerial ability are available. While neglected opportunities certainly exist for improving small-scale pig and poultry production by labour intensive methods, it is felt that these can be seized by the application of known methods of disease control and better feeding and management, and do not require internationally sponsored research.

44. The establishment of the International Livestock Centre for Africa (ILCA) and the International Laboratory for Research on Animal Diseases (ILRAD) also in Africa, represents a major reinforcement for research on ruminant livestock production and health in developing countries. Their joint efforts over time could lead to significant progress toward one of the main priorities indicated by the World Food Conference, the control of trypanosomiasis and the use of the vast area affected by this scourge of Africa for human settlement and improved ruminant livestock production.

45. These two institutes essentially relate to African problems and mainly to cattle: a further area of livestock research to which the TAC has been devoting its attention relates to the improvement of the water buffalo. This is perhaps one of the most clear-out examples of a regional priority, since although the buffalo is domesticated in every developing region, as well as in Europe, and is increasing in importance in Latin America, it is essentially an Asian animal, with 98 percent of the world's population of 130 million head concentrated in West and South Asia and the Far East. (Annex Table 9) Over 50 percent of the milk production of India and 75 percent of the meat in several Southeast Asian Countries is supplied by the water buffalo, which is also a primary source of draft power for small farmers.

46. At the moment there is no internationally supported programme of research on this important animal, and following requests for such support from Pakistan, the Philippines and Thailand, the TAC convened a joint workshop with FAO in Singapore in March 1976 to examine the overall need for research, to define the major gaps in current research programmes, and to draw up a scheme for tackling them 1/.

47. So far the TAC has focussed primarily on the large ruminants because of the apparently very high potential for increasing their productivity, although it has recognized the importance of sheep in relation to the ecological conditions and grazing resources of the Near East and North Africa in recommending that the improvement of sheep husbandry, within the context of better farming systems, should be a major element of the programme of ICARDA.

1/ Conclusions and list of participating countries to be inserted after May TAC meeting.

48. TAC has also become increasingly conscious of the role played by the goat in providing meat, milk and hair, especially for the poor people in developing countries in the more difficult environmental conditions where the survival of other ruminants is precarious. There is evidence of considerable opportunity for improving per capital production and quality by breeding and sound management. Yet, this animal has generally been ignored in research programmes in developing countries due to its being stigmatized as a destructive force; whereas, if properly managed, its browsing habits are often less damaging than the close grazing of sheep.

49. Research on the problems of goat improvement within local systems of animal husbandry is within the remit of ILCA; and also, potentially, of ICARDA. The TAC therefore recommends to the CGIAR that this neglected aspect of livestock research be drawn to the attention of the management of these Centres, which should be asked to report their findings and any related action they feel necessary, either within their own programmes or through other means, to the Committee in due course. This will provide the necessary basis for an informed recommendation from the TAC to the CGIAR.

50. Until husbandry practices, and in particular nutrition, have reached levels which do not restrict the development of the genetic potential of existing livestock, there may be little benefit from breeding for improved strains. For this reason the TAC rates the improvement of feed supplies as of first priority in relation to ruminant livestock development. There is great scope for better range and pasture management, for the introduction of forage crops into arable rotations (particularly in regions with large areas of fallow) and the more effective utilization of by-products and roughages, an enormous quantity of which is wasted at present. This could contribute significantly to additional income.

(v) Aquaculture

51. At present aquaculture accounts for only some 5-6 million metric tons out of a total annual global fish catch of 45 million metric tons, contributing approximately 4 percent of the world's animal protein supplies, excluding milk. However, the consensus of expert opinion is that by the year 2000 the total food fish caught by "capture" methods, even with improved gear and fish finding equipment, is unlikely to be more than double its present level; whereas, given the removal of certain constraints, aquaculture offers the possibility of a tenfold increase over the same period. It resembles agriculture in the sense that the limits to production are directly related to inputs, and production (unlike the situation in conventional fisheries) is relatively susceptible to human intervention. Moreover, there are interesting opportunities for symbiotic linkages on small farms between aquaculture and other forms of small livestock production (e.g. pigs and ducks) as part of a highly intensive recycling system.

52. Because of the apparent potential for mass production of cheap food from aquaculture, the TAC sponsored a seminar in July 1973 to try and further its knowledge on this potential, the state of the art in research, and how reinforcement of existing methods might be effective in accelerating technology leading to higher levels of productivity from fish farming. (14).

53. A number of research areas was defined which were considered critical to the achievement of the potential harvest of 50 million tons by AD 2000. However, because of the differences existing in ecological conditions, it was not felt that all of these could be effectively dealt with at a single location. The meeting therefore recommended the establishment of an international programme for aquaculture regions of the world, to work on problems of a longer-term nature, supported by a network of national centres to investigate problems of a local nature within each region and to undertake pilot scale studies.

54. To follow up the recommendations the TAC appointed an expert sub-committee to advise it on specific action. This prepared a global programme estimated to cost 15 million dollars.

55. The TAC felt that this was too ambitious, particularly in view of the dearth of qualified personnel \int . It therefore recommended that a phased programme should be developed, initially in Asia as the highest priority area, with particular emphasis on the training of additional researchers at selected national institutions there. A need was also foreseen for a mechanism to coordinate bilateral donors' activities, to indicate to them appropriate areas for research, and to ensure an adequate information and training component in the projects which they were prepared to support.

56. While the TAC did not feel that there was an immediate urgency for the CGIAR to support aquaculture research, which it commended to bilateral donors, the Committee nevertheless considers that the potential long-term benefits of greater investment in aquaculture research could be very considerable. It is therefore keeping bilateral efforts under review; without foreclosing the option to approach the CGIAR in order to help develop a stronger coordinated thrust at an appropriate time in the future, when, hopefully, a better base of knowledge and trained manpower will have been developed as a result of bilateral support.

(vi) Intensification

57. Although in the past the two main sources of growth of agricultural output have been area expansion and yield improvement, the combination of population pressure on land resources and rising costs of the manufactured inputs required to achieve high yields has made it increasingly necessary to search for alternative means of maintaining the growth of agricultural production. In some of the more densely populated countries (both developed and developing) turning new land into cultivation is now virtually foreclosed on any significant scale, and almost everywhere the cost of its development is becoming progressively more expensive and traditional conservation systems of land use are breaking down. While the scope for intensification by increasing yields with relatively modest increments of manufactured inputs remains considerable in developing countries, the energy cost/foreign exchange squeeze at the national level, and the risk susceptibility of small farmers at the user level, suggest that it may be unrealistic to depend on the adoption of western input standards in anticipating the future growth of yields.

¹ It was pointed out in the working group's report that nowhere, either nationally, regionally, or internationally is there sufficient personnel trained in aquaculture to implement the development of the industry on the scale which its potential warrants. This lack applies to scientists, technologists and extension workers.

58. On the other hand, cropping intensity in developing countries is usually well below what is feasible with good management, even under irrigated conditions. Relatively little progress has been made in improving this situation, which is due to a complex of factors, including inadequate water supplies and poor water management, salinity and low soil fertility, slow maturation and other weaknesses in the crop varieties traditionally used, inadequate control measures for pest, diseases and weeds, and lack of draft power at critical periods. Recent work by the International Centres and national programmes has significantly shortened maturity of a number of the important food crops, in particular wheat and rice, and opened new horizons for intensification. For example in the case of rice these crops annually are now being grown by small farmers in pilot schemes of substantial area with higher plant population, higher individual plant yield, and higher pest and disease resistance.

59. However, intensification can either involve planting the same crop more frequently in a mono-culture system, or alternatively, introducing additional enterprises to develop a mixed cropping or crop/livestock system. There is mounting evidence from work done so far (e.g. at IRRI and IITA) that there are favourable interactions and complementarities between crops in nutrient uptake; pest, disease and weed control; water use; and possibly in conversion of light into energy in mixed systems, which are not obtainable in mono-cultures ^{1/}. Such systems not only help to economize in the use of scarce purchased inputs, they also maximize abundant resources, such as labour, both on and off the farm. Diversification of the enterprise mix spreads risks and widens the range of product available for consumption on the farm - thus improving family nutrition - as well as for sale, thus increasing disposable income.

60. Progress already made experimentally indicates that once a firm foundation has been laid in respect of the improvement of productivity of the major food staples, intensification could be the main source of long-term growth in many developing countries, particularly in Asia and the Near East.

61. This of course is already a major objective of the work of CIAT, ICRISAT, IITA, ILCA, and IRRI as well as of the projected programme of ICARDA. It involves research both on the socio-economic as well as the physical constraints to developing more productive land use systems. The range of crops which might be included is very considerable, and includes not only food staples, but also many not at present covered by breeding programmes at any International Centre supported by the CGIAR, such as vegetables, some fruits, fodders, cotton and annual oilseeds. In some areas mechanization may be essential to break peak labour and power bottlenecks, and research may be needed to define the optimum type and time of application of mechanical power. There are sharp differences between regional requirements and priorities in this respect. The design and implementation of an effective research

^{1/} Mixed systems may involve sequential cropping in rotations, simultaneous cultivation of crops on the same land, either unsystematically as in many traditional cultures, or through systematic intercropping in rows, relay planting, and ratooning.

programme therefore presents complex problems and there may be correspondingly greater difficulty in developing a suitable methodology for such studies and in generalizing the results, than for more narrowly commodity-oriented research.

62. This is apparent from the difficulties experienced by CIAT and IITA in finding a clear focus for their farming systems programmes, and by IRRI in defining the area suited to its cropping systems work, and in applying outside the Philippines the results of the work it has already undertaken in this field in its host country. A limiting factor is the weak state of national research on farming systems. (15). A second limiting factor has been the lack of focus with respect to the objectives of the cropping systems programmes now being conducted at several institutes.

63. However, there are also deficiencies in understanding of the inter-relationships between climate, soil and crop growth which impede both the planning and location of specific programmes and the extrapolation of the results. This is a field to which the TAC believes much more attention needs to be devoted, both by appropriate individual International Agricultural Research Centres within their own research mandates, and by national institutions, with international or bilateral support, as a means of improving research and land use planning.

64. The TAC has been somewhat concerned that these difficulties may lead the Centres to give lower priority to such work compared to that on individual crops, and it recognizes the difficulties attached to international research on intensification, as well as to the involvement of national programmes in such research and the application of its results. However, although increasing yield of basic staple foods must remain a priority goal, they are in many cases grown in rotation with other crops or the potential exists for doing so. Under these circumstances, increasing the productivity of the total system should then be the ultimate objective of research. Where such an approach seems desirable the TAC and the CGIAR must grasp the nettle boldly in supporting it, and the TAC attaches high priority to cooperating with the Centres in discussing their future plans for such work.

(vii) Post-harvest technology

65. The recent critical world grain reserve situation has called attention to the need to improve storage, and to prevent post-harvest losses from rodent, insect or fungal damage, as well as from poor processing. While research in post-harvest technology has not been assigned specific priority, the TAC recognizes that it is of the utmost importance to capturing the full gains from production research on all food crops.

66. Although some of the problems may require mainly the application of existing knowledge for their solution, there are undoubtedly crops and situations for which more research is needed, particularly in relation to storage and processing at the farm and village level. The work undertaken by CIAT on cassava and IITA on maize storage is evidence of the considerable potential here. Storage quality and resistance to deterioration may also be worthwhile breeding objectives in the case of the more vulnerable crops. The success of production research in shortening time to maturity of certain important food crops grown in the humid tropics so as to facilitate double cropping has also heightened the need for research into drying techniques. However, storage and its related problems may often form

only one component of a much larger post-harvest system, and consideration therefore needs to be given to approaching this system in its totality along inter-disciplinary lines in much the same way as we are now attacking the problems of production prior to harvest. In some cases this may involve new or multiple end uses for a commodity for food, feed, or industrial purposes.

67. The TAC has therefore taken the view that the work of the International Centres in this potentially very broad field (including their cooperation in regional programmes) should be limited to research related to problems of harvesting, drying, storage and milling at the farm and village level, and that for them to extend their horizons beyond this would open a Pandora's box. Nor does it intend to submit specific proposals to the CGIAR for research outside that being undertaken by the IARCs. For this reason it particularly welcomes the interest now being shown in the overall field of post-harvest technology by an informal group of donors within the CGIAR. It sees a need for close and continuing links between these donors and the work of the Centres, and intends to invite their Chairman to discuss their plans with the TAC in the near future, so as to improve cooperation and coordination of future activities in this very important but complex field.

IV. SECOND ORDER PRIORITIES

68. In contrast to its firm position on first order priorities, the TAC has so far made no positive recommendations to the CGIAR in respect of several other important groups including vegetables and tropical fruits among the food crops, and oilseeds and cotton among other agricultural commodities grown primarily for processing, but which may have food as well as agricultural uses ^{1/}. There are two main reasons for according these a lower order of importance up to now.

69. In the case of fruits and vegetables, there is a large and diverse range of species in each group with lesser opportunity for a focus of research and for any uptake of research on an internationally significant scale. Information to illuminate a judgement as to their priority has also proved seriously inadequate, both in respect of their practical importance (production, consumption and dietary significance) and of the state of current research in developing countries. There has also been a lack of well-prepared proposals for research on these commodities compared to several of those accorded higher priority for which the urgency was also clearer. Secondly, the TAC has, until now, taken the position that its first concern must be with research to accelerate food production and for this reason it has not given detailed consideration to other crops even though it has recognized that they have important economic connotations and, in some cases, such as cotton, have multiple uses for fibre, food and livestock feed.

^{1/} We do not have a satisfactory generic name for the widely diverse group of commodities variously described as "non-food", "industrial" and "agricultural raw materials".

70. However not only nutrition but also income, employment, and foreign exchange earnings are essential goals of developing countries. Lack of purchasing power is as critical a cause of malnutrition as problems of food production and it must not be forgotten that such commodities provide in some areas the only source of income to many families ^{1/} while in others they form the major cash component of farming systems in which food is produced largely for subsistence, for example cotton in the semi-arid tropics. Moreover, shortage of foreign exchange may be a key constraint on the supply of inputs required to raise food output.

71. Now that significant progress has been made in respect of its first priorities, the TAC has felt a need to rethink its approach to some of these important second order commodities with the option of drawing sound proposals for research of a specific nature to the attention of either the CGIAR or bilateral donors.

72. In view of the wide range of commodities and related problems outside its first priorities the TAC saw the need for an "overview" which would indicate their current economic and social importance, their market potential, the effectiveness of ongoing research, the potential for useful additional research, where the main thrust of this should lie (i.e. in production, processing, or end-use), and its probable cost.

73. In order to provide this information to the TAC/CGIAR and bilateral donors, as well as to help the developing countries themselves, a study was undertaken by FAO in collaboration with the Tropical Products Institute during 1974 (16). While this study covered eight commodity groups ^{2/} which were selected by FAO as being of major importance, it took as its starting point the contribution of all major agricultural commodities (including fish and forestry products) to economic growth in the developing countries, both in the pre- and post-harvest sectors. This shows that staple food products (excluding hides and skins), account for approximately 56 percent of the total product value of the renewable natural resource (RNR) sector of the developing countries overall, and confirms the high priority being put by TAC on these commodities (Annex Fig. 1). Of the remaining commodity groups the oilseeds, fibres, and hides and skins, contribute something like 18 percent of total RNR. Within these groups cotton was identified as by far the most important item, followed by groundnuts, hides and skins and coconuts. (Annex Fig. 2). However it is noteworthy that fibres as a group obtain two-thirds of their total value from post-harvest activities. within developing countries, and the oilseeds almost 50 percent, whereas most of the crops to which the CGIAR is currently giving support are low down the list in respect of "value added" (Annex Fig. 3).

^{1/} For example many perennial crops of the wet tropics - rubber, coconuts, several beverages and spices, and tropical hardwood forests.

^{2/} Coconuts (including coir); oil palm; groundnuts; soft oils (sesame, sunflower, safflower and mustard); cotton (including cotton seed); jute, kenaf and hard fibres; sisal; hides and skins and leather. Soya beans were omitted from the oilseed list, although considered of high priority, because at the time of selection proposals were already before the CGIAR for the establishment of the INTSOY network.

74. As a result of this study, and its own earlier discussions, the TAC has therefore decided to pay particular attention to the priority needs of vegetables, cotton, and certain of the oilseeds, especially coconut. In respect of these commodities, the situation is as follows:

75. (i) Vegetable research. Following its earlier inconclusive discussions on the subject and the receipt of a proposal from the Rockefeller Foundation for the establishment of a tropical vegetable research centre in Asia (IVRIT)(17), the TAC appointed a mission to appraise the need for additional internationally-supported research, and if possible to provide the TAC with a better base of information on which to formulate a recommendation to the CGIAR. This mission visited several countries in Africa and Asia and has recommended that a new international centre should be established to form a focal point for a research network with national institutions on selected priority vegetables. It stressed the weakness of national research efforts on vegetables in several countries it visited, and drew attention to the need both for more research and for training to help build up national capabilities. (18) The lack of trained personnel in national programmes is a main reason for its recommending an international centre. The report draws attention to the importance of and neglect in research and development programmes of the native species, and particularly the leafy vegetables which are universally consumed but very little marketed. The needs of vegetable research in the tropics are very different from those in more temperate areas and hence there is relatively little technology that is transferable.

76. However, despite a growing feeling among members that there is a need for some form of internationally supported effort to strengthen vegetable research, the TAC is not yet prepared to endorse a particular institutional approach among the alternatives which it has discussed. It wishes first to obtain further information on the priority species and research problems in the main ecological regions of developing countries, and the research currently in progress on them. Thus, while TAC is likely to move to a higher priority position in respect of vegetables, it has not yet finished its examination of this subject.

77. (ii) Cotton. Three quarters of the total world production of cotton originates in the developing countries, where this crop is of great importance for the following reasons:

- (i) The very large number of developing countries (around 70) concerned with its production and processing in which an estimated 200 million families are involved; (19)
- (ii) Its important role as a cash crop in rotations with food crops in many countries. Its area is greater than any other single crop next to the five staple cereals;
- (iii) Its multiple uses for fibre, human food (both oil and protein concentrate flour), and concentrate feed for livestock;
- (iv) Its increasingly important value-added component in developing countries, with consequent implications for industrial job creation; and
- (v) Its contribution to the balance of payments. Cotton is the primary FNR export earner of the developing countries, valued at 3.3 billion dollars in 1972, and is only exceeded by petroleum and possibly by copper.

78. Not only does cotton have great social and economic significance to the developing world, it also has a number of urgent problems demanding research, both in production and utilization. For example, over half of all the pesticides consumed in the agriculture of developing countries are used on cotton, and the increasing costs of control are rendering the crop uneconomic to farmers in some major producing countries. As a fibre cotton faces a continuing battle with synthetics, on which very large sums have been spent in research compared with cotton end-use. Indeed the advent of synthetics appears to have led to some cutbacks by developed countries on research into the natural fibre. Yet in terms of demand for cotton goods the outlook appears to be brighter than for most other natural fibres; while recent research suggests that it has a considerable potential for food use, given the development of appropriate processing technology.

79. These facts indicate a good case for additional research in terms of the TAC's criteria, and (because of the difficult, diverse, and probably costly nature of the research required), point to a case for international support to such research. A further factor of significance which seems to heighten this need, is the closure of the U.K. supported Cotton Research Corporation (CRC), which has been a major source of research strength in the past.

80. The TAC therefore departed from its past tradition of supporting only food commodities by giving serious consideration to the claims of cotton. However, apart from recognizing that this is a crop which certain of the International Centres (especially ICRISAT) might wish to study as an important component of farming systems, the Committee has so far reached no firm decision as to what recommendation to make to the CGIAR concerning cotton.

81. There are two principal reasons for this. The first is that it has been suggested that research expenditures on this crop are already very high compared to most other important crops in developing countries, and that this may have been one reason for the closure of the C.R.C. The TAC wishes to examine this proposition very carefully since it seems to conflict with the findings of the TPI study and the recently published UNDP/World Bank/Rockefeller Foundation report (19) both of which argued strongly for more international support to cotton research.

82. Secondly, the research needs of the crop seem to vary quite considerably from one country to another (despite some over-riding problems such as pest control), as do the possible solutions to its improvement. Under these circumstances, the nature and type of the support likely to be most valuable, whether an international institute, a network, or a bilateral donor/country approach requires very careful consideration. It is proposed to examine these two questions further before making a final recommendation as to the degree of priority to be accorded to cotton.

83. (iii) Oilseeds. A further group of commodities which the TAC believes merits more consideration in national and international research programmes, for economic, social and nutritional reasons is the oilseeds, although here it is necessary to differentiate sharply between the annual and the perennial species.

84. The annual oilseeds are a diverse group. Their distribution, relative importance, and potential importance vary quite widely by ecological zone, and bear comparison with the grain legumes in the sense that it is unlikely that any single international centre could cope with their needs. On the other hand, they form an important component of crop rotations in many countries, particularly in the drier areas, and a solution to strengthening research on them which TAC believes is worth exploring would be to arrange for any additional research needed on individual species to be undertaken, over time, at the International Centres representative of the ecological zones where such crops are, or could be, important. A precedent for this exists with groundnuts at ICRISAT which is in an environment also appropriate to sunflower, sesame and safflower cultivation. The latter is already finding a place in ICRISAT's farming system work. ICARDA when established could also handle sesame and perhaps sunflower or rape seed. Alternatively, it might be feasible in some cases to select a strong national institution for reinforcement to enable it to undertake international responsibilities for an oilseed.

85. The geographic scatter which could be obtained in this way should be sufficient to cover the entire range of annual oilseeds adequately but the approach is seen as an evolutionary one, phased in line with the development of selected institutes, with the TAC maintaining a watching brief on the needs and opportunities for recommending support to a specific programme of research. Here again there is a parallel with the approach the Committee has adopted for the grain legumes.

86. Among the perennial species the two main oilseeds are coconuts and oil palm, and while the latter is receiving reasonably adequate support, either through national programmes and/or in relation to World Bank projects in certain countries such as Indonesia and Malaysia, research on coconuts is very dispersed and there is no major programme located at a single centre comparable with that, for example, on rubber. This crop is important for direct human food, as the main source of cooking oil in much of Asia, for fibre, and for livestock feed. It is widely grown as a smallholder crop and in some countries of Asia and the Pacific is virtually the sole source of livelihood of several million families. The TPI study has identified coconut as second in its priorities for reinforced research. It is clear both from this study and other reports that there is a number of intractable problems requiring research. The TAC therefore wishes to be better informed on the needs of coconuts both in respect of production and of processing, and is deferring its judgement as to their priority for international support until it has had a chance to make appropriate arrangements to do so.

V. OTHER PRIORITY AREAS

87. (a) Tropical fruits. After examining the problems of tropical fruits TAC has concluded that these may best be approached by national institutions with bilateral support or perhaps through networks related to individual species, since the wide range of species, many of rather localized importance, the bimodal pattern of much of the production (either large-scale export, oriented plantation enterprises or very small scattered Kampong garden

type of holdings), and the complex and long-term nature of much of the research make it difficult to see how an effective international programme could be mounted.

88. (b) Forestry. While TAC has always been concerned with the risks of erosion, flooding or desertification resulting from the loss of tree cover, and the possible adverse effects of this on food production, it has not been disposed to support proposals for research on timber production or processing per se, and has explicitly agreed not to accord forestry any priority.

89. Recently, however, it has been argued that TAC should re-assess this position, on two main grounds. Firstly because most research on silviculture, even in the tropics, has depended on temperate methodology and sometimes on imported species, and there is thus an urgent need to develop indigenous technology and to learn how best to manage and harvest native species so as to avoid costly mistakes. Secondly, because considerable opportunities are seen for "agro-silviculture to develop integrated systems of tree culture, crop, and livestock production which might provide a viable alternative in areas of increasing population pressure to pure forestry on the one hand or shifting cultivation on the other. Research on such systems could be a component of certain international or regional centres programmes (e.g. IITA or CATIE 1/).

90. While recognizing that tropical forests represent one of the few relatively untapped sources of wealth in a number of countries, and that there are important research problems both of a technical and social nature in forest management and timber utilization 2/, the TAC feels that since successful follow-up would often depend heavily on discipline and possibly even government enforcement, research at the national level with bilateral support might be more fruitful than an international research approach. In view of its uncertainties concerning the adequacy of existing facilities in relation to needs, the Committee is anxious to study a report now being undertaken on current forestry research in developing countries.

1/ CATIE has an interesting programme with these aims in view, the only regional programme of this nature (20)

2/ A resolution passed at the 1975 FAO Conference urged the establishment of an International Hardwood Pulp and Paper Research Centre or Programme (21).

(vi) IMPORTANT FIELDS OF RESEARCH NOT ASSIGNED SPECIFIC PRIORITIES

(a) Socio-economic research

91. Certain areas of socio-economic research can make an important contribution to the achievement of the objectives of the Consultative Group whether undertaken at the farm or village level (micro-level), at the level of national decision-making (public policy), or at the wider macro-level on broad issues of international food and nutrition policy.

92. Applied nutrition is a related area of research which can provide an important feed-back of information to public policy, and which can also help to guide research planning; the Committee therefore welcomes recent action by FAO, other international agencies and bilateral donors to reinforce studies in this field through a coordinated programme.

93. The TAC has not assigned a ranking priority to this very wide field but it is unanimous that specific activities in socio-economic research of obvious importance to the solution of the practical problems facing developing countries should be accorded very high importance. Despite significant progress made in recent years, e.g. through the reinforcement of the Centres programmes at the micro-level, and through the establishment of IFPRI at the macro-level, it feels that practically oriented socio-economic research still remains inadequate. There may be a particular gap at the level of national policy research.

94. At the micro-level the Committee sees the work of the socio-economists at the Centres as having particular value in defining the parameters of a problem in collaboration with other scientists (e.g. with agro-climatologists in identifying the importance of upland rice and especially in supporting farming systems work), in providing guidance as to whether a new technology is likely to be capable of adoption by producers in their existing farm situation, and in helping the programme development and allocation of resources to research at their institutes. Such information is also of great assistance to the TAC. In reviewing the Centres work it will examine carefully whether their staffs need re-inforcement in this critically important field.

95. In respect of research at this level, the Committee sees two particular areas of concern, these are (a) the extent to which the results of the micro-level research programmes per se of the International Centres can be widely applied because of the location specificity of many of the problems; requiring their study in the physical, social and economic environments in which they occur, and thus making it difficult for the Centres to provide tailor-made solutions relevant to the wide range of situations existing in the countries which they serve; and (b) the general weakness of national systems in this field. Yet the latter not only have to provide the essential complementary linkage to the Centres work at the local level, but are also expected to undertake complex studies related to key policy issues both in relation to commodities and problems on which they are collaborating with the Centres and on a much broader range of questions of national importance.

96. In relation to the level of public policy, the TAC feels that while it is important to be able to recognize local constraints to the adoption of improved agricultural techniques, research is needed to identify weaknesses in the wider institutional mechanisms on which the success or failure of production programmes, marketing organizations, credit systems services, extension and demonstration programmes, marketing organizations, credit systems, etc. These often cut across individual commodities and lead into fields of agricultural policy outside the direct mandate of the International Centres.

97. The TAC feels that while the International Centres should attempt to identify and draw attention to such general constraints, so as to make sure that their technologies not only work but can be applied, they should not be burdened with research on the problems of removing those constraints. This could dilute their efforts and take them into a field for which they are not equipped. To some extent IFPRI might be able to help here, but the Committee believes there is likely to be a gap still unbridged between the micro- and macro-commodity levels in research related to national policies.

98. Because of its concern at finding a solution to this dilemma the TAC considered at one time the possibility of establishing some specially supported institution to coordinate and stimulate work on problems of this nature, to improve information services to policy makers, and to train national cadres. However, it concluded that it was not feasible for any one institute to cope with such a wide range of problems.

99. This remains our opinion and the TAC feels strongly that the ultimate solution to this problem lies in channelling more resources to helping the developing countries to build up their own capacity to undertake socio-economic research both at the farm and at the policy level. This would to overcome the problems of location-specificity impeding the wider application of the socio-economic work of the Centres which is a matter of concern to the TAC.

100. In this process the International Centres could play an important role through the development of generalized methodology (e.g. for the study of production functions) and the construction of flexible models (e.g. on farming systems) capable of wide adaptation by national institutes; in the training of national workers to use and understand the socio-economic technology and to enable them to cooperate in multi-disciplinary research; and in the assembly and analysis of information and the dissemination of the results of socio-economic research to other research workers. The general trends emerging from the Centres' own research would also be of value to policy makers outside their host country, even if the detailed conclusions might have more localized applicability.

(b) Factor-oriented research

101. Although the TAC considers that in the majority of cases research related to factors of production is best studied in relation to specific commodities, it recognizes that there are important exceptions where factor-oriented research can only be undertaken meaningfully in relation to the overall farming system (or vice versa) rather than to an individual commodity.

102. For example, except in monocultures, fertilizer and pesticide residues contributing to environmental pollution come from the totality of the farm and not just one enterprise. Post-harvest technology may also present problems embracing more than a single commodity (e.g. a need for multi-purpose threshers). Multiple cropping, aimed at high output per unit area/unit time involves radically different management of production factors (and plant breeding and cultural concepts), than systems which depend principally on high yield per individual crop. Water use and management has to be related to the crop-mix as well as to the needs of individual crops, and insufficient research on soil/plant/water relationships is frequently a serious obstacle to the development of optimum production systems in irrigated areas. There is thus a close relationship between factor-oriented research and that on intensification.

103. There may also be cases where factor-oriented research is necessary to improve the efficiency of an input itself, e.g. the design of new types of fertilizer suited to use in developing countries. Such research, which may offer considerable potential for increasing food production, is often not commodity specific in its initial stages. This, in fact, has led to TAC recommending support from the CGIAR to the first major departure from the pattern of commodity, or commodity/system oriented International Research Centres, i.e. the International Fertilizer Development Centre (IFDC). While the United States has committed itself to supporting the basic research programme at Muscle Shoals, where highly sophisticated facilities exist, the field testing and application of the results must be done in developing countries with the cooperation of International Centres and national programmes. It is this aspect of the IFDC programme overseas that the TAC strongly commends to the CGIAR. (22)

104. Although there is a wide measure of agreement that more factor-oriented research is required, the TAC does not feel that on the whole new mechanisms are likely to be needed for this. Single factor studies are the basic building blocks in the development of science to which immense resources are being devoted throughout the world and especially in the developed countries. This is not an area generally neglected in any science. The application of the results to individual problems at International Agricultural Research Centres is also expanding and there is growing evidence of the channelling of additional resources from other well-staffed and equipped institutes to help the Centres in particular factor problems. Even so this potential has hardly been tapped, partly because the resources at the Centres themselves are insufficient to do so. Something quite exceptional would therefore have to be identified to justify the establishment of new capacity for research on single facets of science to support the Centres' work, beyond what is now being proposed in the case of the development of fertilizers for the tropics. The TAC has seen nothing on the horizon in this respect. Another instance where factor-oriented research may be necessary is the improvement in the efficiency of managing irrigation or rainfall crop water on the farmer's field. Studies in soil/plant/water relations suggest that significant water savings in crop production can be made through carefully controlled applications of water to the root zone of the plants. Such findings may have great implications for the future development of a high-productivity agriculture throughout the world. The TAC has given careful attention in the past to the research needs of improved crop water management. The TAC's earlier reviews pointed to

large gains in water use efficiency that can be made by appropriate development investment in the improvement of major and minor national irrigation systems, gains that did not require additional research, merely the application of known technologies. However, the TAC is aware that limitations of crop moisture is often the major factor holding farm yields at low levels. For this reason, the TAC is concerned with worldwide research activities on water as an input to crop production. The Committee pays particular attention to the impact these activities might usefully have for the work of the international centres and the CGIAR. Should the Committee find that new research opens opportunities for further investigations either at existing international centres or through other institutions, it will not hesitate to comment such work to the CGIAR. For the present, the TAC has urged all international centres to accord water management an important place on their research agendas.

105. One other aspect of factor-oriented research that has received little consideration in the past is the matter of pre-harvest crop losses from large pests such as locust, birds and rodents. The TAC is aware of the magnitude of these losses, but it has not yet given consideration as to how these losses might be reduced as a consequence of appropriate research. For the time being, IARC's are encouraged to investigate protection from the depredations of pests as part of their general work on plant protection. But such work is often inadequate to the problem. The TAC recognizes that more specific research may have to be undertaken at the international centres or through separate arrangements with specialized institutions such as the International Centre for Insect Physiology and Ecology (ICIPE) in Kenya. In the course of its work ahead, the TAC will examine this problem in greater depth.

VII. INSTITUTIONAL CONSIDERATIONS IN DEVELOPING A GLOBAL AGRICULTURAL RESEARCH SYSTEM

(a) Relations Between Applied and Basic Science

106. Consideration of factor-oriented research leads rather naturally to the important issue of how advanced research in the basic sciences can be brought to bear more effectively on the solution of important agricultural problems, and its interaction with applied agricultural research made more productive. Much of the progress of agriculture in developed countries since 1940 has been the result, sometimes indirectly or almost accidentally, of the application of new basic knowledge, (23), but very few developing countries have the capacity to undertake fundamental studies, and even the international institutes do not claim to be doing so.

107. At first sight this may seem irrelevant to the needs of many developing countries, where average yields and cropping intensities are often so very far below the potential demonstrated on well-managed farms, due to a complex of technical, socio-economic, and institutional factors the nature of which varies within and between countries, and which itself requires further research, e.g. along the lines of IRRI's 'constraints' programme.

108. However, there are some countries, e.g. Egypt, Korea and parts of India, the Philippines and Indonesia, where some yields and cropping intensities are high even by world standards, and which are beginning to press up against the limits of their natural resources. Although further increases in average yields are still technically feasible in these countries, additional increments will tend to become progressively more costly. Further substantial progress is likely to depend on deeper knowledge of resource utilization to enable the area of cultivated land to be extended, and/or on the development of entirely new techniques of agriculture.

109. In other countries yields may be low because of ecological constraints which might be alleviated by better understanding of the fundamentals of crop physiology; or because transport costs are too high to make the use of fertilizer economically attractive. The transference of the nitrogen-fixing mechanism from legumes to cereals could transform the latter situation at one stroke and the TAC is encouraged to note the increasing volume of research in this field, and the evidence of important progress being made. (24)

110. There is also a need to give more weight to biological methods of control of pests, pathogens and rodents, as well as to new approaches to plant nutrition, including recycling of organic human and animal waste products and more efficient and economic methods of formulating and applying fertilizers. Research into methods of monitoring residues, etc., which can be easily applied by developing countries is also needed. The fact that we have so far devised no technology capable of maintaining productivity without high use of manufactured inputs does not mean that we should not search for one.^{1/}

111. There are in fact two somewhat different, but not unrelated, questions to which the TAC is addressing itself in respect of harnessing basic research capabilities of developed countries more effectively to these purposes. The first is how to strengthen working linkages between International Centres and advanced scientific institutions in a way which can help to reduce problems impeding the impact of the more "applied" type of research conducted at the Centres, i.e. to work out an appropriate division of labour that helps the Centres to concentrate on what they are best equipped to do while benefitting from outside help in breaking bottlenecks to advances in their work. Links are now being formed between institutes in several developed countries and the International Centres on a number of agreed lines of research which suggest that such cooperation may offer great potential for the advancement of agricultural science in the developing countries leading eventually to the generation of new knowledge and methodologies of wide practical value.

^{1/} It is noteworthy that the recent Conference on research to meet U.S. and World Food Needs, referred to earlier, accorded highest priority to increasing the efficiency of energy use, out of 49 "research need areas"; third priority to water research; and fourth to problems in plant growth and reproduction. These three areas all have an above-average component of basic research.

112. This form of collaboration is expanding and should be encouraged to do so; it is at present largely on an ad hoc basis and so far the TAC has felt that more formal and systematic arrangements are unnecessary. However it believes that the TAC and CGIAR should be kept informed by the Centres of such linkages and their progress, and that eventually some means may have to be found to prevent the Centres being swamped by offers of cooperation from advanced institutions. ^{1/}

113. The proposal to use ICIPE to undertake work on behalf of the Centres, with at least some capital funding from the CGIAR to equip it to do so, has introduced a new dimension; and the TAC has been grappling with the problem of devising a form of working association between the Centres and ICIPE which will enable it to tackle clearly identified research tasks related to their needs in a manner which would enable progress to be monitored by the TAC without necessarily involving ICIPE as a formal member of the CGIAR.

114. It is unlikely, however, that even a greatly expanded and coordinated effort along these lines, could provide answers to some of the more intractable problems touched on above, since these extend beyond the mandates of the International Centres, although the work of the latter might often be advanced by their solution. The second pertinent question is therefore how to organize the strength of advanced institutions in collaborative efforts on basic research problems important to the developing countries but not necessarily central to the specific goals of the International Centres. Work of great relevance in several fields is undoubtedly going on in developed countries; the trouble is that not enough is known about it, and what could be done to help with its application to developing countries. All that can be said with reasonable certainty is that neither the individual research efforts of developed countries, nor their links to the work of the International Centres, yet amount to the systematic approach on a task force basis which might achieve a breakthrough on difficult problems by a judicious balance of basic and applied science. The TAC's very tentative discussions suggest that this is an area which the CGIAR might wish to study further.

(b) Mechanisms for implementing international research programmes

115. So far the TAC has adhered rather closely to supporting Centres along the classical lines represented by IRRI or CIAT, and these are still the modal which seems most apt for commodity-package oriented research. Nevertheless it is undeniable that large multi-disciplinary institutes are costly to establish and run, nor are they necessarily the best solution to all research problems, particularly those with a strong element of site-specificity. This has led to doubts about continuing to add to their number, and to a search for other institutional approaches to international or regional research which are cheaper and/or more flexible.

^{1/} There are indications of new initiatives by some major donors to increase the resources available for such cooperation.

116. There is a need for perspective in this matter. The capital and running costs of the Centres, although high by standards of research establishments in most developing countries, are considerably lower than those in some developed countries. They also compare favourably both in cost and (according to some recent economic assessments of the work of IRRI and CIMMYT) the speed of flow of benefits, with most other forms of agricultural investment. (25) Where this appears to offer the best institutional form TAC will continue to recommend it.

117. A means of strengthening research on problems of wide importance which may provide an economical alternative to establishing further International Centres, but which does not necessarily preclude utilizing the capabilities of existing ones, is the cooperative research network. These can be commodity-oriented, factor-oriented, or problem oriented, either in the technical and socio-economic fields or both. The approach is attractive in offering a means of involving research institutions in both developed and developing countries, International Centres and agencies, universities, foundations, etc., in a jointly planned effort with low capital costs. If the objective is well chosen, in line with a generally accepted need of a region or ecological zone, this sense of involvement should be reflected in the interest of participants both in the success of the programme and in the wide application of the results. Networks can be quite flexible in the conduct of research; provided that the planning and coordination are sound, all cooperating institutions do not have to contribute exactly the same input, they can participate according to their capabilities. Publication of their results is subject to less restraints and can be more widely disseminated than those from individual national programmes, and the externalities of both the network management and its financial support make it easier to transmit its findings to planners and decision-makers. However, one of the main constraints to support to such programmes is the difficulty of ensuring a uniformly-high standard of technical competence without offending the national susceptibilities of the countries with weak cadres of agricultural technologists.

118. It is appropriate here to stress that TAC's considerations in recommending support for various institutional approaches to research have not been influenced by arbitrary distinctions of geographical responsibilities such as "global", "inter-national" or "regional", in the sense that one might appear more valid for CGIAR support than another. The Committee's view is that such distinctions are largely semantic and are not meaningful criteria for determining support; ILCA, ILRAD, IITA, and CIAT were all established to serve specific regions or ecological zones, even though the two latter claim "global" responsibilities for research in certain crops. Conversely some "regional" problems may affect more human beings than others which might affect a wider geographical area.

119. The TAC has followed three main criteria in guiding its judgements on such matters; these are, the number of people and countries which might benefit, the technical soundness of the research proposed, and the possibility of conducting it through an autonomous international structure so that its content and management are not subject to local political constraints. The latter carries the implication that the programme must be subject to periodic independent review; and possibly one of the main impediments to CGIAR support for networks may be that it is more difficult to ensure freedom and independence of action where a number of countries and institutions is involved than in the case of an individual internationally-supported research institution.

(c) Strengthening National Research Institutions

120. A strong national research capability is essential to the ultimate success of investments in "international" research as well as to enabling developing countries to deal with localized problems not being touched on by the work of international institutions. The question of how to strengthen national research capabilities has therefore been in increasing preoccupation of the Committee, even though it is not its task to review or recommend the CGIAR to support investment in individual national research programmes.^{1/}

121. The TAC views its role and that of the International Centres as an interim one, to identify and help to fill the immediate and urgent gaps in technical knowledge affecting the developing countries. Unless the scientific capacity of those countries can be strengthened to enable them to move ahead, the ultimate aim of the system, of helping them to achieve self-sustaining technical and economic growth, is likely to be far removed.

122. However, to obtain a grasp of the complexities of a problem involving nearly a hundred countries has not proved easy, especially as there are wide differences in the relative research capabilities of different countries. A first step is the establishment of a better information base on the present strengths of the research institutions in developing countries, and the nature of their current research programmes so that they can be classified more adequately in terms of the level of their ability to cooperate with the International Research Centres as well as to undertake independent research effectively; and as a means of guiding funding and technical assistance agencies as to their needs for investment in research, and even more in research training.

^{1/} Exceptions may have to be considered for special purposes related to the objectives of an international programme, whether of one of the Centres as in the case of ICRISAT's core research linkages in Africa, or to build a research network as with IATDA.

123. Lack of an adequate data base of this nature has constantly impeded decision-making by the TAC, and made it necessary to organize workshops and field missions to provide the missing information. Even these, however, have found difficulty in making an adequate assessment of what research is actually going on, and how effective it is in tackling identified needs; the recent vegetable mission is an excellent example. It is clear from TAC's discussions, and those of the Bellagio meetings on strengthening national research, that other agencies face similar difficulties.

124. This was a main reason for TAC recommending CGIAR support for the FAO proposal to establish the Current Agricultural Research Information System (CARIS) project which aims to collect and publish, initially in directory form, information on research institutions and current research programmes in developing countries, as well as a classified list of their scientific workers.

125. In addition to fostering cooperation between scientists and institutions in research and training, this should indicate to national governments and to aid agencies working with them, where the need for reinforcement of their own programmes lies, or how existing resources might be regrouped to work more effectively. In the last analysis this is a national decision, although the International Centres and agencies like FAO can offer guidance and help through information, training and other measures designed to build national scientific skills and to improve research organization and management.

126. A complementary activity which the TAC Secretariat has been requested to undertake is to develop a register of donor activities in, or in the interest of, developing countries, in a manner which can be made compatible with the CARIS directories. This will be based on information supplied to the Secretariat by the donors, recorded on a standard format for comparison. This should help to pinpoint gaps and to avoid overlapping as well as indicating what donor agencies are able to do to help developing countries or International Centres in specific fields of research. The need for this will increase as the activities of developed country institutions in support of agricultural research expand, and the TAC strongly urges all donors to cooperate in this endeavour.

127. These are major tasks requiring sustained effort, and while TAC hopes to have the donor register prepared during 1976, the first CARIS directories will not be available before 1977. Even then a considerable analytical task lies ahead if the information is to be used effectively to strengthen national research capabilities.

128. Meanwhile there is a need to see what practical steps can be taken to help national research institutions in the more immediate future and in this the International Agricultural Research Centres are already playing an important role in research, in information and the exchange of materials, and in training. Just how far and in what directions they should extend this support, however, has been an issue which has required very careful consideration by PIC, both in view of its financial implications for the CGIAR (e.g. in supporting proposals for "regional services" from the Centres), and of its inherent risks in overloading the Centres with "off-campus" activities to the possible detriment of their mission to develop new and outstanding agricultural technology.

129. The Committee is unanimous in attaching the highest priority to helping to build national research capabilities and the TAC has had this as its constant concern *ab initio*. It recognizes and sympathizes with the dilemma faced by International Centres in trying to assist national programmes which are too weak to benefit effectively from their results, whether this assistance is requested formally by the country or not.

130. At the same time TAC does not believe that the Centres should or could respond to all needs or calls for help from countries, since if they try to do so in respect of some of the demands on them it might be to the detriment of the whole CGIAR system, and thus ultimately to the countries it aims to benefit. TAC has therefore proposed the following guidelines for consideration by the Consultative Group in respect of the limits of the Centres' collaboration with and assistance to national programmes:

- 1) First and foremost the relationship between the Centres and national programmes must be in the interests of research. The Centres must have the means of studying the performance and identifying problems impeding the adoption of their improved plant materials or other research output, not only at experiment stations in countries where these are being utilized, but also at the farm level under field conditions. This on-farm testing (which is distinct from extension demonstrations) is seen as the logical scientific end to a Centre's work and an essential feedback to their future programming. It should normally be conducted in cooperation with national research institutions, but this in no way interferes with national prerogatives to undertake such work on their own where they have trained staff to do so, nor to release varieties or other proven results to their own farmers.
- ii) To enable Centres to undertake such important work the provision of core staff to work outside the Centres on a regional basis is considered reasonable; however, their primary task should be to forward the research objectives of the Centres. While they may help national staff with lectures on how to demonstrate the use of their materials to farmers, the Centres' personnel should not accept responsibility for organizing demonstrations, nor for extension or supporting services. Someone else, whether FAO or another agency, should assist countries in this respect. Similarly the TAC does not believe that regionally posted core staff should accept responsibilities in respect of advice to governments on policy and related activities of a marginal nature to the Centres' main research mandates. Again this does not mean that TAC wishes to prevent the Centres from undertaking or sponsoring socio-economic research appropriate to the furtherance of their main objectives.
- iii) In respect of training the Centres must be encouraged to train effective collaborators for their research activities, whether at their headquarters or on a decentralized basis, connected with the use of their planting materials on farmers' fields. Where training of production specialists with in countries is essential to the adoption of a Centre's research results, the Centre's role should be to help organize the training activities, but not to do the training. Neither is the administrative burden of taking responsibility for extension training in a large number of countries considered to be within the bounds of the Centres' responsibilities. However it is not the Committee's intension to discourage production training courses or training of trainers at the Centre's headquarters, where the relatively large training staffs can cope with such courses without interfering with the core research work.
- iv) Where more than one Centre is engaged in a country in activities of a similar nature, sensible arrangements should be worked out for their collaboration in those activities, with an agreement amongst them as to which should take the lead.

131. In order to help the Centres to avoid taking on commitments outside their remit (e.g. in extension training, seed production, economic policy guidance, etc.), because they feel that they have to fill a vacuum which may impede the acceptance of their research results, the TAC urges that other arrangements should be made to provide the necessary assistance and services to countries, with adequate arrangements for linkages and feedback to the Centres; for example, by FAO, or other international and bilateral agencies. Wherever such services are available to countries the TAC feels that it is entitled to advise the Centres to restrict their activities in this direction.

132. It may even now be legitimate to query whether the resources being devoted by FAO and the World Bank to the important activities of technology transfer are adequate, or whether sufficient weight is being given to strengthening national research and extension services in the UNDP country programming exercises. In addition, encouragement and support should be

given by all donors for the building of working linkages from individual research institutes in developing countries into whatever global networks exist in relation to the problems with which they are concerned. It is important that support being channelled to international research through CGIAR should not lead to any out-back in support from FAO, the World Bank, UNDP and bilateral donors for developing national research capacities; indeed the tempo of financial and technical assistance might well be raised.

133. This raises a further question. How far are the results generated by international research programmes being incorporated into FAO/UNDP or World Bank pre-investment or investment projects? This might not only increase the benefits but also reveal the snags of new technology within a broader environment than the individual farm, and help to devise solutions. Put in another way, how can one broaden and accelerate the input of research into the development process? CIMMYT and IRRI have attempted this in developing the Plan Puebla and Managana 92 projects with their respective host countries, but it is legitimate to question whether such projects really ought to be undertaken by the Centres themselves, given that their major task is research.

134. Nevertheless, as pointed out in the 18th FAO Conference paper (26), which makes a number of pertinent proposals for action, there is a real need for projects specifically designed to link research to development, and which would enable more to be learned about the processes of technological change and the impact of policy on the adoption of technical innovations by farmers. This would provide an important feed-back to national policy makers and to the International Centres. This is not necessarily to suggest that the Consultative Group would be asked to fund such projects, but to offer guidance to agencies which might, and to provide moral support for their doing so.

135. Finally, and this is an issue on which the TAC was somewhat divided at its eleventh meeting - what should be the role of the CGIAR in relation to national research? Several members, as well as the CIMMYT representatives and some speakers from development agencies, were concerned at evidence of overlapping and lack of coordination among development assistance agencies in their support to national research and development efforts. It was suggested by some participants that in respect of research and related activities the CGIAR might serve as a meeting ground to promote coordination and as a catalyst for further action.

136. On the whole, however, the TAC doubts the ability of the CGIAR to act effectively in coordinating efforts at the national level. It feels that experience in trying to improve coordination in country programmes shows that this must be done locally, since countries vary so greatly in their mechanisms for coordination, and that this probably lies outside the competence of this Consultative Group. While studying the processes by which research results are taken up by farmers, TAC has been acutely aware of the many constraints imposed by factors such as fertilizer supply, seed supply, storage and transport which are outside the remit of CGIAR. The formation of the CGFPI and IFAD offer hopeful opportunities to remove these constraints. It is suggested that any distraction of CGFPI from such major tasks

by attention to agricultural research matters would needlessly overlap the work of CGIAR. Provision of capital for financing of research in individual countries has been particularly the chosen field of bilateral aid and should continue to be so, but more use should be made of the established FAO network in identifying needs and coordinating aid.

VII. CONCLUDING CONSIDERATIONS

137. The TAC is very conscious that the resources of the CGIAR are limited, and this is why it has attached so much importance to defining a framework of priorities. Nevertheless, it will be seen from this paper that there are important fields of research, some new and some to which the CGIAR is already giving support, for which the TAC may be recommending reinforcement over time. While it is not possible at this moment to forecast exactly what form these will take or their cost, the CGIAR can be assured that the TAC will, as always, exercise the utmost care in submitting any new proposals for its consideration.

138. A major reason for caution is that most proposals for international support to research or related activities carry not merely implications for capital expenditures (which experience has shown can be very heavy), but also long-term commitments to support recurrent operating expenses. The TAC has been concerned at the difficulties experienced by the CG Secretariat in ensuring a smooth cash flow to the International Centres, and has noted with satisfaction the improvements made in this respect. However it wishes to emphasize that once resources are committed to a programme there must be a reasonable assurance of continuity of funding from donors as long as there remains a reasonable prospect of a successful outcome to the research.

139. Since the TAC was first established there have been significant changes in the orientation of its work. Initially it devoted most of its time to examining new proposals, mainly related to staple food crops and ruminant livestock, while its actions in relation to the existing International Centres were mainly confined to looking at proposals for annual additions to their programmes. The only major new programme at an existing Centre in which the TAC played a significant role was the cropping systems development at IRRI.

140. An important shift in emphasis resulted from the Bell Committee's recommendation, accepted by the CGIAR, that the TAC should undertake quinquennial reviews of the entire programme of each Centre, its balance, orientation and future objectives. In parallel there has been a trend towards widening the horizons of TAC in respect of some activities which were not initially treated as first priority. This has mainly been the result of progress made by the CGIAR in supporting the most immediate imperatives, but it has also reflected the evolution of TAC's thinking in the light of its experience and a feed-in of information on needs of developing countries from FAO and other sources, including the representatives of developing regions on the CGIAR. To discriminate between gaps and priorities for international support to research as the more obvious needs are covered will require continuing rigorous scrutiny on the part of the TAC.

141. Despite the increased responsibilities placed on the TAC by the CGIAR, there are two aspects of the operations of the overall system which remain a matter for concern. These are first the relationship between the core and specially-funded activities of the IARCs; and secondly the absence of any regular mechanism for periodic review and evaluation of the total balance of the CGIAR operations.

142. The two are not un-related, since the bilateral addition of specially-funded operations to Centres programmes inevitably swells their headquarters needs for technical and administrative supervisory staff, thus causing a somewhat insidious expansion of the whole system since each institute operates independently in this respect. The TAC has felt that the lack of control of the CGIAR over this aspect of the Centres' programmes represents a serious weakness in its overall management, and while recognizing the essential role that specially-funded programmes have played in disseminating the results of the Centres' core research efforts, would hope that a means might be found of bringing these under annual review.

143. The wider issue of how to review the entire CGIAR system periodically remains. Shifts between and within priorities must be anticipated, and in order to maintain flexibility to accommodate new research thrusts without always adding to the overall financial commitments of the CGIAR as well as to avoid the risk of petrification inherent in research and to encourage new growth, pruning may sometimes be necessary. This is another matter the CGIAR review committee will no doubt be examining. If the TAC should be given this role it would represent a further stage in its evolution in relation to the determination of priorities, the implications of which for its structure and other functions would require most careful study.

REFERENCES

- (1) DDPH: IAR/73/23: Priorities for International Support to Agricultural Research in Developing Countries. 7th TAC Meeting, 4 - 8 February, 1974, FAO, Rome.
- (2) CGIAR 1975: Integrative report from Secretariat. Consultative Group on International Agricultural Research. World Bank, Washington, July, 1975.
- (3) CGIAR 1975: Report of Second Meeting, November, 1975. Washington, December, 1975.
- (4) United Nations World Food Conference 1974. Report of the Conference, Rome, November 1, 1974.
- (5) ARPAC 1975: Research to meet U.S. and World Food Needs. Report of a Working Conference sponsored by the U.S. Agricultural Research Policy Advisory Committee, Kansas City. July, 1975.
- (6) FAO 1976: Report of FAO Conference, FAO, Rome.
- (7) USDA 1974: The World Food Situation and Prospects to 1985. Economic Research Service, Washington. Foreign Agricultural Report, No. 98, December, 1974.
- (8) Society for International Development, 1975. "Era of Agricultural Scarcity Looms". (Based on Lester Brown's "Worldwatch Paper 2" and "The World Food Prospect"). Survey of International Development, Vol. XII, No. 5, November, 1975.
- (9) FAO 1969: Provisional Indicative World Plan, Vol. I, p. 82, FAO, Rome, 1970.
- (10) UN World Food Conference, Agenda Item 8. Assessment of the World Food Situation, Present and Future, P. 89, Rome, November, 1974.
- (11) University of California 1974. A Hungry World: The Challenge to Agriculture. Report of University of California Food Task Force July, 1974.
- (12) FAO 1975. Report of the FAO/UNDP Expert Consultation on the Use of Improved Technology for Food Production in Rainfed Areas of Tropical Asia (Hyderabad, Khonkaen, Kuala Lumpur).
- (13) TAC 1975. Report of the TAC Working Group on the Biology and Yield of Grain Legumes. DDPH: IAR/75/2. FAO, Rome, 1975.
- (14) TAC 1973. Report of the TAC Working Group on Aquaculture. FAO November, 1973.
- (15) Cummings R.W. (Jr.) 1975. The State of Present and Expected Technology and Agricultural Research on Food Crops for the Low-Income Countries. The Rockefeller Foundation, October, 1975.
- (16) T.F.I. 1975. Research Needs and Priorities in relation to certain Agricultural Commodities. Tropical Products Institute, Ministry of Overseas Development, London, 1975 (3 Vols.). Study commissioned by FAO.
- (17) McClung 1974. Proposal for the Formation of an International Vegetable Research Institute for the Tropics (IVRIT). Prepared in consultation with Dr. R.F. Chandler and submitted to TAC, February 1975.
- (18) TAC 1976. Report of the TAC Vegetable Research Appraisal Mission. FAO, Rome, January, 1976.
- (19) Harrar, 1975. Report and Recommendations for an expanded research and development programme for cotton. Report of Cotton Study Team to UNDP, IBRD, and the Rockefeller Foundation.
- (20) CATIE 1974. A proposal to finance a reinforcement of CATIE's core programme. Tropical Agricultural Research Training Centre, Turrialba, December, 1974.

- (21) FAO 1975. Report of the Conference of FAO (Eighteenth Session) Res. 6/15, Rome, November, 1975.
- (22) Programme Proposal for an International Fertilizer Development Centre, DEDR:IAR/75/12. Agenda Item 4. Ninth meeting Technical Advisory Committee. Rome, January, 1975.
- (23) FAO, 1972. The State of Food and Agriculture, Chapter 2 - Accelerating Agricultural Research in the Developing Countries, Rome, 1972.
- (24) Hardy, R.W. and Hevelka, U.D., 1975. Nitrogen Fixation Research: A Key to World Food Science, Vol. 188, No. 4188, pp 633 - 643, Amer.Assoc. for Adv. of Science, May, 1975
- (25) Agricultural Development Council, 1975. Resource Allocation & Productivity in National and International Agricultural Research. Report of Airlie House Seminar. Agricultural Development Council, New York, September, 1975.
- (26) FAO 1975. Strengthening of National and International Agricultural Research. Doc. C75/15, Item 8, Eighteenth Session of FAO Conference, FAO, Rome, November, 1975.

STATISTICAL ANNEX

TABLE 1

WORLD CROPS BY COMMODITY ACCORDING TO LAND AREA, PRODUCTION, AND ENERGY (kcal) 1970

	LAND AREA ^{1/}		PRODUCTION		ENERGY	
	Ha x 10 ⁶	%	Metric Tons x 10 ⁶	%	kcal x 10 ⁵	%
Total Cereals	698	73.5	1 208	38.4	4 210	74.5
Wheat	211	22.2	318	10.1	1 062	18.8
Rice	134	14.1	307	9.8	1 108	19.6
Coarse Grains	353	37.2	583	18.5	2 040	36.1
Maize	108	11.3	260	8.3	910	16.1
Millet-Sorghum	71	7.5	64	2.0	225	4.0
Other	174	18.4	259	8.2	905	16.0
Roots and Tubers	49	5.2	551	17.5	496	8.8
Sugar Crops	19	2.0	814	25.9	285	5.0
Pulses and Nuts	60	6.3	43	1.4	147	2.6
Oilseeds	102	10.8	105	3.4	390	6.9
Vegetables	7	0.7	220	7.0	48	0.9
Fruits	14	1.5	204	6.5	76	1.3
TOTAL	949	100.0	3 145	100.0	5 652	100.0

Source: Research to meet U.S. and World Food Needs, Vol. II (Reference 5).

^{1/} It should be noted that the area figures shown here are generally lower than those compiled from FAO statistics in Table 2. This may be because this table does not include some centrally planned economies.

Table 2(a): DISTRIBUTION OF AREA OF MAJOR CROPS - 1974
(million ha)

	AFRICA	LATIN AMERICA	WEST ASIA	EAST ASIA	TOTAL LDC's (inc. Others)	ASIAN Centrally planned economies	TOTAL DEVELOPED (inc. USSR)	TOTAL WORLD	% LDC + Asian CPSs WORLD
TOTAL CEREALS	54.0	33.3	36.0	152.7	302.4	106.7	302.4	733.7	55.7
Wheat	3.4	8.7	20.8	25.8	61.7	23.4	133.6	224.7	10.0
Rice, paddy	4.0	4.1	1.3	82.0	93.5	35.6	1.7	134.3	34.5
Maize	11.9	17.9	1.5	14.1	55.5	11.7	43.2	115.7	15.6
Barley	4.7	1.2	6.1	3.7	15.7	13.7	59.5	98.3	33.1
Millet	13.6	0.5	1.6	19.4	35.0	30.3	3.1	69.4	25.1
Sorghum	10.5	4.4	3.2	17.6	35.7	0.1	6.8	42.5	10.1
Others	3.0	0.9	1.1	0.1	5.1	2.9	47.3	55.4	14.5
TOTAL ROOTS AND TUBERS	14.3	1.2	0.8	4.6	24.6	16.2	15.7	56.5	72.2
Potatoes	0.3	1.0	0.3	0.5	2.4	4.0	15.5	21.9	39.1
Sweet Potatoes	5.3	0.1	0.1	1.0	7.0	12.1	0.1	19.3	99.2
Cassava	6.3	2.7	0.2	2.4	11.7	0.1	-	11.9	100.0
Yam (inc. Taro)	2.6	-	-	-	2.7	-	-	2.7	98.5
TOTAL PULSES ^{2/}	11.1	7.0	1.6	25.5	45.3	9.4	11.6	66.3	82.4
TOTAL OILSEEDS	7.2	9.5	2.6	19.7	40.0	20.8	37.2	97.0	61.6
Soya beans	0.2	5.5	-	1.2	7.0	14.8	22.7	44.5	49.0
Groundnuts (in shell)	5.9	1.0	0.9	7.9	15.6	2.2	1.0	18.9	34.5
Others ^{3/}	1.1	3.0	1.7	10.6	16.4	3.7	13.5	33.6	59.9
TOTAL VEGETABLES ^{4/}	0.4	0.9	1.4	1.4	4.0	0.3	5.1	9.4	45.9
TOTAL SUGAR	0.5	6.0	0.5	4.5	11.6	0.9	8.2	20.7	60.3
Beet Sugar	-	-	0.4	-	0.5	0.3	7.4	8.2	9.7
Cane Sugar	0.5	5.9	0.1	4.5	11.0	0.6	0.8	12.4	32.6
TOTAL BEVERAGES	7.1	6.5	-	1.5	15.3	0.4	0.1	15.8	39.2
Coffee	3.3	5.1	-	0.6	9.4	-	-	9.4	100.0
Cocoa	3.6	1.1	-	-	4.8	-	-	4.8	100.0
Tea	0.1	-	-	0.8	1.0	0.3	0.1	1.5	31.3
TOTAL FIBRES	4.0	5.3	2.6	12.4	24.3	5.1	10.4	39.9	73.9
Cotton (lint)	3.5	4.5	-	9.9	20.5	4.8	8.6	33.9	74.6
Other fibres ^{5/}	0.5	0.8	2.5	2.5	3.9	0.3	1.8	5.9	70.0
FORAGG	0.2	0.5	0.4	1.0	2.3	0.7	1.2	4.2	70.8

Notes

- 1/ The figures generally refer to harvested areas. No area figures are available for fruits, nuts, olives, coconuts, oil-palm, tung, natural rubber.
- 2/ Includes dry beans, peas, chick-peas, lentils, vetches, lupins, miscellaneous pulses.
- 3/ Includes castor, sunflower, rape, sesame, linseed, mustard, poppy, safflower.
- 4/ Includes cabbages, artichokes, tomatoes, cauliflowers, pumpkins, cucumbers, eggplants, chillies, onions, garlic, green legumes, melons. (Data refer principally to marketed vegetables.)
- 5/ Includes flax, hemp, jute, sisal, agave, abaca.

(Source and definition of regions: FAO Production Yearbook, 1974)

TABLE 1.1
REGIONAL DISTRIBUTION OF AREA UNDER CROPS IN DEVELOPED COUNTRIES AS PERCENT
OF TOTAL AREA IN ALL DEVELOPED COUNTRIES* OF THE WORLD 1

	AFRICA		LAT. AMERICA		NEAR EAST		FAR EAST		S. ASIA**	DEVELOPED COUNTRIES AS % WORLD
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	
TOTAL CEREALS	1.7	7.1	1.7	6.1	11.7	4.4	31.7	22.7	35.5	41.5
Wheat	10.3	2.3	14.1	3.3	33.7	3.3	41.1	11.5	41.0	27.5
Rice, paddy	4.2	2.3	6.3	4.5	1.2	0.7	57.3	60.0	33.1	63.4
Maize	21.3	10.2	50.0	23.2	3.4	1.6	25.3	12.1	11.6	47.3
Barley	30.0	5.3	7.4	1.3	39.0	6.5	23.5	4.2	18.2	17.7
Millet	33.7	15.5	1.4	0.73	4.6	2.3	55.3	28.3	53.2	51.1
Sorghum	23.4	24.7	12.4	10.5	3.5	7.4	49.3	31.3	45.1	83.9
Others	58.2	5.4	17.2	1.7	22.0	2.0	1.6	0.17	1.3	9.3
TOTAL ROOTS & TUBERS	60.3	26.2	17.3	7.5	3.1	1.3	18.6	8.1	5.9	43.1
Potatoes	12.4	1.4	40.3	4.5	13.7	1.5	33.0	3.6	26.4	11.0
Sweet Potatoes	76.3	27.6	5.6	2.0	2.1	0.75	14.5	5.3	4.8	35.7
Cassava	53.9	53.3	23.2	23.0	2.0	1.9	20.7	20.5	4.1	78.0
Yam (incl. Taro)	94.8	93.2	1.1	1.1	2.2	2.2	1.4	1.4	0	97.9
TOTAL PULSES 2/	24.5	16.7	15.6	10.6	3.5	2.4	56.3	38.5	52.8	68.2
TOTAL OILSEEDS	17.9	8.1	23.6	10.7	8.7	4.0	49.7	22.6	45.3	45.4
Soya beans	2.7	0.42	79.6	12.5	0.34	0.06	17.4	2.7	0	15.7
Groundnuts (in shell)	38.0	31.4	5.9	4.9	5.5	4.6	50.5	41.8	42.4	82.7
Others 3/	6.5	3.2	18.5	9.0	10.5	5.1	64.4	31.4	53.4	48.7
TOTAL VEGETABLES 4/	9.8	4.2	21.8	9.3	34.5	14.9	33.7	14.4	19.0	42.8
TOTAL SUGAR	4.6	2.6	51.9	29.1	4.2	2.4	38.9	21.8	30.4	55.9
Beet Sugar	15.8	1.0	10.6	0.68	72.3	4.7	1.3	0.02	1.3	6.5
Cane Sugar	4.1	3.6	53.8	47.8	0.96	0.85	40.7	36.1	31.8	88.4
TOTAL BEVERAGES	46.3	44.9	42.6	41.2	0.44	0.43	9.9	9.5	5.3	96.0
Coffee	35.1	35.0	57.5	57.4	0.15	0.15	6.9	6.9	1.5	99.5
Cocoa	75.3	75.3	22.0	22.0	0.	0.	0.9	0.9	0.39	98.2
Tea	13.6	9.4	3.6	2.5	5.1	3.5	77.4	53.1	61.6	68.5
TOTAL FIBRES	16.3	10.0	22.0	13.4	10.6	6.5	51.1	31.2	46.7	61.1
Cotton (lint)	17.0	10.2	22.2	13.4	12.5	7.5	48.4	29.2	47.1	60.3
Others 5/	13.0	8.5	20.9	13.7	0.90	0.59	65.1	42.5	44.6	65.3
TOBACCO	10.9	5.8	23.8	12.7	19.0	10.1	46.3	24.7	24.4	53.3

* Excluding the Asian Centrally Planned Economy countries from Far East Region.

** India, Pakistan, Bangladesh, Sri Lanka.

1/- 5/ Please see Table 2(a).

(Source of data and definition of regions: FAO Production Yearbook, 1974.)

TABLE 3. REGIONAL DISTRIBUTION OF VALUE OF AGRICULTURAL PRODUCTS IN DEVELOPING COUNTRIES 1/ AS PERCENT TOTAL VALUE 2/ IN (a) DEVELOPING COUNTRIES, (b) THE WORLD

PRODUCT:	AFRICA REGION		LATIN AMERICA		NEAR EAST		FAR EAST		TOTAL IN DEVELOPING COUNTRIES 1/ AS % OF WORLD TOTAL
	(a)%	(b)%	(a)%	(b)%	(a)%	(b)%	(a)%	(b)%	
TOTAL CEREALS	8.6	2.6	15.9	4.9	11.4	3.5	64.1	19.8	30.8
Wheat	6.5	1.3	18.6	3.7	32.9	6.6	42.0	8.4	20.0
Rice, paddy	3.1	1.7	4.1	2.5	2.5	1.3	89.7	47.7	53.2
Millets	16.	3.7	51.3	12.1	8.4	2.0	23.5	5.6	23.6
Barley	22.1	1.7	9.8	0.8	37.3	2.9	30.8	2.4	7.8
Maize	31.1	12.8	2.1	0.9	11.2	4.6	55.5	22.8	41.1
Sorghum	20.1	12.0	35.8	22.5	10.3	6.5	33.7	21.1	62.7
Other	39.6	3.4	27.1	2.3	30.8	2.6	2.6	0.2	8.5
TOTAL ROOTS & TUBERS	57.3	16.4	17.6	5.0	5.6	1.6	18.6	5.3	28.6
Potatoes	10.5	1.2	43.5	4.9	22.7	2.5	23.3	2.6	11.2
Sweet potatoes	40.1	4.9	20.2	2.5	2.2	0.3	34.0	4.2	12.3
Cassava	68.7	62.2	11.6	10.5	1.0	0.9	18.6	16.8	90.6
Yam and taro	96.6	94.5	1.0	1.0	0.4	0.4	0.3	0.3	97.8
Other	25.0	24.3	22.2	21.6	-	-	43.8	42.6	97.3
TOTAL PULSES	20.0	9.2	21.4	9.6	11.1	5.0	46.7	20.9	44.7
VEGETABLES (marketed)	15.5	4.1	16.7	4.5	19.0	5.1	48.0	12.9	26.8
TOTAL FRUITS	9.5	3.9	33.3	13.7	15.9	6.6	39.4	16.2	41.2
Citrus fruit	10.2	4.3	42.0	11.2	19.2	5.1	22.5	6.0	26.6
Other fresh fruit	1.8	0.2	33.1	4.4	55.6	6.9	13.6	1.8	13.3
Tropical fruit	8.6	7.3	30.4	25.7	9.1	7.7	49.1	41.5	84.5
Bananas	9.7	9.0	40.7	38.0	1.2	1.1	39.5	36.8	93.2
TOTAL OIL SEEDS	16.7	5.4	25.8	8.3	13.3	4.3	43.5	13.9	32.1
Soyabean	0.9	0.1	80.2	8.5	0.6	0.1	18.3	1.9	10.6
Groundnuts	40.0	17.8	7.0	4.2	12.0	7.2	50.9	30.2	59.4
Cotton seed	9.1	3.8	27.6	11.5	25.7	10.7	37.6	15.7	41.7
Other	15.0	6.3	21.3	8.9	14.0	5.9	48.0	20.2	42.0
TIGAR, centrif. raw	9.8	4.0	53.9	21.8	6.7	2.7	28.0	11.4	40.5
TOTAL BEVERAGES	37.1	32.3	28.3	24.6	2.2	1.9	31.6	27.5	87.0
Coffee	40.5	40.4	46.0	45.9	0.2	0.2	12.5	12.5	99.8
Cocoa	71.6	71.6	23.7	23.7	-	-	2.0	2.0	100.0
Tea	15.0	10.3	1.7	1.2	6.4	4.4	76.9	52.7	68.6
FIBRES									
Cotton (lint)	7.9	2.4	32.8	10.0	28.5	8.7	30.7	9.4	30.5
Others	12.3	3.6	5.8	1.7	30.8	9.0	51.1	14.9	29.2
Tobacco	11.7	2.5	29.9	6.5	17.0	3.7	41.4	9.0	21.7
Natural rubber	6.6	6.6	0.8	0.8	-	-	92.3	92.3	100.0
TOTAL LIVESTOCK	13.9	1.9	55.2	7.6	10.9	1.5	19.7	2.7	13.7
Cattle & buffalo	12.5	2.3	65.2	11.8	8.2	1.5	14.0	2.5	18.1
Sheep and goats	25.3	9.3	14.7	5.4	43.3	16.0	16.7	6.1	36.8
Pigs	6.8	0.4	52.3	2.9	0.8	-	39.0	2.2	5.6
Poultry	17.8	2.7	51.5	7.8	8.5	1.3	22.2	3.4	15.2
TOTAL LIVESTOCK PRODUCTS	10.1	1.7	34.7	5.9	18.0	3.1	37.1	6.3	17.0
Milk	10.0	1.9	27.8	5.3	19.4	3.7	42.7	8.2	19.1
TOTAL ALL CROPS	15.9	5.2	20.5	6.7	12.8	4.2	50.3	16.5	32.7
TOTAL ALL LIVESTOCK	11.8	1.8	43.6	5.6	14.9	2.3	29.5	4.6	15.4
TOTAL PRODUCTION	15.1	4.0	25.2	6.7	13.2	3.5	46.1	12.3	26.6

1/ Excluding Asian Centrally Planned Economies

2/ Values expressed in terms of regional wheat-based price relatives compiled from average national producer prices in 1961-65

Note: Source of data FAO Production Yearbook 1974

TABLE 4

INDEX OF WORLD FOOD SECURITY, 1961-76

Year	Reserve Stocks of Grain ^{1/}	Grain Equivalent of Idled U.S. Cropland	Total Reserves	Reserves as Days of Annual Grain Consumption
(Million Metric Tons)				
1961	163	68	231	105
1962	176	81	257	105
1963	149	70	219	95
1964	153	70	223	87
1965	147	71	218	91
1966	151	78	229	84
1967	115	51	166	59
1968	144	61	205	71
1969	159	73	232	85
1970	188	71	259	89
1971	168	41	209	71
1972	130	78	208	69
1973	148	24	172	55
1974	103	0	108	33
1975	111	0	111	35
1976 ^{2/}	100	0	100	31

Source: Based on U.S. Department of Agriculture data and author's estimates (Reference 8).

^{1/} Based on carry-over stocks of grain at beginning of crop year in individual countries for year shown. The USDA has recently expanded the coverage of reserve stocks to include importing as well as exporting countries; thus the reserve levels are slightly higher than those heretofore published.

^{2/} Preliminary estimates by USDA.

TABLE 5
TOTAL DEMAND OF DEVELOPING MARKET ECONOMIES BY MAJOR COMMODITY GROUPS^{1/}

	Consumption	Projected demand			Total increase		Growth rates	
	1969-71	1980	1985	1990	1985/70	1990/70	1970-85	1970-90
	. . . million metric tons . . .			percentage		percent p.a. compound		
Cereals ^{2/}	335.70	534.3	628.5	737.6	63.0	91.2	3.3	3.3
Wheat ^{2/}	67.0	119.3	140.2	164.0	61.1	88.5	3.2	3.2
Rice, paddy ^{2/}	171.2	235.3	274.8	318.6	60.5	86.1	3.2	3.2
Coarse grains ^{2/}	127.5	179.7	213.5	255.0	67.5	100.0	3.5	3.5
Starchy roots	107.9	136.5	153.4	171.6	42.2	59.0	2.4	2.3
Sugar, centrifugal (raw basis)	23.9	36.9	46.7	59.3	95.2	148.1	4.6	4.6
Sugar, non centrifugal	10.8	13.5	15.3	17.4	42.1	62.0	2.4	2.4
Pulses, nuts and oilseeds	32.4	44.7	52.8	62.3	63.0	92.2	3.3	3.3
Vegetables	69.7	99.4	119.3	142.4	71.1	104.3	3.6	3.6
Fruits	73.4	107.5	130.4	157.3	77.5	114.2	3.9	3.9
Meat ^{3/}	21.1	32.2	40.6	51.7	92.1	144.4	4.4	4.6
Beef and veal	9.6	14.0	17.3	21.5	80.1	123.8	4.0	4.1
Mutton and lamb	2.6	4.2	5.5	7.1	110.9	174.4	5.1	5.2
Pigmeat	3.5	5.3	6.6	8.3	88.0	135.5	4.3	4.4
Poultry meat	2.3	4.1	5.6	7.9	143.6	241.1	6.1	6.3
Eggs	2.8	4.5	5.9	7.7	112.4	179.7	5.2	5.3
Fish	12.3	19.0	24.3	31.4	98.7	155.9	4.7	4.8
Whole milk, including butter ^{4/}	93.7	137.6	168.4	205.8	79.6	119.6	4.0	4.0
(Skimmed milk)	(13.6)	(20.2)	(25.1)	(31.1)	(84.9)	(129.4)	(4.2)	(4.2)
Cheese	2.6	3.7	4.5	5.5	75.0	112.6	3.8	3.8
Fats and oils ^{5/}	9.9	14.8	18.5	23.0	84.9	129.4	4.2	4.2
Butter (fat content)	1.1	1.7	2.1	2.5	81.4	122.6	4.1	4.1
Vegetable oils	7.7	11.7	14.5	18.1	87.6	133.6	4.3	4.3

^{1/} Demand for food unless otherwise stated, all data rounded.

^{2/} Including feed and non-food demand, in primary commodity equivalent.

^{3/} Including offals.

^{4/} Including milk products in liquid milk equivalent.

^{5/} Including animal fats.

Sources: For 1969-71, i) OECD - Food Consumption Statistics

ii) FAO - Supply Utilization Accounts - Statistical Division

For 1980, 1985 and 1990, UNCTAD data.

Table 6: CEREALS: ACTUAL CONSUMPTION AND PROJECTED TREND DEMAND BY MAIN TYPES OF UTILIZATION,
1970-1990 "TREND" GROWTH CONSUMPTION

	Actual Cons.		Projected Demand		Percentage Increase		Rates of Growth	
	1970	1980	1990	1970-80	1970-90	1970-80	1970-90	
	Million Metric Tons			Percent		Percent p.a. Compound		
<u>Developed countries</u>								
Food	160.9	162.1	164.6	1.3	2.0	0.1	0.1	
Feed	371.5	467.9	565.7	25.9	52.3	2.3	2.1	
Other uses	84.9	100.6	116.4	18.5	37.1	1.7	1.6	
Total	517.3	731.6	846.7	18.5	37.2	1.7	1.6	
Per caput (kg.)	576	623	663	8.2	15.1	0.8	0.7	
<u>Developing market economies</u>								
Food	303.7	409.3	547.2	34.8	80.2	3.0	3.0	
Feed	35.6	60.9	101.9	71.1	186.2	5.5	5.4	
Other uses	46.4	64.1	88.5	38.1	90.7	3.3	3.3	
Total	385.7	534.3	737.6	38.5	91.2	3.3	3.3	
Per caput (kg)	220	233	246	5.9	11.8	0.6	0.6	
<u>Asian centrally planned economies</u>								
Food	164.1	200.5	225.3	22.2	37.3	2.0	1.6	
Feed	15.3	38.7	61.4	152.9	301.3	9.7	7.2	
Other uses	24.6	32.6	39.1	32.5	58.9	2.9	2.3	
Total	204.0	271.8	325.8	33.2	59.7	2.9	2.4	
Per caput (kg)	257	290	304	12.8	18.3	1.2	0.8	
<u>World</u>								
Food	628.7	772.9	937.1	22.9	49.1	2.1	2.0	
Feed	422.4	567.5	729.0	34.4	72.6	3.0	2.8	
Other uses	155.9	197.3	244.0	26.6	56.5	2.4	2.3	
Total	1 207.0	1 537.7	1 910.1	27.4	58.3	2.5	2.3	
Per caput (kg)	333	349	357	4.8	7.2	0.5	0.3	

Source: FAO.

TABLE 7

OBJECTIVES OF LAND AND WATER DEVELOPMENT UP TO 1985

Region	Renovation and Improvement of Existing Irrigation Areas	Area to be Covered by New Irrigation	Development of New Land
(Million hectares)			
Far East	28	15	24
Near East	12	3	10
Africa	1	1	34
Latin America	5	4	85
TOTAL	46	23	153

Source: The World Food Problem; Proposals for National and International Action, FAO, 1974.

TABLE 8

AVERAGE "WORLD" YIELDS 1970/72 (MT/HA) AND
GROWTH OF YIELD (% COMPOUND) 1961/65-1970/72;
SIX MAJOR CEREAL AND LEGUME SPECIES

Cereals	Average Yield	Growth of Yield	Legumes	Average Yield	Growth of Yield
Wheat	1.63	3.6	Soya	1.35	2.0
Barley	1.79	3.0	Chickpea	0.66	1.3
Maize	2.80	2.4	Beans (Phaseolus)	0.48	1.0
Sorghum	1.17	2.3	Pigeon Pea	0.68	0.4
Millet	0.66	2.0	Groundnut	0.89	0.3
Rice	2.25	1.1	Cowpea	0.24	-2.0

Source: FAO Production Yearbook, Vol. 25, 1972.

Table 2(a): LIVESTOCK NUMBERS BY REGION IN 1974
(in 1000 head)

Livestock	Africa (without North/ Central Africa)	North/ Central Africa 1/	Near East 2/	Latin America	Far East (without India and Pakistan)	India and Pakistan	Sub- Total LDC 3/	Asian Centrally Planned Economies (CPE)	Total LDC	Total Developed Countries 4/	Total World
Horses	682	2 667	1 929	23 191	1 485	1 300	31 311	9 194	40 505	23 500	64 005
Mules	33	2 131	594	9 328	20	119	12 225	1 571	13 796	879	14 675
Asses	1 608	9 054	6 719	8 768	21	1 880	28 050	11 672	39 722	2 362	42 084
Cattle	76 374	61 156	26 149	256 285	61 892	193 054	675 450	67 388	742 838	436 029	1 178 867
Buffaloes	-	2 150	1 826	157	23 417	70 199	97 749	31 693	129 442	870	130 312
Camels	399	9 011	944	-	-	1 957	12 311	687	12 998	257	13 255
Pigs	5 989	143	231	70 719	31 317	6 990	116 827	248 684	365 511	305 147	670 658
Sheep	33 248	84 521	121 275	124 390	6 688	58 072	428 224	87 248	515 472	517 472	1 032 668
Goats	55 021	57 717	49 951	40 949	25 284	81 749	310 788	63 859	374 647	23 270	397 917

Notes

- 1/ North-Central Africa: Algeria, Chad, Ethiopia, Mali, Mauritania, Morocco, Niger, Somalia, Spanish Sahara, Tunisia (Africa), Egypt, Libyan Arab Republic, Sudan (Near East).
 2/ Excluding "Near East" African countries shown under 1/.
 3/ Includes "Others".
 4/ Total Developed Countries : Developed Countries + European CPE + USSR.

Source: FAO Production Yearbook 1974, Vol. 28-2, 1975.

TABLE 9 (b) RELATIVE IMPORTANCE OF LIVESTOCK BY REGIONS IN 1974 1.

(percent)

Livestock	Africa without North-Central Africa	North Central Africa 1/	Near East 2/	Latin America	Far East without India & Pakistan	India and Pakistan	Sub-Total LDC 3/	Asian CPE	Total LDC	Total developed countries 4/
Horses	1.0	4.3	3.0	36.3	2.3	2.0	48.9	14.4	63.3	36.7
Mules	-	14.6	4.0	63.7	-	1.0	83.3	10.7	94.0	6.0
Asses	3.8	21.5	16.0	20.8	-	4.5	66.6	27.8	94.4	5.6
Cattle	6.5	5.2	2.2	21.7	5.3	16.4	57.3	5.7	63.0	37.0
Buffaloes	-	1.6	1.4	0.1	18.0	53.9	75.0	24.9	99.3	0.7
Camels	3.0	68.0	7.0	-	-	14.8	92.8	5.2	98.0	2.0
Pigs	0.9	-	-	10.5	4.7	1.0	17.4	37.1	54.5	45.5
Sheep	3.2	8.2	11.8	12.0	0.6	5.6	41.4	8.5	49.9	50.1
Goats	13.8	14.5	12.6	10.3	6.4	20.5	78.1	16.0	94.1	5.9

1/ North-Central Africa: Algeria, Chad, Ethiopia, Mali, Mauritania, Morocco, Niger, Somalia, Spanish Sahara, Tunisia (Africa), Egypt, Libyan Arab Republic, Sudan (Near East).

2/ Excluding "Near East" African countries shown under 1/.

3/ Includes "others".

4/ Total Developed Countries: Developed Countries + European CPE + USSR.

Source: FAO Production Yearbook 1974, Vol. 28-2, 1975.

Figure 1

The contribution of commodity groups to the total value of the RNR sector of LDC's—1970.

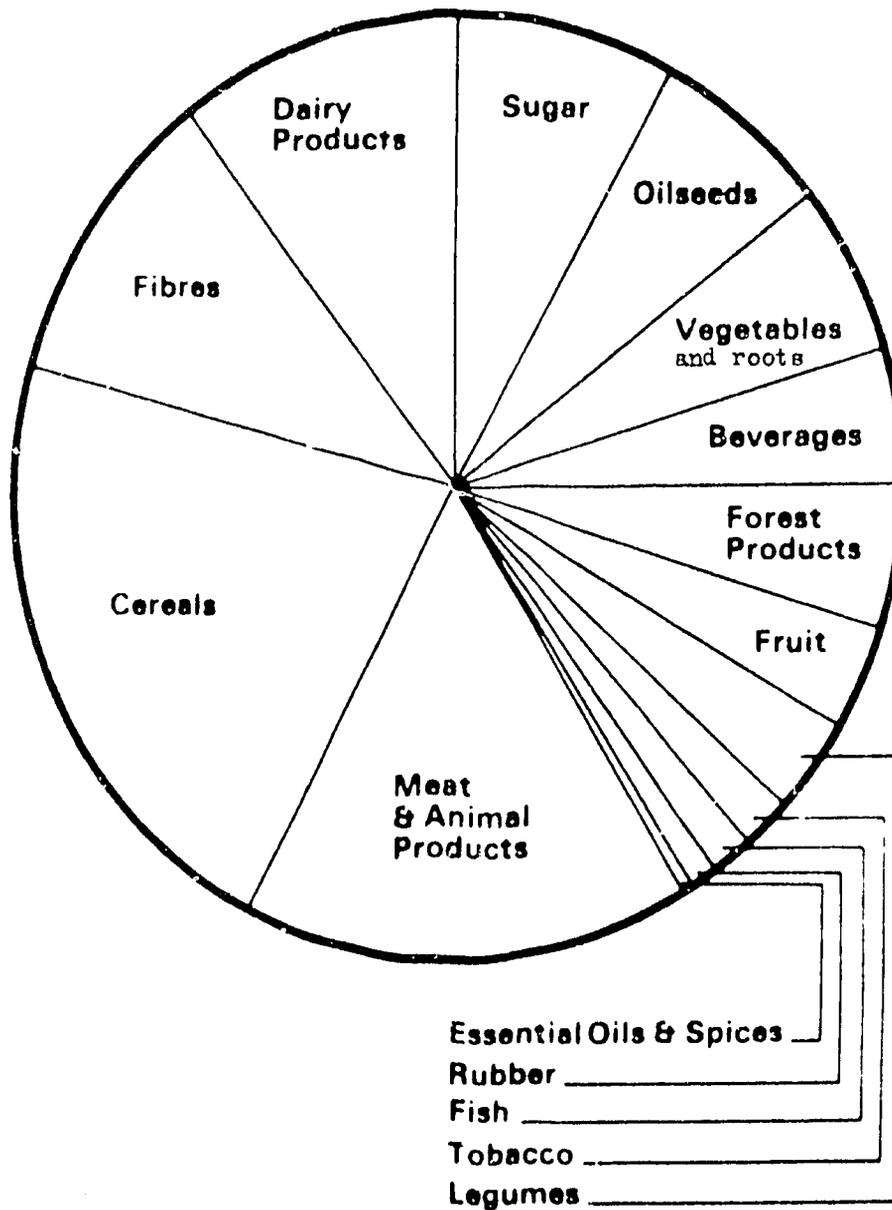


Figure 2

The relative economic importance of the commodities discussed in the study

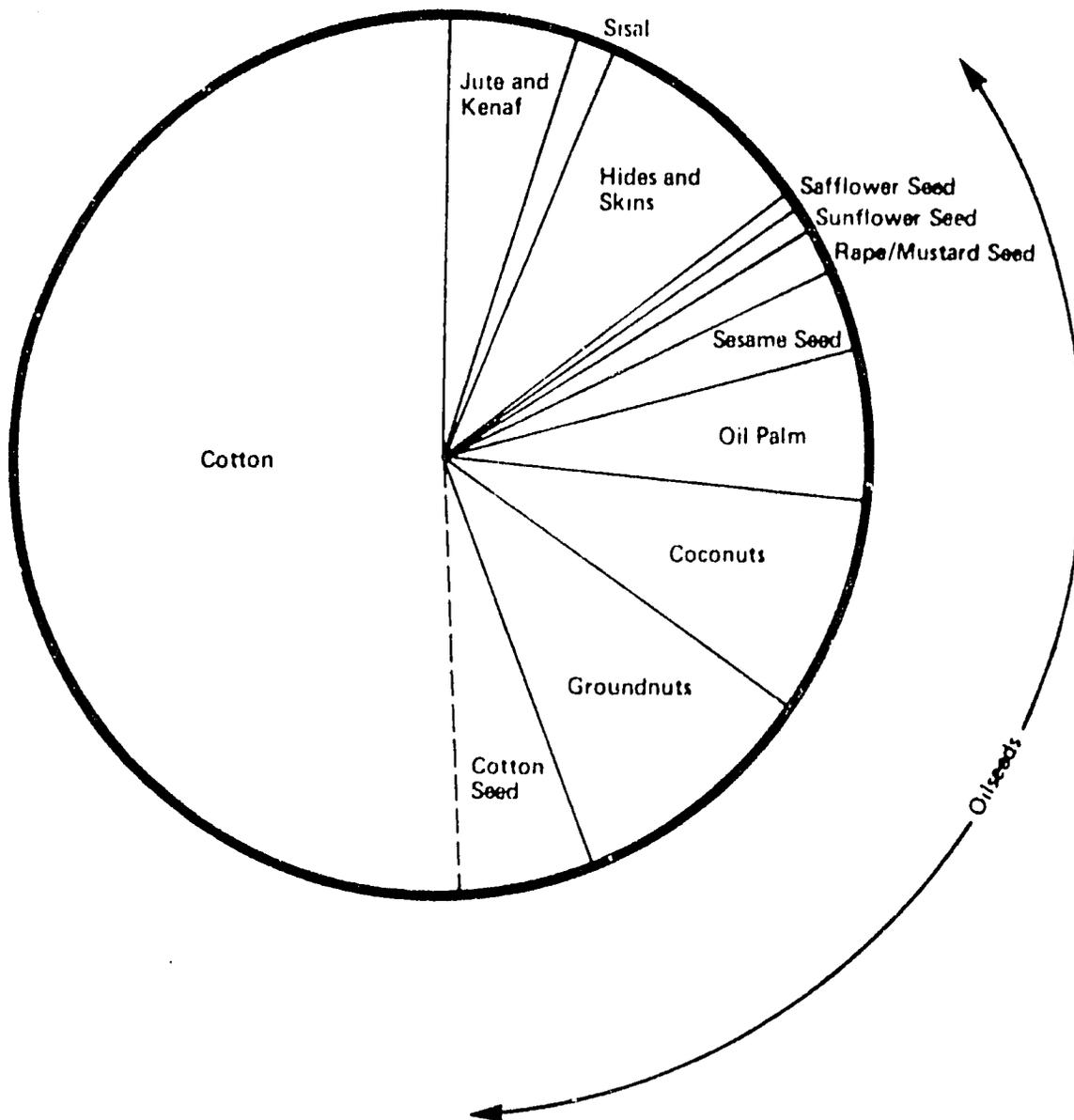


Figure 3

The proportion of the total value of each commodity group added post-harvest within LDC's—1970.

