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Setting Agricultural Research Priorities for the CGIAR

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ABSTRACT

The CGIAR (Consultative Group on International Agricultural Research) is a small but significant component of the global agricultural research system. With its limited financial resources, it has to be selective in its role and choice of research portfolio. An updated report on CGIAR priorities and strategies is produced every five years by TAC (Technical Advisory Committee to the CGIAR) to guide system-wide resource allocation taking into consideration an appropriate balance between centers, activities, commodities, regions and agro-ecological zones. In considering priorities, TAC is guided by several important factors such as the CGIAR mission and goal, emerging trends in world agriculture, and the evolution of scientific capacity in developing countries. The current approach has been modified to account for the expanded mandate of the CGIAR, greater emphasis on sustain-ability and resource management issues, allow for meaningful interactions with stakeholders, ensure transparency in decision making, and develop mechanisms which facilitate CGIAR priority setting as a continuing activity. The analytical framework used by TAC has three dimensions: first, an activities dimension, including the five categories of CGIAR research and research-related activities; second, a spatial dimension with nine agro-ecological zones and four geographic regions; third, a product dimension, with four main production sectors and their respective commodities. Quantitative tools have been used in addition to informed judgement and decision making. The implications of TAC's views on CGIAR priorities are discussed and conclusions made on

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outstanding issues and current TAC views on the future structure of the CGIAR.

INTRODUCTION

The Consultative Group on International Agricultural Research (CGIAR), established in 1971, is an informal association of more than 40 donor countries, international and regional organizations, private foundations, and representatives from national research systems in developing countries, formed to support a system of international research centers. The mission of the CGIAR is:

> Through international research and related activities, and in partnership with national research systems, to contribute to sustainable improvements in the productivity of agriculture, forestry and fisheries in developing countries in ways that enhance nutrition and well-being, especially of low income people (TAC/CGIAR, 1991*a*).

The goals of the CGIAR are (i) effective management and conservation of natural resources for sustainable production; (ii) improved productivity of high priority crops, livestock, trees, and fish and their integration into sustainable production systems; (iii) improved utilization of crop, livestock, tree and fish products in both rural and urban areas through improved post-harvest technology; (iv) progress towards equity (including gender equity), as well as improved diets, nutrition and family welfare through better understanding of the human linkages between production and consumption; (v) appropriate policies for increased productivity of crops, livestock, trees and fish, and for the sustainable use of natural resources; and (ix) strengthened human resources and institutions for greater research capacity in developing countries' research systems.

CGIAR supports 16 international centers covering a broad spectrum of crop, livestock and forestry production, plant breeding, farming systems, natural resources conservation and management, animal diseases, plant protection, irrigation management, agroforestry, post-harvest technology, research management and food policy. Of the 16 centres, 11 (CIAT, CIMMYT, CIP, ICARDA, ICRISAT, IITA, ILCA, ILRAD, INIBAP, IRRI and WARDA) have mandates that cover food commodities, agro-ecological zones or regions, one (IBPGR) is devoted to the collection and conservation of plant genetic resources, another (ICRAF) deals with research on agroforestry and three (IFPRI, IIMI, and ISNAR) deal with policy issues, irrigation management, and the strengthening of national agricultural research systems.

The CGIAR is only one component in the global agricultural research system for developing countries and commands only about 1% of the number of the scientists and 4% of public sector agricultural research expenditures (Pardey *et al.*, 1991). It plays primarily a gap-filling and bridging role in agricultural research. CGIAR centers fill gaps in research that are International in scope and cannot be met by national systems, and provide a bridge to advanced institutions active in basic and strategic research.

Given the limitations in available resources (currently around US$235 million in core funds and an additional US$40 million in complementary funds) the CGIAR has to be very selective in its choice of research portfolios to meet the many demands for international agricultural research. Recommendations for CGIAR priorities are made by its Technical Advisory Committee (TAC). These recommendations are made at the broad system level which guides the allocation of CGIAR resources to allow an appropriate balance among centers, activities, commodities, regions and agro-ecological zones. At the program level, priorities are set by the centers themselves through their strategic and medium-term plans.

TAC updates the CGIAR priorities and strategies report regularly. Stakeholders (national research systems, centers, donors, etc.) provide an input into the discussion, and the final report incorporates comments from these stakeholders.

This paper discusses the setting of agricultural research priorities by CGIAR and provides an overview of TAC's current efforts to develop recommendations on CGIAR agricultural research priorities for the period up to the year 2010.

EVOLUTION OF THE CGIAR AND ITS AGRICULTURAL RESEARCH PRIORITIES

The CGIAR System was established in 1971 to improve the productivity of crops important in the diets of low-income people in developing countries. Initially, highest priority was given to research on cereals, particularly rice and wheat, which are the most important food staples. Attention was also given to food legumes and ruminant livestock for their potential to improve the quality of diets, and to starchy foods for their potential in terms of energy supply per hectare.

Table 1 shows how CGIAR research priorities by commodity and major activity have evolved over the years. Research has traditionally received the largest share of CGIAR resources from 1971 to 1990, accounting for 50–62% of core expenditures. The remainder was allocated to training and institution building, documentation and infor-

TABLE 1
Allocation of CGIAR Core Research Resources by Commodity, 1971–88[a]

Research	*1971–75 (%)*	*1976–80 (%)*	*1981–85 (%)*	*1986–88 (%)*
Cereals				
Rice	21·5	17·2	17·3	17·2
Wheat, barley and triticale	13·8	10·9	10·3	9·1
Maize	19·5	9·3	7·2	7·3
Sorghum and millet	3·1	3·3	4·8	5·0
Subtotal	57·9	40·6	39·6	38·7
Crop research				
Potatoes	4·6	7·0	6·1	6·8
Other roots and tubers	6·8	5·4	4·8	4·5
Legumes	8·1	11·4	11·2	12·9
Subtotal	77·4	64·4	61·7	62·9
Commodity research				
Livestock	10·2	19·8	19·1	19·7
Subtotal	87·6	84·2	80·8	82·6
Other research/activity				
Farming systems	12·2	11·7	9·9	8·5
Food policy[b]	0·1	2·0	3·1	3·7
Genetic resources	0·1	2·0	4·2	2·8
NARS capacity building[c]			1·9	2·4
Subtotal	12·4	15·8	19·2	17·4
Total	100·0	100·0	100·0	100·0

Source: Gryseels & Anderson, 1991.
[a] Core operating expenditures for research only.
[b] IFPRI only. Other socio-economic research is included in commodity research.
[c] ISNAR only.

mation, and administration. Rice has the largest share of core resources for research, although this has declined from 21·5% in 1971–75 to 17·2% in 1986–88. Although the share of resources allocated to research on cereals has declined from almost 58% to less than 39%, in real terms the amount spent has grown three-fold, i.e. from 10 1 million constant US dollars per annum during 1971–75 to US$32 5 million in 1986–88.

Roots and tubers have remained relatively constant at around an 11% share, whilst legumes have steadily increased from taking an 8% share to about 13%, and the share of livestock has doubled from 10% in 1971–75 to nearly 20% in 1986–88. The dominant recipients of resources for non-commodity-specific research have been farming systems, food policy, genetic resources and capacity building of national research systems.

TAC's 1986 review of CGIAR priorities and strategies identified a number of issues that required further elaboration: sustainability, natural resources management and environmental degradation, income generation, employment and equity, evolving partnerships with national research systems and the sluggish progress in food production in less favoured areas. The review also identified vegetables, fish and coconut as new commodities to be considered for inclusion in CGIAR research at some future date. TAC recognized that CGIAR needed to give special emphasis to strategic research, and that a farming system perspective should be adopted for formulating research programs and for identifying and shaping technologies for farmers' circumstances. It was further noted that the location of the most urgent food problems had shifted from Asia to sub-Saharan Africa. TAC reiterated its long-standing perception that the need for research on factors of production, such as fertilizer and weather, was best met through the multidisciplinary commodity approach. TAC recognized that the single commodity approach was an inadequate vehicle for research on the management of natural resources.

In 1990, the CGIAR, recognizing the need to expand research to natural resources management, redefined the mission statement in order to expand the goals of the CGIAR. The new CGIAR mission and goal statements introduced the notion of food self-reliance rather than self-sufficiency, gave greater emphasis to sustainability issues, and added improved productivity of fisheries and forestry to that of crops and livestock.

Gradually, the commodity base was broadened and the need for policy research that will strengthen national research systems was recognized. Between 1971 and 1991, the CGIAR System grew from 4 to 16 institutions, and the scope of activities broadened considerably (TAC Secretariat 1973, 1976 and 1979). The CGIAR mandate now covers three production sectors (agriculture, forestry and fisheries) and more than 20 crop and livestock commodities, excluding vegetables.

FRAMEWORK FOR SETTING PRIORITIES FOR THE CGIAR

Because of the changes in the CGIAR mandate, a different approach to the review of CGIAR priorities was necessary. In pursuing its new approach, TAC has also made substantial efforts to ensure transparency in the priority-setting process, and to develop mechanisms that allow priority setting to become a continuous interactive process.

In considering CGIAR priorities, TAC has made use of quantitative analysis. It is important to stress, however, that quantitative analysis is considered as an aid to, not a substitute for, informed qualitative judgement

and decision making. Priority setting at the broad system level cannot be done mechanically. As Cetron & Johnson (1972) point out, 'Data plus analysis yield information. Information plus judgement yield decisions.'

The main factors that guide TAC in the consideration of CGIAR priorities are the following:

(1) The CGIAR mission and goals.
(2) Emerging trends in agriculture in a changing global context.
(3) Changes in science, the evolution of scientific capacity in developing countries and the organization of research.
(4) The relative importance of production sectors and commodities across regions and agro-ecological zones. The more economically significant the production sector or commodity, the greater the expected economic return from research resulting in a given productivity gain or cost reduction.
(5) The importance and the international character of the development problem which generates the need for research.
(6) The opportunities for strategic international research and its potential to improve the productivity of major commodities.
(7) The comparative advantages of the CGIAR System and the complementarity of its efforts with those of other research and development agencies, especially national research systems.

A three-dimensional framework

The analytical framework used in TAC's current approach to the assessment of CGIAR priorities has three dimensions—activities, spatial and product dimensions. This framework allows the juxtaposition of natural resources, people and production opportunities.

The activities dimension reflects the spectrum of activities that must be supported if the CGIAR is to achieve its broader goals. It has five categories: management and conservation of natural resources; germplasm enhancement and breeding; development of production systems for agriculture, forestry and fisheries; socio-economic, public policy and public management research; and strengthening of national research systems.

The spatial dimension forms the basis for setting geographically-defined regional priorities by agro-ecological zones. It has nine broad agro-ecological zones (AEZs) derived from the FAO agro-ecological zones classification (FAO, 1978–81), and four geographical regions. The AEZs are the warm arid and semi-arid tropics (AEZ 1), the warm subhumid tropics (AEZ 2), the warm humid tropics (AEZ 3), the cool tropics (AEZ 4), warm arid and semi-arid subtropics with summer rainfall (AEZ 5), warm subhumid subtropics with summer rainfall (AEZ 6), the warm/cool humid sub-tropics with summer rainfall (AEZ 7), cool subtropics with summer rainfall (AEZ 8), and the cool subtropics with winter rainfall (AEZ 9). The regions are Asia (which includes the Pacific), sub-Saharan Africa (SSA), Latin America and the Caribbean (LAC) and West Asia–North Africa (WANA). Applying the AEZ classification to the 4 regions leads to a total of 23 regional agro-ecological zones (RAEZs): 4 in SSA, 3 in WANA, 7 in Asia and 9 in LAC.

The product dimension provides the basis for setting priorities in the productivity context. It has four main production sectors—crops, livestock, forestry and fisheries—and their corresponding commodities. These four sectors are closely linked and frequently integrated in production systems (see Table 2).

Natural resources and socio-economic database

To allow an analysis of priorities on the basis of activities, regions, agro-ecological zones and commodities, a database was developed in spreadsheet form. It contains primary and derived agro-ecological, demographic and economic information mostly from FAO, the World Bank and the CGIAR centers. The database includes time series data by country, by agro-ecological zone, by regional agro-ecological zone and by region on both urban and rural populations and their growth rates, income, poverty, nutritional status, production of and demand for major food commodities and livestock feed, exports of industrial crops, prices and value of production of major commodities and product groups, trends in resource utilization and resource productivity, land use patterns, soils and soil constraints, land form (rainfed arable land, grazing land, permanent crop land, irrigated land, livestock, forests, etc.), lengths of growing periods and thermal conditions, vegetative resource and potential productivity. Table 3 gives examples of information compiled by regional agro-ecological zone.

An initial analysis

Investments in research today may not pay off at the producer level until two or three decades from now. The context for priority setting and long-term planning, therefore, should be the food needs, poverty status and natural resource base of developing countries in the year 2010 and beyond. Initial analysis by TAC considered trends affecting food demand such as population growth, income growth and urbanization. It also discussed evolving trends in the natural resource base and the environ-

TABLE 2
Land Area, Population, Food Demand, Arable Land and Production by Regional Agro-ecological Zone (RAEZ)[a]

RAEZ	*Land area (10^6 ha)*	*Population 1990 (10^6)*	*Population 2010 (10^6)*	*Population growth (%)*	*Food demand 1990 (10^6 tGE)*[b]	*Food demand 2010 (10^6 tGE)*[b]	*Food production 1990 (10^6 tGE)(B1)*[b]	*Cash crop production 1990 (10^6 tGE)*[b]	*Rainfed arable (10^6 ha)*	*Irrigated arable (10^6 ha)*	*Total arable (10^6 ha)*
SSA	2 191·2	501·1	922·3	3·10	115·2	223·9	104·2	72·3	156·5	5·22	161·8
1	1 245·7	166·6	301·3	3·01	37·9	72·6	33·3	8·7	60·3	3·69	64·0
2	348·4	106·3	197·0	3·13	24·6	48·5	22·7	13·2	43·3	0·43	43·8
3	502·1	152·3	282·4	3·14	36·1	71·9	33·4	35·7	36·8	0·44	37·3
4	95·0	75·9	141·6	3·17	16·6	30·9	14·8	14·7	16·1	0·66	16·7
WANA	1 253·1	316·0	510·1	2·42	103·8	185·0	65·2	22·4	64·3	18·66	83·0
1	49·1	5·5	9·8	2·93	1·5	3·3	0·3	0·1	0·1	0·10	0·2
4	33·3	8·0	15·5	3·36	2·0	4·3	0·9	0·2	1·1	0·25	1·4
9	1 170·7	302·5	484·8	2·39	100·3	177·4	64·0	22·0	63·1	18·31	81·4
Asia	2 035·0	2 739·7	3 678·2	1·48	735·8	1 073·6	732·6	236·7	326·8	135·75	462·5
1	149·2	466·2	666·2	1·80	115·4	167·7	113·0	14·5	63·8	22·15	85·9
2	184·0	228·9	319·0	1·67	59·7	89·2	69·4	25·9	32·8	7·70	40·5
3	385·3	474·5	677·2	1·79	123·5	204·2	124·6	58·3	30·5	14·50	45·0
5	178·4	456·6	645·2	1·74	120·7	190·9	117·9	65·1	63·0	43·02	106·0
6	53·7	212·9	269·8	1·19	61·5	86·3	54·2	36·9	22·4	10·14	32·5
7	148·8	485·9	587·3	0·95	138·1	179·7	138·1	31·4	55·6	22·77	78·4
8	935·6	414·7	513·5	1·07	116·9	155·6	115·6	4·8	58·7	15·47	74·2
LAC	2 038·3	447·7	630·1	1·72	133·4	209·4	141·8	118·7	147·5	14·07	161·4
1	190·8	37·7	51·3	1·55	10·9	16·4	11·8	4·2	9·2	1·76	10·9
2	312·4	70·3	100·0	1·78	20·8	33·3	21·1	32·3	24·0	2·16	26·1
3	743·9	87·3	123·9	1·77	25·1	39·7	23·4	27·2	20·0	1·80	21·8
4	259·5	130·2	191·1	1·94	38·0	62·1	33·1	28·3	13·4	2·02	15·4
5	103·2	13·5	18·9	1·70	4·6	7·2	4·4	1·7	5·5	2·59	8·1
6	16·6	3·8	4·7	1·07	1·3	1·7	3·0	1·0	6·6	0·47	7·1
7	108·7	62·5	87·0	1·67	18·8	30·0	20·5	21·5	32·6	1·14	33·7
8	149·6	27·8	34·3	1·06	9·5	12·6	20·6	2·1	32·1	0·10	32·2
9	153·6	14·6	18·9	1·30	4·4	6·4	4·0	0·3	4·1	2·03	6·1
Overall	7 517·6	4 004·5	5 740·7	1·82	1 088·2	1 691·9	1 043·8	450·1	695·1	173·70	868·7
1	1 634·8	676·0	1 028·6	2·12	165·7	260·0	158·4	27·5	133·4	27·70	161·0
2	844·8	405·5	616·0	2·11	105·1	171·0	113·2	71·3	100·1	10·29	110·4
3	887·4	626·8	959·6	2·15	159·6	276·1	157·9	121·2	67·3	14·94	82·3
4	354·5	206·1	332·7	2·42	54·6	93·0	48·0	43·2	29·5	2·68	32·1
5	281·6	470·1	664·1	1·74	125·3	198·1	122·3	66·8	68·5	45·61	114·1
6	70·3	216·7	274·5	1·19	62·8	88·0	57·2	37·9	29·0	10·61	39·6
7	257·5	548·4	674·3	1·04	156·9	209·7	158·5	53·0	88·2	23·91	112·1
8	1 085·2	442·5	547·8	1·07	126·4	168·2	136·1	6·9	90·8	15·57	106·4
9	1 324·3	317·1	503·7	2·34	104·7	183·8	68·0	22·3	67·2	20·34	87·5

Source: FAO data files.
[a] SSA = sub-Saharan Africa, WANA = West Asia-North Africa, LAC = Latin America and the Caribbean.
[b] GE = Grain equivalent.

TABLE 3
Selected Socio-economic Indicators by Region[a]

Indicator	*SSA*	*Asia*	*LAC*	*WANA*	*Absolute number million*
Population (% of LDC total)	12·5	68·4	11·2	7·7	4 005
Number of poor (% of LDC total)	16·2	72·1	6·3	5·4	1 110
Share of urban population	28	25	69	65	1 340
Calorie intake/caput (1986/88)	2 030	2 600	2 730	2 960	
Income/caput (US$)	294	448	1 847	1 544	
Arable land (%)	18·6	53·2	18·6	9·6	868·7 m ha
Irrigated land (%)	3·0	78·2	8·1	10·7	173·7 m ha
Demand in 1990 for food crops (million tGE)[b]	115	736	133	104	1 088
Demand in 2010 for food crops (million tGE)[b]	224	1 074	209	185	1 692
Production of cash crops (million tGE)[b]	72	237	118	22	450
Production of food crops (million tGE)[b]	104	733	142	65	1 044
Production of food and cash crops (million tGE)[b]	176	970	260	87	1 494
Use of fertilizer (kg/ha)	7·2	82·8	35·1	49·1	
Food self-sufficiency ratio	90	100	107	63	
Agr. GDP/agr. laborer (US$)	413	341	2 116	1 196	
Agr. GPD/total GDP (%)	34	24	10	16	
Agr. land–labor ratio (ha/worker)	4·7	1·0	18·8	7·0	
Deforestation (1980–90, % p.a.)	1·7	0·9	1·4	1·0	16·8 m ha
Total wooded area (1987/89 m ha) (closed + open + forest fallow)	668	489	961	59	2 177

Source: FAO and World Bank data files.
[a] SSA = sub-Saharan Africa, LAC = Latin America and the Caribbean, WANA = West Asia–North Africa.
[b] GE = Grain equivalent.

ment, in equity and gender issues, and in evolving capacities of national research systems. TAC then analyzed the resulting challenges to agricultural development and resource management and the implications for research in each of the regions and agro-ecological zones. Results of these analyses are reported in TAC/CGIAR (1991*a*).

An overview of some important socio-economic indicators at the regional level is presented in Table 3. The major share of the world's total population and of its poor people live in Asia. Per caput incomes are four to five times as high in Latin America and the Caribbean, and in West Asia–North Africa as they are in sub-Saharan Africa and Asia. In proportion to the size of its population, Asia has a smaller area of arable land than other regions, but it accounts for more than two-thirds of all irrigated land. Calorie intake in sub-Saharan Africa is well below that of the other regions; this region has the highest incidence of malnutrition and the lowest per caput income. A significant amount of foreign exchange is generated through exports of industrial crops in both sub-

Saharan Africa and Asia. This is of particular importance with respect to the self-reliance of these regions.

The food self-sufficiency ratio ranges from only 63 in the West Asia–North Africa region to 107 in Latin America and the Caribbean, while it amounts to 90 in sub-Saharan Africa and 100 in Asia. The productivity of agriculture is also highest in Latin America and the Caribbean, where agricultural GDP per agricultural laborer amounts to US$2116, more than six times that of Asia. In Latin America and the Caribbean the agricultural land–labour ratio is 18·8 ha/worker, well above that of 1 ha/worker in Asia. The use of fertilizers is highest in Asia and lowest in sub-Saharan Africa. The ratio of deforestation is a source of concern throughout the developing world, but is particularly high in sub-Saharan Africa and Latin America.

QUANTITATIVE ANALYSIS TO ASSIST IN PRIORITY SETTING

The congruence approach

TAC's quantitative analysis in priority setting for agricultural research was based on a congruence approach in which priorities are allocated according to the relative value of production by region or commodity. While the approach has a lot of conceptual appeal, it also has weaknesses. It assumes that the opportunities for research to generate new knowledge to increase productivity are equal across commodities. It further assumes that the value of new knowledge produced by research is proportional to the value of output, ignoring the costs of inputs or the value added by processing.

A congruence approach can be applied usefully to the initial distribution of CGIAR priorities. Other types of quantitative analysis to supplement the approach are needed to make it more dynamic and less dependent on the simplifying assumptions. The analysis must be restricted to parameters that measure extensity—value of production, the number of poor people or the area of agricultural land. Other parameters measure intensity—GDP per caput, or value of production per hectare—and cannot be applied to the congruence approach because they cannot be added across regions.

Initial priority setting

An overview
Initially, priority setting was based on a weighted average of some important extensity parameters that reflect the three main concerns of

the CGIAR in its mission statement. These are the contributions of research to productivity, to the well-being of low income people and to sustainability of the natural resource base.

In the congruence approach, relative priorities can be distributed in proportion to the value of production, the number of poor people or the area of land in use. It should, however, always emphasize efficiency. If research has to enhance production, it is better done where the value of production is large; if it has to alleviate poverty, it is better done where the number of poor people is large; and if it has to serve sustainability, it is better done where there are large areas of land resource base in use.

This initial priority setting does not reflect the many other factors that should be taken into account, such as the need for research, the potential for impact, the capacity of national research systems to use the outputs of international research, or the advantages of the CGIAR research. Furthermore, it is based on a static concept (historical data) that reflects the past and does not allow for future changes or evolving trends.

To take these and other considerations into account, a standard procedure was developed for modifying the initial priorities by the intensity parameters. In the following sections, the three extensity parameters that determine the baseline for initial priorities are further considered.

(1) Value of production: crops account for 58% of the value of production of agriculture, forestry and fisheries; livestock for 18%; trees for 20%; and fish for 4%. The value of each of these commodity groups by region is presented in Table 4. Data were also compiled by RAEZ. For the analysis of agriculture, the values of crops and livestock were aggregated into a common production value. Crops and animal husbandry systems are so interrelated that the initial analysis was better applied to agriculture as a whole rather than to its separate components.

(2) Poverty: regional data on the number of poor people by region and agro-ecological zone were obtained from a recent World Bank study. An estimated 1110 million are reported to live in absolute poverty, defined as having per caput incomes of less than US$370 per year. Of this, 16% live in sub-Saharan Africa, 5% in West Asia–North Africa, 72% in Asia, and 7% in Latin America and the Caribbean (World Bank, 1990).

It proved more difficult to obtain reasonable estimates of the number of poor by agro-ecological zone. An analysis by IFPRI (Broca & Oram, 1991) provided some indications, but in general TAC considered that the database was too narrow and that available evidence did not allow meaningful conclusions to be drawn.

TABLE 4
Annual Gross Values of Agricultural Production of Major Commodity Groups by Region in Developing Countries, 1983–85 (US$ billions)

Commodity group	*Region*[a]					
	Asia/ Pacific	*SSA*	*LAC*	*WANA*	*Total*	*Share (%)*
Crops	200	42	73	26	341	58
Trees	69	22	24	3	118	20
Livestock	51	8	32	11	102	18
Fish	14	2	8	1	25	4
Total	334	74	137	41	586	100
Share (%)	57	13	23	7	100	

Source: Compiled by ACIAR for TAC/CGIAR (1990).
[a] SSA = sub-Saharan Africa, LAC = Latin America and the Caribbean, WANA = West Asia–North Africa.

In addition, because of migration, any estimate of the number of poor people by agro-ecological zone would have to be treated with caution. For example, recent studies at IRRI suggest that there are only marginal differences in wage rates between areas that have benefited from the green revolution than in other areas because of migration. In Latin America and the Caribbean, many resource-poor farmers of the high Andes move to lower, more fertile areas in the valleys. In sub-Saharan Africa, migration is particularly important in the semi-arid zones of Southern and West Africa.

For the purposes of this report, the number of poor people by regional agro-ecological zone was therefore estimated on the basis of regional estimates by the World Bank, disaggregated by regional agro-ecological zone on a *pro rata* basis by overall population and adjusted for the value of GDP per caput. This estimate is to be treated with considerable caution, but was considered the most reliable available.

(3) Land resource use: land resource base under use was the third parameter in initial priority setting for agriculture. Three categories of land resource use can be distinguished: cultivated land (including arable and permanent crop land), grazing land and forest land. The borders between these are not always clear because of shifting cultivation, mixed farming agroforestry and fallowing. All have major sustainability problems (TAC/CGIAR, 1988). They were, therefore, aggregated into a common 'usable land' resources category.

TABLE 5
Baseline for Priority Setting in Agriculture[a]

Region[b]	Value of production (0·333)	Number of poor (0·333)	Usable land (0·333)	Baseline
SSA 1	27·40	52·81	131·45	70·55
SSA 2	31·82	35·77	52·62	40·07
SSA 3	34·40	42·72	88·74	55·28
SSA 4	17·48	30·70	20·91	23·03
WANA 9	71·37	54·00	75·06	66·81
ASIA 1	62·49	147·89	23·31	77·89
ASIA 2	47·29	58·27	21·52	42·36
ASIA 3	108·21	110·81	64·04	94·36
ASIA 5	130·42	142·70	32·52	101·88
ASIA 6	67·25	35·08	14·89	39·07
ASIA 7	130·72	112·05	40·31	94·36
ASIA 8	57·20	114·21	82·72	84·71
LAC 1	16·96	5·19	27·68	16·61
LAC 2	42·30	9·13	77·77	43·07
LAC 3	41·62	12·39	107·11	53·71
LAC 4	33·44	20·28	42·11	31·94
LAC 5	10·37	1·84	12·16	8·13
LAC 6	5·17	0·48	6·43	4·03
LAC 7	39·88	8·15	36·03	28·02
LAC 8	20·03	3·37	32·78	18·73
LAC 9	4·19	2·17	9·83	5·40
SUM	1 000	1 000	1 000	1 000

[a] Value of production—crops and livestock. Number of poor—based on World Bank data. Usable land—arable land plus permanent cropland, plus grazing land + forest and woodland.
[b] SSA = Sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.

Baseline for agriculture

The next step in the analysis was to determine the weight to be attached to each component of the base. Since each of the three parameters is an important indicator of efficiency, it was decided to weight them equally. In terms of CGIAR goals, the highest pay-off will be obtained by developing new technology (i) where there is the highest level of production; (ii) where it will benefit the largest number of poor people; and (iii) where the area of usable land available for more sustainable use is greatest.

Table 5 presents the results for agriculture across the 21 regional agro-ecological zones used in the analysis. (WANA 9 includes the results for WANA 1 and WANA 4, both of which cover very small areas.) Values across the regions are normalized to sum to 1000 for all three sets of

TABLE 6
Baseline for Agriculture by Region

Region[a]	Value of production (0·33) (%)	Number of poor (0·33) (%)	Usable land (0·33) (%)	Baseline
SSA	11·1	16·2	29·4	18·9
WANA	7·1	5·4	7·5	6·7
ASIA	60·4	72·1	27·9	53·5
LAC	21·4	6·3	35·2	21·0
WORLD	100·0	100·0	100·0	100·0

[a] SSA = sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.

data. Values are then averaged (equal weights) to determine a baseline value.

Table 6 presents the same data, by region. In both tables it is clear that the value of production and number of poor people favor Asia, whereas area of usable land shifts the emphasis more towards sub-Saharan Africa and West Asia–North Africa. For sub-Saharan Africa, the net effect is to yield a weighted baseline that exceeds the value of production, for Latin America and the Caribbean one that is about the same, and for Asia and West Asia–North Africa, a lower one.

Baseline modification

Standard procedure

Because the initial priority rankings do not take into account other important factors that determine CGIAR priorities, a standardized approach was, therefore, developed to modify the initial baseline by the use of intensity parameters. The approach was developed by C. T. de Wit and is computerized through the use of spreadsheets.

As an illustrated example, GDP per caput is used as a possible equity modifier for agriculture. Although the number of poor people by region and agro-ecological zone is one of the three elements that compose the baseline, it needs to be modified with measures that reflect the intensity of poverty in a particular area. For reasons of equity, higher priority should be given to areas where income levels are generally low. In such areas, GDP per caput is usually also low.

Table 7 shows how the modifier GDP per caput affects the allocation of priorities by region. The modifier is weighted at 0·5. The initial baseline value for agriculture is given in row 1. The values for GDP per

TABLE 7
An Example of a Baseline Modification Analysis

	SSA	*WANA*	*ASIA*	*LAC*	*Total*
1 Initial relative priority	189	67	534	210	1 000
2 GDP/caput (US$)	294	1 544	448	1 847	
3 GDP/caput (standardized)	0·16	0·84	0·24	1·0	
4 1 − row 3 (change direction)	0·84	0·16	0·76	0·00	
5 (0·5 × row 4) to give weight 0·5	0·42	0·08	0·38	0·00	
6 row 1 × row 5	79·38	5·36	203·3	0·00	288·04
7 (row 1 × total of row 6/1000)	54·44	19·29	153·81	60·48	288·04
8 row 6 − row 7	+25	−14	+49	−60	0

caput by region are presented in row 2. The range is then normalized by setting the highest GDP per caput at 1, as in row 3. Because in this particular case highest priority is given to the region with the lowest GDP per caput, the order is reversed in row 4 by subtracting the values in row 3 from 1. This value is now adjusted for the weight of the modifier in row 5. The values are only half of those of row 4, because a weight of 0·5 was attached to this modifier. The baseline data of row 1 are multiplied with the total of row 6, divided by 1000. The differences between the values in row 6 and row 7 are given in row 8. The value obtained in row 8 indicates the difference with the baseline or the effect by region of this modifier.

The relative priorities of Asia and sub-Saharan Africa, where GDP per caput is low, increase by 49 and by 25, respectively, while the priority rankings of West Asia–North Africa and Latin America and the Caribbean are reduced. Table 7, however, only takes into consideration values by region. As will be discussed later, the analysis has been carried out for each modifier by agro-ecological zone. Computations are done with the use of spreadsheets.

The values obtained for each modifier through this procedure are then aggregated for each agro-ecological zone, region, and regional agro-ecological zone and applied (added to or subtracted from) the initial distribution of relative priorities. The overall total remains constant at 1000. As a result, the modified baseline is also obtained on an overall total of 1000. The order in which modifiers are applied does not influence their impact.

The effect of the modifier depends on the weight it has been assigned and on the spread (or variability) of its value across regional agro-ecological zones. One may attach a large weight to a certain modifier, but, if its values do not differ much between the regional agro-ecological zones, its effect on the distribution of priority will be small. For example, if the value of GDP per caput had been 100 in sub-Saharan Africa, 105 in Asia, 110 in West Asia–North Africa and 115 in Latin America and the Caribbean, the effect of this modifier would have been negligible. The greater the spread of values, the stronger the effect of the modifier. The variability within the modifier data set therefore gives a certain implicit weight to the effect of the modifier.

Another issue is the direction in which intensity parameters are weighted. In the example, greater weight was given to areas where GDP per caput was small. One could argue, however, that, for reasons of efficiency, greater weight should be given to areas where GDP per caput is high. Such areas are likely to have strong national research systems, so that the CGIAR could limit its activities to the strategic research for which it has a strong comparative advantage. If this argument were accepted, row 4 in the table would then have to be deleted and the effect of the modifier altered accordingly.

The same data set can be used to estimate both extensity parameters and intensity parameters without double counting because both parameters express two different concerns. For example, the number of poor people, used as an important extensity parameter in calculating the baseline, can be logically transposed into an intensity parameter by expressing it as a percentage of the total population in the region. Using the absolute number of poor as an extensity parameter merges efficiency and equity considerations. Using the proportion of poor people out of the total population in a region directs priorities to regions where poverty is particularly severe.

The proposed framework is not an optimizing procedure, but aims only at clarifying choices. By following this approach in its priority-setting exercise, TAC makes it clear how priorities are initially arrived at, and the process remains transparent. TAC is then in a better position to engage in reasoned dialogues internally and with other stakeholders in the process to arrive at global priorities.

Selection of modifiers

In considering modifiers for agriculture the following factors were taken into account: (1) the special nature of the CGIAR as an international organization; (2) alternative sources of research supply; (3) the strength of national research programmes—capacity of the national system and country size; (4) the nature of self-reliance; (5) concerns for the efficiency of research; (6) equity issues—intensity of malnutrition and GDP per caput; (7) sustainability—urgency, magnitude of deforestation and soil degradation risk; and (8) special issues.

Modifiers chosen

Efficiency: since the baselines already reflected the efficiency criterion, only one modifier to reflect the need for efficiency was chosen. This was the yield gap or scope for growth, the difference between best possible yields with current technologies and actual performance. It was decided that higher priority should be given where the gap was narrow and the scope for growth low, because strategic research was critical for increasing yield potential. The potential productivity data used were estimated from the FAO AT2000 database. The values varied from 0·45 in the warm arid and semi-arid tropics of Asia to 0·88 in the warm subhumid tropics of sub-Saharan Africa.

Equity: (1) Malnutrition. TAC decided that high priority should be assigned to areas where poverty and malnutrition are severe and widespread. The data used for this modifier were FAO estimates of the number of malnourished as a proportion of total population. The highest proportion was in sub-Saharan Africa (35%) and the lowest in West Asia–North Africa (9%); the proportions for Asia and for Latin America and the Caribbean were 22% and 14% respectively. (2) GDP per caput. The use of GDP per caput as a modifier enables higher priority to be assigned to poorer areas. Since poorer countries tend to have lower budgets for research and development, this modifier also takes into account the resources likely to be available to national research systems.

Sustainability: (1) Urgency. The urgency modifier is based on FAO data on the growth in food demand (in grain equivalent) between now and the year 2010. The greater the urgency, the more pressure there will be to produce more on less and marginal lands. The parameter used was annual increase in food demand as a percentage of current food and cash crop production. Values across regions range from 1·17% in Latin America and the Caribbean, to 3·47% for West Asia–North Africa, with Asia 1·45% and sub-Saharan Africa 2·21%. The higher the value, the greater the urgency. (2) Deforestation. Annual deforestation globally is estimated at 16·8 million ha/year. Deforestation can be slowed down by improving productivity and resource management in adjacent agricultural lands. The modifier used is the proportion of the deforestation occurring in each region, divided by the priority baseline to obtain an intensity dimension. (3) Soil degradation risk. Land degradation is a major threat to the sustainability of agriculture in various areas of the developing world. Data for this modifier were derived from the FAO population supporting capacity study (FAO, 1982) which contains a model quantifying the effects of unchecked soil erosion on the long-term productivity of rainfed cropland. This is expressed as the percentage of cropland lost from production if erosion is unchecked. Values range from 11% in Latin America and the Caribbean, to 35·6% in Asia.

Strength of national research systems: (1) Number of scientists. This modifier takes into account the strength of national research systems (Pardey & Roseboom, 1991). The values were weighted by the baseline value to provide an intensity dimension. Higher priority was assigned to areas with the lowest density of scientists. Again, sub-Saharan Africa emerges as the region of greatest need. (2) Country size. Small countries have more difficulty than large ones in finding the resources to develop strong national research systems. The average number of countries within a regional agro-ecological zone, weighted by the baseline value, was therefore used as modifier.

Self-reliance: To establish the self-reliance concept as a modifier, TAC turned to a recent IFPRI study on food aid needs to the year 2000 (Ezekiel, 1989). The need for food aid was estimated as the difference between production plus imports, and demands minus exports. Regions with a large food aid gap were given high priority.

Forest resource preservation: The encroachment of agriculture on forests not only has unfavorable environmental consequences but also causes fuelwood scarcity. In these areas, high priority should be given to agroforestry. TAC therefore used FAO data on area of forests and woodland per caput as a modifier to indicate pressure on forest resources. Where the area per caput is low and pressures are high (as in West Asia–North Africa and Asia) high priority was assigned.

Data for modifiers

Table 8 presents an overview of the values of the data used to estimate the modifiers chosen, by region and agro-ecological zone. Data on malnutrition and deforestation were available only at the regional level. It is acknowledged that the quality of the data set could be improved. It was particularly difficult to disaggregate data available on a country basis so that they would fit into an agro-ecological zone framework. However, TAC considered that, as priority setting is a continuing activity, well-informed 'guestimates' could be used when more reliable data are not available.

Modifier weights chosen

Having selected the modifiers, weights were then attached to each. TAC examined the impact of three levels of weights: 0·25, 0·5 and 1·0. Given the linearity of the analytical process, these were sufficient to determine the trend in the impact of each modifier. A sensitivity analysis was also carried

TABLE 8
Value of Modifiers by Region and Agro-Ecological Zone[a]

Agro-ecological zone	*SSA*	*1*	*2*	*3*	*4*	*WANA*	*ASIA*	*1*	*2*	*3*	*5*	*6*	*7*	*8*
1 Yield gap or scope for growth	0·82	0·72	0·88	0·84	0·77	0·72	0·60	0·45	0·46	0·60	0·64	0·62	0·66	0·64
2 Malnutrition (% population malnourished)	35					9	22							
3 GDP/caput (US dollars)	294	291	255	379	185	1 544	448	298	424	490	304	1 043	504	368
4 Production growth needed to meet demand (% p.a.)	2·21	2·98	2·37	1·83	1·77	3·47	1·45	1·71	1·27	1·72	1·53	1·15	1·08	1·40
5 Deforestation ('000 ha/priority baseline)	20 074					6 258	3 721							
6 Soil degradation hazard (% rainfed cropland)	16·5	10·8	15·2	28·8	10·6	20·1	35·6	29·2	31·1	63·0	17·9	17·9	46·0	46·2
7 Capacity of NARS (scientists/priority baseline)	27	25	31	32	24	98	97	55	64	73	90	113	134	128
8 Size of countries (countries/priority baseline)	10·7	8·6	8·6	11·2	13·1	140·5	35·3	16·9	126·4	13·3	185·9	47·5		
9 Food import gap by 2000 (MMT/priority baseline)	0·15					0·52	0·01							
10 Wooded area/caput (ha)	1·33	1·32	1·14	1·98	0·31	0·19	0·18	0·07	0·26	0·47	0·05	0·07	0·04	0·30

Agro-ecological zone	*LAC*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1 Yield gap or scope for growth	0·79	0·61	0·84	0·77	0·53	0·84	0·90	0·82	0·86	0·82
2 Malnutrition (% population malnourished)	14									
3 GDP/caput (US dollars)	1 847	1 887	2 061	1 758	1 504	2 029	2 458	2 109	2 422	1 750
4 Production growth needed to meet demand (% p.a.)	1·17	1·41	0·99	1·15	1·54	1·71	0·44	1·06	0·60	1·93
5 Deforestation ('000 ha/priority baseline)	27 160									
6 Soil degradation hazard (% rainfed cropland)	11·4	12·0	17·1	26·0	10·4	9·1	12·1	4·9	5·0	7·3
7 Capacity of NARS (scientists/priority baseline)	50	50	58	58	44	44	32	58	31	61
8 Size of countries (countries/priority baseline)		4·4	7·1	4·6	11·8	15·3	18·1	36·6	44·9	18·2
9 Food import gap by 2000 (MMT/priority baseline)	0·04									
10 Wooded area/caput (ha)	2·15	2·62	2·48	5·10	0·77	1·68	0·93	0·99	1·04	1·76

[a] SSA = sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.

out. As the results of the quantitative analysis only provided one input in TAC's discussion prior to the development of a collective judgement, there was no need to decide on the use of a uniform weight.

In the tables that follow, the impact of each modifier by agro-ecological zone, region and regional agro-ecological zone is explored using a uniform weight of 0·5. This is done in the interests of transparency, and to allow other stakeholders in the system to present arguments for proceeding differently in subsequent rounds of the analysis.

Quantitative impact of each modifier

The actual impact of each modifier was weighted at 0·5 by region, by agro-ecological zone and by regional agro-ecological zone (Table 9). The column figures show two things: (1) whether the modifier had a positive or negative impact on the distribution of priority; and (2) by how much.

For example, modifier 1 (yield gap) has a relatively small negative impact on all four agro-ecological zones of sub-Saharan Africa (SSA 1–4) and a large positive impact on Asia 3. The row figures show how a regional agro-ecological zone is impacted by a modifier and by how much. For example, for WANA 9 we see that yield gap (modifier 1) subtracts 1·6 from the West Asia–North Africa baseline value, malnutrition (2) subtracts 9·5, GDP per caput (3) subtracts 10·1, but that urgency (5) adds 17·1 to the baseline value, and so on across the row. The net effect of all the modifiers is to increase the West Asia–North Africa baseline value by 14·8, despite the fact that 6 of the 9 modifiers subtract from it. Clearly the largest impact on the West Asia–North Africa baseline value comes from modifier 9 (food import gap).

The table also allows the reader to compute what would happen to a regional agro-ecological, regional or agro-ecological baseline value if one or more modifiers were removed. If you wish to change the direction in which a modifier is used, simply invert all the signs (for example, if in your opinion greater weight rather than less should be given to areas where the density of scientists is high and national programmes are strong). The impact of alternative weights can also easily be considered by adjusting the impact value proportionally. For example, the impact of a modifier weighted at 1·0 can be computed by doubling the value of impact of the modifier at 0·5.

Outcome of the spreadsheet analysis

Rating by region, agro-ecological zone and regional agro-ecological zone

The effect of all the nine modifiers (all weighted at 0·5) on the priority

TABLE 9
Quantitative Impact of Agricultural Modifiers at 0·5 Weight

Baseline relative priority	*Regional agro-ecological zones*	*Number and name of modifier*								
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
		Yield gap	*Mal-nutrition*	*GDP/ caput*	*Urgency*	*De-forestation*	*Soil degradation*	*Strength of NARS*	*Av. size of country*	*Food import gap*
		Direction in which modifiers are weighted								
		neg	*pos*	*neg*	*pos*	*pos*	*pos*	*neg*	*neg*	*pos*
70·5	SSA1	−0·9	15·87	7·3	13·0	10·6	−9·6	12·9	8·4	5·2
40·1	SSA2	−5·0	9·01	4·4	3·8	6·0	−4·1	6·4	5·0	3·0
55·3	SSA3	−2·6	12·44	4·7	1·1	8·3	0·4	8·7	8·9	4·1
23·0	SSA4	−1·5	5·18	2·9	0·3	3·5	−2·7	4·3	2·7	1·7
66·8	WANA9	−1·6	−9·5	−10·1	17·1	−6·9	−4·2	−6·1	7·5	28·6
77·9	ASIA1	7·6	−2·57	8·0	0·2	−11·7	0·8	5·6	−18·0	−5·1
42·4	ASIA2	5·1	−1·40	3·2	−2·5	−6·4	1·1	1·5	2·2	−2·8
94·4	ASIA3	11·3	−3·12	6·0	0·4	−14·2	26·2	0·2	9·6	−6·2
101·9	ASIA5	1·4	−3·37	10·3	−2·3	−15·3	−8·1	−6·3	−19·6	−6·7
39·1	ASIA6	0·1	−1·29	−1·9	−3·0	−5·9	−3·1	−5·7	4·4	−2·6
94·4	ASIA7	−1·8	−3·12	5·7	−8·2	−14·2	13·5	−21·2	−33·3	−6·2
84·7	ASIA8	−0·7	−2·80	7·4	−3·5	−12·7	12·3	−17·2	1·7	−5·5
16·6	LAC1	0·5	−1·21	−3·7	−0·7	4·7	−2·1	1·5	2·3	−0·6
43·1	LAC2	−4·4	−3·15	−11·0	−4·7	12·1	−3·7	2·5	5·5	−1·5
53·7	LAC3	−3·1	−3·92	−10·5	−4·2	15·1	−0·8	3·1	7·3	−1·9
31·9	LAC4	3·1	−2·33	−4·6	−0·7	9·0	−4·5	3·5	3·7	−1·1
8·1	LAC5	−1·0	−0·59	−2·0	0·0	2·3	−1·2	0·9	0·9	−0·3
4·0	LAC6	−0·6	−0·29	−1·4	−0·7	1·1	−0·5	0·6	0·4	−0·1
28·0	LAC7	−3·0	−2·05	7·5	−2·5	7·9	−5·1	1·7	1·4	−1·0
18·7	LAC8	−2·4	−1·37	−6·2	−2·9	5·3	−3·4	3·0	0·5	−0·7
5·4	LAC9	−0·6	−0·39	−1·0	0·2	1·5	−0·9	0·2	0·7	−0·2
1 000·0	SUM	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
188·9	AFRICA SS	−10·0	42·5	19·4	18·2	28·4	−16·1	32·3	22·9	13·9
66·8	WANA	−1·6	−9·5	−10·1	17·1	−6·9	−4·2	−6·1	7·5	28·6
534·6	ASIA	23·1	−17·7	38·6	−19·0	−80·4	42·5	−43·1	−53·0	−35·0
209·6	LAC	−11·5	−15·3	−47·8	−16·3	58·9	−22·3	16·9	22·5	−7·5
165·1	AEZ1	7·2	12·1	11·6	12·6	3·6	−11·0	20·0	−7·3	−0·5
125·5	AEZ2	−4·3	4·5	−3·4	−3·4	11·8	−6·7	10·4	12·7	−1·4
203·3	AEZ3	5·6	5·4	0·2	−2·7	9·2	25·7	11·9	23·7	−4·0
55·0	AEZ4	1·7	2·8	−1·7	−0·4	12·4	−7·2	7·8	6·4	0·6
110·0	AEZ5	0·5	−4·0	8·2	−2·3	−13·0	−9·4	−5·4	−18·7	−7·0
43·1	AEZ6	−0·5	−1·6	−3·3	−3·7	−4·7	−3·6	−5·1	4·8	−2·7
122·4	AEZ7	−4·8	−5·2	−1·8	−10·8	−8·3	8·4	−19·6	−31·9	−7·2
103·4	AEZ8	−3·1	−4·2	1·2	−6·4	7·5	8·8	−14·3	2·2	−6·2
72·2	AEZ9	−2·2	−9·9	−11·2	17·3	−5·4	−5·1	−5·9	8·2	28·4

TABLE 10
Summary Tables from Agriculture by Region, Agro-Ecological Zones and Regional Agro-Ecological Zones[a]

Regional agro-ecological zones	*Baseline*	*Final*	*Agro-ecological zones*	*Baseline*	*Final*
SSA1	70·55	133·32	AEZ1	165·05	213·33
SSA2	40·07	68·69	AEZ2	125·50	145·66
SSA3	55·28	99·21	AEZ3	203·35	278·46
SSA4	23·03	39·32	AEZ4	54·98	77·34
			AEZ5	110·01	58·91
WANA9	66·81	81·52	AEZ6	43·10	22·61
			AEZ7	43·10	22·61
ASIA1	77·89	62·70	AEZ8	103·43	74·02
ASIA2	42·36	42·32	AEZ9	72·21	86·43
ASIA3	94·36	124·58	Totals	1 000·00	1 000·00
ASIA5	101·88	51·84			
ASIA6	39·07	20·09			
ASIA7	94·36	25·53			
ASIA8	84·71	63·59			
LAC 1	16·61	17·30	Regions		
LAC 2	43·07	34·65			
LAC3	53·71	54·67	SSA	188·93	340·54
LAC4	31·94	38·02	WANA	66·81	81·52
LAC5	8·13	7·07	ASIA	534·64	390·64
LAC6	4·03	2·52	LAC	209·62	187·30
LAC7	28·02	17·72	Totals	1 000·00	1 000·00
LAC8	18·73	10·43			
LAC9	5·40	4·90			
Totals	1 000·00	1 000·00			

[a] SSA = Sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean, AEZ = Agro-ecological zones.

analysis for agriculture is shown in Table 10. The most striking cumulative effect of the modifiers is the shift in priority from the subtropical to the tropical agro-ecological zones. The only subtropical agro-ecological zone whose priority rating increased significantly was the cool subtropics with winter rainfall (AEZ 9), which predominates in West Asia–North Africa.

Consequently, this shift boosts the priority for sub-Saharan Africa by more than 80% relative to the baseline. Asia, on the other hand, declines by almost 30%. The other regional changes are relatively minor—an increase of 22% in West Asia–North Africa and a decrease of 12% in Latin America and the Caribbean.

On a regional basis, the analysis results in a final ranking of Asia at 390·6, sub-Saharan Africa at 340·5, Latin America and the Caribbean at 187·3 and West Asia–North Africa at 81·5. On an agro-ecological zone basis, the warm humid tropics (AEZ 3) receive the highest ranking at 278·5, the arid and semi-arid tropics (AEZ 1) rank second with 213·3, while the subhumid tropics (AEZ 2) score third with 145·6. According to the analysis, the least important zone appears to be AEZ 6, the warm subhumid subtropics with summer rainfall.

Ratings by commodity and region

Setting priorities by region and agro-ecological zone using the baseline and modifiers chosen by TAC would have considerable consequences for priorities among commodities. To quantify these, a method was developed for adjusting the value of production of each commodity in each regional agro-ecological zone by the ratio between the final priority ranking with modifiers weighted at 0·5 and the initial ranking based on value of production. The ratio is calculated by dividing the final value by regional agro-ecological zone (Table 10) by the value of production by regional agro-ecological zone (Table 5). If modifier weights change, the ratio will have to be adjusted also. The ratio ranged from 4·87 in RAEZ 1 in sub-Saharan Africa to 0·20 in RAEZ 7 in Asia.

Next, the value of production of each commodity in each regional agro-ecological zone is multiplied by the ratio obtained for that zone. This means that a crop with a high production value is grown mainly in an area that is accorded low priority may end up with a lower priority than a crop with a cow production value grown mainly in an area that is accorded high priority. Commodities produced in RAEZ 1 of sub-Saharan Africa would increase almost fivefold in their value of production. Those produced in RAEZ 7 of Asia will be reduced by more than 80%. These adjusted values of commodity production can then be aggregated by region and by agro-ecological zone. The results which show the unadjusted and adjusted values, respectively, globally and by region are shown in Tables 11, 12 and 13.

The percentage share of 35 major agricultural commodities in the global value of production are shown in Table 11. Rice represents 16·4%, wheat 6·4%, etc. Regional distributions of this value of production by commodity are shown. However, since regional price differences were not used in calculating the total value of production, the regional distribution reflects production only. For example, 2% of rice is produced in sub-Saharan Africa, 1% in West Africa–North Africa, 93% in Asia and 4% in Latin America and the Caribbean. Barley is produced predominantly (66%) in West Asia–North Africa, cassava (45%) in

TABLE 11
Values of Production Across Regions Not Adjusted for Regional Agro-ecological Zone Priorities

Commodity	*Region*[a]					
	SSA	*WANA*	*ASIA*	*LAC*	*SUM*	*Global value of production (%)*
Rice	2	1	93	4	100	16·40
Wheat	1	19	70	10	100	6·37
Maize	10	4	57	28	100	5·30
Barley	5	66	23	6	100	0·50
Sorghum	32	3	40	25	100	1·11
Millet	41	1	58	0	100	0·72
Cassava	45	0	35	20	100	2·64
Potato	3	15	65	17	100	1·79
Sweet potato	5	0	93	2	100	2·98
Yam	97	0	1	3	100	0·65
Banana and plantain	34	1	29	36	100	5·91
Beans	13	3	51	32	100	1·22
Broad beans	9	23	64	5	100	0·39
Chickpeas	3	15	80	3	100	0·74
Lentils	1	48	48	3	100	0·26
Groundnut	22	1	74	4	100	1·85
Soybean	1	1	33	65	100	2·64
Coconut	5	0	88	7	100	0·78
Tomato	5	49	23	23	100	1·27
Onion	3	23	59	15	100	0·69
Cabbage	1	9	85	5	100	0·44
Cotton	9	11	66	15	100	4·61
Coffee	20	0	17	63	100	4·32
Tea	12	9	77	2	100	1·25
Tobacco	6	6	73	15	100	2·26
Cocoa	58	0	15	28	100	1·20
Sugar	7	7	40	47	100	1·69
Rubber	6	0	93	1	100	1·29
Oil palm	17	0	78	6	100	0·83
Beef and buffalo meat	13	9	21	57	100	4·41
Sheep and goat meat	18	30	44	8	100	2·03
Pig meat	1	0	88	11	100	6·27
Poultry meat	6	14	44	36	100	2·07
Milk	8	11	52	28	100	9·94
Eggs	4	12	61	23	100	3·15
	11	7	60	21	100	100·00

[a] SSA = Sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.

TABLE 12
Value of Production Unadjusted and Adjusted for Regional Agro-ecological Zones Priorities Baseline Priority Plus Overall Weight of 0·5

Commodity	*Unadjusted*	*Adjusted*
Rice	16·4	11·6
Wheat	6·4	4·2
Maize	5·3	5·3
Barley	0·5	0·5
Sorghum	1·1	1·9
Millet	0·7	1·4
Cassava	2·6	5·1
Potato	1·8	1·4
Sweet potato	3·0	1·3
Yam	0·6	1·6
Banana and plantain	5·9	8·7
Beans	1·2	1·3
Broad beans	0·4	0·4
Chickpeas	0·7	0·6
Lentils	0·3	0·3
Groundnut	1·9	2·5
Soybean	2·6	1·6
Coconut	0·8	0·9
Tomato	1·3	1·4
Onion	0·7	0·6
Cabbage	0·4	0·3
Cotton	4·6	4·1
Coffee	4·3	5·5
Tea	1·2	1·2
Tobacco	2·3	1·6
Cocoa	1·2	2·5
Sugar	1·7	1·8
Rubber	1·3	1·5
Oil palm	0·8	1·1
Beef and buffalo meat	4·4	5·2
Sheep and goat meat	2·0	2·8
Pig meat	6·3	4·1
Poultry meat	2·1	2·1
Milk	9·9	10·7
Eggs	3·1	2·8
Sum	100·0	100·0

TABLE 13
Values of Production per Region Adjusted for Regional Agro-ecological Zones Priorities Baseline Plus Overall Weight of 0·5

Commodity	*Region*[a]				
	SSA	*WANA*	*ASIA*	*LAC*	*SUM*
Rice	8	2	85	5	100
Wheat	4	33	54	10	100
Maize	33	5	39	23	100
Barley	10	71	14	5	100
Sorghum	71	2	15	12	100
Millet	80	0	19	0	100
Cassava	72	0	18	10	100
Potato	10	23	48	19	100
Sweet potato	32	0	64	3	100
Yam	98	0	0	1	100
Banana and plantain	57	1	18	24	100
Beans	34	4	37	25	100
Broad beans	28	28	39	4	100
Chickpeas	8	19	70	3	100
Lentils	3	55	40	3	100
Groundnut	61	1	36	2	100
Soybean	3	2	22	73	100
Coconut	13	0	81	6	100
Tomato	15	53	13	19	100
Onion	11	29	45	15	100
Cabbage	3	15	74	8	100
Cotton	37	14	34	14	100
Coffee	39	0	14	47	100
Tea	28	10	60	2	100
Tobacco	28	10	45	17	100
Cocoa	78	0	8	14	100
Sugar	25	7	27	41	100
Rubber	15	0	84	1	100
Oil palm	32	0	63	5	100
Beef and buffalo meat	38	8	14	39	100
Sheep and goat meat	49	25	22	5	100
Pig meat	6	0	78	16	100
Poultry meat	21	16	31	33	100
Milk	32	12	34	22	100
Eggs	16	15	44	25	100
Sum	34	8	39	19	100

[a] SSA = sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.

sub-Saharan Africa, and soybean (65%) in Latin America and the Caribbean.

The unadjusted baseline data are dominated by the value of production of the staple cereal crops (rice, wheat and maize), and by the large differences between regions in the production not only of cereals but also of many other commodities. Banana and plantain, beef and buffalo meat, and milk are the other CGIAR commodities with a significant (>4%) share in the value of production. The most significant aspect of the regional distribution is the dominance (>80%) of Asia in the production of CGIAR commodities like rice, sweet potato, chickpea, coconut and cabbage. Rubber and pig meat are also of particular importance in Asia. The bulk share of sweet potato and pig meat is produced in China.

Tables 12 and 13 present the outcome of the weighting process. Commodities that are mostly produced in Asia and in the subtropics generally reduce in importance, while commodities produced in the tropics and in sub-Saharan Africa generally rank higher.

The weighting process generally shifted the ranking of commodities in favor of sub-Saharan Africa and away from Asia, as might be expected from the analysis above. Overall, rice shifts from 16·4 to 11·6%, and on a regional basis rice in sub-Saharan Africa increases from 2 to 8%. Similar regional shifts can be seen in the case of wheat, maize, millet and sorghum, although the overall ranking of maize does not change, and those of millet and sorghum increase. In the case of wheat, the priority for West Asia–North Africa increases from 9 to 35%. Other significant regional shifts include large improvements in the ranking in sub-Saharan Africa of cassava, sweet potato, banana and plantain, phaseolus beans, broad bean, groundnut, beef and buffalo meat, sheep and goat meat, and milk.

Sensitivity of adjusted commodity values, and their regional distribution to modifier weights

To explore the sensitivity of the distribution of adjusted values of production of commodities in the agriculture analysis, TAC tested the impact of weighting all modifiers at 0·25 and at 1.

The results for selected CGIAR commodities on a global basis showed that some commodities are very sensitive to the weight given to all modifiers while others are not (Table 14). The higher the weight attached to modifiers, the smaller the share of rice, wheat and sweet potato, and the higher the shares of cassava, sorghum, millet and banana. The first three commodities are produced mainly in Asia, while the latter are associated more with sub-Saharan Africa. Given that the modifiers on balance give more weight to sub-Saharan Africa and less to Asia, the higher the weight, the more the modified commodity base shifts toward

TABLE 14
Sensitivity of Modified Relative Commodity Value of Selected CGIAR Commodities to Baseline and Modifier Adjustment[a]

Selected CGIAR commodities	*Value of production*	*Baseline weighted value of production*	*Modified baseline value of production*		
			0·25	*0·50*	*1·00*
Rice	16·4	14·2	12·9	11·6	9·9
Wheat	6·4	5·8	5·0	4·2	2·8
Maize	5·3	5·6	5·4	5·3	5·0
Barley	0·5	0·5	0·5	0·5	0·6
Sorghum	1·1	1·4	1·7	1·9	2·3
Millet	0·7	1·0	1·2	1·4	1·8
Cassava	2·6	3·4	4·3	5·1	6·5
Potato	1·8	1·7	1·5	1·4	1·1
Sweet potato	3·0	2·3	1·8	1·3	0·8
Bananas	5·9	6·5	7·6	8·7	10·5
Beef and buffalo meat	4·4	4·7	5·0	5·2	5·4

[a] Columns will not add to 100 because only selected CGIAR commodities are included.

sub-Saharan African commodities. But also note that the other commodities are redistributed less by the analysis: the relative value attached to maize, barley, beef and buffalo meat change little at different weights.

The regional analysis for five CGIAR commodities comparing unweighted values of production to modified values weighted at 1 reveals that modification in some cases causes enormous shifts between regions (Table 15). The most extreme is in sweet potato, where the share with modifiers weighted at 1 is 68% for sub-Saharan Africa compared with levels of 5% for unweighted value of production and 10% for weighted baseline value. The inter-regional shifts are also pronounced in sorghum (away from Asia towards sub-Saharan Africa), wheat (away from Asia towards West Asia–North Africa) and beef and buffalo meat (away from Latin America and the Caribbean towards sub-Saharan Africa). Even in rice, the relative allocation to sub-Saharan Africa increases sixfold over the unweighted value of production.

Additional inputs: the ACIAR framework

ACIAR has developed an information system to assist in its own resource allocation decisions. The system consists of a multi-regional international trade model using the concept of economic surplus to derive ex-ante measures of the relative economic benefits of alternative com-

TABLE 15
Sensitivity of Regional Distribution of Selected CGIAR Commodities: Value of Production Unweighted, Baseline Weighted and Modified

Selected CGIAR commodities	*Region*[a]	*Value of production*	*Baseline weighted value of production*	*Modified baseline value of production*		
				0·25	*0·50*	*1·00*
Rice	SSA	2	4	6	8	13
	WANA	1	1	1	2	2
	ASIA	93	90	88	85	80
	LAC	4	5	5	5	5
Wheat	SSA	1	2	2	4	8
	WANA	19	19	25	33	55
	ASIA	70	69	63	54	28
	LAC	10	10	10	10	9
Sorghum	SSA	32	51	62	71	82
	WANA	3	2	2	2	2
	ASIA	40	29	21	15	7
	LAC	25	18	15	12	9
Sweet potato	SSA	5	10	18	32	68
	WANA	0	0	0	0	0
	ASIA	93	81	79	64	27
	LAC	2	2	3	3	4
Beef and buffalo	SSA	13	23	31	38	51
	WANA	9	7	8	8	9
	ASIA	21	19	16	14	11
	LAC	57	51	45	39	29

[a] SSA = sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.

modity and regional research portfolios. To be considered, the research should cause a 5% reduction in the unit cost of production of a commodity. The economic benefits of such research are proportional to the value of production of the commodity. The distribution of these benefits among consumers, producers, importers and exporters is also estimated. The model allows for an assessment of the spillover effects of research on particular commodities to other environments. It also enables judgements about the relative strength of research and extension systems and rural infrastructure to be made.

The ACIAR framework allows analysis to be conducted at the international level. It includes all major production and consumption regions of the world and is based on FAO's agro-ecological zone concepts.

Details on the system and its results are provided in Davis *et al.* (1987), Ryan & Davis (1990), Davis *et al.* (1988), Fearn & Davis (1991) and Ryan *et al.* (1991).

A review of ACIAR commodity priority by region reveals consistency with TAC's analysis in several major commodities. The major difference between both outcomes at the regional level relates to the relative ranking of livestock in sub-Saharan Africa and wheat research in West Asia–North Africa. ACIAR's results also suggest that, for all the developing countries taken together, commodities such as rice, potato and sweet potato appear to deserve more investment than the level suggested by the TAC analysis.

ANALYSIS OF NON-COMMODITY SPECIFIC RESEARCH

Natural resources management

The widespread degradation of the natural resource base has been a growing concern in many countries in recent years. The sustainability of agriculture in some areas of the developing world is under threat because of the loss of genetic diversity, depletion of forest and water resources, soil erosion, salinization, acidification, waterlogging, desertification, deforestation, and environmental pollution.

Farmers' use of external inputs affects the quality of the resource base; underuse and overuse have detrimental effects. In farming systems where farmers plant crops annually with little or no external inputs, soil nutrient reserves are depleted and vegetative cover is reduced, thereby exposing the soil to erosion. Many cropping areas of Africa have been affected in this way. Research needs to develop integrated nutrient supply systems based on a balanced mix of external inputs, organic manures, biological nitrogen fixation and efficient cycling of nutrients. While high levels of external inputs are needed to sustain high levels of production in better endowed areas, it may induce pollution problems. The generally lower rates of agrochemical applications in many developing countries imply that pollution has not yet become a widespread issue for them. However, in some intensive crop production areas, particularly in Asia, Latin America and North Africa, policy measures are needed to increase public awareness of potential problems to ensure that subsidies do not encourage overuse.

Research needed to address the many and diverse problems of resource degradation and environmental pollution is beyond the capacity of the CGIAR System. TAC then decided that CGIAR research on resource management should be focused on issues that directly deal with productivity and sustainability of agriculture, forestry and fisheries. Furthermore, such research should be confined to issues associated with those commodities and production systems within the CGIAR mandate.

Important resource management research topics at the global level include the substitution of renewable resources, the conservation (stewardship) of genetic resources and various valuable ecosystems (including their wildlife), the contribution of agriculture to atmosphere composition and climate change, and the impact of those changes on agriculture. Broad issues requiring research include the roles of community and government agencies, agriculture and other businesses in resource management and conservation. In addition to developing new technologies for resource management, research should be focused on the organizational, educational and policy aspects of resource management, and on institution building. The size of management unit considered in resource management research is also important in assessing priorities. For most purposes, the management unit is the individual farm, but for some research a larger unit such as a landscape, a watershed or an irrigation system is more suitable.

Strengthening national research systems and information services

The CGIAR began as a mechanism primarily for funding technological research, but over the years increasing emphasis is being placed on collaboration with national systems in research and on institution building. TAC believes a balanced approach to research and institution building to be appropriate.

The CGIAR system has provided training for large numbers of scientists from national systems (approximately 25 000 during 1985–89). However, the training programmes at the CGIAR centers need to take account of the progress made. Group training, especially production-oriented training, should be reduced in favor of individual post-graduate training and visiting scientist arrangements. In addition, advances in information technology will offer the CGIAR centers new opportunities to collect, analyze and disseminate research information.

Institutional weaknesses still place major limitations on technology generation and adoption in the national systems of many countries. In the past the CGIAR centers have played important roles in institution building, including the organization of research networks, the provision of consulting services and the forging of institutional links. Furthermore, ISNAR provides a comprehensive integrated and systematic approach to strengthening national research systems. In the future,

collaborative relationships between CGIAR centers and national research systems will increasingly augment the traditional institution-building activities.

Research on socio-economics, public policy and public management

The mission and goals of the CGIAR are unlikely to be achieved without a conducive policy environment. The lead CGIAR center involved in research on these policy issues is IFPRI, but other centers, notably ISNAR and IIMI, also play a role. The CGIAR primarily acts as a catalyst in the field of food policy research in (1) understanding the interactions between government action and human behavior in relation to agriculture, technology, natural resources, and consumption, and (2) collaborating with national systems in identifying policy and management options.

The broadening of CGIAR goals to embrace self-reliance extends policy and management research to include cash crops, reduction of staple food costs and the more efficient use of inputs and natural resources. The role of international trade in providing food security is gaining in importance.

More policy research on sustainability issues is also needed, particularly in securing stable funding for national research systems.

CGIAR will continue the research on human linkages, particularly in relation to human nutrition and gender issues. More work is also needed on the structures and processes by which research products reach and are utilized by rural producers and urban consumers.

There is also a need to develop a knowledge base on the management of public organizations, such as national research agencies and irrigation management institutions, to develop improved management concepts and tools.

IMPLICATIONS FOR CGIAR PRIORITIES AND STRATEGIES

Priority setting in the CGIAR is a complex multi-dimensional process. The framework for priority setting developed and used by TAC has many advantages. It allows the introduction of modifiers to reflect the various goals for the CGIAR, and it requires TAC to recognize at every stage that increasing some activities means decreasing others. The framework facilitates greater transparency in the priority setting process. However, there are also disadvantages—such as the possibility of introducing biases in the choice of modifiers and their weights, and the danger of relying too greatly on the numbers resulting from the spreadsheet analysis. It is also important to take into account the totality of the analysis, not just the spreadsheet analysis. The spreadsheet analysis relates only to the allocation of priorities by region and agro-ecological zone, and by agricultural commodity. A different approach was used for the analysis of activities that are not commodity or regional specific.

In this section we present TAC's preliminary views on priorities by research activity category, and on the implications of the quantitative analysis for the distribution of resources across regions and production sectors. Some outstanding issues are also addressed, including the link between CGIAR priorities and resource allocation, and the implications of revised CGIAR priorities for strategies and the future structure of the CGIAR.

Priorities by activity category

CGIAR resources allocated across activity categories in 1989 were 15% to conservation and management of natural resources; 25% to germplasm enhancement and breeding; 35% to production systems; 5% to socio-economics, public policy and public management research; and 20% to strengthening national systems. This distribution need not necessarily provide the basis for future allocations across activity categories. Indeed, it will have been altered by the recent addition of new institutions and subject matter areas to the CGIAR System.

In all regions and agro-ecological zones, there was a perceived need for an expanded effort in research on the conservation and management of natural resources. TAC therefore suggested an increase in CGIAR efforts in this category from the current level of 15% to 20%, with particular attention to sub-Saharan Africa and Latin America and the Caribbean.

On germplasm enhancement and breeding, TAC's overall view was that the current level of allocation of 25% should be maintained, with greater emphasis on Asia, particularly for rice. In the longer term, national systems should be able to do most of the applied and adaptive research needed under the production systems category. TAC therefore suggested that the future allocation to this category be reduced from 35% to 25% of the total.

There are strong indications that the need for socio-economics, public policy and public management research will become increasingly important in the future. TAC therefore proposed that the CGIAR double its efforts in this category from 5% to 10% of the System's resources.

Regarding the strengthening of national systems, TAC's tentative conclusions were that overall emphasis on training should be reduced. Continued strong efforts in training will, however, be required in sub-Saharan Africa, where institution building should also be emphasized. Information services is another area that should be strengthened to enhance partnerships with national systems. Thus the overall proportion of CGIAR activities devoted to strengthening national systems would remain the same, but with less in training and more in institution building.

The overall tentative judgements on resource allocation by activity category, pending further consultations with stakeholders, are shown in Table 16.

TABLE 16
Priorities by Activity Category and by Region

Activity	*(System) 1989 Base*	*(System) 2010 Rec.*	*Region*[a]			
			SSA	*WANA*	*ASIA*	*LAC*
1. Conservation and management of natural resources including germplasm preservation (biodiversity)	15	20	+	+	−	+
2. Germplasm enhancement and breeding in agriculture, forestry and fisheries	25	25	−	−	+	0
3. Production systems of agriculture, forestry and fisheries	35	25	+	0	−	−
4. Socio-economic, public policy and public management research	5	10	0	−	+	+
5. Strengthening national research systems (including training, information and institution building)	20	20	+	+	−	−
Total	100	100				

+ = More than the new system level allocation; 0 = equal to system level allocation; − = less than system level allocation but possibly higher than current allocation.
[a] SSA = sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.

Relative priorities by agro-ecological zone

The analyses of priorities by agro-ecological zone and by regional agro-ecological zone show that, with respect to the baseline values for agriculture, relative emphasis should increase in tropical agro-ecological zones (AEZs 1–4) and in the cool subtropics with winter rainfall (AEZ 9).

TAC does not have information on the current allocation of CGIAR resources by agro-ecological zone. The proposed new allocations can therefore not be compared with existing allocations. However, based on its knowledge of current efforts TAC feels that the shifts implied in the analysis are already under way in the CGIAR system.

Regional priorities

In previous TAC reviews of CGIAR priorities insufficient emphasis was placed on regional priorities. The current exercise began with regional agro-ecological zones and therefore allowed a more comprehensive analysis of the regional distribution of CGIAR resources (Table 17).

Using the three-point base (area of land resource base under use, number of poor people, and value of production) shifted the baseline value in favour of sub-Saharan Africa. Applying the modifiers and increasing their weights further shifted the emphasis towards sub-Saharan Africa and also towards West Asia–North Africa. Having considered the implications of the analysis for regional balance very carefully, TAC concluded that any weighting greater than 0·5 would have a distorting effect.

TABLE 17
Impacts of Baseline and Modifiers of Regional Distribution of Values Relative to Current Allocation in Agriculture

Region[a]	*Baseline components*[b]			*Baseline*	*Modified baseline*			*Current (1989) allocation*
	Value of production (%)	*Number of poor (%)*	*Usable land (%)*		*0·25*	*0·5*	*1·0*	
SSA	11·1	16·2	28·1	18·9	26·5	34·1	47·2	40·6
WANA	7·1	5·4	12·3	6·7	7·4	8·2	9·2	12·9
ASIA	60·4	72·1	33·3	53·5	86·3	39·1	27·8	29·5
LAC	21·4	6·3	26·4	21·0	19·8	18·7	15·8	17·0
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

[a] SSA = sub-Saharan Africa, WANA = West Asia–North Africa, LAC = Latin America and the Caribbean.
[b] Each component is given a weight of 0·33.

The rapid population growth coupled with declining per caput food production in sub-Saharan Africa make a strong case for a major involvement of the CGIAR in that region. The fragility of some of the marginal areas of its tropical agro-ecological zones and the slow rate of progress in productivity improvement to date add to the apparent urgency. On the other hand, the magnitude of population numbers, the narrowing yield gap and the limited scope for land expansion argue strongly for more long-term strategic and applied research in Asia. TAC's tentative position was that further transfers of resources to sub-Saharan Africa should occur only after a full debate has been held by members of the CGIAR.

Priorities by commodity

Although TAC has yet to reach final conclusions on commodity priorities, preliminary discussions have raised several important issues. TAC began by comparing the list of the top 27 agriculture commodities in developing countries with the current list of CGIAR commodities. Firstly, strong new candidates for inclusion in the CGIAR System were considered. Current CGIAR commodities were then reviewed, particularly those with relatively low modified values of production but which are important for limited subsets of regions and for countries. This led to a discussion of whether any current commodity should be dropped. Lastly, TAC looked at the congruence between the modified values of production and the current allocations to determine whether there was a need to consider altering the distribution of resources among commodities in the agricultural production sector.

Results of the spreadsheet analysis

The analysis showed that 16 of the 27 commodities listed were already supported by the CGIAR System. It also confirmed TAC's earlier (TAC/CGIAR, 1990) recommendation that vegetables (tomato, onion and cabbage) should be included in the CGIAR System. Of the remaining 10 commodities, coffee, pig meat and cotton rank within the top 10. However, TAC's position on these and the other seven commodities (eggs, cocoa, poultry, tobacco, rubber and tea) is not to recommend their inclusion at this time for reasons related to the availability of other sources of research supply, and lack of comparative advantage of the CGIAR System.

Current CGIAR commodities with relatively low modified value of production included lentil (0·3%), pigeonpea, cowpea, chickpea (0·6%), phaseolus beans (1·3%), soybean (1·7%), sweet potato (1·4%), potato (1·4%), yam (1·3%) and pearl millet (1·4%). In 1986, TAC had already recommended phasing out faba bean and lentil.

Criteria used by TAC

To determine whether there was a need to consider altering the relative rankings of priorities among current CGIAR commodities, TAC examined the results of its modified congruence analysis. The criteria used included current level of resource allocation relative to the outcome of the spreadsheet analysis; low-base weight; importance of the commodity (whether global, regional or in one or two countries only); strength of national research programmes; importance of the commodity within the farming system for the poor; alternative sources of supply; record of impact achieved through research; possibilities for progress and comparative advantage of the CGIAR.

Implications

The modified values of groups of commodities for all developing regions combined were cereals 37·4%, roots and tubers 14·1%, food legumes 7·5%, banana and plantain 13%, and livestock 28%. These figures compare with 1990 core resource allocations of cereals 50%, roots and tubers 11·3%, food legumes 12%, banana and plantain 0·7% and livestock 27%.

If congruence analysis were to be strictly applied, differences between modified values and actual allocations could be used to raise the issue of whether CGIAR resources should be reallocated from cereals and food legumes towards roots and tubers and banana and plantain. TAC's view was that only large differences should be explored further.

Based on the strength of national research systems, TAC proposed reduced emphasis on three commodities, i.e. phaseolus beans, chickpea and pigeonpea. Phaseolus beans are mainly produced in Brazil and Mexico, and over 80% of the world's production of pigeonpea and chickpea is grown in India. Brazil, India and Mexico are considered to have relatively strong national programmes. TAC nevertheless felt that current efforts in West Asia–North Africa on chickpea and in sub-Saharan Africa on pigeonpea and phaseolous beans should be maintained because of the importance of *Ascochyta* blight in the former, and the weakness of national programmes in the latter.

Cowpea is largely produced in Nigeria, and could be an important commodity throughout West Africa, where national systems are still weak. TAC concluded that it would therefore be appropriate to continue short- to medium-term CGIAR support.

TAC noted that soybean ranked above several other legumes and thus has substantial potential in developing countries.

Yam, potato and sweet potato were not in the top 20 commodities in the modified list. In its 1986 review of priorities, TAC recommended short-term continuation of efforts on yam, followed by a performance

review in five years. The assessment of the Third External Review of IITA (TAC/CGIAR, 1991*a*) was that the comparative advantage in yam improvement lay with the Nigerian national research system, and that IITA should concentrate on germplasm conservation and on the critical constraints to germplasm improvement. TAC endorsed this view, and suggested that a review of the effectiveness of CGIAR research on yam should be part of the next external review of IITA, which has the global mandate for this commodity.

Potato fell in the modified ranking, mainly because it is predominantly grown in the subtropics and cool tropics. National systems in these agro-ecological zones are relatively strong. A case could therefore be made for reducing the emphasis on potato in some regions. TAC notes that CIP has already started to de-emphasize research on potato in its long-term strategy.

Over 80% of the global production of sweet potato is in China which has a relatively strong national research system. Furthermore, there has been a steady decline in the importance of sweet potato as a food staple, and shifts in product utilization have occurred, largely in Asia. TAC proposed that the level of CGIAR support for sweet potato be maintained in the short term, but to reduce it in the long term.

Pearl millet is an important crop in sub-Saharan Africa, where approximately half of the world's production is found. In Asia, millet is mainly produced in India. In 1986, TAC recommended a shift towards sub-Saharan Africa, to which ICRISAT responded positively. The assessment of the Third External Review of ICRISAT (TAC/CGIAR, 1991*a*) was that most applied and, in due course, strategic research of interest predominantly to India should be transferred to the national programme. TAC endorsed this view.

In 1986, TAC recommended a relative reduction in the emphasis given to rice from its 25% level of commodity research expenditure. This recommendation was based on the apparent over-emphasis on the commodity relative to its importance in global food supply and on the strength of national programmes in Asia. The analysis just completed seems to support this recommendation, but, for a variety of reasons well-known in the CGIAR, the relative funding for rice has not declined.

The Committee reconsidered its earlier recommendation to reduce the relative allocation of rice, particularly in Asia where national programmes have grown even stronger. In West Africa, rice consumption continues to rise rapidly as a component in diets, substituting for traditional staple cereals and roots and tubers, especially in urban areas. Furthermore, weaker national programmes and higher research costs make African research in general more expensive than research elsewhere. Given the

CGIAR decision to have a major upland rice improvement effort in Africa, TAC recommended funding at a critical minimum level which gave the research programme a reasonable chance of success. Thus, the issue remains complex. TAC currently is mounting an inter-center review of rice in the CGIAR in conjunction with external reviews of IRRI and WARDA. TAC therefore will continue to consider the relative distribution of resources for rice.

With respect to wheat, TAC noted that national research systems frequently have good capabilities for adaptive and applied research and that greater focus on strategic germplasm research is needed. The private sector is also assuming greater responsibility, as in the case of maize.

Finally, TAC noted that, while the congruence on livestock research appears close globally, there remain major questions about activity, and regional and species emphasis. When Winrock International completes its current livestock study and ILRAD and ILCA finalize their next external reviews, TAC will revisit livestock research priorities.

Concluding remarks

While TAC has not yet finalized its priority recommendations, some general propositions have emerged. This priority analysis is more comprehensive and more quantitative than previous TAC efforts. TAC has attempted to bring into the analysis quantitative indicators of the most important dimensions of the CGIAR mission and goals. It has also carefully reviewed the outputs of similar efforts such as that of ACIAR. The quantitative analysis enhances the transparency of the thought process and the rationale for decision-making. A major conclusion arising from TAC's analysis is that the current constellation of CGIAR activities is highly congruent with present and future research and research-related needs.

The challenges facing the CGIAR at its birth have intensified. Population growth continues at high rates, particularly in Africa, poverty and malnutrition remain pervasive, the need for increased productivity grows more acute as the opportunities for area expansion diminish, and long-term issues of sustainability have become both more prominent and more severe. Thus TAC concluded that applied and strategic research at the international level focused on productivity improvement and sustainable resource management for agriculture, forestry and fisheries, is needed more now that it was in 1970. Despite a broadening commodity portfolio and additional interests in natural resources management, the CGIAR system remains a highly focused organization. The system still devotes critical and necessary levels of resources to selected commodities of major

importance, and still focuses on a set of research activities that are most efficiently and effectively conducted internationally.

Thus the tentative conclusion that no major changes in activities, regional emphasis and commodity portfolios should be made, should be seen as the strength of the CGIAR System. The Group and all its components have always been futuristic and devoted to handling emerging issues of importance. The 1991 CGIAR System is both similar and different from the innovative 1971 model. It is similar in its commitment to improving the lot of the poor in developing countries by increasing their access to an affordable and sustainable food supply. It is different in its scale, breadth of activities, and emerging partnerships with developing countries. The challenge ahead remains enormous.

OUTSTANDING ISSUES

Links to resource allocation process

The basis for an effective resource allocation process should be a comprehensive priorities framework which establishes, in quantitative terms, the relative emphasis to be given to the various research and research-related activities in the System and the centers (CGIAR Secretariat, 1990). TAC has made recommendations, in the form of broad quantitative targets, for the allocation of CGIAR priorities by category of activities, by commodity, by region and by agro-ecological zone. A quantitative assessment of priorities, however, cannot simply be translated in an equivalent allocation of resources. Other factors have to be taken into account, such as need for minimum critical mass, the cost of the research activity, comparative advantage, possibility of breakthrough, economies of scale, availability of alternative sources of supply and the need for international strategic research.

The CGIAR has requested that TAC develop a mechanism for linking the resource allocation process to the System's overall priorities. The 1989–90 review of the new resource allocation process highlighted the growing imbalance between perceived research needs and the availability of funds. TAC is thus cautioned to be aware of potential funding constraints. The aim is to use the priority-setting framework to set potential funding targets for CGIAR centers.

The spreadsheet framework used by TAC in the current analysis of priorities is largely mechanical and does not handle activities that are not commodity (or region) specific. It can therefore provide only a partial input into the linkage mechanism. TAC intends to develop a more aggregate and institution-oriented approach which will draw on the totality of the priority assessment exercises, including TAC's collective judgement and the institutional strengths and strategic plans of the centers. With this caveat, TAC remains convinced that the translation of priorities into institutional resource allocation targets is feasible. A proposal will be formulated at TAC's 57th meeting in March 1992.

Implications for TAC's analysis of agricultural priorities for strategies and the future structure of the CGIAR

If TAC's tentative conclusions on priorities are confirmed, the major remaining issue that needs to be resolved is the strategic and structural implications of its analysis for center mandates and the future structure of the CGIAR System.

TAC had already presented preliminary discussions on these matters (TAC/CGIAR, 1990; 1991*b*). TAC proposed that the CGIAR System should have two primary operational mechanisms: ecoregional and global. Ecoregional mechanisms would be charged with developing a comprehensive understanding of agro-ecological zones, e.g. the soil, water and biological characteristics and processes, the impact of human decisions and their utilization, and applied and strategic work on important commodities—crops, trees and livestock. Global mechanisms would pursue either, highly focused germplasm-based commodity research mainly at the strategic level, or strategic research on selected subject matters such as policy and management of transnational and global significance. Movements to restructure the CGIAR System in that direction would require adjustments in the mandates of many of the existing CGIAR centers and explicit consideration of how ecoregional research needs would be addressed, particularly in eastern and southern Africa and in Asia. Clearly, the future structure and the size of the CGIAR will be heavily influenced by issues of fund availability, governance needs and operational forms. TAC is still debating the issue and is currently formulating proposals on future strategies and the structure of the CGIAR System.

Next steps

TAC will continue its discussion of priorities and strategies, the linkage with the resource allocation process, and structural implications at its 57th Meeting in March 1992. As already indicated, it plans to continue its interactions with national research systems, center directors, board members, donors, and other members of the CGIAR and the research community. With these further inputs, TAC will finalize its review of CGIAR

priorities and strategies and present it to the CGIAR in time for the Mid-Term Meeting in May 1992.

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