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STRATEGIC ANALYSIS OF CGIAR SUPPORTED MAIZE RESEARCH

(Agenda Item 11 (b) (i))

Objectives of the Discussion

At TAC 45, the Committee agreed to undertake, as a regular activity, strategic analyses of research on particular commodities, groups of commodities, or activities. This new initiative would start, on a trial basis, with an analysis of issues related to CGIAR supported maize research. The attached Secretariat paper serves as a background note to the discussion. It reviews the role of maize in agriculture of developing countries and makes an appraisal of current CGIAR efforts. Some issues are presented for consideration by TAC.

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

May 1988

STRATEGIC ANALYSIS OF CGIAR SUPPORTED MAIZE RESEARCH

1. Introduction

At TAC 45, the Committee agreed to undertake, as a regular activity, strategic analyses of research on particular commodities, group of commodities or activities. The analysis would consist initially of a desk study undertaken by the Secretariat to appraise research needs and opportunities in the light of current CGIAR efforts. This new initiative would proceed on a trial basis, starting with an analysis of issues related to CGIAR supported maize research.

This paper reviews the role of maize in agriculture of developing countries. It highlights the importance and productivity of maize in different regions and makes an appraisal of current CGIAR efforts. Due to time constraints, it was not possible to incorporate an assessment of maize research by national agricultural research systems, and of institutes in developed countries. Some issues are presented for consideration by TAC.

2. Maize in Agriculture of Developing Countries 1/

Although rice and wheat are more important in terms of production, area harvested and contribution to consumption in terms of calories, maize is the most widely grown cereal grain in the developing world. It is grown in more agro-ecological environments, both temperate and tropical, than any of the other cereals, and some 54 developing countries each produce maize on more than 100,000 ha. Some 173 million tons of maize are produced in developing countries annually on 78 million ha of land. Since 1979/81 (the base years for the CGIAR priority study), maize production in developing countries has increased by 17% (3.2% p.a.) and area harvested by 3.6% (0.7% p.a.) Approximately 57% of maize output is produced in Asia, 32% in Latin America and 11% in Africa. China alone accounts for 40% of total output of the developing world, Tropical South America for 15%, South Asia for 10%, Central America for 9% and Eastern/Southern Africa for 7%. Maize production has expanded rapidly during the last decade, with 3.5% per annum, of which 2.8% through increases in yield and 0.7% through an expansion of acreage. Approximately 70% of output is yellow maize, while 30% is white maize.

Maize is a major staple food in developing countries. Although overall average contribution to calorie supply is only 8%, in regions such as Eastern/Southern Africa and Central America it is more than one third. Annual per capita food use of maize averages 19 kg per head for all developing countries, 13 kg in Asia, 36 kg in Africa and 43 kg in

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1/ The statistical information presented in this section is based on an annual mean of the 1984/86 period and has been obtained through an analysis of FAO's Agrostat data base, unless specified otherwise.

Latin America. In Central America, per capita consumption of maize as a food amounts to 100 kg/head, in Eastern/ Southern Africa 63 kg, and in North Africa 46 kg per head. Since 1979/81, overall per capita consumption as a food has remained constant, but increased slightly in Africa and Latin America, and declined by 1.3% p.a. in Asia.

In addition to its use for food consumption, maize is also grown for livestock feed. Approximately 54% of maize is produced for food and 46% for feed. Total per capita utilization of maize averages 49 kg, ranging from 37 kg in Asia to 49 kg in Africa and 129 kg in Latin America. Some of the production is also used for seed and some for industrial purposes. The high utilization of maize in Central and South America is due to its importance as a cattle feed.

As incomes increase, the demand for maize as a food tends to decline while the demand for maize as a livestock feed increases. The latter is a derived demand resulting from the high income elasticity of livestock products. Among the poorest, however, rising incomes will initially lead to an increase of maize consumption. It is to be noted that maize is a staple food of the lowest income groups.

Africa and Asia are net importers of maize, while Latin America is a net exporter. In recent years, the situation of China has changed dramatically. Imports declined from 1.8 million tons in 1979/81 to 245,000 tons in 1984/86, while exports increased during the same period from 95,000 to 4.3 million tons. Virtually all of China's maize exports are destined for Japan, Korea and the Soviet Union. These exports have recently led to a scarcity of livestock feed in China, however, particularly for pig production, resulting in a reduction of its maize exports during the last two years. Other major exporters are Argentina and Thailand. The major importing regions are Southeast Asia, Near East and West Asia, Central America and Tropical South America, and Eastern/ Southern Africa. World prices of maize have dropped substantially since 1980 as a result of a large build-up of world stocks and the effects of US trade policies.

Maize is grown mainly on small subsistence farms, and yield levels have historically been very low. Until the sixties, in many developing countries average yields were below 1 ton/ha. Maize is traditionally low in two essential amino acids, lysine and tryptophan, which limits its nutritive value for consumption by malnourished people.

Average yields of maize in developing countries increased from 1.4 tons/ha during 1961/65 to 1.9 tons/ha during 1979/81. Since the latter period, average yields have further increased by 2.4% p.a. to 2.2 tons/ha during 1984/86. In contrast, average yields in developed countries amount to around 5.5 tons/ha.

Among developing countries wide variations can be observed in the rates of yield increases. China, North Africa and temperate South America now produce at a rate of more than 3.5 tons/ha, while yields in sub-Saharan Africa have remained relatively stable at around 1 t/ha in Central and Sahelian Africa, and 1.3 t/ha in Eastern/Southern and Humid West Africa. Since 1979/81, yields have declined slightly in Central Africa, South Asia and Oceania. During the same period, yields increased rapidly in China (+ 24%), Humid West Africa (+ 33%), Sahelian

Africa (+ 24%) and North Africa (+ 20%). Because of population growth, overall per capita output of maize has declined by 1.5% between 1974/76 and 1984/86.

The wide variation in maize yields between different regions can be attributed to differences in agro-ecological environments and the subsistence nature of many producers. The problems of weeds, insects and diseases remain considerable. An overview of basic statistical indicators of maize production and utilization in developing countries is provided in Table 1.

3. CGIAR Efforts in Maize Research

3.1. Overall CGIAR scope of activities and resource allocation

Research on maize is part of the operational mandate of two CGIAR-supported Centres: CIMMYT and IITA. Total CGIAR core expenditures on maize in constant 1983 dollars increased from US$ 3.6 million in 1971 to US$ 6.2 million in 1983. Expressed in current dollars, such expenditures amounted to US$ 4.6 million in 1983 and increased to an estimated US$ 6.9 million during 1988 (Table 2).

When the CGIAR System was established in 1971, maize received about a quarter of its core research resources. When the System was expanded to about a dozen Centres during the mid-seventies, this allocation dropped to about 8% and has remained relatively stable since. Similarly, maize accounted for 38% of CGIAR expenditures on cereals research in 1971. This allocation declined to 23% in 1977, and to 16% in 1983, but increased again during 1984 and 1985 and has remained stable at 20% since. This relative strengthening of CGIAR support to maize research with respect to other cereals was in line with TAC's recommendation in the priority study. The recommendation stated that additional support was to be given to accelerate the promising results from work in progress, and that efforts had to be shifted to those areas where maize was a staple food, particularly in Eastern/Southern Africa.

Although CIMMYT in recent years has substantially strengthened its efforts in sub-Saharan Africa, the overall regional distribution of CGIAR resources to maize research between 1983 and 1988 seems to have shifted somewhat in favour of Asia and Latin America. The share of Africa declined from 55% to 46%, while that of Latin America increased from 30% to 35%, and of Asia from 15% to 19%.

Of the 1988 CGIAR expenditures of $6.9 million on maize research, $5.8 million was allocated to CIMMYT and $1.1 million to IITA. In addition, CIMMYT used approximately $1 million of non-CGIAR resources in its maize programme, and IITA $220,000. CIMMYT has 37 senior staff in its maize programme, against 7 for IITA.

3.2. CIMMYT activities

The overall objective of the maize improvement programme of CIMMYT is to supply national research programmes with essential materials and services for improving maize productivity, production and utilization in developing countries. The main materials provided are

improved populations and varieties. These are intermediate research products that must be further refined and adapted by national programmes before being released to farmers. The programme also provides research methodologies, training of national researchers, and information services.

The principal thrust of CIMMYT's maize improvement programme is germplasm development and population improvement. CIMMYT attempts to develop materials that are broadly adapted for the important maize growing environments in developing countries. As it is not possible for CIMMYT to supply varieties to each of the agro-ecological zones, the Centre develops germplasm suitable for large areas termed "mega-environments". CIMMYT defines a mega-environment as a broad but distinct crop-dependent environment whose scope is international. The boundaries of a mega-environment are defined by plant performance (absence of significant genotype/environment interactions); climatic, edaphic and cropping system discontinuities; consumer preference for specific crop products; and a minimum area planted, normally 0.1 to 0.5 million ha. Each mega-environment comprises various macro-environments (defined by particular stresses), which are in turn composed of specific environments, for example through particular cropping patterns. The latter are made up of farmers' fields.

CIMMYT has developed a set of maps illustrating these mega-environments. They cover the lowland tropics, mid-altitude tropics, high-altitude tropics, subtropical areas and temperate areas. The germplasm complexes developed for these mega-environments are subdivided into three groups of different length of maturity, which are further broken down according to grain color (yellow or white) and type (flint, dent or floury). This germplasm is then distributed to national programme researchers.

This "mega-environment" approach allows for priority setting within the breeding programmes, and for the identification of gaps within germplasm collections.

In the development of germplasm, CIMMYT has given strong emphasis to open-pollinated varieties. Only 25% of resources of maize germplasm programmes are allocated to the development of hybrids which require a more sophisticated form of controlling cross pollination. Hybrids can be divided into two broad categories, conventional and non-conventional. Conventional hybrids result from the union of inbred lines, created through self-pollination, usually for three or four successive generations. Non-conventional hybrids are formed through crosses in which at least one parent is not an inbred line. Conventional hybrids are made from genetically pure lines, but the uniform plant is more susceptible to adverse environmental conditions. Recently, CIMMYT has given more emphasis to non-conventional hybrids which show less hybrid vigor than the conventional ones, but they can be developed and released in a shorter period. Non-conventional types are easier to manage, and seed production is simpler than for conventional hybrids.

During the 1970s and early 1980s CIMMYT had a vigorous programme for the development of quality protein maize (QPM) using the opaque-2 gene. Although this gene improves protein levels substantially, it is recessive and loses its effectiveness when QPM crosses with normal maize.

In addition to the more conventional selection criteria of breeding programmes, CIMMYT puts considerable emphasis on resistance to pests and diseases, and particular physiological criteria relevant to yield potential and resistance to drought. Some of the materials developed are gene pools that serve as sources of resistance or tolerance to biotic and abiotic stresses.

Although traditional plant breeding techniques remain of predominant importance to achieve crop improvement, CIMMYT is increasingly making use of biotechnology, particularly for diagnostic purposes. Another promising area of upstream research is wide-crossing.

3.3. IITA activities

IITA's research strategy for maize involves a primary focus on the lowland moist savanna and humid forest ecologies of West and Central Africa. The lowland moist savanna, with a growing period of between 150 to 240 days, is thought to have the greatest potential for future maize production in West Africa, and is therefore given first priority by IITA. The emphasis is on the development of low external input smallholder production systems using improved varieties, good husbandry and limited use of purchased inputs. Nevertheless, the application of nitrogen and phosphorus fertilizer is seen as essential.

The lowland humid forest is characterized by high rainfall and humidity, and elevations below 800 m. Double cropping of maize is widespread, commonly in interplanted mixtures with other crops, mainly cassava. High disease and insect pressures, acid soils and low soil fertility, as well as low light intensity and storage problems are seen by IITA as the major constraints to an improvement in maize production.

Maize yields are commonly low (about 1 t/ha) in IITA's target environments. The main objectives of IITA's maize programme are to develop varieties that are (a) better adapted than local cultivars to the environmental and agronomic conditions, and (b) resistant to the major pathogens and pests affecting the crop.

The development of improved maize includes work on both open-pollinated and hybrid varieties. The initial emphasis was on resistance to two diseases, lowland rust and lowland blight. Improved varieties, with resistance to these diseases, encountered Cicadulina leafhoppers however, vectors of maize streak virus disease. IITA therefore developed, in collaboration with CIMMYT, high yielding streak-resistant varieties and hybrids. Improved germplasm is evaluated through a multilocation international variety testing programme.

Future work will incorporate breeding for resistance to the parasitic weed striga in the lowland moist savanna, and to lepidopterous stem borers and downy mildew in the lowland humid forest. The Centre intends to develop a capability to use biotechnology in the search for resistance to Striga. In the mid-altitudes, research priority will be given to breeding combined resistance to mid-altitude rust and blight and to streak virus diseases. IITA does not plan to work for the high altitudes.

3.4. Collaboration with national research institutes

Both CIMMYT and IITA stress their strong partnership with National Agricultural Research Institutes (NARS). Improved germplasm is tested through international testing programmes. IITA has thirty-four collaborating national programmes, and CIMMYT works with virtually every maize producing developing country. In addition, more than 2000 national research staff have received training at either of these Centres.

National maize research capabilities in developing countries vary widely. The top five producers (China, Brazil, Mexico, Argentina, India) account for approximately 70% of maize output in developing countries. Some of these countries have strong national programmes, producing their own hybrids. Among the smaller countries, research capacity for maize is generally poor. CIMMYT has estimated that among maize improvement programmes of NARS only 14% were technically adequate to meet needs of their country's agricultural sector, 33% were approaching technical adequacy, while 53% were classified as technically inadequate. In maize crop management programmes the respective percentages were 9%, 26% and 65%, and in social science programmes nil, 20% and 80%. National views on this assessment are not available. It is also not clear what the characteristics of a "strong" national programme are. Nevertheless, assuming that CIMMYT's evaluation reflects the true situation, the need for continuing strong CGIAR support to the strengthening of national research capacity is highlighted.

3.5. Impact achieved

The impact study has estimated that by 1983, approximately 238 maize varieties, based on materials supplied by the centers, had been developed and released by national authorities in 41 countries. About 53% of these varieties were released in Latin America, 26% in Africa, 20% in Asia and 1% in the Middle East and North Africa. These varieties are grown on well over 6 million ha in developing countries. The effect is to some extent reflected in the rapidly growing average yields in developing countries. Recently it has been estimated that about half of the maize planted in the Third World during 1985-86 was improved, although large regional variations can be observed. In Africa, just over 30% of maize sown was improved, and if China, Argentina and Brazil (where more than 70% is improved) are excluded, this proportion is only around one third even in Asia and Latin America.

To date, maize research has had less impact on production than research on wheat or rice. This can be attributed to several factors. First, unlike wheat and rice which are inbreeders, the crossbreeding nature of maize and the great diversity of agro-ecological conditions under which it is grown extends the time frame needed to achieve results. It is to be noted that improved wheat and maize varieties have been most successful in areas with adequate rainfall and under irrigation. Second, research has until relatively recently focused on yellow dent types of maize, although people in developing countries consume particularly white flint types. Third, some of the improved varieties, such as Quality Protein Maize (QPM), are visually undistinguishable from normal maize and have not yet received recognition in the market as quality products. Fourth, researchers may

have overly focused on the grain characteristics of new varieties with inadequate attention to multiple objectives of farmers in growing maize, particularly the role of maize stover as a livestock feed.

4. Issues for TAC Consideration

4.1. Overlapping mandates between CIMMYT and IITA

There is an overlap in responsibilities for maize research in the tropical areas of West and Central Africa between CIMMYT and IITA. Both Centres have worked closely together in the development of germplasm for these areas, but cooperation has often been difficult. At TAC 33, it was decided that CIMMYT would coordinate all maize research in Africa and that the maize programme director at IITA would be CIMMYT staff. This arrangement never worked, partly because of personality problems, partly because of the differences in underlying philosophies of maize breeding between both Centres. The cooperative agreement for joint research in the mid-altitude zone of Southern Africa has also collapsed, with the withdrawal by IITA of its staff. Negotiations are in progress for a more effective sharing of responsibilities for maize germplasm development in the tropical areas of Africa between CIMMYT and IITA.

4.2. Development of open-pollinated against hybrid varieties

The relative importance of open-pollinated versus hybrid varieties in maize research has been subject of much debate. Development of open-pollinated varieties requires less skill and technology than the development of hybrids, and is more likely to be conducted effectively by national programmes. In addition, the development of inbreds to support hybrid breeding could lead to a narrowing of the genetic base for maize grown over a large region, making these materials vulnerable to new virulent races of pathogens. Hybrids appear to have less yield stability and require a sophisticated system of seed production. The production of hybrid seed is only feasible in countries with a strong capacity (both public and private sector) for seed development. The production of seed of open-pollinated varieties can be undertaken by the farmers themselves. Hybrids have a higher yield potential however, and there is a strong demand from commercial farmers for these varieties.

4.3. Focus on maize as food versus livestock feed

The demand for maize as livestock feed in developing countries is expected to rise until 2000 by 3.9% per annum. The demand for maize as a human food will increase at a slower speed of 1.8% p.a. By the year 2000, it is expected that 62% of maize production will be for feed use (Longmire, 1987).

Global maize supply is expected to grow much faster than demand leading to the likelihood of persistent low prices.

4.4. Regional and ecological focus

CIMMYT allocates 75% of its resources on maize research to the lowland tropics. The mid-altitude germplasm development programme

receives 10% of resources and highland maize 15% of resources. IITA focuses on the subhumid tropics and humid forest ecologies of West and Central Africa.

CGIAR efforts in maize research are largely concentrated on sub-Saharan Africa and Latin America.

Is the distribution of CGIAR resources across regions and ecological zones optimal?

4.5. Cooperation with NARS

IITA has not yet presented a clear strategy on how it intends to cooperate with NARS in the future. CIMMYT is moving towards decentralization to help strengthening of national programme capabilities. Three types of decentralization are considered: regional location of a programme, transfer of certain research functions in partnership and shuttle breeding.

What is the optimal strategy for cooperation with NARS? Should Centres increasingly hand over responsibilities for training to national programmes? What will be the demand from NARS for support in upstream research?

4.6. Role of the private sector

A rapidly increasing proportion of maize sown are hybrids developed by the private sector, which in many countries also controls the distribution of hybrid seed. The focus of the private sector is on favourable environments and commercial farmers.

Although Centres give first priority to supplying germplasm to publicly funded national programmes, they also provide materials to the private sector. By releasing germplasm to private seed companies, are Centres weakening NARS? What is the future role of private companies with respect to the development of hybrids?

4.7. Balance between upstream and downstream research and role of biotechnology

TAC has foreseen that the CGIAR System will gradually move upstream, as the capacity of NARS to undertake downstream research improves. It is not clear, however, in which areas Centres have a comparative advantage in upstream research. Sometimes, such research can better be undertaken by collaborative arrangements. What should be the Centres' involvement in biotechnology for the improvement of maize?

4.8. Other issues

- How can the sustainability issue be best incorporated in maize research? Is the development of short maturing varieties in certain agro-ecological zones a threat to ecological stability? How important is CGIAR research on maize in low rainfall and other marginal environments? There is a trend for maize to be grown in less favourable environments, often in direct competition with sorghum which is more adapted to these ecologies.

- What is the appropriate balance between germplasm development activities and crop management research for maize productivity research?

- What is the future of QMP (Quality Maize Protein)? Is it likely future demand going to be as a feed for livestock?

- How far should CGIAR Centres be involved in on-farm maize research?

- How much quantitative information is necessary for an appropriate monitoring of the impact of CGIAR activities?

- What is the appropriate balance in resource allocation among cereals?

- How can Africa's needs best be met?

Table 1. Basic Indicators of Maize Production and Utilization in Developing Countries

Region Name	AREA (thousand ha) 79/81	84/86	% change	PRODUCTION (thousand mt) 79/81	84/86	% change	YIELD (kg/ha) 79/81	84/86	% change	IMPORTS (thousand mt) 79/81	84/86	% change	PC Utilization (kg/head) 79/81	84/86	% change	SELF SUFFICIENCY RATIO (percent) 79/81	84/86	% change	Contribution TO FOOD CALORIES (percent) 79/81	84/86	% change
1 Temperate South America	3142.6	3446.1	9.7	9930.0	12108.6	21.9	3101.1	3504.6	13.0	300.0	38.8	-87.1	101.8	112.2	10.2	244.0	220.7	-9.6	1.5	1.7	16.7
2 Tropical South America	13608.1	14592.7	7.2	22438.8	25202.7	12.3	1648.6	1729.5	4.9	2622.4	1941.0	-26.0	126.0	121.5	-3.6	89.7	93.6	4.3	8.4	9.1	9.0
3 Central America	8375.7	8686.1	3.7	14075.9	15521.5	10.3	1667.5	1786.1	7.1	2739.0	2610.8	-4.7	163.3	177.9	8.9	84.9	85.9	1.1	29.6	28.9	-2.3
4 Caribbean	322.3	317.2	-1.6	324.7	349.0	7.5	1011.2	1100.1	8.8	1018.8	949.1	-6.8	45.2	41.1	-9.2	25.1	26.9	7.4	2.6	2.8	5.3
5 Eastern/Southern Africa	7802.8	8800.9	12.8	9755.9	11504.9	17.9	1250.7	1302.4	4.1	1044.5	1227.0	17.5	83.9	85.7	2.1	92.4	93.4	1.1	25.8	27.9	8.3
6 Central Africa	1827.7	1905.0	4.2	1671.6	1708.6	2.2	914.8	896.7	-2.0	233.5	60.9	-73.9	30.9	27.1	-12.3	88.0	97.3	10.5	9.1	8.3	-9.2
7 Humid West Africa	1955.0	2411.6	23.4	1821.5	2985.1	63.9	932.3	1236.4	32.6	236.5	104.7	-55.7	18.4	22.0	19.6	88.7	97.9	10.4	5.4	6.4	18.9
8 Sahelian Africa	390.1	508.7	30.4	334.2	549.4	64.4	856.5	1062.1	24.0	60.6	192.8	218.1	8.3	11.6	40.0	84.8	73.9	-12.9	2.6	3.7	42.0
9 North Africa	1198.8	1184.2	-1.2	3406.3	4032.2	18.4	2841.8	3410.7	20.0	1333.8	3122.2	134.1	55.5	69.3	24.8	72.7	56.6	-22.1	8.4	8.5	1.5
10 Near East/West Asia	1923.5	2005.9	4.3	3189.8	3986.0	25.0	1658.6	1985.9	19.7	2079.1	2502.8	20.4	22.0	23.7	7.5	61.9	61.4	-0.8	3.0	2.6	-12.2
11 India	5886.7	5823.4	-1.1	6485.7	7514.1	15.9	1100.1	1290.4	17.3	17.4	1.1	-93.8	9.8	9.9	1.7	99.7	100.0	0.2	3.1	2.9	-4.1
12 South Asia	478.0	640.1	33.9	714.3	891.0	24.7	1490.5	1392.3	-6.6	0.8	8.3	936.0	6.9	6.3	-8.5	101.0	99.8	-1.2	3.0	2.5	-15.5
13 Southeast Asia	9888.5	11091.5	12.2	16429.6	21788.4	32.6	1659.8	1964.3	18.3	4138.0	5198.4	25.6	33.0	39.0	18.3	103.9	108.6	4.6	4.5	4.4	-2.9
14 China	19949.8	18451.7	-7.5	60616.7	69364.0	14.4	3038.5	3757.5	23.7	1764.7	244.6	-86.1	62.9	61.7	-1.9	97.4	106.6	9.5	8.5	6.8	-19.8
15 Oceania	2.9	3.3	14.6	4.7	5.0	7.3	1590.0	1507.3	-5.2	14.8	21.2	43.3	3.9	4.6	19.6	24.6	19.5	-20.7	0.7	0.7	1.4
16 All Developing Countries	75463.1	78161.2	3.6	148167.5	173093.4	16.8	1962.1	2214.5	12.9	18040.8	18658.8	3.4	47.7	48.9	2.5	94.4	98.1	3.9	7.4	6.9	-6.3
17 World	125941.2	128307.6	1.9	421570.7	473746.3	12.4	3346.3	3691.6	10.3	76830.4	63393.3	-17.5	91.6	91.2	-0.5	100.7	100.7	0.0	5.2	5.1	-2.6
Latin America	25448.7	27042.1	6.3	46769.5	53181.8	13.7	1829.6	1966.5	7.5	6680.1	5539.7	-17.1	126.1	128.7	2.1	99.6	102.6	3.0	12.7	13.2	4.1
Africa	13174.4	14810.4	12.4	16989.4	20780.2	22.3	1289.7	1400.6	8.6	2908.9	4707.7	61.8	45.3	49.3	8.8	86.6	83.2	-4.0	11.7	12.4	6.3
Asia and Oceania	38129.5	38015.9	-0.3	87440.8	103548.6	18.4	2293.0	2723.1	18.8	8014.8	7976.5	-0.5	36.2	36.5	1.0	96.6	103.3	6.9	5.5	4.8	-13.7

Data Source: FAO Agrostat Data Base.

Table 2. Allocation of CGIAR Resources to Maize Research

Year	Actual Core Expenditure 1/ (US$ '000)	% Core Expenditures on Cereals	% Core Research Expenditures
1971	3,573	38	25
1972	3,452	34	20
1973	3,749	35	19
1974	3,091	26	13
1975	3,765	26	12
1976	3,722	22	9
1977	4,576	23	9
1978	5,406	23	8
1979	5,600	21	8
1980	5,749	19	7
1981	5,136	17	6
1982	5,578	17	6
1983 A	6,204	16	7
1983 B	4,600	16	7
1984	5,180	18	7
1985	5,920	20	8
1986	6,280	20	8
1987 (est.)	6,250	20	8
1988 (est.)	6,870	19	7

1/ From 1971 to 1983 A expenditures are expressed in constant 1983 dollars. As from 1983 B, expenditures are expressed in current dollars.

Source: CGIAR Secretariat. 1983. Statistics on Expenditures by International Agricutural Research Centres, 1960-1987.

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