CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

THE CONSULTATIVE GROUP

AND THE

INTERNATIONAL AGRICULTURAL RESEARCH SYSTEM

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An Integrative Report

July 29, 1977
CGIAR Secretariat

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The Consultative Group and the International Agricultural Research System

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An Integrative Report

I. INTRODUCTION

1. The brief history of the Consultative Group on International Agricultural Research has been one of impressive growth, in scientific, institutional and financial terms. By 1975, the speed of this expansion prompted the Consultative Group to review its efforts and consequently decide to enter into a period of "consolidation" during which new initiatives would be limited. This pause was designed to bring to maturity the institutions established by the Group in its earlier years before embarking on major new activities. A secondary benefit was the opportunity for the Group to consider systematically the character of the "next generation" of activities which it might wish to support when the three-year period of consolidation ended in 1979.

2. It appears that the interlude may be considerably briefer than originally envisaged, for though the consolidation phase is barely nine months old, initiatives are being taken by groups of donors, TAC, and individual CG members which could bring proposals to the Group for funding, some in 1978. Some of the international centers have submitted budget requests for 1978 which provide for significant program expansion.

3. The Consultative Group has developed within the context of a generally accepted, common understanding of its objective and the mechanisms for achieving it. Its first priority is the application of existing knowledge to research on basic staple foods to increase the amount and quality of food produced. Primary emphasis is given to the cereals, followed by food legumes, starchy roots and tubers and ruminant livestock. 1/ The chosen means of attaining this objective is a system of international agricultural research centers. Potential new activities are considered on the basis of established priorities and identified research gaps warranting international support.

4. The common agreement on the objective continues and is, if anything, stronger than ever. Now, however, new and wider opportunities for working toward its achievement are arising, and present new issues for the Group as to the range of activities it should properly support. The original concept

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1/ Priorities for International Support to Agricultural Research in Developing Countries. TAC Secretariat, Rome, 1976.

of the CGIAR, and the TAC priorities paper, do not provide explicit guidance on such activities as factor-oriented research, technical assistance services, research networks and direct support for national research, some or all of which may be before the Group quite soon. So far resources have not been a significant constraint but, as the system continues to expand, the Group may find that the supply of funds does not keep pace with the demand.

5. The members of the Group may feel it would be appropriate to begin now to build a new consensus regarding the priorities and overall responsibilities of the CGIAR in the post-consolidation period, however quickly that comes. It may wish to start planning how to consider the basic issues which it is likely to face in shaping the character of the CGIAR for the future.

6. The review Committee Report has laid the foundations for the future organization of the CG network, and has identified the basic issues. This 1977 Integrative Report is intended as a further contribution to this process. Building on the work of the Committee, it attempts to put the evolution and possible future growth of the scientific programs of the CG network in perspective. From this overview, it suggests possible ways of approaching the consideration of these issues, particularly the Group's future responsibilities for setting priorities and undertaking new activities.

7. Part II of this report reviews investment in agricultural research in the developing countries. Part III reviews the evolution and scientific achievements of the international research centers. Part IV summarizes the needs of the CGIAR system for 1978. Part V considers some issues which the Group may wish to analyze in greater depth: (i) the means of determining priorities in allocation of research funds, including priorities for new activities; (ii) the need for basic research and (iii) the roles of the Group and the centers in technology transfer.

II. INVESTMENT IN RESEARCH IN THE LDCS

Production Needs

8. A recent study has shown that, on past production trends, the net deficits in cereal production in Asia, in North Africa and the Middle East and in Sub-Sahara Africa will increase from about 17 million tons in 1969-71 to between 66 and 83 million tons in 1985-86, 60-70 percent of which would be in the low-income countries. 2/ The research on cereals, grain legumes and starchy root crops, already selected as the priority food crops for international support, will thus play a key role in meeting the projected gap.

9. There has, of course, been a steady trend of increasing production in the LDCs despite some violent year-to-year fluctuations. Such increases

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2/ Meeting Food Needs in the Developing World. IFPRI, 1976.

have come from additions in both yield and area. Annual increases in yield over the period 1961-65 to 1971-73 vary from 2.6 percent for wheat to nil for millets. Rice, maize and sorghum have averaged about 1.5 percent, but virtually all the other crops with which the system is concerned have averaged less than 1 percent. 3/

10. Aggregates of yield increases conceal large ranges, both within and between countries. In India, for example, over the period 1956-57 to 1972-73, annual growth rate in agricultural output varied from less than 1 percent in one state to 9.7 percent in another;4/ increase in yield appears to have been the major factor. Growth rates in yields of rice averaged 1.34 percent in the 1961-74 period, but covered a range from 5.2 percent (Pakistan) to less than 0.5 percent. 5/ Over the same period, maize increased at the average rate of 1.23 percent, but the maximum rate for this crop was about 3 percent. These data also indicate that there was virtually no increase in cassava yields in many of the major-producing areas. These figures thus show that, where technology is suitable, for example, for rice in Pakistan, or wheat in Mexico, very high growth rates in yield, of the order of 5 percent per annum, can be sustained over a considerable time. Such growth rates compare very favorably with those in Japan, also a nation of small farmers, or the United States, but it should be emphasized that these yield increases have usually been based on high input technology, using fertilizers, irrigation where possible, and pest control on modern varieties. Despite these impressive achievements, food production growth in Asia has scarcely kept pace with population growth even with the introduction of the new foodgrain technology. The future needs are clearly summarized in the recent study by the National Academy of Sciences: "Thus adequate food supplies for the low-income areas of the world depend on substantial increases in production per hectare, averaging about 2.5 percent per year over the next 20 to 25 years. Areas that are experiencing rapid population growth and lack land reserves may require increases in yields from 3 to 5 percent per year."6/

Investment in Research

11. Though research is only one of the many inputs necessary to deal with the deficits projected in paragraph 8, it is an essential element in

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3/ Food Crops in the Low-Income Countries: The State of Present and Expected Agricultural Research and Technology. Ralph W. Cummings, Jr. 1976.

4/ Kahlon et al. Returns to Investment in Agricultural Research in India in Resource Allocation and Productivity in National and International Agricultural Research. ed. Arndt, Dalrymple, Ruttan.

5/ CGIAR. Report of the Review Committee. 1977.

6/ World Food and Nutrition Study: The Potential Contributions of Research. National Academy of Sciences, Washington, D.C. 1977.

the technological change needed to improve yields. Nevertheless, such is the lead time that it is only research already completed, or in an advanced stage, which will have any marked impact on production by the middle of the next decade.

12. The international system is only part of the total international contribution to agricultural research in the LDCs. It has been estimated that the low-income countries spent about $380 million on research in 1971, of which approximately 20 percent was from external aid.7/ In that year, CGIAR expenditure was about 4.5 percent of the total. The latest available figures are for 1974, in which CGIAR expenditure represents about 7 percent of the total. The total expenditure by CGIAR has expanded at 27 percent per annum, probably faster than the national system expenditure, and is now possibly of the order of 10 percent of the total.

13. There is little doubt that the developing world requires new technology urgently and thus more funds must be invested in research; however, most of this must come from the LDCs themselves. The size of the additional requirements is very difficult to estimate, though it may be possible to make some tentative suggestions. Countries with a successful agriculture based on high technology appear to spend between 2 and 3 percent of the value of their agricultural production on research, of which about 1.5 percent is from public funds. In contrast to this, the poorest countries appear to spend less than 0.7 percent, all from public funds. Interestingly enough, the poorest countries are reported to spend about three times as much on extension (1.82%) as do the richest countries (0.60%). 7/ As a group, the countries with GNP per capita of less than $1,000, would appear to spend about 0.9 percent of the value of agricultural production on research, but there is very little information on the resources applied to individual projects, programs or commodities in many of the LDCs.

14. There is no way of determining whether a total of 2 to 3 percent is the right target for the LDCs; the richest countries were, for example, spending about 1.2 percent of the agricultural product value in 1950, yet many scientific developments on which the more recent increases in production are based took place at or before that time. A lesser investment in research may be adequate in the developing countries if they can take advantage of scientific breakthroughs in the developed countries, so lessening the need to do the basic research. The international system should reduce investment needs because its research approach through the collection of germ plasm, the mixing of genes and the distribution of improved genetic materials is a cheaper and faster way of providing better plant types for the LDCs than each country operating such a program in isolation.

7/ Boyce & Evenson. National and International Agricultural Research and Extension Programs. Table 1.7 and Table 2.7.

15. Expenditure on research is only a small fraction of the total investment that is required to implement new technology. In countries where it is difficult to find the resources to invest in research, it may be even more difficult to find the resources for investment in the new technology that the research generates. In this connection, a recent paper8/ suggests that 20 to 30 billion dollars in investment would be needed over the next five years to achieve a 45 million ton increase in cereal production.

16. In conclusion, it would appear that, considering the LDCS' urgent need of better technology, it would be sensible to plan on the premise that investment in research in, or on behalf of the LDCs, should be above 1 percent of agricultural product. Whilst the catalytic and leadership qualities of the international research system must remain one of the major hopes for encouraging development of new technology to a degree commensurate with the needs, the system cannot, by itself, solve all the problems. As discussed in paragraph 109, et seq, there must be a balance between the growth in international research and the improvement of national research and production programs. Investment in the former cannot by itself overcome the weaknesses in the latter.

III. GROWTH AND ACHIEVEMENTS OF THE INTERNATIONAL AGRICULTURAL RESEARCH SYSTEM

17. Many aspects of this topic are familiar to members of the Group and no attempt will be made here to make an in-depth analysis of the achievements of the international agricultural research system. Nevertheless, it is worthwhile summarizing what has happened in terms of programs, finances and human resources since the first center, IRRI, was established in 1960. Analysis of financial growth forms a useful basis for future projections of costs, not only for existing but also for potential new activities. Allocation of resources to various activities has been analyzed to obtain a better basis for future planning of the allocative process. Research depends on trained manpower, so some examination of this scarce human resource is relevant. The analysis of programs forms a background against which accomplishments can be set.

Evolution of the System

18. In reviewing the growth and achievement, it is of interest to examine how the objectives, both of the individual centers and of the system as a whole, have changed over time. Broadly, the objective of the system is to develop technologies that will enhance production, especially by small (resource poor) farmers in the LDCs. The system is concentrating on

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8/ A Perspective on the Foodgrain Situation in the Poorest Countries. World Bank Staff Working Paper No. 251.

food supply since an improvement in quantity and quality will improve human welfare in both rural and urban communities and raise living standards in the rural areas.

19. The original mandate of IRRI was to carry out basic and applied research on the rice plant to develop high-yielding non-lodging varieties that respond to high rates of fertilizer application;9/ though a challenging scientific problem, this was a relatively straightforward mandate, compared with that of several of the later centers. CIMMYT also had commodity mandates, for wheat, maize, triticale and later barley. Although outside the major wheat-growing areas of the LDCs, it had a very well-established research foundation on which to build and an ecological environment in northern Mexico similar to that of the major irrigated wheat-growing regions in Asia. Mexico also represents a region in which maize is a major food crop. Wheat, maize and rice had already had, of course, a large amount of research in the developed countries.

20. The mandates of the later centers include both ecological regions and commodities. CIAT works on livestock as well as several crops and IITA works on farming systems. Furthermore, the crops for which they have worldwide mandaates -- tropical root crops and grain legumes -- are usually the crops of poor subsistence farmers, often farming the poorest soils. Root crops being vegetatively propagated, present additional hazards of disease spread. Such crops have other handicaps, too, for in very few of the developing countries are they the dominant crops, so that the national governments have focused less strongly on them. Unlike rice and wheat, they are seldom grown in mono-culture, being normally part of a complicated mixed cropping system. In its work on the potato CIP is concerned with a crop which, though having excellent potential, is highly susceptible to diseases and requires a well-organized seed production system to achieve this potential. Increases in yields of grain legumes through plant breeding have proved more difficult than in cereals.

21. The mandate of the latest of the crop centers to come into operation, ICRISAT, is the improvement of agriculture and crops such as sorghum and millets in a harsh environment, where rainfall fluctuations between and within seasons lead to major difficulties in stabilizing production. This harsh environment will limit the average rate of increase in yields. ICARDA will also concentrate on the harsher environments and its systems research component will include livestock, with the attendant sociological problems where livestock and land are controlled by different groups of people.

22. The two livestock centers have very different mandates. ILRAD has a difficult technical problem in its research on trypanosomiasis and theileriasis, whilst ILCA has to concern itself with socio-economic as well as technical constraints; ILCA is, in fact, the ultimate in systems research, the whole center being devoted to this topic.

9/ IRRI Annual Report, 1964.

23. This outline of the evolution of the system is not intended to suggest that early progress cannot be expected at the more recently established centers; in fact, some excellent progress on technical fronts has already been achieved. Rather the intent is to suggest that even when technical problems are overcome, implementation of the technological packages by the farmers is likely to be slower and the increases in yield perhaps less.

Centers' Changing Emphases

24. Research strategies, as well as the objectives of the system, have also changed over time. The original work of IRRI and CIMMYT on rice and wheat has often been described as "breakthroughs," but this is a term that is used very loosely. Research organizations may operate a "breakthrough" strategy or an "incremental" strategy or a combination of the two. In general, the centers operate an "incremental" strategy, a major exception being ILRAD, where success in controlling trypanosomiasis through immunization would depend on making scientific breakthroughs in immunological techniques. Creating new plants by wide crosses, development of cereal varieties with strong nitrogen fixation capacity, the synthesis of varieties with a high degree of salt tolerance, are also examples. But for the most part the focus of the centers is on the "incremental" type of research.

25. The importance of research strategies is demonstrated by the apparent shift in goals of the centers. Thus the goal of IRRI and CIMMYT was to produce a plant type very responsive to improved fertility, day-length insensitive and with resistance to some of the serious diseases. The scientists working on wheat and rice were highly successful in producing short-strawed, nitrogen responsive, day-length neutral varieties that spread rapidly in certain parts of the world (paragraph 66). Such varieties were, in fact, bred for relatively well-defined ecological zones, essentially the irrigated areas, though some of the modern wheat varieties have done well in rainfed areas of the Middle East. On the other hand, the modern rice varieties yield at about the same levels as the traditional varieties under conditions of poor water supply.10/

26. However, the centers, recognizing that such varieties benefit most those farmers who have access to irrigation and fertilizers, have increasingly emphasized the importance of yield stability through tolerance to the wide range of adverse biological and environmental conditions under which many of the poorest farmers operate. To achieve this they have progressively widened their germ plasm base, so that most centers have estabished world germ plasm collections for their particular crops, a program which has given the centers some unique advantages.

10/ IRRI Proposed Budgets, 1978 and 1979, page 48.

27. In a national program the emphasis is usually on breeding varieties for relatively well-defined biological conditions, but the international center has to provide materials for a wide range of environmental and pest and disease situations. Thus the more recent approach of the centers is directed towards aggregating those genes which are essential for widely varying situations such as acidity, salinity, drought, low fertility and a range of pests and diseases. It is also directed at providing a plant type which is day-length neutral and with a favorable ratio of edible to inedible parts. This "pyramiding" of desirable genes is being done by testing large numbers of crosses, at many localities, thus increasing the probability that some of the crosses, at some of the sites, will be subjected to intense disease, pest or environmental pressures. This approach also exploits the unique advantages of the centers, a wide germ plasm base, the resources to make large numbers of crosses and the opportunities to test segregating materials worldwide. Wide adaptability is also a highly desirable characteristic, since there has been a presumption that a genotype that has a high degree of adaptability across locations will also have a high degree of stability over time at a given location. However, a recent paper by IRRI workers suggests that the two may not be highly correlated11/ which may mean some re-examination of this concept.

28. Though the ultimate goal of agricultural research is the same in developed and developing countries, i.e., more efficient production in the farmers' fields, two somewhat different philosophies are being followed. In the developed countries, the approach has been to remove as many of the constraints as possible by other than biological means: for example, acidity is corrected by liming, low fertility by adding fertilizers, salinity by drainage, drought by irrigation and pests by pesticides. A corollary of this has been the strong emphasis on research on methods of making these inputs more efficient. Now the international centers in their philosophy of developing a low-risk, inexpensive technology, are attempting to circumvent these constraints by biological means. This does not mean, however, that they are neglecting the potential use of these inputs, though perhaps in lesser quantities.

29. This approach leads the centers into paths where the foundations of basic knowledge generated in the developed countries tend to be less complete. Since maximizing yields in the developed countries thus depended on using inputs such as those noted above, researchers in these countries have perhaps paid less attention to some fundamental processes in plants, for example the basis of host resistance to insect pests, on which this intermediate technology goal of the centers will have to be based.

11/ Multi-site Tests Environments and Breeding Strategies for New Rice Technology. R.W. Herdt and R. Barker. IRRI Research Paper, Series No. 7, 1977.

30. Though the centers work mainly on producing better plant types, one factor-oriented program in which several centers are involved is the design of farm implements that can be constructed at the local or village level. In spite of the fact that many of the developing countries have surplus rural population, labor may be short at critical times and adoption of new technology may require an additional energy input, either through machines or animal power. Hence, some of the centers have become involved in mechanization programs, the most advanced of which is that at IRRI; other centers are developing animal-drawn equipment and better hand tools.

31. Having developed better plant types, the next concern of the centers is to ascertain how these materials fit into the wide diversity of cropping and farming systems of the countries they serve. Farming systems research has concentrated on investigations into intensifying land and water use. IITA, for example, is developing techniques for eliminating the bush fallow resting period and for intensified use of the better watered valley bottom land. It has been calculated that, between 1900 and 1965 about half the forest area in developing countries was cleared for agriculture and that 3.6 billion hectares are currently under shifting cultivation; if shifting cultivation expands at the present rate, most of the remaining forest may be destroyed in the next 40 years.

32. ICRISAT's farming systems research is directed at the conservation and better use of water and IRRI's at intensifying production on the ricelands, where the new technologies, such as shorter-season varieties and direct seeding of the crop, would allow additional crops. CIMMYT's work in North Africa has been directed at more productive use of the fallows between the wheat crops and CIAT's at increasing the productivity on poor soils, through the production of a high-value cash output -- beef.

33. Whilst the centers are working on the above approach, they are also involved in studying existing farming systems to determine intervention areas where research would be profitable. In addition, several of the center economists are involved in another aspect of the farming systems, the ex post analysis of the impact of new technology. By such analysis, IRRI and CIMMYT have been able to determine some of the major factors limiting the uptake of new technology.

34. The third area in which the centers are operating is the transfer of their technology to the farmers. The two aspects of this are the validation of their technology in the real world of the farmer and the improvement of the ability of national programs to convey their technology either in its existing or in modified form to the farmer. The latter involves technical assistance in the form of training nationals, acting as short-term advisers to national programs, indoctrinating the national program decision-makers, and supplying long-term advisers. It is in this area that the Review Committee recognized that the demand on the centers would greatly exceed

their capacity to respond and stated that "extensive involvement can detract a center from its primary research mission and place an undue burden on center management."12/

Growth and Allocation of Financial Resources

35. These rapid increases in the size and scope of the international center system have obviously required an equally substantial increase in investment of financial and manpower resources. The analyses that follow examine the allocation of resources over the period 1971-80 in constant (1977) dollars. Between 1971 and 1976, actual expenditures have been used. The figures for subsequent years are the centers' own estimates for 1977 and 1978 and projections for 1979 and 1980 are as given in their budget documents issued in mid-1977.

Core Operating Expenditure

36. Between 1971 and 1980 core operating expenditure will have increased from $15 million to $83 million (Figure 1).* From 1960 to 1980 the CGIAR family of centers (excluding WARDA, IBPGR and CARIS) will have cost $504 million. Approximately 92 percent of this will have been spent between 1971 and 1980, representing an annual compound real growth rate of 21.2 percent since the Group was founded. The older established centers have played a major part in this with IRRI, CIMMYT, IITA and CIAT growing at 15.2 percent, 11.7 percent, 15.0 percent and 13.5 percent per annum, respectively, over the period 1971-80.

37. Although a decrease is forecast in the rate of increase in expenditure from 1977 onwards, this forecast may not be very reliable. In the past, centers' expenditure projections have invariably turned out to be low. The Review Committee's projections estimated some growth during the period of consolidation as programs already decided upon reached full development, but growth in 1978 exceeds the Committee's projections and it seems likely they will be exceeded in the remainder of the consolidation period.

Capital Expenditure

38. The total capital expenditure, including buildings, land preparation, and equipment at each of the centers is given in Table I. Over the period 1971-80, the four established centers, IRRI, IITA, CIAT and CIMMYT will have accounted for approximately 47 percent of the total capital expenditures of the Group.

12/ CGIAR, Report of the Review Committee, January 1977.

* Figures 1-5 are based on tables in Annex I.

FIGURE 1
INTERNATIONAL CENTERS
ANNUAL CORE OPERATING & CAPITAL EXPENDITURES 1960–80
(IN TERMS OF CONSTANT 1977 DOLLARS)

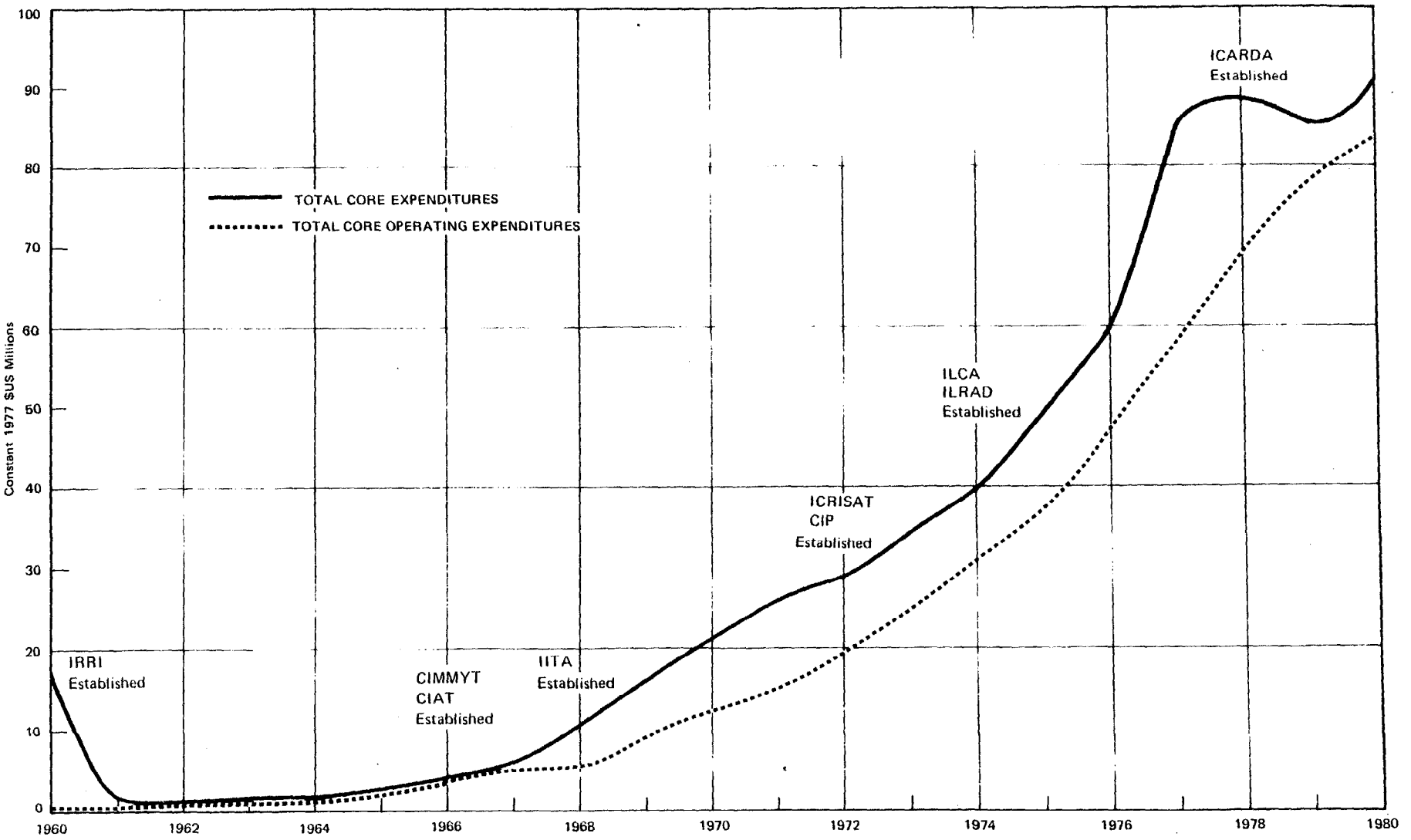

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Table I: Capital Expenditures by Center -- 1960-1980
(in constant 1977 $ millions)

	Capital
IITA	37.8
IRRI	34.2
ICRISAT	25.5
CIAT	16.1
ILCA	11.9
CIMMYT	10.7
ILRAD	10.6
CIP	4.7
ICARDA	12.5
TOTAL	164.0

Since ICARDA has just begun operations and has not yet begun construction, the figure given for the period is almost entirely an estimate. Construction is planned to be completed in 1984 by which time total capital expenditures are projected to be $27 million.

39. Unit costs and type of construction obviously affect costs greatly. The two most expensive centers, IITA and IRRI, which provide on-site housing for their international staff, visiting scientists and postdoctoral fellows, have had to invest considerable sums in staff housing: moreover, construction costs for IITA have proved particularly high.

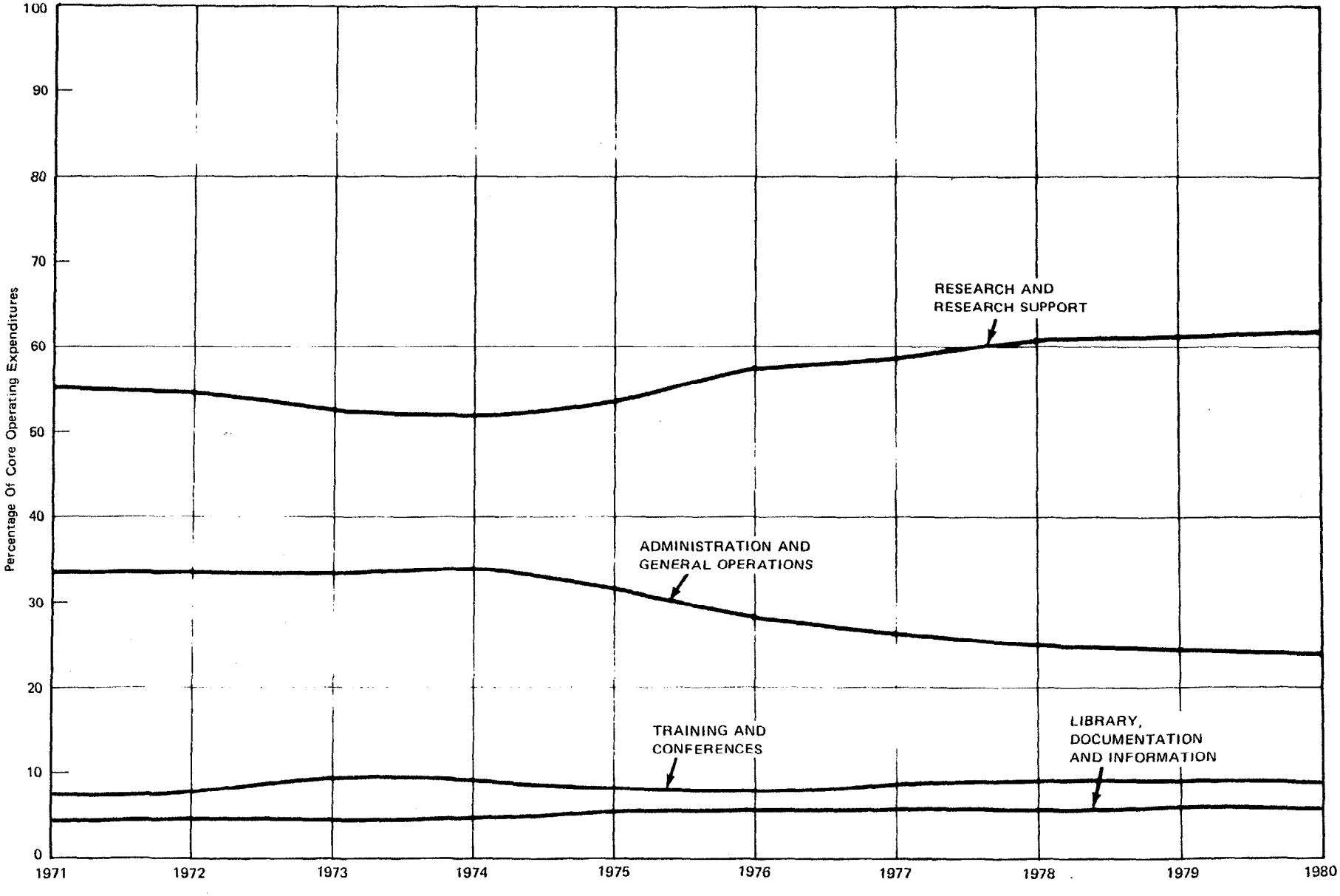
Cost by Activity

40. Figure 2 shows a breakdown of costs by activity -- research, training, library, documentation and information, and administration (including general operating costs) -- for the period 1971-80. In compiling the relative costs, the IRRI practice of combining research and research support has been followed for all centers. Research support has been allocated to individual commodity programs in the ratio of their cost to total research expenditures.

41. The proportions of expenditure on library, documentation and information have remained almost constant during this period, whereas the proportion related to research has risen slightly and administrative costs have

FIGURE 2

CENTER ACTIVITIES AS A PERCENTAGE OF CORE OPERATING EXPENDITURES



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steadily fallen. The proportion of resources devoted to training and conferences has changed relatively little since 1970, which is somewhat surprising, taking into account the need for strengthening national programs, the major role of training in this, and the increasing availability of new technology from the centers. The aggregate figures conceal differences between centers and the expenditures in core budgets do not give the complete picture, since training also receives special project funding at a number of centers.

Resources Devoted to Commodities

42. Figure 3 sets out the yearly expenditures for 1971-80 for individual commodities, and figure 4 the cumulative expenditures on the same commodities for the period 1960-80. In 1978 the distribution is as follows:

Cereals	38.2%
Roots and Tubers	12.4%
Grain Legumes	12.1%
Total Crops	62.7%
Livestock	24.8%
Farming Systems	12.5%

43. Both the pattern of growth and the proportion of resources devoted to each commodity are of interest and can be examined in relation to one another and to the importance of the commodity as measured by a range of criteria.

44. In figure 3, sorghum, millet and triticale show very little real growth over the period 1976-80. Several other commodities -- roots and tubers, maize, wheat and potatoes -- show the characteristic leveling off which has been a feature of budget projections, but which is seldom attained in practice. Expenditure on livestock shows the most dramatic increase, but rice, farming systems and grain legumes project steady increases, the latter two due principally to the development of ICARDA. The general pattern of growth is one that would be expected from the form of incremental budgeting practiced by the centers. Single commodity centers tend to grow at a rate similar to that of the multi-commodity centers. There would appear to be rather little coordination in the allocation of resources to the same commodity being researched at different centers, e.g., rice, maize, cassava. A commodity which forms only a part of one center's program may thus become less well funded than a commodity which is the sole preoccupation of a center or in which several centers are involved.

45. The above analyses show that, on the basis of past and planned allocations, trends in expenditure on the different commodities over the next few years are already determined. These trends are likely to continue unaltered unless scarcity of funding or deliberate action by the Group brings about changes.

FIGURE 3
ANNUAL RESEARCH AND RESEARCH SUPPORT EXPENDITURES BY COMMODITY 1971–80
(IN TERMS OF CONSTANT 1977 DOLLARS)

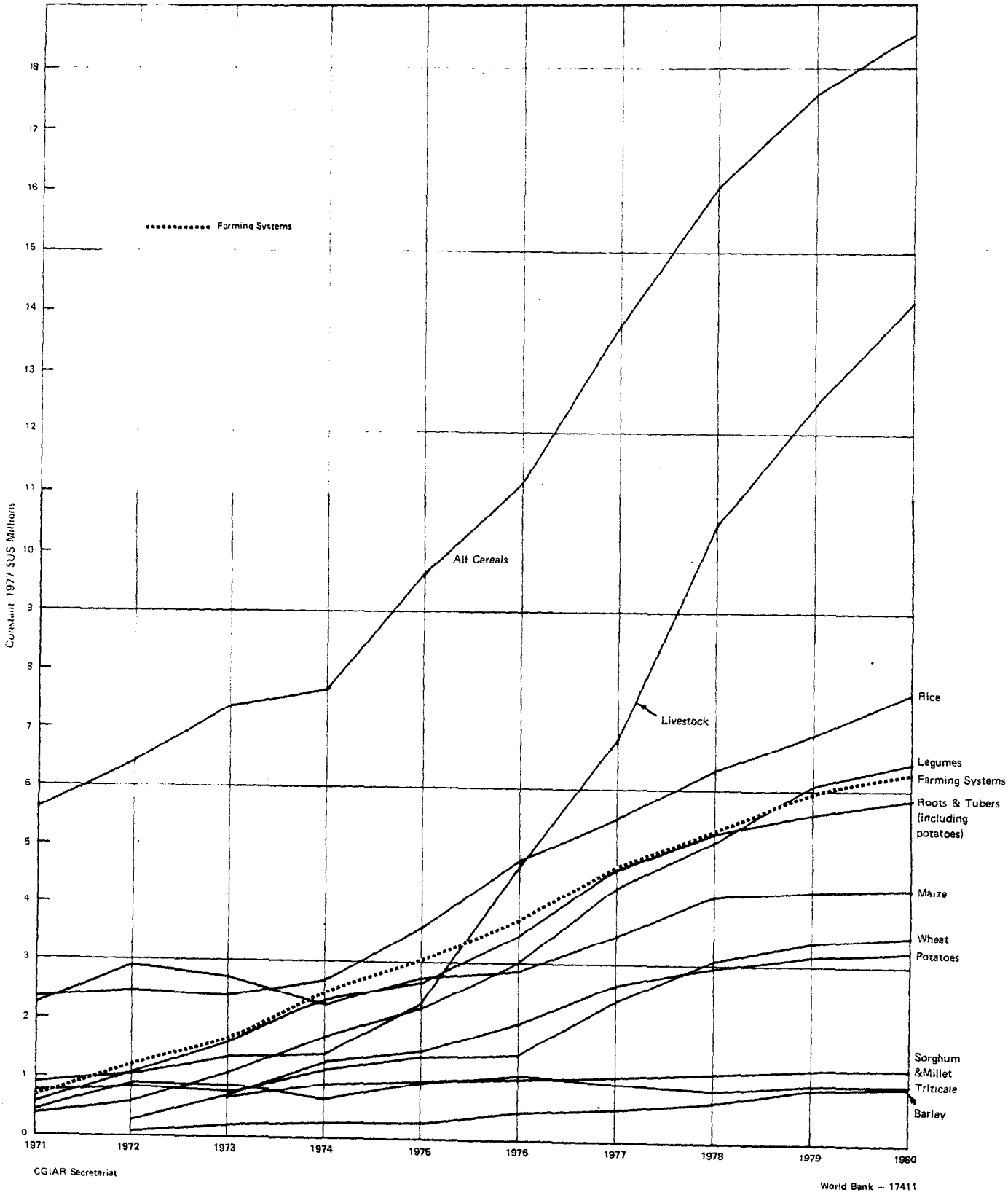

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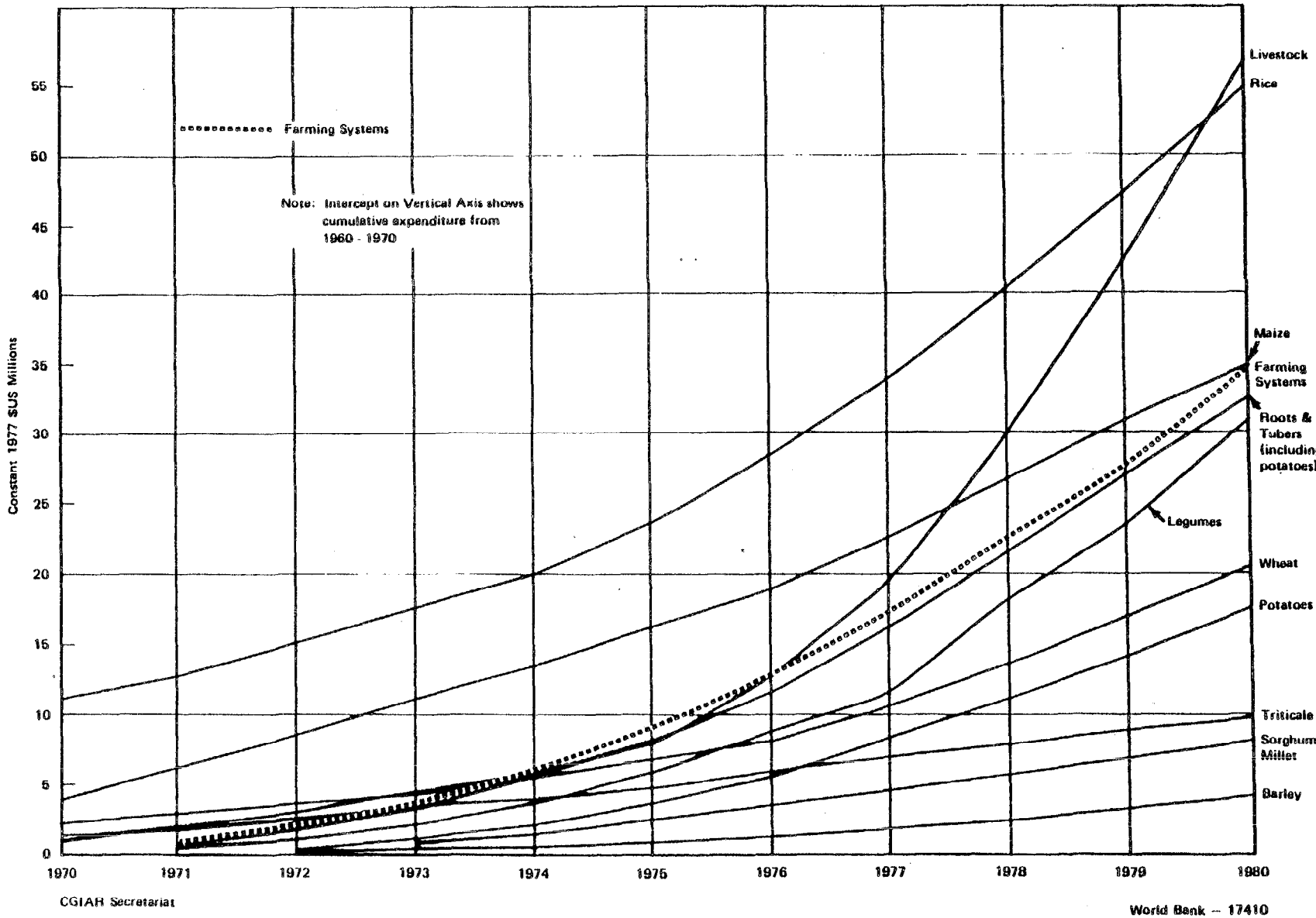
FIGURE 4

CUMULATIVE RESEARCH AND RESEARCH SUPPORT EXPENDITURES BY COMMODITY 1960–80
(IN CONSTANT 1977 DOLLARS)



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46. The next paragraphs do not attempt to outline criteria by which such action could be taken. They set out only to show how expenditures compare with certain criteria that some of the centers themselves have set and hence with criteria that could be measures of the importance of a crop, that is: as a source of calories, of protein, its value and area harvested. It is, of course, obvious that an assessment of this type is based on the present situation and disregards any external factors which might influence the allocation of resources, such as the need to make good a dearth of research, or the prospect that successful research might lead to wide adoption of the crop with important economic and social benefits.

47. The relationship between Group expenditure and the criteria in paragraph 46 are set out in Figure 5. As would be expected, cereals are by far the most important commodity in all respects and share 41.3 percent of the Group's resources invested in commodities. However, there may be some imbalance within the cereal group: sorghum and millet receive only 3.0 percent of total commodity research funds (7% of cereals), yet rank first in order of calorie intake in Africa and third in Asia and the Middle East and are second in area only to rice. Within the roots and tubers group, potatoes account for over 50 percent of the expenditure. Figure 5 shows the high productivity of potatoes in terms of area harvested and the relatively low productivity of cassava and other root crops.

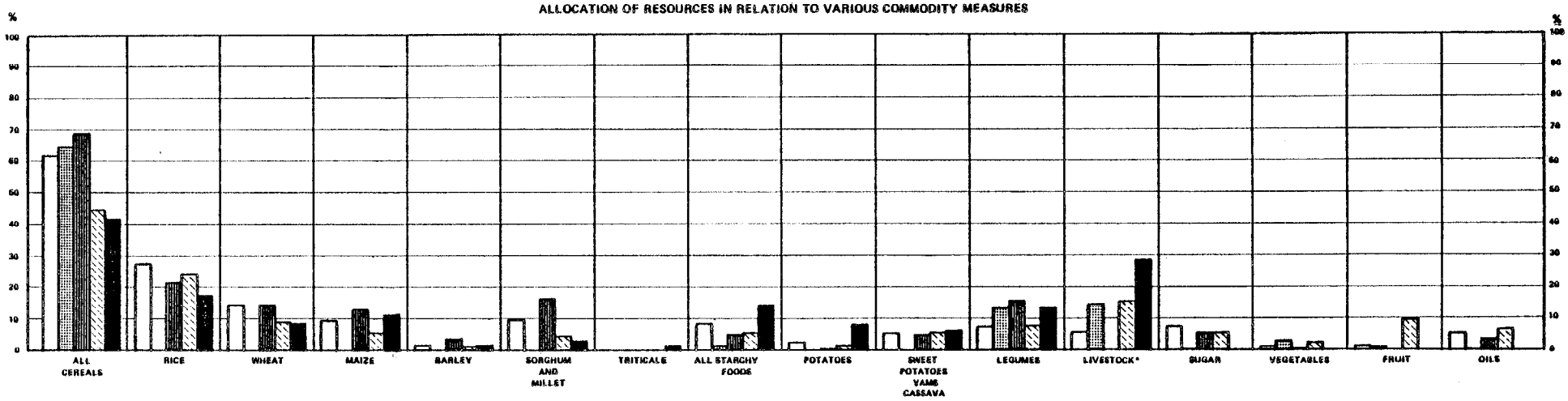
48. The case of livestock is a special one in that 73 percent of the research funds are spent in Africa, but 65 percent of the relative value of the product arises in Latin America and only 13 percent in Africa. Furthermore, the product value includes production of some kinds of livestock in which the centers are not involved. Any assessment of the priority of livestock research must, however, give due weight to the production potential of vast regions as the tsetse infested areas of Africa and the llanos of South America. The higher costs of livestock research must also be taken into account.

49. The importance of legumes is often emphasized because of their contribution to protein in the diet of the poorest people, though, in fact, certain make a larger contribution, but of lower quality.

50. The foregoing analysis has been confined to the use of resources within the CG system. Quantitatively these are only a small part--at most 10 percent--of the resources devoted to agriculture in the developing countries, though the programs of the system on which they are used are, in terms of quality and influence, more important than their size would suggest. A full analysis would take into account past research and all that is being done elsewhere, but, as mentioned in paragraph 11, the information on the national programs is not adequate for such a full analysis. From what is known, it would appear that a great deal of research has been done, and is being done, for example, on rice, maize, wheat and potatoes in both developed and developing countries, whereas very little effort has been devoted to such crops as millets, food barley, cassava and several of the grain

FIGURE 5

ALLOCATION OF RESOURCES IN RELATION TO VARIOUS COMMODITY MEASURES



*Includes milk, eggs & fish in calorie and protein measurement

** Not broken down for individual cereals or starchy foods

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legumes. Thus it would seem that the present trend in the allocation of resources within the CG system reflects much the same balance observed elsewhere, which is possibly not the most appropriate for achieving the objectives of the Group. As discussed in Part V, the group may wish to address the question of an appropriate allocation and to develop criteria for this purpose. Nevertheless, it must be recognized that any set of criteria can at best be no more than a general guide for what must be judgmental decisions.

Manpower and Management

51. The scientists at the international centers are the CGIAR's prime asset. Together with Board members, managements, and the members of TAC, they comprise a human resource of wide expertise and diversity. The ability to attract, retain, and productively use staff of the highest technical excellence has always been, and will remain, the first priority for center managements.

52. Senior staff positions, which include a small number of senior administrators as well as senior scientists, grew from 134 in 1971 to an expected 482 in 1978. Of these additional 348 senior staff, most are accounted for by the establishment and growth of new centers, but the senior core staff of the four oldest centers, IRRI, CIMMYT, CIAT and IITA have also grown. Although these four centers were fully operational by 1973, their senior core staff grew by 99 positions between 1973 and 1977, from 172 to 271, an increase of 58 percent. Some of this growth is due to positions being transferred to the core budget from Special Projects. Now that the centers in the system are approaching a period of maturity or consolidation, the number of senior staff for these centers may be expected to stabilize at around 500-520 and the number of support scientists at about 1,000. Such numbers are small compared with those in the developed world, where one single institution may be able to command resources on a similar scale. In fact, despite their rapid growth, the international centers still represent a very small part of total scientific manpower devoted to agriculture.

53. Among the senior staff of the centers, the largest single nationality group is United States nationals, accounting for over 30 percent. Developed country nationals, including US, account for two-thirds of the senior staff. Host country nationals account for 14 percent. From the partial data available, it appears that, while the number of US scientists has doubled between 1974 and 1977, their relative importance has declined somewhat. Employment of scientists from countries other than the US has increased quite noticeably, from 23 percent in 1974 to 35 percent in 1977. The predominance of US nationals in center senior managements has somewhat declined, though six out of nine center directors are from the US.

54. The age distribution shows a good balance between senior and long-experienced scientists, and those in early or mid-career. Few young scientists have the necessary experience for a senior post at one

of the centers -- only 6 percent are 30 or younger. Nearly half are in the 31-40 age group, 30 percent between 40 and 50, and 15 percent over 50. The system is too new to be able to draw any conclusions about length of service or staff turnover rates. In common with other international institutions, the centers may begin to find that turnover rates vary greatly with country of origin.

55. Based on even more fragmentary information, it appears that scientists are predominantly recruited from universities in developed countries, nearly one-third coming from this source. Next in importance, with about 15 percent each were scientists from research institutes in developing countries, and "other" international organizations other than the IARCS. Some 10 percent came from research institutes in developed countries, and about the same number from universities in developing countries. The rest came from a variety of sources, including the centers' postdoctoral programs; movement between international centers is not as yet very common, only some 8 percent being recruited in this way.

56. In terms of the different disciplines represented among the senior staff, plant breeding is the most important, followed by animal science. Administration comes next, but this category includes a wide range of disciplines, whereas scientific posts are more precisely described.

57. As would be expected in centers set up to maintain high international standards, salaries and benefits tend to be broadly competitive with those other international organizations. It may be that there is some tendency towards more uniform benefit policies between the centers, and perhaps some scientists are beginning to look for a career structure within the system at large.

58. Management of research is recognized as being particularly difficult under any circumstances. In the case of the centers, the difficulties are compounded by having international staff, locations in developing countries, worldwide mandates, and financial support from many different sources but with no long-term security. Moreover, the newer centers face, or will shortly face, the problem of transition from managing the establishment, funding, and staffing of a new enterprise, to the management of that enterprise over an extended period of little or no growth. In general, center managements have coped with these difficulties outstandingly well.

59. As the amount of funds coming into the system has increased dramatically, and the sources of funding have icnreased and become more varied, so the need for better financial control has become more apparent. The centers have now generally adopted standard budget presentations, improved their expenditure control and reporting, their cash management systems and their accounting procedures. At least three centers have engaged consultants to reorganize their internal financial management.

60. While the inherent difficulties of managing international research result in personnel problems from time to time, the professional dedication and enthusiasm of center scientists is one of the features on which visitors most commonly remark. Problems created by recent changes in the US tax law have led center directors jointly to review personnel practices, which may ultimately result in some greater uniformity in general personnel matters. Boards of Trustees will, however, continue to set those policies which they feel appropriate to the special needs of their center.

Achievements of the System

61. In the foregoing paragraphs the financial and manpower inputs into the system have been assessed. However, whilst the inputs are easy to define, the outputs of the system -- products like improved seeds, improved farming techniques, trained manpower -- are very difficult to quantify. Potentially, each of these may make an important contribution to increased production in the farmers' fields, but they may take years or even decades to work their way into the actual production system. Furthermore, one "generation" of researchers builds the foundations for the progress of the next, so that the achievements of the international system cannot be considered in isolation. The technology that is finally implemented in the farmers' fields is the product of many inputs--basic research in years past, national research by the LDCs themselves, multinational and bilateral assistance, as well as the work of the CGIAR system.

62. The incremental contribution to knowledge that comes from each of the centers annually marks impressive progress in knowledge of tropical food crops, many of which have been subjected to very little previous research, and provides the essential foundation for improved technology. It adds to the pool of technology which can be tapped when other inputs become available. Many examples of the contributions are given each year by the centers in their annual reports. One of the most impressive is undoubtedly the collection of germ plasm for the 15 or so crops with which the system is concerned. Total accessions of these crops are now approaching 100,000 and the active collecting programs underway will add greatly to these numbers in the next few years. To this must be added the activities of the IBPGR in stimulating national and regional collections. Concomitant with the assemblage of these collections has been the construction of safe and permanent storage, research on methods of their preservation and the development of computerized classification systems which will foster the exploitation, not only of these collections, but of national collections as well. The germ plasm collections are a scientific asset the value of which it is impossible to quantify.

63. There are several examples of technologies which may be ready for exploitation. Disease-free bean seeds would give much better yields in several Latin American countries if there were adequate infrastructure to provide such seeds for the farmers. Whilst mosaic resistant cassavas were

developed many years ago in East Africa,13/ the yields were often poor, but new crosses have better yield potential. New methods of propagating cassava, of producing healthy "seed" and of better cultivation and storage techniques have been developed. Cowpeas, notoriously susceptible to insect attack, have new varieties that yield better, with less insecticide protection. Breeding for pest and disease resistance is a continuing need being met by a constant flow of new rice and wheat varieties from the centers.

64. There are many other actual or potential benefits of the center system, some of which will be intangible, but nevertheless highly important. The modern varieties have demonstrated to governments that agriculture research is a worthwhile investment. The international system has aroused a wide interest amongst agricultural scientists in basic and applied research in the developed world. Contract research at institutes in developed countries has encouraged such institutes to concentrate more on some of the problems of the developing world, and more of the younger scientific talent in both developed and developing countries is being attracted to agricultural research. The benefits of the training programs and the very rapid build-up of outreach staff (para 78) participating in regional and national research programs (see paragraph 78), are also intangible, but nevertheless of great potential importance in future improvements in production. The centers training programs will be discussed in a meeting of the CGIAR during Centers Week.

65. Finally, there are some products of the international system, the uptake of modern varieties of rice and wheat which can actually be quantified. Thus CIMMYT has estimated that new wheat varieties have added $2 billion annually to the value of wheat production and the next section summarizes some of the information that has been published on the spread of these new varieties.

The Spread of Modern Varieties and Factors that Limit such Spread

66. The latest available estimates indicate that there are 21.5 million hectares of rice and 19.3 million of wheat under modern varieties. Table II shows the distribution of these in some important areas.

13/ Breeding for Resistance to African Cassava Mosaic Disease: Progress and Prospects. D.L. Jennings, African Cassava Workshop, February 1976.

Table II: Adoption of Modern Varieties ('000 ha) 14/

1974/75 Unless Otherwise Stated

		Rice		Wheat	
Country		Area	% of Total Area	Area	% of Total Area
Afghanistan		-	-	522	17.4
Bangladesh		1,444	14.9	33	23.4
Burma		332	6.4	-	-
Colombia		271	72.0	-	-
India		11,045	29.9	11,778	61.7
Indonesia		3,440	40.3	-	-
Iran		-	-	293	6.7
Malaysia	(1973/74)	217	36.7	-	-
Pakistan		631	40.3	3,683	62.5
Philippines		2,175	64.0	-	-
Thailand		450	5.5	-	-
Tunisia		-	-	55	5.5
Turkey	(1971/72)	-	-	650	8.0

14/ Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less Developed Countries. D. Dalrymple, Foreign Agricultural Economic Report, No. 95.

67. The rapid adoption of modern rice and wheat varieties is an example of how a suitable technology can spread extremely rapidly — it has been estimated by CIAT that 90 percent of the irrigated rice grown in Colombia was in modern varieties within 5 years of their introduction. However, such adoption was mainly by irrigation farmers, many of the traditional (upland) rice producers going out of rice production.

68. Rates of adoption of new agricultural technology are at first exponential, but then level off since adoption never reaches 100 percent. The rates of adoption for wheat in several countries are shown in Table III.

Table III: Rates of Adoption of New Wheat Varieties 15/
(in Percentage of Total Area under Wheat)

Year	Afghanistan	India	Nepal	Pakistan	Tunisia
66/67	-	4	5	2	-
67/68	1	20	13	16	-
68/69	4	30	26	38	2
69/70	5	30	34	43	7
70/71	9	36	43	52	11
71/72	10	41	52	57	6
72/73	15	51	66	56	9
73/74	16	57	76	59	6
74/75	17	62	85	63	6

15/ Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations (1976). D. Dalrymple, Foreign Agricultural Economic Report, No. 95.

69. The rates for India, Pakistan and Nepal follow a pattern similar to that in developed countries. In fact, the initial rate of adoption is surprisingly high, higher than that in many developed countries. The rapid adoption in Nepal took place even though that country has only a very modest national research program. The low adoption in Afghanistan and Tunisia is presumably due to the lack of suitable varieties for some of the major ecological zones in these countries.

70. One valuable outcome of the work on new varieties is the opportunities provided to socio-economists for ex post analysis of the factors associated with the adoption of such varieties. Both IRRI and CIMMYT have done a considerable amount of work on studying constraints to adoption. For example, IRRI economists have identified such factors as lack of modern varieties to suit a particular locale, price relationships between modern and local varieties and the high cost of insect control as factors limiting adoption or

yield increases from modern varieties.16/ In its investigations of the spread of modern maize and wheat varieties, CIMMYT has found that the suitability of the technology to a particular agro-climatic zone is a major factor controlling the degree of adoption.

71. The investigations on the adoption of modern varieties of rice and wheat suggest that yield instability has been a greater problem in the modern rice varieties than in the modern wheat varieties. Some surveys have shown that farmers benefited for one or two years from the earlier high-yielding rice varieties, but these were overtaken by pests and diseases or other problems and some farmers reverted to their traditional varieties.17/ Modern wheat varieties, on the other hand, do not appear to have experienced these setbacks from pests and diseases though CIMMYT is well aware of such possibilities and, apart from developing a stream of new materials, is also working on "multilines," basically a mixture of varieties that look alike, but have differing sources of disease resistance.

72. The conclusion to be drawn from this discussion on the use of modern varieties is the rapidity with which they spread and, in spite of some setbacks, their impact on production. Considerable attention has been given to "second generation" and socioeconomic problems18/ and IRRI and CIMMYT have been well aware of these. The future problems are to maintain and, if possible, increase yields in the areas of adoption and to obtain similar yield increases in the areas which have not taken up modern varieties of rice and wheat. Modern varieties of most of the other crops under study at the centers are mainly at the stage of trial in farmers' fields and are not yet ready for general adoption.

IV. THE NEEDS FOR 1978 AND BEYOND

1978

73. In some respects, 1978 represents a coming of age for the Consultative Group network.

16/ Annual Reports, IRRI. 1973, 1975.

17/ The Green Revolution in Bihar — The Kosi Area -- A Field Trip. Wolf Ladejinsky, ADC No. 28, 1976.

18/ Green Revolution (I): A Just Technology, Often Unjust in Use. N. Wade, Science, 186, pp. 1093-1096, 1974.

- the four original centers (IRRI, CIMMYT, IITA and CIAT) will have completed a period of vigorous "second growth," in which their staffs, operating budgets and physical facilities have more than doubled in five years.

- the "second generation" centers created by the CGIAR itself in its initial years (CIP, ICRISAT, ILCA and ILRAD) should reach their planned full development, and operate from completed headquarters facilities.

- the newest center -- ICARDA -- established in 1976 to complete the network's coverage of major food crops and ecological zones in the developing world should be carrying out a substantial research program.

- the Consultative Group itself will be in the midst of its three-year period of consolidation, and beginning to shape the character of the next generation of activities after 1979.

74. The practical effect of reaching this level of maturity is the temporary leveling off of the financial requirements of the network. The estimated net budget requirement of the CG-sponsored centers and programs in 1978 is about $88 million, an increase of 16 percent in current terms over the revised net budget estimates for 1977, or 7 percent in real terms. This compares with an average rate of 30 percent in current terms and 21 percent in real terms in the period 1971-77.

75. This rather modest overall growth rate is, however, deceptive. It is due almost entirely to a 35 percent reduction in capital budget requirements. The operating budget would grow by 30 percent, which is the same as the annual compound growth rate from 1971 to 1977. The increase in the operating budget of $17.9 million would in fact be the largest absolute increase in the Group's history, despite the apparent stability in research programs and institutional developments.

76. The 1978 budget requests of the international centers are given below. A center's gross requirement is the amount estimated to be needed to carry out its planned core program. The net requirement is the amount requested from the CGIAR after taking into account estimated earnings and amounts to be carried forward from 1977.

Table IV: 1978 Budget Requirements
(current $ thousands)

	Core Operating	Capital	Total Gross	Total Net	% Increase Over 1977 Total Net Requirements
Established Centers					
CIAT	10059	767	10826	10426	+17.5
CIMMYT	12787	343	13130	11350	+ 8.4
CIP	5742	440	6182	6116	+ 5.0
IITA	11669	2223	13892	13074	+18.2
IRRI	10983	1599	12582	12332	+ 5.7
Subtotal	51240	5372	56612	53298	+11.2
Newer Centers					
ICRISAT	6900	5950	12850	7619	- 6.4
ILCA	6822	3244	10066	9061	+ 8.7
ILRAD	5273	1256	6529	6499	+40.4
ICARDA	4852	3282	8134	7848	+109.6
Subtotal	23847	13732	37579	31027	+24.9
Other Programs					
WARDA	1183	224	1407	1407	+ 9.3
IBPGR	1969	-	1969	1908	+36.3
Subtotal	3152	224	3376	3315	+23.4
TOTAL	78239	19328	97567	87640	+16.1

77. In 1977, the operating budgets were 67 percent of the total core budgets (operating and capital together). They will be 80 percent in 1978. The established centers will spend 91 percent for operations (compared to 80 percent in 1977) and the newer centers will spend 63 percent (up from 43 percent in 1977). The established center operating budgets will increase by 22 percent (13 percent in real terms) and will be adding 28 additional senior staff. While no new research programs will begin in 1978, the senior staff at the five established centers will increase by 10 percent. Eight of the eleven new positions at CIMMYT and IRRI will be for expansion of the core-funded outreach programs; sixteen new staff at CIAT and IITA will enlarge on-going research programs. As might be expected of the newer centers with newly completed physical facilities, their operating budgets will grow by 52 percent in 1978 (41 percent in real terms).

Outreach Activities

78. Probably the most significant single development in 1978 will be the expansion in outreach activities, i.e., those outside the host country. The number of outreach senior staff would increase as follows:

Senior Staff (Core and Special Projects)

	HQ Based	Outreach	Total
1976	310	92	402
1977	355	117	472
1978	412	157	569

This represents an increase of 33 percent in headquarters-based staff for the period 1976-78, with a corresponding increase of 71 percent in outreach staff. The numbers of outreach staff are distributed as follows:

	1976	1977	1978
CIAT	2	6	8
CIMMYT	29	28	34
CIP	8	15	15 (or more)
ICRISAT	6	10	15
IITA	20	17	31
ILCA	7	13	17
ILRAD	-	-	-
IRRI	20	28	37
Total	92	117	157

The above figures should be regarded as indicative, as complete data on headquarters-based and outreach staff are not available from all centers.

79. There is a clear implication in this trend. The centers appear to be making a concerted effort to ensure that national research programs are capable of accepting, testing and adapting and disseminating the technology developed by the centers. New initiatives in this area include CIP's "third dimension," IRRI's regional liaison scientists, CIMMYT's regional programs and CIAT's regional cassava and prospective bean specialists located outside Latin America. The size of these programs is also becoming significant. IRRI will have 12 staff in Indonesia in 1978; ICRISAT will have 13 in its West African sorghum program; IITA will have 9 in its Nigerian national food program.

80. There will be budget implications as well, particularly as outposted staff tend to be more costly than headquarters-based staff, and many of these programs, currently financed as special projects, may well become core funded eventually. The administrative problems of the centers are also likely to increase as a result of this expansion.

81. Drawing the appropriate boundaries between activities of the centers and the needs of individual national programs has always been a major issue facing the Group. It is likely to become even more important as center outreach activities expand and international attention is turning more and more towards the capacity and effectiveness of national research.

Special Project Expenditures

82. Total center special project expenditures for 1978 are estimated to be $13.6 million compared to $10.8 million in 1977. This represents an increase of 26 percent, although these figures may be subject to considerable change; experience has shown that future special projects expenditures are usually overestimated.

The Needs to 1980

83. Three centers--CIAT, ILRAD and IRRI--have prepared biennial budgets for 1978-79. Their budgets demonstrate a continuing rapid growth in the 1978 and 1979 operating budgets, with a steady overall decline in capital expenditures over the two-year period. The budget increases in the second year of the biennial budgets (1979) are consistently lower than in year one; taken together, they still represent a real growth of six percent over 1978.

84. Assuming similar growth on the part of other centers, and a very substantial increase in ICARDA's capital program, the total gross core budget requirements of the current CG-supported activities will, in current dollars, exceed $110 million in 1979 -- nearly $100 million net. Assuming some new activities are to be added after (if not during) the period of consolidation, a total CG requirement of more than $130 million may be expected for 1980.

New Activities

85. The figures for 1978 and 1979 exclude any new activities which may be added following (or perhaps during) the three-year "period of consolidation" which the Group initiated in October 1976. The TAC continues to review proposals on a range of initiatives and several such activities may be brought before the Group for consideration, some perhaps for funding as early as 1978. Such initiatives could increase total financial needs substantially.

86. As additional activities are put to the Group for support one by one, there is a risk that, no matter how worthy the proposals individually, the cumulative result may be to give the Group's program and system a direction, shape and balance it may not find fully satisfactory. The Group may wish, therefore, to approach more systematically the process of growth.

V. THE FUTURE DIRECTION OF THE SYSTEM

87. Research is a long-term process the success of which depends largely on according the research center and its scientists the maximum freedom to pursue their enquiries consistent with ensuring that their work is germane and effective. Moreover, it takes time to establish and develop any individual program. Changes in direction and emphasis should, therefore, be made carefully and not too frequently. At the same time the efforts of the various entities comprising the CG system need to be consistent with the objectives of the Group, and each entity should be accountable to the Group in the sense that its programs should be relevant to the problems of the developing world as perceived by the members of the Group, and that the resources provided to it should be used efficiently.

88. Being comprised of a variety of essentially independent entities, the system as a whole can function coherently and effectively only if the aims of the Group are articulated specifically enough to permit it to follow progress and make adjustments from time to time. To give guidance to the research effort as a whole and to those concerned with developing programs or considering new activities, the Group may wish to use the period of consolidation to articulate more explicitly its longer-term aims and its views on the use of its resource to achieve them.

89. Three areas of potential importance to which the Group may wish to give attention over the next few years are: (i) priorities in allocation of resources, (ii) basic research and (iii) the transmission of new technology to farmers.

Priorities in Allocation of Resources

90. Earlier sections of this paper, particularly in Part III, have described the evolution of the system, the changing emphases of the centers and the distribution of resources to research on the various commodities. One of the main objectives of the CGIAR when it was set up was "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." The Review Committee underlined the Group's continuing concern for identifying priorities and translating them into specific goals. It suggested that the criteria for priority should include the importance of the commodity in the diet of target populations, environmental limitations, nature of past and ongoing research and some estimate of the impact research might have in raising both the technically achievable levels of yield and the economic levels attainable with "perfect information and astute economic sense."

91. Members of the Group have expressed the concern that the benefits of research should flow more specifically to the poor in the LDCs, hence the need for priority to research which would benefit the small farmer and the rural landless and produce low risk, inexpensive technology that can be applied quickly.

92. There is, of course, a strong interdependence between adoption of new technology and socioeconomic conditions. Whilst it is relatively easy to design a technology that will help mainly the better-off farmers or one that is scale neutral and will help both rich and poor farmers, it seems virtually impossible to design a technology that will help the poor farmer and not the rich.

93. Most countries are not specific in their research objectives. The system may be emphasizing low input technology on the one hand, while the developing countries, on the other, may be giving more emphasis to higher input technology. An IRRI survey in India, for example, showed that the major objective in 80 percent of the rice-breeding work was fertility responsiveness.19/

94. The two objectives of helping the poor and maximizing growth in the rural sector, may or may not be compatible, but they raise an important question in defining goals. Researchers find it relatively straightforward to define goals in terms of production increases and they can usually indicate the probability of attaining them. However, where research is being used to promote such social objectives as a relative improvement in the position of the small farmer, both the methodology and the time frame are much less well understood and the latter can change drastically with policy changes at government level.

19/ IRRI Annual Report, 1975, page 32.

95. As well as influencing the policy towards target groups, social and economic goals could also influence the choice of priorities amongst crops. The more elastic the demand for a crop, the greater the benefits to the producer. Nevertheless the best that research can do is to focus on scale neutral technology, leaving it to each government's policies to ensure that the benefits flow to the specific groups it wishes to benefit.

96. The Group has suggested priorities in terms of target groups and the TAC in terms of commodities, whilst the centers determine their priorities within their specific commodities and between countries or regions. However, there is no direct way by which the LDCs or their farmers, the ultimate decision-makers in the implementation of new technology, can express their preferences within the CG system. Center Boards and staff are in close contact with country problems and can thus advise on priorities for the individual center and the individual crop, but not for the CG system as a whole. Even then, however, a center priority could conflict with a system priority. For example, ILCA is considering expanding its role in the more humid areas of the tropics which it regards as having greater opportunities than the dry areas, but the Group might regard work in the latter as of higher priority since "ruminants are of dominant social and economic importance in some of the poorest and most backward countries which have little scope for other agricultural development."20/

97. Another aspect of the priorities question possibly deserving further attention is research on problems related to factors or inputs such as fertilizers and water, and pest, disease and weed control. In paragraph 28 attention was drawn to the importance of inputs and input-related research in developed country agriculture. The international system devotes in aggregate about 13 percent of its resources to research on inputs (including research on soil fertility, water management and socioeconomic factors). ICRISAT and IITA are involved in conservation and utilization of water, whilst IRRI is investigating water distribution systems in rice. Outside the system, IFDC is involved in fertilizer research. However, the total research effort in these areas is small compared with the large investments in fertilizers and irrigation. Most of the research on pest and disease control is on host-plant resistance; diseases, including viruses, are researched on a crop-by-crop basis, but the proposals to use ICIPE would increase the factor-oriented research on pests. Increasing emphasis on specific ecological areas, e.g., the Ilanos of South America, the cold plateau areas of the Middle East, the fragile soils of the humid tropics, and the Sahelian Zone, many necessitate more attention to factor-oriented research in the future.

20/ Priorities for International Support to Agricultural Research in Developing Countries. TAC Secretariat. Rome 1976.

98. These considerations suggest that whilst planning the allocation of research resources is beset with many difficulties, the alternative of making allocative decisions in an ad hoc manner may be even less satisfactory. Assuming that some such planning is necessary, there remains the problem of whether it should be "bottom up" or "top down." The individual centers must obviously make most of the decisions about priorities within the commodities with which they are concerned, but the Group must decide on priorities among crops and major activities.

99. Both the Group and the Review Committee have suggested more attention to priorities, and the Committee has emphasized the need for better forward planning by the centers. The Committee also suggested a mechanism for allocating funds in case of shortfall. In conclusion, however, it would appear that even when there is no sigificant shortfall, there is a need for improving the present ad hoc system of allocating resources to ensure that overall priorities are properly reflected and distortions avoided. Development and implementation of the methodology would take time and the best time for doing this is before pressures from shortfalls arise.

Basic Research

100. In the academic sense, "basic research" can be defined as the search for new knowledge for the sake of such knowledge. In the CGIAR system, basic research may be regarded as the search for new knowledge on which specific advances in technology can be based (e.g., an immunization procedure for trypanosomiasis) but the route to that objective and the time frame for attaining it are not known with any certainty. Most of the work at the centers is applied research; that is, the application of existing knowledge and techniques to the development of new technology. Developed country basic research is the source of most new knowledge, generated to support their own agricultural technology development. However, the direction of such research and its emphasis, is dominated by the needs of developed country agriculture, and reflects their priorities.

101. Even though developed country basic research is the main foundation on which advances in LDC agricultural technology have been based, it is possible that changes in emphasis and priorities would help the development of such technology even more in the long run. For example, biologically fixed nitrogen is more valuable to the farmer in a developing country than in a developed one. Leaching of plant nutrients is a loss for any farmer but more serious for the poor farmer. Developed country agriculture has, in general, been able to keep pace with changing pest problems through development of new pesticides that the LDC farmer could scarcely afford. Now increased attention to pollution caused by leached plant nutrients and environmental damage by pesticides in the developed countries is leading to more basic research which will obviously benefit the LDCs as well. However, the question that remains is whether the kind of knowledge being generated now in the developed countries will fulfill the needs of the LDCs in 10 to 20 years time. Furthermore, there

are aspects of basic research, like insect ecology, the characteristics of certain viruses, the behavior of tropical soils, which can be investigated only in the tropical environment.

102. New knowledge is needed for research on plant improvement and for work on second generation technical problems. As an example of the first, the major advances in plant improvement in rice and wheat were based on the basic knowledge of these plants generated through many years of research. Potato research is at an advantage over cassava research because there is a vast amount of knowledge about its diseases which the cassava researchers do not have. Many of the other crops in the system have had very little systematic basic research.

103. Second generation technical problems are typified by the work at IRRI in which certain insects, e.g., brown plant hopper, once a relatively minor pest, has now assumed major proportions in some areas due to changes in agronomic techniques and selection pressures on the insects exercised by new plant types, resulting in new biotypes. In fact, selection for pest and disease resistance, is something of a treadmill from which it may be impossible to get off without much better understanding of the basic science involved.

104. The centers recognize the need for supportive research of this nature and several have developed contracts with scientific institutes in developed countries, an example being the joint program on nitrogen fixation in rice fields by IRRI and the Boyce Thompson Institute. A number of proposals are being developed by the IARCs and ICIPE for joint projects on pest investigations and by the IARCs and IFDC on fertilizers.

105. In conclusion, it is obvious that the centers are well aware of the need for basic research; the question is how best to define the kinds of basic research that the LDCs will need in future and to decide whether some kind of coordinated effort is needed to foster such research.

The Transfer of Technology

106. Regardless of the quality of the research and development work at the international centers, it will not increase production unless applied by the millions of decision makers, the farmers of the LDCs. Whilst it is uneconomic to develop a large pool of technological knowledge without the means to apply it, it is also essential to have such a pool in order to bring about production increases. Even though, as indicated earlier, the modern varieties of wheat and rice have spread rapidly, such rates are probably the exception and uptake of new technology will usually be considerably slower. On the other hand, the centers can generate new materials relatively quickly; thus CIAT developed improved cassava and bean technology, both crops with rather little previous research, in 4 or 5 years, and IRRI, starting in 1960, began testing IR8 in several countries in 1965. Shortening the time lag in applying research results is thus one of the major preoccupations of the system.

107. Parallel with this problem is the question of the size of the gap between technology available and that being applied. For example Table V illustrates the gap between yields in crop trials and farm averages.

Table V: Farm Averages and Highest Productivity in Crop Trials and Demonstrations in India [21] (kg/ha)

Crop	Farm Averages	Highest Yields in Crop Trials
Rice	1,600	10,000
Maize	1,130	11,000
Wheat	1,170	7,200
Sorghum	520	9,800
Potato	8,000	41,000
Cassava	13,000	48,000
Sweet potato	5,800	37,200

108. Such gaps, which undoubtedly exist in most developing countries, suggest that there is a large pool of underutilized technology. It is easy to identify inputs or techniques--use of fertilizers, better water control, weed, pest and disease control, control of plant population--which would increase yields substantially. However, it is probable that the application of existing knowledge would be in the most favored areas, thus excluding many of the poorer farmers. The dilemma thus facing both the international and national programs is that of avoiding an ever increasing gap between technology and its application on the one hand, and, on the other, having no reserves of technology which can be utilized as soon as other inputs are available. In developed country research much of the emphasis has to be on raising the yield ceilings, but, in the developing countries, filling this gap has priority.

109. It is clear that the impact of international research on LDC production must in the end be determined by the adequacy of national research and development programs. It is equally clear that national programs vary immensely in their ability to generate, modify or apply technology. Those in close contact with national programs have qualitative information on them, but there is little quantitative information. Some figures for investment in national research programs were given in paragraph 13, but these aggregate figures are of limited value, since there is little information on individual project or program expenditure. Of course, expenditure, *per se*, does not measure quality, but it is obvious that absence of adequate financial support usually means that little useful research can be done. The converse that adequate funding will *per se* produce good research does not hold, for the connection between research quality and financial resources is tenuous.

21/ *Accelerating Agricultural Research in the Developing Countries. The State of Food and Agriculture*. 1972. Rome, Table 4.4.

110. There may be other measures that might be used to indicate the effectiveness of national research, for example, the amount for support of scientists. A scientist working in either an international or a national institute has basic requirements which must be covered if he is to function effectively. These include libraries, laboratories and laboratory equipment that functions properly, adequate qualified support staff, well managed field stations, transport and good communications within the country and with the outside world. In the international centers, the ratio of staff costs to other costs is about 60:40; developed country programs have a similar ratio. In most LDC national programs the ratio would be expected to be more like 50:50 or 40:60 since the staff cost less, but the support costs would be similar to those in the international centers. However, the meager information available shows that the ratio may be as adverse as 90:10, thus suggesting that such programs are likely to be ineffective. A certain minimum size of institute is also critical, but many of the national institutes in the LDCs are small and fragmented. Thus the CARIS project for West Africa22/ shows that 79 percent of the experiment centers had less than 5 scientists and 83 percent less than 10. Taking into account isolation, poor communications, small budgets, lack of experienced scientific management and the desire to satisfy regional and political demands, one can only conclude that many of these small research groups must be ineffective unless joined together in some effective linkage.

111. Even if the effectiveness of research is substantially improved, there remain many constraints on the adoption of the technology developed. Adequate extension service must be built up, credit and other inputs must be readily available to the farmer and tenure, price and tax policies must provide him with incentives. Only when governments take effective action in these areas is the technology likely to be taken by the farmer.

Center Interactions with National Research Programs

112. The foregoing discussion underlines the problems facing the system in ensuring the transfer and validation of the centers' technology. Centers have reacted predictably to this situation by attempting to strengthen national research programs. They need adequate national programs as collaborators in testing their material in the real world of the farmer and to demonstrate to the production agencies and the farmers the superiority of their materials, and they appreciate that effective national programs are essential to achieving higher production, which many of the centers regard as their ultimate objective. Initially, the centers' efforts to strengthen national reserach were largely in the form of technical assistance provided by center staff under special arrangements outside a center's core program. The center acted as agent for a particular donor in carrying out a special

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22/ CARIS. Directory of Agricultural Research Institutions and Projects in West Africa. Pilot Project, FAO, 1973.

project of assistance as agreed between the donor and the country concerned. Now, however, there is a growing tendency for the centers to provide technical assistance as part of their core programs, as evidenced in the growth of "regional programs" or networks involving increasing numbers of outposted staff.

113. The need to test and validate materials and to obtain information which can be fed back to the central research program has justified this expansion. At the same time, the wider the need to help in strengthening national research is obvious, and as long as it is not being adequately met by other external assistance, the centers will be under pressure to provide the help themselves. Moreover, as each center, in the course of carrying out its core program, creates networks with national programs for the exchange of materials and ideas, the opportunity exists to build up this collaboration into a program of technical assistance. This opportunity is hard to resist.

114. In conclusion, therefore, it is obvious that the whole field of transfer of technology is one of the most important for the effective operation of the center system. The Review Committee, whilst recognizing this, urged on centers the need to avoid distortion of their research thrust by excessive involvement in cooperative programs. Nevertheless, it is obvious that as long as the need for technical assistance exists and is unsatisfied, centers will be drawn into providing it as is shown by the fact that center staff in outreach activities is growing more than twice as fast as in headquarters programs. Because of lack of information there has been little progress beyond generalized discussion of the problem. As the Review Committee commented, a sound knowledge of the resources actually devoted to national programs and the manner in which these resources are used, seems an essential requirement. The need for trained personnel and the most effective manner of training requires examination. Finally, the best way to organize assistance--whether based on individual commodities or on a wider system of production--needs study. The group may feel that better information on each of these segments of the problem could lead to better informed and focused discussion on the general subject.

VI. SUMMARY AND POSSIBLE NEXT STEPS

115. In Section IV three issues possibly needing further consideration were identified. All three--priorities in allocation of resources, the place of basic research in the CG system and the transfer of technology through interaction with national programs--were considered by the Review Committee. This paper has attempted to carry the discussion further.

Resource Allocation

116. The question of priorities in allocation of resources has arisen each time the aggregate of center requirements has appeared to exceed the

likely support from the donors, but so far has always disappeared as technical adjustments have cut center requirements and as total contributions from traditional and new donors have risen. The Group accepted the Review Committee's recommendation of a three-year consolidation period which allows time for careful consideration of the problem. The estimated cost of the system in 1978, however, is about $98 million compared with the Review Committee's estimate, based on several different models, of about $90 million; centers like ICARDA and ILCA have suffered delays in development while some older centers plan larger real growth than the Review Committee contemplated.

117. The Group, with the advice of TAC, has arrived at a consensus that the resources it provides are to be used for research on certain food crops and livestock and related activities such as training and research on farming systems, and has adopted or established centers appropriate to the task. It has not, however, formulated a policy for allocating resources among the various programs of research and related activities accepted for support, beyond seeking to ensure that each center was using the resources allocated to it efficiently and for the agreed purposes; nor has it developed criteria for arriving at a suitable allocation. In considering this question, the Review Committee concerned itself only with allocation in times when funds were scarce, but even where funds are adequate to meet all claims, there is still a need to judge whether resources are suitably allocated to achieve the Group's objectives quickly and effectively.

118. The Group may feel that a policy on allocation would help in guiding the rates of growth of the different elements of the system. Uncoordinated yearly incremental changes in the size of the programs of individual centers may in the aggregate lead to resource allocation which does not fit the objectives of the Group. A policy on allocation would also provide guidance in times of scarcity when the claims on the Group's resources would have to be reduced. It would also help in the consideration of new activities put forward for support and provide guidance on the balance to seek between research itself and activities for facilitating its application.

119. This would suggest that the next step should be to prepare a paper for the Group which would analyze in greater depth the present allocation of resources, develop criteria for periodic judging of the broad allocation, consider what changes, if any, should be sought over the next five years and propose a policy for the Group which would provide guidelines for all those within the system concerned with planning the future character and size of the various programs and activities supported by the Group.

Basic Research

120. Adequate basic research is fundamental to the success of the CGIAR system in achieving its objectives. The Group needs to be satisfied that the scientists engaged in the applied research which is the principal concern of the international centers will have available to them a store of fundamental knowledge fitted to their needs. It is important to establish

with some certitude the position for the system taken as a whole so that any inadequacies identified may be made good, either by additional work at institutions in the developed or developing countries or by the international centers themselves.

121. As a first step in ascertaining the position, the centers could be invited to assess the situation individually and then collectively so as to identify not only their individual needs but the needs common to more than one center. They could then report on their findings and proposals, and TAC could review these and give its recommendations to the Group.

122. In the course of deliberations on this question it might be useful to hold a meeting attended by scientists from the centers, selected basic research institutions, TAC and others in the system at which the question could be discussed generally before specific proposals are formulated.

Technology Transfer

123. The third area needing further work is technology transfer. The Group has been concerned about this since the beginning. It is a broad subject and one of deep concern to the international centers. Many elements of the problem lie outside the purview of the Group, but there appears to be a growing sense on the part of the members of the Group, as well as the centers, that greater efforts are needed to build links to national programs to adapt and disseminate new technology. The role of the Group and of the centers in tackling this problem is evolving, but there are signs of an increasing involvement in technical assistance as distinct from the research and training which are established functions of the centers. The Group, in its capacity as a forum for general discussion of subjects of common interest, will devote an afternoon to training during Centers Week. Later in the week, during the CG Meeting, a proposal for providing assistance for strengthening national research may be considered. Thus, two important aspects of the problem are likely to get review. Either or both may call for further work on the Group's behalf, but whatever may be undertaken respecting these two aspects, the Group may wish to come back to the general subject next year. Some more systematic study of this problem seems needed. Its several aspects -- technical services for national research, the level of resources needed to be devoted to it, the centers "outreach" activities and training -- could be studied separately and papers prepared for discussion by the Group.

July 27, 1977

ANNEX I

TABLES

NOTES: (a) The data contained in these tables pertain to the nine international agricultural research centers funded by the CGIAR (CIAT, CIMMYT, CIP, ICARDA, ICRISAT, IITA, ILCA, ILRAD and IRRI). The data for 1977 and later are taken from information available from the Centers as at July 1, 1977; in some instances, center final Program and Budget Papers contain minor revisions, which do not materially affect aggregate figures.

(b) Sources for the data contained in these tables and the methodology used in constructing them will be included in a set of more detailed statistical tables which will be available separately.

Table 1: TOTAL CORE OPERATING AND CAPITAL EXPENDITURES 1960-80

	Current $ U.S. Millions			Constant 1977 $ U.S. Millions		
Year	Core Operating	Capital	Total Core Operating and Capital	Core Operating	Capital	Total Core Operating and Capital
1960	0.16	7.24	7.40	0.36	16.38	16.74
1961	0.19	-	0.19	0.42	-	0.42
1962	0.43	-	0.43	0.95	-	0.95
1963	0.51	0.36	0.87	1.05	0.74	1.79
1964	0.57	-	0.57	1.12	-	1.12
1965	1.09	0.17	1.26	2.11	0.33	2.44
1966	1.83	0.11	1.94	3.42	0.20	3.62
1967	3.04	-	3.04	5.51	-	5.51
1968	2.90	2.94	5.84	5.03	5.11	10.14
1969	5.65	4.61	10.26	9.33	7.62	16.94
1970	7.64	5.62	13.26	11.99	8.81	20.79
1971	9.87	8.00	17.87	14.73	11.94	26.67
1972	13.36	6.18	19.54	19.15	8.85	28.00
1973	18.11	7.56	25.67	24.50	10.23	34.73
1974	24.88	6.76	31.64	30.70	8.34	39.04
1975	32.89	10.79	43.68	37.13	12.18	49.31
1976	43.82	11.82	55.64	47.13	12.71	59.84
1977	58.17	26.73	84.90	58.17	26.73	84.90
1978	75.05	19.74	94.79	69.50	18.78	88.28
1979	90.84	7.63	98.47	78.22	6.56	84.78
1980	103.39	8.97	112.36	83.23	7.22	90.45
Total	494.39	135.23	629.62	503.75	162.73	666.48

Table 2: CGIAR CENTER ACTIVITIES AS A PERCENTAGE OF CORE OPERATING COSTS

Year	Research & Research Support	Conferences & Training	Library Documentation & Information	Administration and General Operations
1971	55.3	7.7	4.3	2.7
1972	54.8	7.8	4.6	32.8
1973	52.9	9.4	4.4	33.3
1974	51.8	9.1	4.9	34.2
1975	53.8	8.3	5.9	32.0
1976	57.8	7.7	5.9	28.6
1977	58.7	8.8	6.0	26.5
1978	60.6	8.9	5.7	24.8
1979	60.9	8.9	5.9	24.3
1980	61.6	8.8	5.7	23.9

Table 3 (a): ANNUAL RESEARCH AND RESEARCH SUPPORT EXPENDITURES BY COMMODITY 1971-80

Current $ U.S. Millions

Year	Rice	Wheat	Barley	Triticale	Maize	Sorghum & Millet	Total All Cereals	Legumes	Roots & Tubers*	(Potatoes)	Livestock	Farming Systems	Total
1971	1.54	0.48	-	0.28	1.49	-	3.79	0.25	0.38	-	0.60	0.44	5.46
1972	1.73	0.57	0.04	0.59	1.60	-	4.53	0.40	0.74	(0.19)	0.73	0.83	7.23
1973	1.72	0.53	0.12	0.64	2.00	0.45	5.46	0.79	1.17	(0.52)	0.98	1.19	9.59
1974	2.12	0.90	0.21	0.54	1.80	0.71	6.28	1.37	1.90	(1.01)	1.12	1.99	12.66
1975	3.16	1.19	0.23	0.82	2.40	0.80	8.60	1.94	2.31	(1.28)	2.01	2.69	17.55
1976	4.45	1.30	0.43	1.02	2.65	0.94	10.79	2.80	3.22	(1.83)	4.31	3.45	24.57
1977	5.44	2.33	0.52	0.96	3.46	1.08	13.79	4.32	4.62	(2.60)	6.84	4.63	34.20
1978	6.82	3.29	0.67	0.92	4.45	1.21	17.36	5.50	5.62	(3.18)	11.29	5.67	45.44
1979	8.11	3.89	1.02	1.08	4.89	1.42	20.41	7.05	6.46	(3.63)	14.44	6.96	55.32
1980	9.51	4.32	1.19	1.20	5.34	1.51	23.07	8.00	7.22	(4.02)	17.58	7.79	63.66
Total	44.60	18.80	4.42	8.05	30.08	8.12	114.07	32.42	33.63	(18.25)	59.90	35.65	275.67

* Includes potatoes.
( ) Not included in total.

Table 3 (b): ANNUAL RESEARCH AND RESEARCH SUPPORT EXPENDITURES BY COMMODITY 1971-80

Constant 1977 $ U.S. Millions

Year	Rice	Wheat	Barley	Triticale	Maize	Sorghum & Millet	Total All Cereals	Legumes	Roots & Tubers*	Potatoes	Livestock	Farming Systems	Total
1971	2.30	0.71	-	0.42	2.23	-	5.66	0.37	0.57	-	0.89	0.66	8.15
1972	2.49	0.82	0.06	0.84	2.29	-	6.49	0.58	1.06	(0.27)	1.05	1.20	10.36
1973	2.33	0.71	0.16	0.86	2.70	0.62	7.38	1.06	1.58	(0.70)	1.32	1.61	12.96
1974	2.61	1.12	0.26	0.67	2.20	0.88	7.75	1.70	2.34	(1.25)	1.39	2.46	15.63
1975	3.56	1.34	0.26	0.93	2.71	0.90	9.71	2.20	2.61	(1.44)	2.27	3.04	19.81
1976	4.79	1.40	0.46	1.09	2.85	1.01	11.60	3.00	3.46	(1.96)	4.62	3.71	26.39
1977	5.44	2.33	0.52	0.96	3.46	1.08	13.79	4.32	4.62	(2.60)	6.84	4.63	34.20
1978	6.31	3.05	0.62	0.86	4.12	1.12	16.07	5.09	5.21	(2.94)	10.45	5.26	42.08
1979	6.98	3.35	0.88	0.93	4.21	1.22	17.58	6.07	5.56	(3.13)	12.44	5.99	47.64
1980	7.65	3.48	0.96	0.97	4.30	1.21	18.56	6.44	5.81	(3.24)	14.15	6.27	51.23
Total	44.47	18.31	4.17	8.52	31.09	8.04	114.59	30.82	32.81	(17.53)	55.41	34.81	268.45

* Includes potatoes.

( ) Not included in total.

Table 4 (a): CENTER CUMULATIVE RESEARCH AND RESEARCH SUPPORT EXPENDITURES 1960-80

Current $ U.S. Millions

Year	Rice	Wheat	Barley	Triticale	Maize	Sorghum & Millet	All Cereals	Legumes	Roots & Tubers*	Potatoes	Livestock	Farming Systems
1960-70	5.74	1.21	-	0.71	1.91	-	9.57	Not Estimated	Not Estimated	-	0.68	-
1971	7.29	1.69	-	0.98	3.41	-	16.86	0.25	0.38	-	1.27	0.44
1972	9.02	2.26	0.04	1.57	5.00	-	34.75	0.65	1.12	0.19	2.00	1.28
1973	10.75	2.79	0.16	2.21	7.00	0.46	22.89	1.44	2.28	0.70	2.98	2.47
1974	12.86	3.69	0.37	2.75	8.80	1.17	28.46	2.81	4.18	1.71	4.10	4.46
1975	16.02	4.88	0.60	3.57	11.20	1.97	38.23	4.76	6.49	2.99	6.11	7.15
1976	20.47	6.18	1.03	4.59	13.85	2.91	49.02	7.56	9.71	4.81	10.41	10.60
1977	25.91	8.51	1.55	5.55	17.31	3.99	60.10	11.88	14.33	7.42	17.26	15.23
1978	32.73	11.80	2.21	6.47	21.76	5.20	80.16	17.38	19.95	10.60	28.54	20.90
1979	40.84	15.69	3.23	7.56	26.65	6.61	100.58	24.42	26.41	14.23	42.99	27.86
1980	50.34	20.01	4.42	8.76	31.99	8.12	123.64	32.42	33.63	18.25	60.57	35.65

* Includes potatoes.

Table 4 (b): CENTER CUMULATIVE RESEARCH AND RESEARCH SUPPORT EXPENDITURES 1960-80

Constant 1977 $ U.S. Millions

Year	Rice	Wheat	Barley	Triticale	Maize	Sorghum & Millets	All Cereals	Legumes	Roots & Tubers*	Potatoes	Livestock	Farming Systems
1960-70	10.27	2.00	-	1.17	3.96	-	17.44	Not Estimated	Not Estimated	-	1.08	Not Estimated
1971	12.58	2.71	-	1.58	6.19	-	23.10	0.37	0.57	-	1.97	0.66
1972	15.06	3.53	0.06	2.42	8.48	-	29.58	0.95	1.63	0.27	3.01	1.85
1973	17.40	4.24	0.22	3.29	11.18	0.62	36.97	2.01	3.20	0.96	4.33	3.46
1974	20.01	5.36	0.47	3.95	13.40	1.50	44.72	3.71	5.55	2.21	5.72	5.92
1975	23.57	6.70	0.74	4.88	16.11	2.40	54.43	5.90	8.16	3.65	7.99	8.95
1976	28.35	8.10	1.20	5.97	18.96	3.41	66.02	8.91	11.61	5.61	12.61	12.66
1977	33.80	10.43	1.72	6.93	22.42	4.49	79.81	13.23	16.23	8.22	19.45	17.29
1978	40.11	13.47	2.34	7.79	26.54	5.61	95.88	18.32	21.44	11.16	29.91	22.55
1979	47.09	16.83	3.21	8.72	30.75	6.83	113.46	24.39	27.00	14.29	42.34	28.54
1980	54.74	20.31	4.17	9.69	35.05	8.04	132.03	30.82	32.81	17.53	56.49	34.81

* Including potatoes.

Table 5: ALLOCATION OF CGIAR RESOURCES IN 1978 IN RELATION TO VARIOUS COMMODITY MEASURES

	Percent Ascribable to Each Crop				
	Calories Provided (Food Deficit Countries)	Protein Provided (Food Deficit Countries)	Area Harvested (All LDCs)	Value of Production (All LDCs)	CGIAR Resources* Invested
All Cereals	61.6	64.4	68.7	44.5	41.3
Rice	27.6	-	21.6	24.0	17.1
Wheat	14.1	-	14.3	8.9	8.3
Maize	9.2	-	12.9	5.7	11.2
Barley	1.6	-	3.6	1.5	1.7
Sorghum & Millet	9.1	-	16.3	4.4	3.0
Triticale	-	-	-	-	2.3
All Starchy Food	8.5	1.7	5.0	5.7	14.2
Potatoes	2.4	-	0.6	1.7	8.0
Sweet Potatoes, Yams, Cassava	5.3	-	5.0	5.7	6.2
Legumes	7.4	13.4	15.7	7.9	13.8
Livestock	5.9	14.8	Not applicable	15.4	28.4
Sugar	7.5	0.5	5.3	5.5	-
Vegetables	1.1	3.0	0.9	2.6	-
Fruit	1.5	1.0	Not available	9.7	-
Oils	5.7	0.01	3.8	7.0	-

* *Excludes Farming Systems*

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

Membership as of January 1, 1977

A. Continuing Members

Countries

Australia	Iran	Norway
Belgium	Italy	Saudi Arabia
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Denmark	Netherlands	Switzerland
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African Development Bank
Arab Fund for Social and Economic Development
Asian Development Bank
European Economic Communities
Food and Agriculture Organization
Inter-American Development Bank
International Bank for Reconstruction and Development
United Nations Development Programme
United Nations Environment Programme

Foundations

Ford Foundation
International Development Research Centre
Kellogg Foundation
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B. Fixed-Term Members Representing Developing Countries

Asia Region	India Philippines
African Region	Congo Ghana
Latin American Region	Costa Rica Peru
Southern and Eastern European Region	Israel Romania
Near Eastern and South Asia Region	Iraq Tunisia

CGIAR CONTRIBUTIONS (1972-1977)
(US$ Millions)

DONOR	ACTUAL 1972	1973	1974	1975	1976	ESTIMATE 1977	TOTAL 1972-1977
Arab Fund						.310	.310
Asian Dev. Bank				.300		.500	.800
Australia		.005	1.015	1.214	1.747	1.705	5.686
Belgium	.140	.600	.380	.621	1.742	2.410	5.893
Canada	1.160	1.780	4.675	4.340	5.392	7.367	24.714
Denmark	.250	.225	.370	.400	.456	.616	2.317
EEC						2.500	2.500
Ford Foundation	5.315	3.675	3.000	2.800	2.000	1.500	18.290
France			.130	.411	.511	.535	1.587
Germany		1.805	3.040	3.936	4.474	5.756	19.011
IDB			2.030	4.122	5.000	5.700	16.852
IDRC	.175	.345	.645	.990	1.779	1.475	5.409
Iran					1.975	2.000	3.975
Italy					.100	.100	.200
Japan	.105	.230	.265	.675	1.200	2.500	4.975
Kellogg Foundation	.155	.290	.280	.290	.300	.310	1.625
Netherlands	.375	.430	.555	1.234	1.500	1.500	5.594
New Zealand					.105	.100	.205
Nigeria				.646	.643	.640	1.929
Norway	.075	.185	.445	.807	1.119	1.520	4.151
Rockefeller Foundation	3.990	4.545	3.500	2.885	2.165	1.600	18.685
Saudi Arabia					1.000	1.000	2.000
Sweden	1.000	.150	1.490	2.290	2.256	2.490	9.676
Switzerland		.410	.140	.460	.855	1.213	3.078
United Kingdom	.690	1.110	1.920	2.411	2.889	3.330	12.350
UNDP	.850	1.000	1.465	2.164	1.929	3.880	11.288
UNEP				.600	.340	.340	1.280
United States	3.770	5.390	6.805	10.756	14.870	18.350	59.941
World Bank	1.260	2.780	2.375	3.226	6.625	8.000	24.266
Others							
Kresge	.750						.750
TOTAL	20.060	24.955	34.525	47.578	62.972	79.247	269.337

Source: Centers' Program & Budget Papers and accounts 1974-1979.

July 22. 1977