

Consultative Group on International Agricultural Research
Technical Advisory Committee

Review of CGIAR Priorities and Strategies

This report comprises:

- (a) Extract from: "Summary of Proceedings and Decisions", CGIAR Mid-Term Meeting, Istanbul, Turkey, 19-22 May 1992
- (b) Letter from TAC Chairman transmitting the Report of the Review of CGIAR Priorities and Strategies
- (c) Report of the Review of CGIAR Priorities and Strategies
- (d) TAC Chairman's transmittal letter and summary of the CGIAR Medium-Term Resource Allocation 1994-98 – Analysis and Recommendations

Consultative Group on International Agricultural Research
Technical Advisory Committee

Review of CGIAR Priorities and Strategies

TAC SECRETARIAT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Consultative Group on International Agricultural Research

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From: The Secretariat

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CGIAR Mid-Term Meeting

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Istanbul, Turkey

CGIAR Priorities, Strategies and Resources¹

Context and Consultation

At MTM92, the Group resumed discussion of TAC's proposals for priorities, strategies, structure and resource allocation in the CGIAR system.

Discussion began at ICW91 when the Group considered two documents prepared by TAC, **A Review of CGIAR Priorities: Advanced Working Draft**, which provided a framework for assigning relative priorities by activities, agroecologies, regions, production sectors and commodities; and a second paper which was a summary of the first.

After a searching discussion of TAC's draft proposals, the Group reached broad agreement on several themes, raised a number of questions that needed further examination and agreed that a final set of proposed priorities should be presented at MTM92.

These final proposals would be presented in the context of their translation into five-year resource envelopes, and their longer-term implications for the structure of the CGIAR system. Endorsement by the Group of the proposed resource envelopes would allow preparation of five-year program plans by the centers.

Also at ICW91, there was a strong feeling among all sections of the CGIAR system for working toward the redefinition of a system-wide strategy. There was a consensus that a synthesizing exercise by a small group could move the process along.

Consequently, the CGIAR Chairman convened a consultation at London in February 1992. A report on that consultation has been distributed within the system.

At MTM92, Mr. Walter Falcon who served as Moderator at the consultation, reported on its main outcomes.

¹ Extract from "Summary of Proceedings and Decisions", CGIAR Mid-Term Meeting 1992, Istanbul, Turkey.

Mr. Falcon said that he would summarize the major themes that emerged from the consultation under 10 points which focused on some organizational issues, some funding issues, some substantive issues and some communications issues. Most of them were actually talked about. Some were in the undercurrent and in the back rooms. Almost all start with the phrase "a concern about" or "a concern with".

- There was genuinely a concern at the London meeting that "business as usual" was not going to work any more.

This is because the CGIAR system was at a new point in its history that had to do with the proposed expansion, and with the fact that the system was facing new serious budget constraints of the kind that it had not dealt with for a very long time in its history. Adding to this, was the bureaucratization of the system and the maturity problems that arise when an institution such as the CGIAR moves from a first generation to a second generation of leadership, at all levels.

Under the same rubric of "business as usual won't work" is the need to come to grips with environmental and natural resource issues; and to define the system's most effective relationship with environmental groups.

The system also had to take note of the fact that with surpluses and declining real prices of commodities in the developed world, the CGIAR system with its emphasis on agricultural growth in developing countries is a "tough sell" among donors.

To deal with this concern, Mr. Falcon suggested that the CGIAR system badly needs a new crisp 15-page statement pointing the way to the future.

- There was a general concern that the success stories, of which there are many, had not been told well enough, widely enough and clearly enough.

The whole question of impact in telling that story better is a major conclusion of the London group, and it is probably a focus that external management and program review teams need to deal with much more than they have done in the past.

- There was concern about the administrative structure of the system.

Pointing out that there was great unhappiness at ICW91 on this score, Mr. Falcon suggested that some of the problems noted could be handled by the establishment of an executive committee.

In the absence of an executive committee, everything falls to TAC. TAC does five-year planning and strategy, annual reviews of programs, budget allocations and so on. To say this is not to condemn TAC. Alex McCalla and his colleagues perform exceptionally well, but they are caught up in the wrong structure, with too many functions.

If an executive committee is not in the cards, he asked, would the Group think about at least creating five standing committees, to deal with key functions such as

strategies, programs, fund raising, resource allocation and public awareness? That would streamline TAC and permit it to be more of a technical advisory group.

- There is a concern with International Centres Week, particularly with the size of this undertaking. It is not centers week any more, it is approaching centers month. In terms of participation, it is very hard to get above pro-forma set speeches. Given the growing importance of regional activities, and the growing importance, potentially, of the regional development banks, and the fact that some of the ecoregional activities are going to have to be done on a regional basis perhaps the answer is to hold a couple of parallel sessions running by region at ICW.

- There was great concern on funding levels, and on the need to develop processes that match supply and demand for funds.

Uniformly, the urgent need was recognized to match plans and budgets.

There was also a feeling, that it is not possible to cut center budgets or hold them constant in real terms or add centers, and expect the centers to do more on a net basis.

- There was concern about resource allocation processes.

It was hoped that the envelope system planned by TAC would move toward an equitable process. It was agreed, as well, that the continued role of the World Bank as "donor of last resort" is essential.

- The seventh point was the role of the private sector. There was general agreement that much could be learned from the private sector, and that this issue needed to be explored further perhaps with an in-depth discussion at ICW.

- There was concern about substantive focus.

There was absolutely no doubt on two fundamental points: germplasm is one pillar on which the system rests, and sustainability is the second. To be quite clear, it was understood that to talk about sustainability, without talking about productivity, was irrelevant.

Other matters discussed under substance included the possibility of including Eastern Europe and nations of the former Soviet Union in the CGIAR orbit. There was a long discussion about livestock, as well, and about the need for clarity in upstream/downstream issues.

- There was a concern about strategic research. This was most evident during discussions on the ecoregional concept. It was generally felt that clarity was needed on how the existing centers would and should take on the ecoregional resource and environmental systems questions.

- There was concern about communication.

The really good thing about the consultation at London was that 25 people around a table for three days in an information setting could really go at the issues. They found that a lot of apparent disagreements were simply due to the fact that they did not understand one another.

Extending this experience across the system, it is clear that in terms of impact analysis, in terms of ecoregional contact, in terms of organizing meetings and of external relations, much needs to be done. Communication within the system, and in external relations, is crucial.

Delegates commended the Chairman for convening the London consultation. They complimented Mr. Falcon both for his written report on the consultation (distributed in advance of MTM92) and for a succinct presentation at Istanbul.

In several interventions, support was expressed for restructuring CGIAR meetings, and for new approaches to disseminating information about the CGIAR.

Some delegates regretted the omission of relations with national research systems in the highlights of the consultation presented at the Mid-Term Meeting.

In this connection, it was emphatically said that several donors would be unable to continue contributing to the CGIAR system unless specific requests for funding were made by beneficiary countries.

Priorities

At MTM92 the Group adopted a comprehensive set of priorities arranged by activity, region, production sector and commodity. These priorities will guide the evolution of the system's programs over the next decade. As a by-product, the Group endorsed a new approach to priority setting developed by TAC and described in its report, **Review of CGIAR Priorities and Strategies - Part I**. This section of the report covers TAC's analysis, conclusions and recommendations on priorities. **Part II** of the report deals with the impact of CGIAR priorities, structure and resource allocation.

A summary of TAC's analysis follows.

Activities. TAC's analysis showed that the current constellation of activities in the expanded CGIAR is largely congruent with present and future research and research-related activity needs, but that much greater emphasis still needs to be given to natural resource conservation and management.

TAC listed five clusters of activities and made recommendations for each.

Conservation and Management of Natural Resources. TAC recommended an increase in this area, with approximately equal weight for ecosystem conservation and management, and germplasm collection, conservation, characterization and evaluation.

Germplasm Enhancement and Breeding. CGIAR centers have an established record of success in this activity, and TAC recommended a slight increase, particularly in Asia where research could help to raise the yield ceilings of food crops.

Development and Management of Production Systems. TAC recommended a reduction in these activities over the long term, as national research systems should take over much of this work which is location specific.

Socioeconomic, Public Policy and Public Management Research. TAC recommended increased priority for these activities for which there is an increasing need in all developing regions. Among the issues that need to be addressed are land use, sustainability, poverty alleviation and self-reliance in food.

Institution Building (including Training, Information, Organization and Management Counselling and Networks). TAC emphasized the need for supporting institution building in developing countries, but recommended a reduction in some of these activities, particularly technical assistance.

Agroecologies. TAC recommended an emphasis on tropical agroecological zones, and the cool subtropics. For forestry, priority was recommended for tropical zones.

Regions. For the long term, TAC's recommendation is that the emphasis be shifted from Africa to Asia. The shift will begin in the short term, and evolve to the proposed levels over time.

Production Sectors. TAC indicated that the magnitude of value of production is greatest in agriculture, followed by forestry, then by fisheries. New initiatives in forestry and fisheries should not be at the expense of agricultural research.

Commodities. A detailed analysis of commodity priorities was presented for agriculture, forestry and fisheries. This included increased emphasis on roots and tubers, oil crops, vegetables, bananas and plantain, and forestry research thrusts endorsed by the 1988 Bellagio Task Force on Forestry.

Reviewing this final version of TAC's recommendations presented for discussion at MTM92, Mr. McCalla said that they reflected views expressed by CGIAR members at ICW91 as well as calculations resulting from updated data.

The revised document was not very different from the version discussed at ICW91. The methodology and general approach are unchanged. Some numbers are different, however, partly because of new pricing data, but also because projections were made (in the revised version) for 17 centers, not 13 as before.

Mr. McCalla said that a major recommendation from TAC was that there should be a substantial increase in priority allocation to the conservation and management

of natural resources including germplasm conservation, and an increased emphasis on socioeconomic, public policy and public management research. These emphases, he added, were endorsed by the Group at ICW91.

He reminded the Group that at ICW91 TAC had said that on the basis of its analysis it could not find compelling reasons for a continued adjustment of CGIAR resources in the direction of Africa and away from Asia. Further analysis had confirmed that view.

In the broad area of commodities research, TAC was not recommending major changes, he added. TAC's analysis suggested that there was overinvestment in livestock research. This issue would be re-examined, however, on the basis of the external program and management reviews of ILCA and ILRAD, and the livestock study led by Winrock International.

Mr. McCalla reminded the Group that they were engaged in a sequential process. They had to move on from setting priorities to defining strategies and structure and allocating resources.

The Chairman drew attention to this point as well, reminding the Group that because proposals for strategies, structure and resource allocation were based on priorities, it would be difficult to move ahead with further discussion until agreement was reached on a set of priorities.

Delegates commended TAC for the thoroughness of its approach, for its transparency and for establishing a priority-setting methodology which some CGIAR members might even wish to adopt in their own institutions.

They were living through a period of stringency in the availability of overseas development assistance funds. Efforts, such as those undertaken by TAC, to place ODA funding on a rational basis helped to bring about clarity in donor countries and institutions.

TAC's analysis was uniformly well received. TAC's recommendation for re-emphasizing natural resource management was fully endorsed. The need to devise new and concrete research methodology in this area was accepted. At the same time, it was viewed as a high priority for the CGIAR, perhaps requiring reorientation and innovation at centers.

Concern was expressed that livestock research might be downgraded in the CGIAR, despite its importance to the farming sector in many developing countries. The interaction of livestock with other aspects of farming should also be considered, in the view of some delegates.

There was general acceptance of the principles underlying TAC's approach to national systems. It was stressed, however, that linkages between CGIAR centers and national systems should not be weakened. More ways should be found - through

networks, for instance - by which the centers could benefit from their interactions with national systems.

The importance of the relationship with national systems was emphasized by both the representatives of board chairpersons and center directors. The latter would be meeting with 46 leaders of sub-Saharan Africa for a two-day meeting in June.

Mr. McCalla took note of the views expressed, and said that TAC would continue its examination of some of these issues.

The Chairman observed that broad consensus had emerged on TAC's proposals. The priorities recommended by TAC and endorsed by the Group could, therefore, serve as the basis for a discussion of strategies and structure.

Strategies and Structure

The Group completed a first round of discussion on TAC's proposals for strategies and structure, contained in Chapter 13 of the **Review of CGIAR Priorities and Strategies - Part II**. The Group agreed that TAC's proposals should serve as the working basis for further elaboration, clarification and development. This will be done in consultation with the centers and other stakeholders.

TAC's approach to strategies and structure flows from its medium- and medium/long-term vision for the evolution of the CGIAR system which was presented to the Group when it was engaged in expanding the CGIAR system. TAC defines the medium term as covering five years, the medium/long terms as 20 years and the long term as extending toward a horizon about which detailed discussion is not practicable.

In the medium/long term, TAC envisions the CGIAR system undertaking two separate but complementary research activities - global and ecoregional.

Global programs will concentrate on strategic research on an agreed slate of commodities and subjects. Global research will be conducted with close attention to regional requirements and programs.

Ecoregional activities will cover strategic and applied research on natural resource conservation and management production systems and location-specific aspects of commodity improvement. TAC proposed the establishment of six ecoregional programs - two in sub-Saharan Africa, one in the West Asia/North Africa region, two in Asia and one in Latin America.

TAC went on to offer some preliminary ideas on the institutional and structural options for carrying out these activities; the capacities available and those required for the future. TAC stressed that the relationships between global and ecoregional mechanisms would be "entirely complementary".

The Chairman reminded the Group that TAC's proposals should be considered as being in the form of a draft. Vigorous and incisive comment would help TAC as it reviewed its own proposals and as it continued its dialogue with centers, the leaders of national systems and others.

Some centers have begun to play a stronger ecoregional role. They would benefit from the Group's endorsement of that role and from suggestions for how best it should be carried out. An important element of ecoregional activities at CGIAR centers should be interaction with national systems. Endorsement and clarification of this connection would be helpful, the Chairman suggested.

In a brief overview, Mr. McCalla said that an important characteristic of Chapter 13 was that it fleshed out with even greater detail than before the parameters of ecoregional research, particularly the specific range of expected outputs, the relationship to natural resource management and linkages with national programs.

The current iteration would not satisfy everybody, Mr. McCalla said, but it was a further step forward. The next set of responses would be from the centers which were closely examining the concept itself as well as the operational aspect of the concept. The centers, Mr. McCalla suggested, were better suited than TAC to provide definitions in detail.

Mr. McCalla also shared with the Group the process by which TAC selected a set of ecoregions for concentration. TAC's conclusions were based on a match between the needs of ecoregions and actual or potential activities in existing centers.

TAC had undertaken a careful analysis of institutional options for the activities it had recommended; in effect, exploring what structure was best suited to the strategies envisaged. TAC did not present a fixed set of recommendations on structure, however, because the relationship between strategies and structure would have to be carefully reviewed with the centers and others before a definitive set of options was presented.

Mr. McCalla pointed out that the linkages between ecoregional and global activities were complementary in terms of concept and must be complementary in terms of operation. That critical set of linkages would be the core of TAC's future consultations.

Mr. Eugene Terry, Chairman of the Center Directors Committee (CDC), said that his colleagues would be proactive in meeting the challenges posed by the need for ecoregional research. He said that some of the issues that confronted them as they moved forward with this task were the need to define clearly partnership mechanisms with national systems; the need for additional resources; the need to maintain a judicious balance between crop research and natural resources management research; and ensuring maximum flexibility in putting together the institutions required.

TAC's proposals formed the basis of a vibrant discussion, covering conceptual issues as well as matters of operational detail. TAC's proposals represented a "first cut", and it was felt that the Group had a long way to go before reaching finality on some of

the issues. For that reason, the opportunity to participate in the development of TAC's proposals was welcomed. Overall, the Group supported TAC's approach, while suggesting areas in which further elaboration or clarification are required.

The following major subject areas were covered in the discussion.

Ecoregional Research. The ecoregional concept was overwhelmingly re-endorsed, with both TAC and CGIAR centers being encouraged to move from concept to operations. The need for the CGIAR system to intensify research into the management of natural resources was deemed to be crucial. There was general appreciation of the series of efforts that had been made to add substance and working detail to the concept as originally presented. At the same time, it was acknowledged that the responsibility for defining more specifics would continue to challenge the system because there were no established guidelines for natural resources management research. Elaborating the specifics would necessarily involve working out measurements by which the impact and success of ecoregional research could be determined.

National Systems. While acknowledging that ecoregional research presents the CGIAR system with a strategic research challenge of international significance, there was general agreement that the tasks facing the system could be effectively carried out only in full collaboration with national systems. A range of responsibilities that might fall on national systems was described. They included participation in setting out the agenda for natural resources management research, elaboration of criteria governing ecoregional research and full participation in research activities. Capacity building in national systems would have to proceed concurrently with collaboration in research. Innovative forms of collaboration would be required. In this connection, the use of networks was supported. Some national systems had proposed that CGIAR centers should work through nationally managed substations. TAC was encouraged to review these issues in consultation with national system representatives as well as within the system.

Selectivity. In several interventions, the CGIAR system was cautioned against attempting to do too much. There are many actors in the arena of agricultural research, and the CGIAR should not seek to accomplish more than what its resources and its critical mass of expertise permitted. In this connection, TAC's suggestion that, at least initially, the system should concentrate on a few agroecological regions was commended. TAC could rethink the regions it selected - based on suggestions at MTM92 or at other consultations - but the principle of selectivity should remain paramount. TAC and the system were urged to choose carefully what activities should actually be undertaken; and to choose scientifically. These activities, it was felt, should be transferable in terms of concepts, principles and methodology. Similarly, the selection process should be transparent, and related to the mission of the CGIAR.

Commodities. The emphasis on ecoregional activity should not detract from commodity activities, an area in which the CGIAR has had great success and in which it has a well-established comparative advantage. Moreover, commodity improvement remained so significant a factor in food productivity that its neglect would mean a loss to the international community. There was a clear sense that natural resources management research and commodity research were not mutually exclusive. They had already been

accepted as twin pillars of the system that would foster increased food productivity through sustainable agriculture. It was pointed out, as well, that sustainability concerns should not be restricted to marginal or fragile areas. High potential areas were of equal importance because they would be the source of increased productivity in the foreseeable future.

Structure. Streamlining the CGIAR system was seen as, potentially, a positive development. The point was made, however, that proposals made so far appeared more likely to preserve the status quo than to usher in changes. If a large number of options were presented to existing institutions it was likely that each would pick an option with which it felt comfortable; usually, an arrangement closest to its existing method of operations. The question of structure, therefore, needed further scrutiny on the basis of practicality and systemic judgement. Where changes were required, they should be real and not cosmetic. Old wares should not be repackaged. Many variations were possible as the system sought the most appropriate structure to work on agreed priorities. Some centers might be able to conduct both ecoregional and global research. Existing experience with intercenter collaboration should also be reviewed for any institutional options it might suggest. Notions concerning the amalgamation of existing centers should be cautiously evaluated. Final proposals should be based on a re-examination of options by TAC and the centers.

Mr. McCalla, taking note of the points made, said he interpreted the thrust of the discussion as an authorization to move ahead into the next phase of consultation. He will report back to ICW92 and again at ICW93.

Resource Allocation

The Group accepted a recommendation from TAC which links priorities to resource allocation. It endorsed a set of 1998 resource envelopes as the starting point to guide the centers as they draft new five-year plans and for budget-related discussion among TAC, the centers and the Group.

TAC's recommendations are based on a translation of priorities into program efforts across the system, and on an assumption of constant funding with some additionality for agroforestry, forestry and fisheries.

These recommendations are presented as indicative ranges of 1998 core funding for the centers in Chapter 14 of **Review of CGIAR Priorities and Strategies - Part II**. An indicative resource envelope is presented for each center, and centers were asked to submit to TAC budget proposals and program plans at both 10 percent above and below the resource envelope figure.

Opening the discussion, Mr. McCalla outlined the process by which TAC had moved from a system-level review of funds, with 1991 as a point of reference, to individual recommendations for each center, consistent with the priorities adopted by the Group.

In defining resource envelopes, he said, TAC was mindful of the fact that they were dealing with real well-established institutions (the centers), each with its own programs. The question, therefore, was how to establish the most reasonable interface between a new set of priorities and functioning centers. Mr. McCalla commended his colleagues for the effort they had put into the exercise.

Mr. McCalla pointed out that the resource envelopes represented only an overall number. Translating those numbers into specific programs and budgets, within the framework of established strategies, would be up to each center. The next steps would, therefore, have to be taken by the centers in the context of their medium-term planning. TAC will present its final funding recommendations to the Group at ICW93.

At this point, he said, TAC sought preliminary general endorsement of the resource envelopes. That would trigger the next phase of planning, and TAC-center consultations. Each center could argue its case for more, and TAC would consider these submissions in relation to the criteria on which resource envelopes are based as well as the overall funding situation.

The Chairman reminded the Group that what was expected from them was a close scrutiny of TAC's proposals, and a preliminary response. This would help both TAC and the centers to move the process along.

TAC was commended for its systematic effort to move sequentially from priorities through strategies and structure to resource allocation, and for providing guidelines with which the centers could proceed with the task of reconciling TAC's calculations with their requirements. The centers were living institutions and should not be expected to approach this responsibility in a mechanistic way.

In this connection, there was a sense among some donors that the guidelines provided should be amplified and made more explicit. Unless that was done, it was felt, the centers would find it difficult to move from Chapters 12 and 13 of the TAC paper to Chapter 14.

It was acknowledged that the resource allocation process was evolving, and that the situation would become more clear as consultations progressed between TAC and the centers. There would be converging coherence from this process. Nevertheless, further clarification was considered appropriate by some delegates.

Among the questions raised on matters of detail were the reasons for a holdback by TAC, the perception that "older" centers would suffer most, the need to find a place for networks within the CGIAR system and the danger that centers would play off "core" against "complementary" programs and could thereby subvert the allocation process.

A very strong preference was expressed for the continued role of the World Bank as "donor of last resort".

On behalf of the centers, Mr. Terry said that centers viewed the issues relating to the reduced funding envelopes in terms of a broader problem, that of declining

contributions to the CGIAR system. Center directors are sensitive to this problem. They want it to be known that they will be proactive in terms of their efforts to mobilize more resources.

He pointed out, too, that the centers have "many masters" such as donors, boards and partners in national programs. In whatever direction the centers move - whether it be in terms of resource allocation or any other activity - their actions have to be sanctioned by boards relevant to the needs of partners, attractive to donors and consistent with CGIAR priorities and strategies.

As the discussion evolved, two issues were raised for response and action:

- the specifics for ensuring that TAC and the centers would move in tandem toward a final definition of allocations;
- mechanisms by which program thrusts could be reported both by budgetary categories and program categories, thus making it possible for the CGIAR to present a strong external profile on, for instance, its environmental activities.

In response to the first point, Mr. McCalla outlined the following schedule: center directors, the TAC Chairman and others will hold preliminary discussions in June; a TAC-nominated panel would conduct a system-wide review between June 1992 and May 1993 of existing ecoregional activity; and an open workshop will be held at Puerto Rico immediately after MTM93. These arrangements would provide for a high degree of interaction and input.

On the second issue, Mr. McCalla undertook to examine methodologies at the World Bank and at USAID that could facilitate such a reporting mode.

Reviewing the discussion, the Chairman said that convergence was achieved on three broad fronts.

- (1) The Group endorsed the financial assumptions for the 1994-98 planning period, which maintains core funding at the current level in real terms, augmented by additional resources for agroforestry, forestry and fisheries.
- (2) The Group endorsed the resource envelopes recommended by TAC as starting points for five-year planning by centers.
- (3) The Group agreed that extensive interactions among TAC, the centers and others should precede final decisions at ICW93.

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

Alex F. McCalla
Chair

3 April 1992

Dear Mr. Rajagopalan,

It is my pleasure to submit to you TAC's Report on CGIAR Priorities and Strategies. The report is composed of two parts. Part I (containing Chapters 1-12) deals with TAC's current views on CGIAR priorities, while Part II (Chapters 13 and 14) covers the implications of revised priorities for the strategies and structure of the CGIAR and for resource allocation.

While Part I is very similar to the draft report that was discussed at International Centres Week '91, several changes have occurred reflecting the comments we received from members of the CGIAR, representatives of national research systems, centres and other stakeholders, and the outcome of further discussions by TAC at TAC 56 and 57. While we would, of course, encourage you and others to read through the entire document, we recognize that due to time limitations this may not be possible. Readers should, therefore, give particular emphasis to a careful reread of Chapter 12 which summarizes TAC's recommendations with respect to CGIAR priorities. Other important changes from the previous draft can be found in Section 2.2 on CGIAR activities and Section 4.6 where we have expanded the commodity coverage and have updated the data on prices and value of production. Due to the latter efforts, the outcome of the quantitative analysis reported in Chapter 9 is also slightly different, although the analytical approach has remained the same. In Chapter 9 we have also added new sections on the importance of particular commodities for the poor, and on spillover effects.

Part II of the Report is new. Chapter 13 builds on Chapters 8 and 11 of the report "A Possible Expansion of the CGIAR" (AGR/TAC:IAR/90/24) and contains TAC's views on future alternatives for strategies, and the structure of the CGIAR.

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Chapter 14 considers the implications of TAC's current views on CGIAR priorities for resource allocation, with particular reference to the medium-term programme and budget process. TAC discussed Part II for the first time at TAC 57 in March 1992 in Aleppo and we subsequently needed more time to revise this section than Part I. Part II is therefore being forwarded under separate cover.

Mr. Chairman, in transmitting this report, TAC completes the current round of analysis of CGIAR priorities as requested. We recognize however that priority setting is a continuing activity in the CGIAR. Over the next 12 months we will start monitoring the implementation of these revised priorities through the assessment of centres' medium-term proposals. With respect to Part II of the document, TAC recognizes that it would benefit from further inputs from members of the CGIAR and its stakeholders in the process, so a final version will be submitted to ICW'92.

The paper is a report from TAC as a whole, but I must pay special thanks to several people without whose hard work the task would not have been completed. Professor C.T. de Wit and the members of the TAC Standing Committee on Priorities and Strategies developed the methodology and proposed alternative approaches to TAC. John Monyo, Amir Kassam, Eric Craswell and the other staff of the TAC Secretariat have provided continuing and valuable support. Particular thanks must go to Guido Gryseels whose efforts were invaluable and far beyond the call of duty. Special thanks must also be given to the CGIAR Secretariat for their significant inputs in several sections of the report. Finally, we gratefully acknowledge the assistance received from FAO, ACIAR and many CGIAR institutes, particularly ISNAR and IFPRI.

We look forward to a stimulating discussion of the report at the Mid-Term Meeting of 1992 in Istanbul.

Yours sincerely,



Alexander F. McCalla
Chairman, TAC

THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH
TECHNICAL ADVISORY COMMITTEE

REVIEW OF CGIAR PRIORITIES AND STRATEGIES

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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REVIEW OF CGIAR PRIORITIES AND STRATEGIES

Summary

This report presents TAC's current views on CGIAR priorities and strategies. TAC's previous report on these matters was finalized during 1986 and led to the request at the CGIAR Mid-Term Meeting in 1987 that TAC produce an updated priority report every five years. In addition to producing broad directions for the CGIAR, TAC's recommendations on CGIAR priorities and strategies are used to guide resource allocation in the System, and to evaluate possible new initiatives for their consistency with these priorities.

TAC's present approach to priority setting differs from that used in 1986. It has been modified to take into account the expanded mandate of the CGIAR, the need to give greater emphasis to sustainability issues, to ensure transparency and to develop mechanisms which will allow priority setting to become a continuing activity of TAC. TAC has also made use of a formal analytical framework as an aid to (but not a substitute for) informed qualitative judgement and decision making. It should be stressed that the framework used is not an optimizing procedure, but aims only at clarifying choices. It allowed TAC to make the process of arriving at priorities transparent so that a reasoned dialogue with other stakeholders, such as national programmes, Centre Directors, Board Chairs, and CGIAR members, was facilitated.

TAC started its analysis of CGIAR priorities with an analysis of the mission and goals of the CGIAR which is discussed in Chapter 2. The CGIAR mission statement reads as follows: "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".

The goals of the CGIAR have been formulated as follows: (i) effective management and conservation of natural resources for sustainable production; (ii) improved productivity of high priority crops; (iii) livestock; (iv) trees; (v) fish, and their integration into sustainable production systems; (vi) improved utilization of crop, livestock, tree and fish products through improved postharvest technology; (vii) 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; (viii) appropriate policies for the increased productivity of crops, livestock, trees and fish, and for the sustainable use of natural resources; (ix) strengthened human resources and institutions for greater research capacity in developing countries' research systems.

The level and nature of the CGIAR's future involvement with each of these goals will vary greatly, but all are recognized as essential concerns. The aim is to contribute to the nine goals through research and institution building. Through research, the CGIAR Centres also contribute to science. All goals converge on the central mission of the CGIAR through a number of CGIAR activities. A comprehensive list of these activities is presented in Chapter 2.

Chapter 3 reports on the framework for CGIAR priority setting. Several factors guided TAC in its consideration of CGIAR priorities: the CGIAR mission and goals; emerging trends in the agriculture, forestry and fisheries sectors of developing countries; changes in science and the organization of research; the evolution of scientific capacity in developing countries; the relative importance of production sectors and commodities across regions and agroecological zones; the importance and international character of the development problem which generates the need for research; the opportunities for international research of a strategic nature and the potential for technical breakthroughs; and the comparative advantages of the CGIAR System to undertake such research and the complementarity of its efforts with those of other agencies.

The analytical framework used by TAC had three dimensions - activities, spatial, and product - each of which is described below.

An **activities** dimension, with five major categories of activities:

- conservation and management of natural resources including germplasm conservation (biodiversity);
- germplasm enhancement and breeding;
- production systems development and management;
- socioeconomic, public policy and public management research; and
- institution building (including training, information, organization/management counselling and networks).

TAC recognizes that there is no clear dividing line between these activities, and that a number of CGIAR objectives cut across several categories, such as strengthening of national research systems, and improvement of the sustainability of production systems.

A **spatial** dimension, with four geographical regions and nine broad agroecological zones (AEZs). The regions are Asia (which includes the Pacific); sub-Saharan Africa (SSA); Latin America and the Caribbean (LAC); and West Asia-North Africa (WANA). The zones are:

- AEZ 1: warm arid and semi-arid tropics;
- AEZ 2: warm subhumid tropics;
- AEZ 3: warm humid tropics;
- AEZ 4: cool tropics;
- AEZ 5: warm arid and semi-arid subtropics with summer rainfall;
- AEZ 6: warm subhumid subtropics with summer rainfall;
- AEZ 7: warm/cool humid subtropics with summer rainfall;
- AEZ 8: cool subtropics with summer rainfall; and
- AEZ 9: cool subtropics with winter rainfall.

Applying this AEZ concept to the four regions leads to a total of 23 regional agroecological zones (RAEZs): four in sub-Saharan Africa, three in West Asia-North Africa, seven in Asia and nine in Latin America.

A **product** dimension, with four main production sectors - crops, livestock, forestry and fisheries - and their corresponding commodities.

In Chapter 4 on problem identification and research emphasis, TAC began its analysis with an investigation of the challenges facing research and development in agriculture, forestry and fisheries between now and the year 2010. The analysis showed that food demand is increasing rapidly and its composition is changing in developing countries because of population growth, income growth, and urbanization. While the world produces more food per head of population today than ever before in human history, more than 1100 million people in developing countries still are identified as poor. The sustainability of agricultural production is at risk, the degradation of resources is accelerating, and poverty and malnutrition remain widespread in the developing world. During the next two decades, yields of staple foods in developing countries will need to more than double to maintain food production per caput at today's levels.

Meeting the demand for more food will remain the central challenge facing research by the CGIAR System. Producing more food will increase pressures on the natural resource base. It will therefore become necessary to pay greater attention to research on resource management. Examples of research topics at the global level include the substitution of renewable for non-renewable resources, the conservation of genetic resources, and studies of possible or actual changes in global atmosphere and climates. Greater attention will also need to be paid to issues of poverty, malnutrition and equity, especially gender equity.

The strength of national research systems in developing countries will greatly affect the scope and quality of research and its impact. The different capacities and resource endowments of national programmes will alter their collaborative relationships with centres. This must be taken into account in planning future strategies at the international level. While there has been a considerable increase in trained human resources, many national research systems remain weak or are constrained by a shortage of operational funds.

The remainder of Chapter 4 presents a discussion of the challenges to research and development by production sector in each of the regions and agroecological zones. It also gives an overview of the importance of each production sector and of the corresponding commodities in each of the regions.

The challenges facing the CGIAR have thus intensified since its inception in 1971. 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 finds that the need for applied and strategic research at the international level focused on productivity improvement and sustainable resource management for agriculture, forestry and fisheries, is more pressing now than it was when the CGIAR was founded.

Chapters 5 to 8 subsequently analyze the research issues faced in each production sector (crops, livestock, forestry and fisheries) and their respective commodities in greater detail.

A description of TAC's comprehensive quantitative analysis based on regionally defined agroecological zones is given in Chapter 9. A modified congruence approach was taken using a composite baseline made up of value of production, number of poor people and total usable land area. This composite base was then modified by a series of

variables (modifiers) to take into account issues of efficiency, equity, sustainability, strength of national programmes, self-reliance and potential for agroforestry. The results provided a basis for priority setting by agroecological zone, region, production sector and commodity. They also provided insight regarding the priority need for particular activities.

In Chapter 10, TAC presents its views on institution building activities in the CGIAR. The CGIAR was established primarily as a mechanism for funding technological research, but as it evolved, increasing emphasis has been placed on collaboration with national systems in research and institution building. TAC believes a balanced approach to research and institution building to be appropriate.

TAC notes that the CGIAR System has provided training to large numbers of scientists from national systems (approximately 25,000 during 1985-89). TAC believes that the training programmes at the CGIAR Centres need to change to take account of the progress made. Group training, especially production-oriented training, should be reduced in favour of individual postgraduate training and visiting scientist arrangements. Greater emphasis is needed on training in the areas of research management, fisheries, forestry, agroforestry, and the management of natural resources. In addition, advances in information technology will offer the CGIAR Centres new opportunities to collect, analyze and disseminate research information.

TAC believes that institutional weaknesses still place major limitations on the generation and adoption of technology in the national systems of many countries. In the past, the CGIAR Centres 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 organization and management counselling. TAC believes that, in the future, collaborative relationships between CGIAR Centres and national research systems will increasingly augment the traditional institution building activities.

Research needs in socioeconomics, public policy and public management research are discussed in Chapter 11. The mission and goals of the CGIAR are unlikely to be achieved without a conducive policy environment. The CGIAR acts primarily as a catalyst in the field of food policy research. Its main tasks are to understand the interactions between government action and human behaviour in relation to agriculture, technology, natural resources, and consumption, and to collaborate with national systems in identifying policy options. The broadening of CGIAR goals to embrace self-reliance extends policy research so as to include cash crops as well as the reduction of staple food costs and the more efficient use of inputs. More policy research on sustainability issues is also needed. The role of policy in influencing human behaviour at the farm and community level will be a key component of multidisciplinary research on forestry and natural resources. Continuing attention will be paid by the CGIAR to research on human linkages, particularly in relation to human nutrition and gender issues. The management of public organizations, such as national research agencies and irrigation management institutions, is another important topic for research in the CGIAR. Research on national research systems is needed to accumulate and analyze a knowledge base on these systems and to develop improved management concepts and tools.

The results of these analyses assisted TAC in formulating its views on priorities in Systemwide terms by: (a) category of research activity; (b) by agroecological and

regional agroecological zone; (c) by region; (d) by production sector; and (e) by commodity. These are discussed in Chapter 12.

With respect to the assessment of priorities by activity category, TAC recommended a substantial increase in the priorities allocated to the conservation and management of natural resources including germplasm conservation, and to socioeconomic, public policy and public management research. The Committee recommended a reduction in the priority allocated to development and management of production systems and of institution building, and the maintenance of current priority ranking of germplasm enhancement and breeding. This is illustrated in the following table which shows the proposed shifts among activity categories and an indication of the differential efforts by region relative to the new proposed level of activity.

Priorities by activity category by region (core resources only)

Activity Category	1991 base	2010 Rec.	Region ^{1/}			
			SSA	WANA	Asia	LAC
1. Conservation and Management of Natural Resources including Germplasm Conservation (Biodiversity)	13	17-19	+	+	-	+
2. Germplasm Enhancement and Breeding	21	21-23	-	-	+	0
3. Devpt. and Mgmt. of Production Systems	33	28-30	+	0	-	-
4. Socioeconomic, Public Policy and Public Management Research	9	10-12	-	-	+	+
5. Institution Building (incl. Training, Information, Org./Mgt. Counselling and Networks)	24	19-21	+	+	-	-
TOTAL	<u>100</u>	<u>100</u> ^{2/}				

^{1/} + = more than the new System level priority but possibly lower than current allocation
 0 = equal to new System level priority
 - = less than new System level priority but possibly higher or lower than current allocation

^{2/} the mid points of the ranges add to 100

N.B. This table can be found in Chapter 12 of Part I (Table 12.1).

TAC subsequently considered CGIAR priorities by region. At present, 43% of the CGIAR's core resources are allocated to sub-Saharan Africa, 13% to West Asia-North Africa, 29% to Asia and 15% to Latin America and the Caribbean. The rapid population growth rates, coupled with declining per caput food production in sub-Saharan Africa, make a compelling case for that region. The fragility of its tropical agroecological zones,

the generally limited national research capacities and the slow rate of progress in productivity improvement to date add to the apparent urgency. Many of Africa's development problems are also political in nature, however, and cannot be solved through research alone. In Asia, on the other hand, the magnitude of population numbers, the extent of the poverty problem, the narrowing yield gap and the limited scope for land expansion all argue strongly for more long-term strategic and applied research. On balance, TAC considered that, in the medium term, the current share of resources allocated to sub-Saharan Africa and to West Asia-North Africa should be modestly reduced, while the share allocated to particularly Asia and Latin America should be increased. TAC recommends that in the medium term, CGIAR resources would be distributed with a share of 39% to sub-Saharan Africa, 11% to West Asia-North Africa, 33% to Asia and 17% to Latin America.

The Committee did not make a recommendation on the level of priority by production sector, but noted that the proposed new programmes in forestry and fisheries should not be funded at the expense of critical research needs in crops and livestock.

TAC reaffirmed the priority it is currently allocating to the cereal and root and tuber crops. Among food legumes, it proposes a modest reduction in the level of priority of phaseolus bean, and a significant reduction in that of pigeonpea. The priority ranking of groundnut and soybean should be increased, while that of lentil, chickpea and cowpea should be maintained. TAC recommended that the current level of effort on banana and plantain should be maintained, and it reaffirmed its views on the priority level for research on vegetables and coconut. Finally, the priority analysis led TAC to note that the CGIAR is currently overinvesting in livestock research, particularly in sub-Saharan Africa.

Part II of this report presents TAC's views on the implications of revised priorities for future CGIAR strategies and structure, and for resource allocation in the CGIAR. This sequence reflects the approach taken by TAC in its analysis of CGIAR priorities, strategies, and resource allocation. The first step was to develop an analytical framework to address the question of what research activities should be supported by the CGIAR, and what the relative emphasis of these activities should be. The determination in relative terms of what to do is the object of priority setting. This was discussed in Chapters 1 to 12 of Part I of the report.

The second step relates to the question of how the identified priorities should be addressed. This relates to determining the strategy appropriate for the CGIAR to implement its priorities. The third step, once priorities and strategies are agreed upon, is to explore which institutional entity should do the research and how it should be operationally organized. This is the question of structure. This discussion of strategy and structure is provided in Chapter 13.

The final step of course is to link priorities to available financial resources in the context of current thinking on strategies and structures. This is the subject of Chapter 14.

Part I of the report has been shared previously with the members of the CGIAR and its stakeholders, and the information contained in Chapters 1 to 12 is therefore considered definitive. Chapters 13 and 14 have been produced since then and are new.

Therefore TAC recognizes that their content will benefit from further inputs by the Group and centres, while the medium-term resource allocation process is being implemented.

In developing its views on future CGIAR strategies and structure, TAC drew on work done previously in the framework of assessing potential expansion of the CGIAR ('A Possible Expansion of the CGIAR' AGR/TAC:IAR/90/24). In that document TAC outlined a medium/long and long-term vision for the evolution of the CGIAR System. For the medium/long-term, TAC considered that the CGIAR would have two types of activities: global activities, and regionally defined agroecological activities. For the latter type of activity, TAC has described them as 'ecoregional'. This approach was confirmed and elaborated upon in TAC's recent deliberations. Global activities would comprise strategic research on selected commodities and subject matter areas, while ecoregional activities would focus on applied and strategic research on natural resource conservation and management, the development and management of production systems, and on applied aspects of commodity improvement. Global activities would either have a commodity focus, or a focus on subject matter or discipline. These concepts are further elaborated in Chapter 13.

The ecoregional approach was proposed by TAC as a vehicle for increasing research on the conservation and management of natural resources, needs which were strongly confirmed by the analysis of CGIAR priorities, and for greater rationalization of CGIAR Centre contacts with NARS. Although it recognizes that the primary responsibility for conducting ecoregional research would be with national programmes, TAC notes that the global research community does not yet have an effective paradigm for natural resource management research. Identifying a conceptual framework for conducting such research was a goal of truly international relevance. Thus, TAC carefully defined the nature of the outputs to be expected from CGIAR supported ecoregional research.

TAC proceeded with the translation of the strategic concepts in operational terms. With respect to the ecoregional concept, an assessment was made of the need for particular activities in each regional agroecological zone (RAEZ). TAC considered that six ecoregional programmes were justified: two in sub-Saharan Africa (one on AEZ 1, and one combining on AEZs 2 and 3), one in West Asia-North Africa (AEZ 9), two in Asia (one combining for AEZs 1 and 5, and one that would combine AEZs 2, 3, and 7), and one in Latin America (combining AEZs 2, 3, 6, and 7). In addition, TAC noted the condition to be met for justifying a programme for the cool tropics in Latin America and sub-Saharan Africa.

TAC then considered the institutional options for priority ecoregions. This included comparing identified ecoregional needs with existing CGIAR Centre capacity in order to determine if centre programmes could be adjusted to meet future needs. With respect to global activities, TAC first considered a number of strategic questions, and then explored a number of particular structural options. Both for ecoregional and global concepts, TAC discussed a number of options but did not make firm recommendations pending further consideration by the CGIAR of their feasibilities, advantages, and disadvantages.

TAC also considered the relationships between global and ecoregional mechanisms, which programmatically are entirely complementary. Finally, Chapter 13

briefly discusses the possible implications of TAC's view on strategies and structure for mandates of CGIAR Centres.

Chapter 14 describes the background, process and outcome of TAC's deliberations on linking medium/long-term priorities and strategies to medium-term resource allocation. In its analysis, TAC proceeded in two steps: first at the System level, and then at the centre level.

At the System level, data on 1991 core resource distribution among the priority parameters (categories of activity, regions, production sectors and commodities) constituted the point of reference for TAC to identify the change in direction needed (and the scope thereof) to ensure a gradual implementation in the medium term of medium/long-term priorities. This required the setting of intermediate targets by 1998 in a manner that provided a satisfactory degree of compatibility among the various priority parameters. Following a series of iterations, TAC arrived at a consistent set of recommendations of relative distribution of resources among the priority parameters.

Throughout this analysis, TAC has assumed that core funding in 1998 would be essentially maintained, in real terms, at its current 1992 level, but with incremental core funding for expansion of new CGIAR activities - fisheries and forestry in particular. This funding assumption may be considered too conservative. It should not be seen as an indication by TAC that the current level of resources is adequate to fully meet the challenges and tasks faced by the centres. It is a conservative approach at this stage of the planning process to ensure that the System has the opportunity to explore the operational implications of zero real growth.

Once the relative distribution of core resources was determined, it was translated in absolute core funding terms for 1998, i.e., US\$ 270 million (in 1992 values). This amount is consistent with the funding assumption described above: it consists of the level of 1992 core funding (US\$ 251 million), augmented by ICLARM's 1992 core funding (US\$ 4 million) and an assumed increment of core funding of US\$ 15 million for fisheries and forestry.

A financial spreadsheet provided for an initial mechanical translation of recommendations on System level priorities into centre allocations. This was the beginning point of TAC's development of individual centre resource envelopes, taking into account other factors such as the need for minimum critical mass, stage of maturity and recent development in centre programmes, and relevant information from strategic plans as well as programme and management reviews. TAC also considered the need to have sufficient flexibility at completion of the medium-term resource allocation.

Therefore TAC recommends, on the one hand, that centres' resource envelopes be discounted to set aside a US\$ 20 million reserve which could be allocated either following the review of all centres' MTP proposals, or during the period of implementation of the MTPs. On the other hand, centres are requested to present their MTP proposals in a range of 10% above and below the indicative resource envelope, thus allowing them to disclose their programme potentials at higher levels of core funding as well as the impact lower core funding would have on the programmes.

CHAPTER 1 - INTRODUCTION

1.1. Background

The Technical Advisory Committee (TAC) to the Consultative Group on International Agricultural Research (CGIAR) has several responsibilities with respect to the assessment of CGIAR priorities. It makes recommendations on priorities to guide the allocation of resources across the System, allowing an appropriate balance among centres, activities, commodities and regions. It also evaluates possible new initiatives or activities for their consistency with these priorities. Lastly, TAC monitors the implementation of approved CGIAR priorities through its consideration of centres' medium-term plans and related budget proposals.

At its mid-term meeting in Montpellier in 1987, the CGIAR agreed that TAC would produce an updated report on CGIAR priorities and strategies every five years (TAC/CGIAR, 1987a). The last such report (TAC/CGIAR, 1987b) was completed in 1986, and previous reports had been prepared in 1973, 1976 and 1979. The preparation of the present report was initiated at TAC 50 in 1989. Drafts of the report were discussed with representatives of national research systems in Asia and the Pacific, Latin America and the Caribbean, West Asia-North Africa and sub-Saharan Africa and also with Centre Directors, Board Chairs, members of the CGIAR and other stakeholders.

TAC's recommendations on priorities are made at the broad System level. The Committee does not make recommendations at the programme level as this is the responsibility of the centres. TAC considers the programme priorities of the centres when it assesses their strategic and medium-term plans. It also evaluates mechanisms for priority setting at the centres through its periodic external reviews.

The CGIAR System is only one component in the global agricultural research system and commands only a fraction of its resources. The System has to be very selective in choosing among the many demands for agricultural research, those it will help to meet. The CGIAR has played primarily a gap-filling and bridging role in agricultural research. Centres fill gaps that cannot be filled by national systems and provide a bridge to institutions active in basic and strategic research. As a publicly funded international entity, the CGIAR tries to identify themes and opportunities where individual national programmes have little incentive to make a major commitment, either because of economies of scale or because the spillover effects are so large that they cannot be captured by them. The principal role of the CGIAR is to strengthen the work of national programmes by undertaking activities that are complementary and non-competitive. TAC has therefore made substantial efforts to seek the views of national research systems in each of the regions with respect to CGIAR priorities and strategies, prior to finalizing this report.

1.2. Evolution of the CGIAR and its Priorities

The CGIAR was established in 1971. In its early years it focused on improving 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. Gradually, the commodity base was broadened. Besides commodity-oriented research, the need for policy research and for strengthening national research systems was recognized. Between 1971 and 1980, the CGIAR grew from four institutions initially to thirteen, and the scope of activities broadened considerably (TAC Secretariat, 1973, 1976 and 1979).

Research has traditionally received the largest share of CGIAR resources, accounting for 50 to 62% of core expenditures between 1971 and 1990. The remainder was allocated to training and institution building, documentation and information, and administration. Table 1.1 shows how CGIAR research priorities by commodity and major activity have evolved over the years. Rice is the crop that still receives the largest share of core resources for research, although this share has declined from 21.5% in 1971/75 to 17.2% in 1986/88. The share allocated to cereals as a whole has declined from almost 58% to less than 39%. Although the share of resources allocated to research on cereals has declined in relative terms, the amount spent has grown in real terms, tripling from a constant US\$ 10.1 million per annum during 1971/75 to US\$ 32.5 million in 1986/88.

The share allocated to roots and tubers has remained relatively constant at around 11%, that to legumes has steadily increased from 8% to about 13%, while 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 review of CGIAR priorities and strategies in 1986 identified a number of issues that required further elaboration: sustainability, resource 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 the CGIAR needed to give special emphasis to strategic research, and that a farming system perspective should be adopted for formulating and implementing research programmes. 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 factor-oriented research was best met through the multidisciplinary commodity approach.

As an outcome of the review, TAC made recommendations on CGIAR priorities and the level of resources to be allocated to eight distinct programme thrusts and to each mandate commodity. In 1988, while these recommendations were being implemented, the CGIAR asked TAC to examine a possible expansion of the CGIAR by considering whether and how to incorporate the so-called non-associated centres, or important elements of their programmes. One year later, the CGIAR also recognized the need to further expand research on natural resource management by incorporating forestry research into its mandate.

At ICW'90, members of the CGIAR considered TAC's analyses and recommendations regarding the non-associated centres and the incorporation of a forestry initiative. TAC's proposals to redefine the mission statement and to expand the goals of the CGIAR were endorsed. The new CGIAR mission and goal statements introduced the

Table 1.1. Allocation of CGIAR core research resources by commodity (1971-88) ^{1/}

	1971-75 %	1976-80 %	1981-85 %	1986-88 %
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, cereals	57.9	40.6	39.6	38.7
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, crop research	77.4	64.4	61.7	62.9
Livestock	10.2	19.8	19.1	19.7
Subtotal, commodity research	87.6	84.2	80.8	82.6
Farming systems	12.2	11.7	9.9	8.5
Food policy ^{2/}	0.1	2.0	3.1	3.7
Genetic resources	0.1	2.0	4.2	2.8
NARS capacity building ^{3/}			1.9	2.4
Subtotal, other research/activity	12.4	15.8	19.2	17.4
TOTAL	100.0	100.0	100.0	100.0

Source: Gryseels and Anderson, 1991

^{1/} Core operating expenditures for research only

^{2/} IFPRI only. Other socioeconomic research is included in commodity research

^{3/} ISNAR only

notion of food self-reliance and added improved productivity of fisheries and forestry. It was also decided that IIMI and INIBAP would be incorporated into the CGIAR, while ICLARM would be invited to become a member if certain conditions were fulfilled. The subject matter covered by AVRDC was considered to be appropriate for CGIAR support. At the CGIAR Mid-Term Meeting in May 1991, another two entities were added to the CGIAR, namely ICRAF and a new institution for forestry. TAC was requested to elaborate on its initial proposals to restructure the CGIAR, while the Group constituted a task force to formulate proposals on how to proceed with a forestry and agroforestry initiative. ICLARM was requested to develop a strategic plan for fisheries research in the CGIAR and a proposal on those aspects it intended to emphasize.

Between 1971 and 1991, the CGIAR has thus grown from a System which was selective and exclusive to one which is broader and more inclusive. Mandates of CGIAR Centres now cover more than 25 commodities and a wide range of farming systems, agroecological zones and activities.

1.3. Implementation of the 1986 Recommendations

With respect to programme thrusts, available evidence suggests that the most important shifts of emphasis recommended by TAC in 1986 have been implemented. This is illustrated in Table 1.2. The decrease in the level of total core resources allocated to crop productivity research is noticeable, while the share allocated to research on resource management is increasing, in line with TAC's recommendations. The share of resources to be allocated to strengthening national research capacities has increased well beyond the target level.

With respect to particular commodities, the recommendation to reduce the resource allocation to rice research has not been implemented, largely because activities in sub-Saharan Africa have increased significantly. The proposed increases to roots and tubers research (mainly cassava) have not materialized, while the share of resources allocated to livestock research appears to be significantly above target. The resources allocated to grain legumes have been reduced more sharply than requested by TAC. Recommended and actual resource allocations by commodity are shown in Table 1.3, which also gives a regional breakdown.

Table 1.2. Comparison of 1986 TAC recommendations on priorities by programme thrust with actual allocations (% of total core resources)

	Basis 1986	TAC Recommendations Long-Term 2010	Actual 1991
Resource management and conservation	7.0	13.0	10.9
Crop productivity	57.1	48.0	50.0
Livestock productivity	13.4	15.0	16.7
Food policy	2.3	3.0	2.7
Strengthening national research capacities	18.1	15.0	19.7
Commodity conversion	0.7	2.0	N/A
Human nutrition	0.9	2.0	N/A
Integration of efforts	0.5	2.0	N/A
TOTAL	100.0	100.0	100.0

Source: CGIAR Secretariat, 1991 and TAC/CGIAR (1987b)

Table 1.3. Recommended and actual CGIAR resource allocations by commodity, category and region, 1983, 1986 and 1991 (%)

	1983 Base	1986 TAC Rec.	1991 Share ^{1/}	SSA (%)	Asia & Pacific ^{2/} (%)	LAC (%)	WANA (%)
Rice	25	18	26	28	63	8	0
Wheat and barley	10	9	9	21	14	20	44
Maize	9	10	8	43	18	34	6
Sorghum and millet	6	9	6	53	42	5	0
Potato	6	5	6	30	15	45	10
Other roots and tubers	7	13	8	45	0	55	0
Legumes	16	15	13	18	30	27	25
Subtotal, crop research				30	33	24	13
Livestock	19	20	25	68	0	21	11
Farming systems	N/A	=	8.5	43	28	0	29
Food policy	N/A	+	3.7	42	55	2	1
Genetic resources	N/A	=	2.8	25	25	25	25
NARS capacity building	N/A	+	2.4	25	25	25	25
Information, communication, library and documentation	N/A	+	8.4	47	22	18	13
Training and conferences	N/A	-	5.6	40	30	21	9
Total operating expenditure				39	26	21	14

Source: CGIAR Secretariat, 1991

^{1/} For commodities, data refer to share of resources allocated to commodity research, while for activities the data refer to share of core research resources.

^{2/} Includes China

Note: + refers to a recommendation that the share of resources allocated to this activity should be increased; - refers to a recommendation that this share should decline; while = refers to a recommendation that the share be kept constant.

1.4. Outline of the Report

This report on CGIAR priorities and strategies has four major components. Component 1 provides the context of the priority setting exercise (Chapters 1 - 3), Component 2 identifies the research problems and gives background information on issues related to the crop, livestock, forestry and fisheries sectors (Chapters 4 - 8), Component 3 contains the TAC analysis (Chapters 9 - 11), and Component 4 considers the implications of the TAC analysis for CGIAR priorities, future strategies and resource allocation (Chapters 12, 13 and 14). Chapters 13 and 14 are presented separately in Part II of this report.

Chapter 2 reviews the mission, goals and activities of the CGIAR. The framework for priority setting is discussed in Chapter 3. Chapter 4 provides background information, and evaluates the constraints to agricultural, forestry and fisheries research and development at the global, sectoral, regional and agroecological zone levels. An overview of the important factors determining CGIAR priorities and a discussion of the information base available to TAC with respect to crops, livestock, trees and fish follow

in Chapters 5, 6, 7 and 8 respectively. The analytical process leading to the allocation of priorities by region and agroecological zone is discussed in Chapter 9. Chapter 10 analyses the perceived role of the CGIAR in institution building. In Chapter 11 the important factors determining CGIAR priorities in socioeconomics, public policy and public management research are discussed. Finally, Chapter 12 discusses the implications of TAC's analysis for CGIAR priorities.

CHAPTER 2 - THE MISSION, GOALS AND ACTIVITIES OF THE CGIAR

2.1. Mission and Goals

The logical starting point for a review of CGIAR priorities is a careful assessment of the mission and goals of the CGIAR System. In this important task TAC made considerable progress while assessing a possible expansion of the CGIAR, which also required such an assessment.

The last goal statement, adopted by the CGIAR in 1986, reads as follows: "Through international agricultural research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well-being of low-income people are improved".

In assessing the proposed expansion of the CGIAR, TAC re-examined this goal and concluded that there were compelling reasons for redefining the goal and expanding the objectives of the CGIAR (TAC/CGIAR, 1990).

TAC suggested that the focus on food production should be modified to incorporate the concept of achieving food self-reliance in the developing world. This was an important change from the old concept of food self-sufficiency, and it has major operational implications:

- non-food commodities can be candidates for CGIAR support if they contribute to income generation, especially of low-income people, in ways that enhance their permanent well-being;
- research by the CGIAR ought to reinforce both the comparative advantages of countries and regions regarding the production of agricultural, forestry and fisheries products, and their reliance on markets and trade to satisfy the basic food and nutritional needs of low-income people.

At the Mid-Term Meeting in Canberra in 1989, CGIAR members declared their intention to continue emphasizing the CGIAR mandate for research on sustainable agricultural production and "to expand this emphasis to include research on the optimal management of tropical and sub-tropical forest lands giving particular stress to the interaction of agriculture and forestry, and the use of forest resources as an important contributor to the rural economies, energy needs and (the) wealth of partner nations".

It is also important to point out that issues related to equity, and in particular gender equity, and to sustainability have received increased emphasis from the CGIAR and TAC in recent years.

As a result, TAC proposed to replace the CGIAR goal statement with a revised mission statement. The objectives associated with the 1986 goal statement have been revised and redesignated as goals.

The CGIAR mission statement now reads as follows: "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".

This mission statement implies a focus on:

- international research that complements and supports national research efforts;
- other activities aimed at strengthening national research capacities, such as specialized training, institution building and information services;
- satisfying human needs from agriculture, forestry and fisheries, without degrading the environment or the natural resource base;
- the large numbers of poor people living in developing countries;
- the role of technological change in generating new income streams for the poor.

The ultimate aims are improved nutrition and economic well-being for low-income people, including women, landless labourers and poor producers and consumers in both rural and urban areas. Research should contribute to self-reliance by increasing the purchasing power of the poor through lower costs and prices and through greater equity in the distribution of incomes. It should also contribute to the quality of plant and animal products, to sustainability and stability in their supply, and to the prevention of environmental degradation through improved resource management.

These ultimate aims cannot be achieved solely through research and training. Success depends on many additional factors beyond the control of the CGIAR, such as efficient government policies, marketing channels for farm products, input delivery systems, and employment opportunities that bring purchasing power to the poor.

The goals of the CGIAR have been formulated as follows:

- (i) effective management and conservation of natural resources (i.e. land, water, forests and germplasm) for sustainable production;
- (ii) improved productivity of high priority crops and their integration into sustainable production systems;
- (iii) improved productivity of high priority livestock and their integration into sustainable production systems;
- (iv) improved productivity of high priority trees and their integration into sustainable production systems;
- (v) improved productivity of high priority fish and their integration into sustainable production systems;

- (vi) improved utilization of crop, livestock, tree and fish products in both rural and urban areas through improved postharvest technology;
- (vii) 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;
- (viii) appropriate policies for the increased productivity of crops, livestock, trees and fish, and for the sustainable use of natural resources;
- (ix) strengthened human resources and institutions for greater research capacity in developing countries' research systems.

The level and nature of the CGIAR's future involvement with each of these goals will vary greatly, but all are recognized as essential concerns. The aim is to contribute to the nine goals through research and institution building. Through research, the CGIAR Centres also contribute to science.

The nine goals are closely related to each other. The first five goals refer to the management of natural resources and the integration of improved commodities into sustainable production systems. The next three goals relate to the socioeconomic and policy environments. The last goal relates to all the other goals by focusing on the development of human resources and on institution building at national or regional level.

The nine goals converge on the central mission of the CGIAR through five major categories of activities:

- conservation and management of natural resources including germplasm conservation (biodiversity);
- germplasm enhancement and breeding;
- production systems development and management;
- socioeconomic, public policy and public management research;
- institution building.

Each of these categories includes specific activities which are elaborated in Section 2.2.

2.2. CGIAR Research and Research-Related Activities

The CGIAR Centres use human resources, physical facilities, land, equipment and supplies to undertake research and related activities. These activities in turn form the building blocks of projects designed to produce outputs that contribute to one or more of the nine CGIAR goals. Research projects, which are of limited duration, may be based on several activities, and a single project may contribute to more than one goal. Projects are considered to be the concern of centres.

Activities, however, require specific skills and facilities that commit the centres, and hence the CGIAR System as a whole, for longer periods. The spectrum of activities within the whole CGIAR System is therefore an important concern of any priority analysis at the System level.

For an activity to be considered part of a CGIAR programme it must meet the following criteria.

The activity is research or research-related:

- (i) research: discovery and/or development of new knowledge or technology;
- (ii) research-related:
 - activity designed to enhance the effectiveness of research;
 - collaboration with other research institutes;
 - training in research methods;
 - assistance in planning, organizing and developing research systems.

The activity is international in character and contributes to a priority programme consistent with CGIAR goals:

- (i) international in character:
 - it must involve more than one developing country;
 - it requires movement of people, materials, information across national boundaries;
 - is non-site specific and/or the results are potentially transferable;
 - involves an opportunity for collaboration with developing country programmes and/or advanced institutions.
- (ii) consistent with CGIAR goals:

the activity is a necessary component of a programme that has been identified as a priority by TAC and the CGIAR.

The activity is undertaken by a CGIAR entity because the entity is better qualified to undertake it:

- (i) core activities:
 - a centre can conduct an activity at a lower cost (more efficiently and effectively) than any other entity;

- continuity (sustained effort) is critical to low cost and rapid pay off, and no other entity can assure the continuity;
- positive benefits exist in terms of rapid international exchange of materials and information which no one else can or is willing to do;
- positive inter-relationships with other centre activities (spillover effects);
- the potential pay off is high relative to costs.

(ii) complementary activities:

- are those which a centre can do as efficiently and effectively as any other institution, but for which it does not have the unique advantages indicated above; and,
- those which exceed a centre's normal scope of core operations but in which the centre's involvement is steadily declining; often these are of a technical assistance nature.

Core activities represent a basic portfolio necessary for an international centre to carry out its functions effectively. In addition to research activities, core activities include institution building and the general administrative services which are essential for the efficient operation of a centre.

The activities classified as complementary are priority activities - though not at the same level of core activities - in relation to CGIAR priorities because they are considered important from a global or regional priorities donor point of view. They are retained to complement and expand the depth and coverage of the core activities either on a station or in collaboration with national research systems and advanced research institutions.

In developing the new resource allocation process, TAC prepared a tentative list of activities within each of the categories presented in Section 2.1. The list is based on the strategic and medium-term plans of the CGIAR Centres, and on work done by TAC in evaluating a possible expansion of the CGIAR (TAC/CGIAR, 1990). Below, each of the important categories of research and research-related activities is briefly outlined. It is important to note at the outset that the activities of all five categories are highly inter-related. CGIAR activities should all contribute to the improvement of sustainability of production and aim at strengthening the capacity of national research programmes.

Category 1: Conservation and Management of Natural Resources including Germplasm Conservation (Biodiversity)¹

1.1 - Ecosystem conservation and management

- (i) Ecosystems analysis, ecological characterization and environmental concerns - the characterization, classification, mapping and analysis of aquatic and terrestrial ecosystems, especially in relation to the functioning and use of ecosystems including human use patterns and pressures, climate, hydrology, soil and landform.
- (ii) Biology and ecology of useful organisms and pests - study of the distribution, production and dynamics of economically important plants, animals and fish and of the weeds, insect pests and diseases which affect them, and vectors related to hazards to human health.
- (iii) Land resources conservation and management - research on the maintenance or improvement of the potential productivity of the land resource base and its components especially the edaphic, climatic, hydrological and biological resources.
 - (a) Soil and landform - research on monitoring, maintaining or improving the physical and biological characteristics as well as chemical fertility of soils.
 - (b) Water - research on the conservation and management of rainfall and/or irrigation water.
 - (c) Plants and animals - research on the factors affecting the productivity and conservation of natural vegetation including forests and rangelands, and research to monitor natural populations of wildlife.
- (iv) Aquatic resources conservation and management - research on the maintenance or improvement of the potential productivity of the aquatic resource base, including research on the population dynamics of aquatic resources and their exploitation.

1.2 - Germplasm collection, conservation, characterization and evaluation: Collection and maintenance of *in vitro* (and *in situ*) germplasm collections and the distribution, characterization and documentation of collections.

Category 2: Germplasm Enhancement and Breeding

2.1 - Crops: Crop germplasm enhancement and breeding: incorporating primitive and novel germplasm into useful material for breeding purposes, as well as germplasm evaluation and conventional breeding.

2.2 - Livestock: Breed improvement.

¹ The activities in this category are non-commodity specific.

2.3 - Trees: Tree germplasm improvement: breeding of improved trees including multipurpose trees and shrubs.

2.4 - Fish: Breed improvement.

2.5 - Techniques in molecular biology¹: Development and application of modern methods in molecular biology such as genetic mapping and genetic markers to assist genetic enhancement and breeding programmes.

Category 3: Production Systems Development and Management

3.1 - Baseline studies of production systems (including constraint analysis and monitoring of sustainability)²: Characterization of the socioeconomic and agricultural aspects of farming systems including analysis of constraints to production and sustainability.

3.2 - Development and management of farming systems¹: Design and testing of farming systems and components for more productive and sustainable systems.

3.3 - Cropping systems

- (a) Plant nutrition - crop and pasture nutrient requirements, the availability, cycling and uptake of nutrients (including the role of mycorrhiza and other symbionts), tillage and fertilizer management.
- (b) Plant protection (diseases, insect pests and weeds) - the economic control of diseases, insect pests and weeds of crop, pasture and tree species including systems for integrated pest management.
- (c) Seed production - increase of seed of elite materials, its certification and release.
- (d) Postharvest technology - the development of ways of treating commodities to reduce losses in the storage and marketing system and improve the quality and value of foods through processing.

3.4 - Livestock systems

- (a) Livestock nutrition including studies on feeds, pastures and fodder - assessment of the nutritional status of livestock in relation to the availability of feed resources.
- (b) Animal health - epidemiology, biology, immunology and genetics of animal pests.

¹ These techniques are applicable in a wide range of research activities, including categories 1 and 3. For convenience, this activity is placed under category 2.

² These are generic activities common to the crop, livestock, tree and fish production sectors.

- (c) Livestock reproduction - reproductive biology of livestock and the reduction of reproductive wastage from reproductive diseases and other causes.

3.5 - Tree systems

- (a) Silviculture and tree production - the management of trees in agroforestry, plantation and natural forest systems to enhance and sustain productivity.
- (b) Tree nutrition - tree nutrient requirements, the availability, cycling and uptake of nutrients (including the role of mycorrhiza and other symbionts), and fertilizer management.
- (c) Tree protection (diseases, insect pests and weeds) - the economic control of disease, insect pests and weeds of tree species including systems for integrated pest management.

3.6 - Aquatic systems

- (a) Fish reproduction - reproductive biology of fish and the reduction of reproductive wastage from reproductive diseases and other causes.
- (b) Fish nutrition including studies on feeds - assessment of the nutritional status of fish in relation to the availability of feed resources.

Category 4: Socioeconomic, Public Policy and Public Management Research

4.1 - Economic and social analysis

- (a) Human nutrition - study of the relationship between such factors as nutritional composition of commodities, food quality, income, price, socioeconomic characteristics and the nutritional status of people.
- (b) Gender, human health hazards and sociocultural organization - analysis of gender, health and sociocultural organization in agricultural communities.
- (c) Microeconomic and social analysis - research to determine the economic and social effects and implications of technologies or policies as they affect people, by examining farm, household or village data.
- (d) Market and trade analysis - research to determine the market level economic conditions that may result from various technologies, institutions or policies and to analyze the impact of trade and macroeconomic policy on markets.
- (e) Impact assessment and priority setting - research to assess the impact of research including cost/benefit analysis and to improve the analytical basis on which research priorities are set.

4.2 - Policy analysis: Research to determine the desirability of alternative policies from the viewpoint of society, taking into consideration productivity, equity, sustainability, and environmental concerns.

4.3 - Governance and management of public systems (including irrigation systems): Analysis of organizations for the management of public systems (including irrigation systems) and the development of innovations to improve their performance.

Category 5: Institution Building

5.1 - Training and conferences

- (a) Training - human resource enhancement including specialized training courses, postgraduate research, study tours, etc.
- (b) Conferences and seminars - to foster the build-up of NARS capacities and the effective functioning of international research collaboration; fora for discussion of scientific cooperation among the partners in the global system (IARCs, NARS, specialized institutions); stimulating horizontal transfer of information and technology among national research systems.

5.2 - Documentation, publication and dissemination of information: Efforts to use systematically the global knowledge base in areas and disciplines of relevance to centres' research programmes and to make available to NARS relevant information on progress and output of centres' research programmes, through newsletters, publications, electronic media, and abstracting services.

5.3 - Organization and management counselling

- (a) Research on organization and management of institutes - analysis of research and research management processes aimed at the development/enhancement of approaches, methodologies and tools for conducting these processes. The procedures generated relate to: biological/technological research, i.e. technology generation efforts and organization and management of NARS.
- (b) Institution building/advice to NARS - assisting NARS through the provision of advice and counsel. This covers a range of subjects/topics and includes the biological sciences (conduct of research) and the organization and management field (organization and management of NARS). Primary objective: build-up of NARS capacities (institution building).

5.4 - Networks: Organizing, coordinating, managing or backstopping of collaborative research efforts among various partners in the global research systems with the primary objective of building up national capacities; the objectives cover a broad range and include: research/technology generation (global germplasm network, global/regional/topic specific information exchange, etc.).

2.3. Special Nature of International Research

International research has special advantages in a number of areas. Agroecological environments do not stop at national, nor indeed continental boundaries. Plant material tolerant of acid soils is potentially useful wherever acid soils are found in association with suitable climates, and the principles of managing vertisols are relevant whether in Africa or the Indian sub-continent. In determining priorities in international research, consideration should be given to the maximization of spillover effects. Over the longer term, supranational rationalization of research is a logical goal, with significant savings for partner nations.

Currently, weak national research systems demand more activities at the international level than comparative advantage will eventually dictate. Two types of activities are justified for the CGIAR: those with a continuing advantage at the international level, and those justified over the medium term by the current lack of capacity in the developing countries.

2.3.1. Activities with a Continuing Advantage at the International Level

These include:

- assessing the changing research needs of global agriculture, fisheries and forestry;
- the collation, processing and dissemination of scientific information;
- the collection, preservation and exchange of germplasm, and improvement of the methodology for its use;
- the enhancement of germplasm for crops, livestock, trees and fish dominant in the economic activity of many countries;
- the development of resource management and husbandry principles appropriate for agroecological conditions widely distributed around the globe;
- strategic research on production processes;
- specialized training.

Developing countries with strong national research systems will develop a capability in some of these areas. However, a large number of mainly small developing countries will remain unable to make the necessary investments in research facilities and specialized, higher education. The needs of small countries may be met through strong outward looking national programmes in larger countries, combined with effective networking. In other areas, a continuing international effort will be justified.

2.3.2. Activities Justified over the Medium Term by the Current Lack of Capacity in the Developing Countries

These include all of the above activities, plus:

- training at several levels required for effective research institutions: governance, managerial, scientific and technical;
- assistance in institutional and human resource development;
- assistance in priority setting and in research strategy and programme formulation;
- transfer of research technology from the industrial countries and its application to the needs of the developing countries;
- methodology development and training in its application;
- technical assistance and financial aid for in-country applied and adaptive research, often through bilateral programmes administered by CGIAR institutions.

The need for international involvement in this type of activities will continue for many years, although there is no inherent advantage in conducting them at the international level. The need for direct support differs from country to country and region to region. China and India are increasingly capable in research; at the other extreme most national systems in sub-Saharan Africa remain particularly weak.

CHAPTER 3 - FRAMEWORK FOR CGIAR PRIORITY SETTING

3.1. Priority Setting at the CGIAR System Level

TAC seeks three major outputs from its review of CGIAR priorities:

- a report on CGIAR priorities and strategies that reflects the major recommendations to the Group regarding its future;
- the development of a transparent analytical process that enables TAC to adapt CGIAR priorities and strategies to changing circumstances (including those revealed through impact assessment) on a regular basis, while still maintaining sufficient continuity in commitments;
- a framework to assist TAC in considering resource allocation in the CGIAR System. This framework is in the form of a matrix with broad target values for the relative distribution of resources across categories of activities, agroecological zones, regions, production sectors and commodities for the System as a whole.

The process of priority setting is necessary to steer the resource allocation process, to assist centres in programming and budgeting and to guide institution building in the CGIAR. It does not involve setting the research agenda of particular centres, or second guessing the results of strategic and operational planning at the centre level.

Priority setting is an interactive process in which each stakeholder of the CGIAR has had the opportunity to make inputs and to respond to evolving proposals.

The current approach to the review of CGIAR priorities differs from the analytical framework used by TAC in the previous review of 1986. A different approach was necessary because of the changes in the CGIAR mandate, which now includes forestry and fisheries, gives greater emphasis to sustainability issues, and stresses food self-reliance rather than self-sufficiency. 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, as requested by the CGIAR at its 1987 mid-term meeting.

In considering CGIAR priorities, TAC has made use of quantitative analysis. It is important to stress that TAC considers quantitative analysis to be an aid to but not a substitute for informed qualitative judgement and decision making. Priority setting cannot be done mechanically. As Cetron and Johnson (1972) point out, "Data plus analysis yield information. Information plus judgement yield decisions".

3.2. Guiding Factors in the Consideration of CGIAR Priorities

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

1. The CGIAR mission and goals. In setting priorities, the relative contributions of alternative activities to the mission and goals of the CGIAR must be explicitly evaluated.
2. Emerging trends in developing countries in agriculture, forestry and fisheries.
3. Changes in science and the organization of research.
4. The evolution of scientific capacity in developing countries.
5. The relative importance of production sectors and commodities across regions and agroecological 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.
6. The importance and the international character of the development problem which generates the need for research.
7. The opportunities for international research of a strategic nature and the potential to achieve technical breakthroughs in improving the productivity of major commodities.
8. 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.

3.3. A Three-Dimensional Framework

The analytical framework used in the current approach to CGIAR priority setting has three dimensions:

- an **activities** dimension, with five categories of activities: conservation and management of natural resources; germplasm enhancement and breeding; production systems development and management; socioeconomic, public policy and public management research; and institution building. These categories have been discussed in Section 2.2.
- a **spatial** dimension, with four geographical regions and nine broad agroecological zones (AEZs). The regions are: Asia (which includes the Pacific); sub-Saharan Africa (SSA); Latin America and the Caribbean (LAC); and West Asia-North Africa (WANA). The zones are: warm arid and semi-arid tropics; warm subhumid tropics; warm humid tropics; cool tropics; warm arid and semi-arid subtropics with summer rainfall; warm subhumid subtropics with summer rainfall; warm/cool humid subtropics with summer rainfall; cool subtropics with summer rainfall; and cool subtropics with winter rainfall.

- a **product dimension**, with 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. Their relative importance, and that of their corresponding commodities, is further discussed in Section 4.6 and in Chapters 5, 6, 7 and 8.

The first dimension reflects the spectrum of activities that must be supported if the CGIAR is to achieve its broader goals. The second dimension forms the basis for setting geographical priorities. The third dimension provides the basis for setting priorities in the productivity context.

3.4. Agroecological and Regional Characterization

Agroecological conditions largely determine the production potential and the population supporting capacity of developing countries. The characterization of these conditions allows farming systems and production alternatives to be compared and research spillovers to be assessed. Agroecological characterization also permits a quantitative assessment of the biophysical resources upon which agriculture and forestry depend. It is essential for the improvement of resource management and for the development of sustainable production systems to meet future demand.

TAC has adapted the agroecological characterization originally developed by FAO (FAO, 1978-81). In the FAO classification, a distinction is made between tropical regions, subtropical regions with summer or winter rainfall, and temperate regions. These major ecological regions are further subdivided into rainfed moisture zones, using standard lengths of growing period, and into thermal zones, using the temperature regime prevailing during the growing period. Soils and landform also form important components of agroecological zones in the FAO characterization, but to keep the number of subdivisions to a manageable level they were excluded from the framework used by TAC. Instead, soil and terrain characteristics, as well as other climatic aspects, are taken into account in Chapters 4 and 9.

At the highest level of aggregation, the following nine basic agroecological zones have been distinguished for the review of CGIAR priorities:

1. Warm arid and semi-arid tropics (AEZ 1);
2. Warm subhumid tropics (AEZ 2);
3. Warm humid tropics (AEZ 3);
4. Cool tropics (AEZ 4);
5. Warm arid and semi-arid subtropics with summer rainfall (AEZ 5);
6. Warm subhumid subtropics with summer rainfall (AEZ 6);
7. Warm/cool humid subtropics with summer rainfall (AEZ 7);
8. Cool subtropics with summer rainfall (AEZ 8); and
9. Cool subtropics with winter rainfall (AEZ 9).

Zones 5, 6, 7, 8 and 9 include some temperate areas.

TAC is aware that, for the purposes of research planning at the centre level, variations within the above broad agroecological zones must be taken into account. Furthermore, in the case of forestry, the current framework might well benefit from

further refinement, while in the case of fisheries a quite different approach would be necessary.

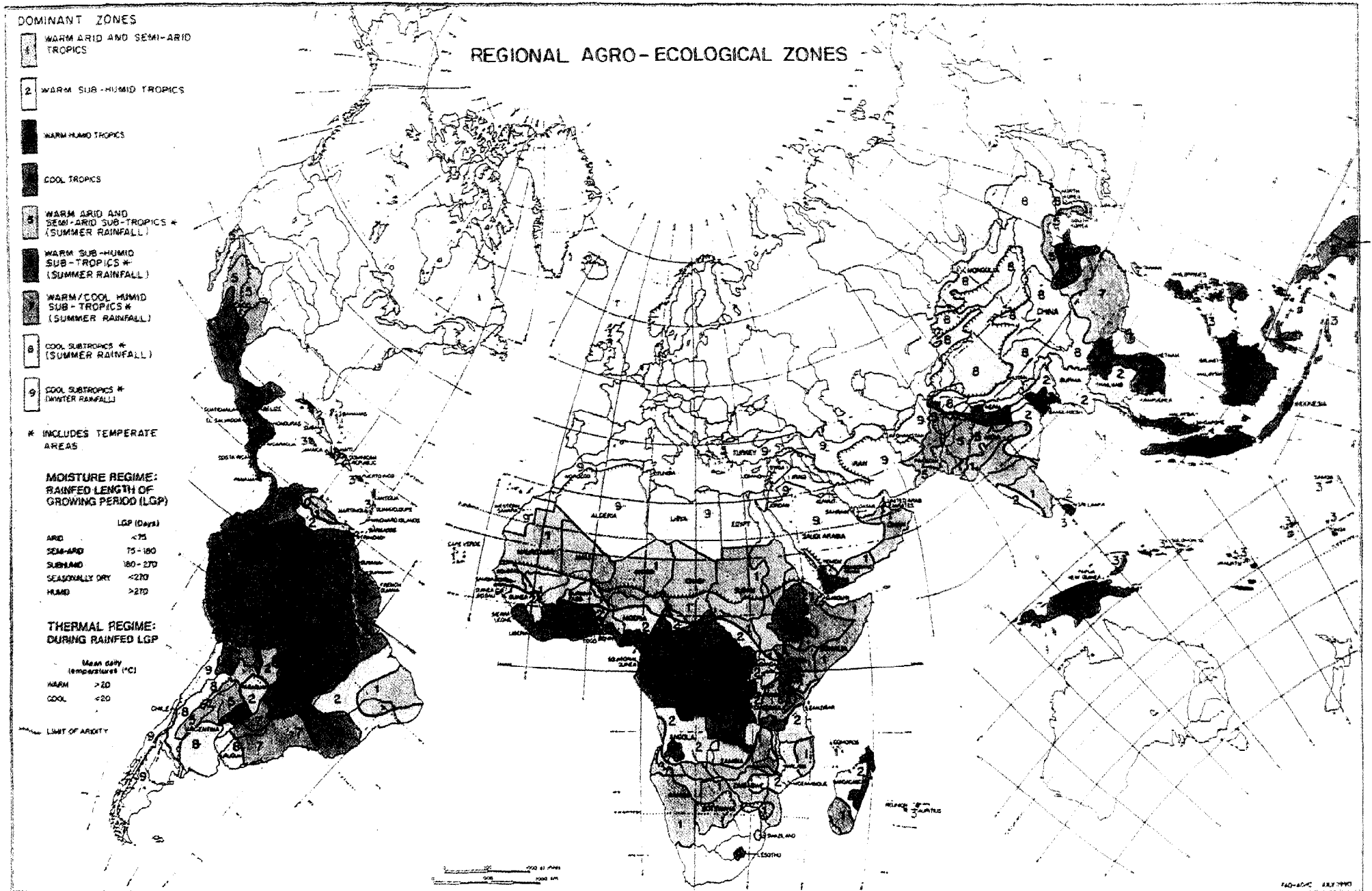
To link the socioeconomic database (which is organized by political units or national boundaries) with the natural resource database (organized by agroecological zones) it was necessary to reconcile agroecological boundaries with political boundaries. For some of the smaller countries with relatively uniform terrain this presented few problems. Larger countries or countries with non-uniform terrain were mostly assigned to more than one agroecological zone. Zone boundaries were then reconciled with provincial or regional boundaries. Data on population and arable land area were available at this national/subnational level and provided the basis for the disaggregation of other socioeconomic data.

The four major developing country regions that are being considered are sub-Saharan Africa, Asia, Latin America and the Caribbean, and West Asia-North Africa. Applying the above classification of agroecological zones to the four regions leads to a total of 23 regional agroecological zones (RAEZs): four in sub-Saharan Africa, three in West Asia-North Africa, seven in Asia and nine in Latin America and the Caribbean (Figure 3.1). Because two out of the three zones in West Asia-North Africa are relatively unimportant, for reporting purposes the results of the analyses for the three zones have been aggregated. Throughout the report, results will, therefore, be presented for 21 regional agroecological zones, although the analysis covered 23.

The definitions of each agroecological zone framework and the data and the classification of countries by regional agroecological zone are found in Annex I.

It is to be noted that TAC's geographic coverage was limited to developing countries of sub-Saharan Africa, West Asia-North Africa, Asia and Latin America and the Caribbean, and excluded the countries of Eastern Europe. TAC recognizes the substantial need for development assistance and collaborative research efforts in these latter countries. However, TAC's background analytical work on the review of CGIAR priorities and strategies was undertaken prior to the occurrence of political events in Eastern Europe that led to a dramatic change in the outlook and perspective of these countries.

Figure 3.1.



CHAPTER 4 - PROBLEM IDENTIFICATION AND RESEARCH EMPHASIS

4.1. Introduction

While the world produces more food per head of population today than ever before in human history, more than 800 million people in developing countries do not have enough to eat to lead fully productive working lives (World Commission on Environment and Development, 1987). The sustainability of agricultural production is at risk, the degradation of resources accelerates at a fast pace, and poverty and malnutrition remain widespread in the developing world. During the next two decades, in developing countries yields of staple foods will need to more than double to maintain food production per caput at today's levels.

In assessing priorities for the next decade, it is essential first to consider a longer range planning horizon. Investment in research today may not have a pay-off at the producer level until two to three decades from now. The context for long-range planning, therefore, should be the food needs, poverty status and natural resource base of developing countries in the year 2010 or 2020.

This chapter presents an overview of the challenges facing research and development in agriculture, forestry and fisheries over that longer time horizon. These challenges are presented globally, by sector, by region and by agroecological zone. Much of the information has been summarized from studies by FAO (FAO 1986a, 1987, 1988). Reference is also made to the recent FAO/Netherlands Conference on Agriculture and the Environment, which resulted in the "Den Bosch" declaration stressing the need for specific actions by governments to ensure sustainable agricultural development in each region (FAO, 1991a).

4.2. Agriculture, Forestry and Fisheries in a Changing Global Context

4.2.1. Trends Affecting Food Demand

Population growth is the main determinant of increasing food demand. The United Nations medium variant projection estimates that the population of developing countries will increase from 3.6 billion in 1985 to 5.8 billion in 2010 and 7.0 billion in 2025 (United Nations, 1988). At present, about 75% of the world's population lives in developing countries. This proportion will increase to 79% in 2000, 81% in 2010, and 83% in 2025. The population of sub-Saharan Africa is expected to expand threefold by 2025. Asia's population increase will be the largest in absolute terms of any world region; its population will grow from 2.6 billion in 1985 to 4.4 billion in 2025.

Income growth is a significant factor determining the composition, as well as the level, of food demand. Estimating income growth over the long term is difficult because such growth is determined largely by highly unpredictable factors such as political developments, the level of energy prices, and national economic and trade policies. The

World Bank has projected an average annual growth rate in per caput income of 3.5% during the next decade for developing countries as a group, but only 0.5% growth is expected for sub-Saharan Africa (World Bank, 1990). In most developing countries, food consumption will increase and there will be a shift in diets from staple grains to livestock products and vegetables. Increases in the demand for livestock products will lead in turn to a rise in the demand for feed grains.

Urbanization is also a major factor determining the composition of food demand. At present 31% of the population of developing countries lives in urban areas, but this is expected to increase to 40% by 2000 and to 57% by 2025. In sub-Saharan Africa it will increase from 28% today to 55% in 2025, in West Asia-North Africa from 65% to 72%, in Asia from 25% to 50%, and in Latin America from 69% to 84%. The diets of urban consumers tend to consist of high-value cereals, livestock products and vegetables. To cater for the needs of urban consumers, more food processing is required. Urbanization also affects the mode of food supply, since more food has to be produced for market production rather than subsistence. Food produced for urban markets needs to be transported and stored. Cities are usually located on better soils, sizeable amounts of which are taken out of agricultural production as they grow in size.

With respect to the demand for forestry products, for many of the poor in developing countries, the demand for fuelwood already greatly outstrips supply, particularly in dry areas. FAO has estimated that more than 100 million people experienced acute fuelwood scarcity during the early 1980s (FAO, 1983). With rising incomes, the demand for other sources of energy will increase, reducing the pressure on fuelwood markets to some extent.

The demand for fish and fish products has been growing rapidly in recent years. The traditional sources of fish - seas, lakes and rivers - have for the most part already been fully exploited. This has led to rapidly increasing prices for fish and fish products.

Malnutrition and poverty remain common features of the developing world. People are malnourished either because not enough food is available or because they are too poor to buy available food. Increasing food production alone will, therefore, not solve the problem of malnutrition. Poverty has many causes, including inadequate incomes, malnutrition itself, lack of social services, and lack of social and political status. The World Bank has recently estimated that 1.1 billion people, or 33% of the population of developing countries, live in poverty (World Bank, 1990). About three-quarters (800 million) of them live in Asia, although proportionally Africa has more poor people than any other region.

The implications of these numbers are awesome. Even if the agricultural land area continues to expand at the same rate as over the last two decades - an optimistic assumption - yields of the world's major marketed crops will have to more than double during the next two decades simply to maintain current per caput consumption. Unless yields increase still further, malnutrition and poverty will remain common, particularly in sub-Saharan Africa and South Asia.

During the past two decades, developing countries have relied increasingly on international trade for their food supplies. Imports of cereals have increased particularly rapidly. Meanwhile, exports from developing countries have remained relatively stable.

Net agricultural trade surpluses and terms of trade in general have deteriorated considerably.

4.2.2. Resource 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.

The level of external inputs used by farmers is a key factor affecting the resource base, because both underuse and overuse have detrimental effects. Farming systems in which farmers use few or no external inputs but plant crops annually eventually deplete soil nutrient reserves and reduce vegetative cover, thereby exposing the soil to erosion. Many cropping areas of Africa have been affected in this way. Research is needed to develop integrated nutrient supply systems based on a balanced mix of external inputs, organic manures, biological nitrogen fixation and efficient cycling of nutrients. In better endowed areas, high levels of external inputs are needed to sustain high levels of production, but may induce pollution problems. The generally low rates of application of agrochemicals in many developing countries imply that pollution has not yet become an issue for them. However, in some intensive crop production areas, particularly in Asia, Latin America and North Africa, policy measures are needed to increase awareness of potential problems, to educate the public and users of agricultural chemicals, and to ensure that subsidies do not encourage overuse.

The successful management of resources is central to the concept of sustainable agriculture. However, the research needed to address the many and diverse problems of resource degradation and environmental pollution is beyond the capacity of the CGIAR System. TAC considers it essential that CGIAR research on resource management should be focused on issues which bear directly on the productivity and sustainability of agriculture, forestry and fisheries. Further, such research should be confined to issues associated with those commodities and production systems with which the System is involved from the point of view of improving productivity.

Important resource management research topics at the global level include the substitution of renewable for non-renewable resources and the conservation (stewardship) of genetic resources and of various valuable ecosystems (including their wildlife). Other significant global research topics are the contribution of agriculture to changes in the composition of the atmosphere and in the climate, and the impact of those changes on agriculture (see below). Broad issues requiring research include the roles of community and government agencies and of agricultural 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.

4.2.3. Changes in the Atmosphere and Climate

The atmospheric content of carbon dioxide and methane is increasing as a result of human activities. The major source of carbon dioxide is the combustion of fossil fuels, which releases about 5.6 billion tonnes of carbon annually into the pool of 700 billion tonnes in the atmosphere. The pools of carbon held in forests and in forest soils are being steadily drained by deforestation, which releases between 1 and 3 billion tonnes of carbon each year.

Global warming is in itself expected to increase rates of respiration (including the respiration of plants and organic matter in soils), thereby further speeding the release of carbon dioxide and methane from forest lands and other vegetation sources. On the positive side, it should be noted that increased carbon dioxide levels will increase photosynthesis, with benefits to plant growth rates and storage of CO₂.

The contribution of forest burning to global warming has been deemed sufficiently serious to warrant recommendations by several international agencies that governments should take steps to contain deforestation. If, in addition, new forest could be established on a large enough scale, carbon could be removed from the atmosphere and stored. However, between 1 and 2 million square kilometres of new forest would be needed every 75 years to store carbon at a rate of 1 billion tonnes per annum. (This estimate is based on the unlikely assumption that bare land would be used; the carbon fixation of existing grassland should be taken into account to obtain a more accurate estimate). The massive reforestation required to realize these levels of storage would be very difficult to achieve.

The keys to the containment of global warming lie in reducing the use of fossil fuels, improving conservation and energy efficiency, and switching to renewable sources of energy, as well as in curbing tropical deforestation.

Assessing the possible effects of global climate change on agriculture is a vital task. Climate and weather have been and continue to be dominant factors in agricultural productivity despite technological advances.

The Intergovernmental Panel on Climatic Change (IPCC) recently concluded that climate change could modify both regional production and trade of agricultural commodities and could have severe effects for certain vulnerable regions (IPCC, 1990). However, it acknowledged that the present state of knowledge was inadequate for drawing firm conclusions.

4.2.4. Equity and Gender

The CGIAR mission statement implies a strong focus on research to benefit low-income people, including women, landless labourers and poor producers and consumers in both rural and urban areas (see Section 2.1). In setting priorities for the CGIAR, it is therefore important to assess the location and size of each of these target groups, their consumption patterns and the constraints they face in producing, selling or buying food. It is also important to assess whether the problems of these target groups should be addressed through strategic international research, or whether adaptive and applied research at national level will be sufficient.

The implications of equity considerations for CGIAR priority setting are that:

- higher priority should be given to small-scale farms in developing countries, and not to commercial agricultural corporations;
- higher priority should be given to commodities that poor people produce and consume (it could also be given to commodities produced by commercial farmers for consumption by the poor, and that provide income earning opportunities for landless labourers);
- higher priority should be given to geographical areas with large numbers of poor people that depend on agriculture, forestry or fisheries for their livelihood;
- higher priority should be given to research activities that will particularly benefit low-income people or resource-poor farmers.

With respect to gender, special attention should be given to households headed by women, to enterprises managed by women, to the role of women in agricultural production, and to women's consumption patterns.

Women represent a disproportionately high share of the total population living in poverty. They are disadvantaged by their farming and family responsibilities and by their lack of access to productive assets. Women, and often children, play an important role in all aspects of agricultural production, and usually carry primary responsibility for the collection of fuelwood. Significant gender differences in husbandry practices are associated with reduced access to credit. Women are also heavily involved in the postharvest processing of most food products. Often, technology is gender-biased against women. Changes in the allocation of women's time will influence the well-being of the family through changes in areas such as food availability, food preparation and child care. Technological change may also influence child labour and education. Women's expenditure patterns may be different to those of men. Lower food prices will favour women and children where these groups are currently less well fed than men.

4.2.5 Perspectives on National Research

Pardey and Roseboom (1991) and Pardey et al (1991) have analyzed regional differences in resource allocations to national research programmes in developing countries.

Between 1961-65 and 1981-85, the number of researchers grew four times faster in developing than in developed countries (7.1% against 1.6%). Asia now accounts for 72% of the developing country total, Latin America and the Caribbean for 12%, West Asia-North Africa for 10% and sub-Saharan Africa for 6%. In terms of research expenditures, Asia accounts for 59% of the total for developing countries, Latin America and the Caribbean for 20% and West Asia-North Africa and sub-Saharan Africa each for 11%. The growth in expenditures per caput was considerably slower in developing than in developed countries and, except in Asia, below the rate of growth in the number of researchers. Thus, in general, the levels of support available per scientist have declined during the last two decades, particularly in sub-Saharan Africa and in Latin America and the Caribbean.

The average size of public-sector national research system in developing countries (excluding China) has more than doubled during the last two decades, from approximately 150 to 350 researchers during 1981-85. In spite of the increasing number of medium- to large-sized systems, a substantial number of small systems remain with little capacity to undertake anything but highly focused adaptive research on a few commodities. During 1981-85, 39 national agricultural research systems had fewer than 25 researchers. These are mostly located in the Caribbean, the Pacific Islands and sub-Saharan Africa.

In all regions, research is oriented predominantly towards crops, with other sectors accounting for a far lower proportion of the overall number of researchers (Table 4.1). Research on forestry and fisheries has the largest share of research resources in Asia, while crop research is more dominant in West Asia-North Africa than in the other regions.

Table 4.1. Allocation of researchers by production sector and by region, 1981-85

Region	Crops	Livestock	Forestry	Fisheries
Sub-Saharan Africa (%)	67.3	20.0	7.3	5.4
Asia (%)	63.7	17.4	9.4	9.6
Latin America and the Caribbean (%)	68.7	24.1	5.4	1.8
West Asia - North Africa (%)	75.4	16.2	5.7	2.7
All developing countries (%)	68.3	18.7	7.3	5.7
Expenditures (US\$'million)	2,480	679	266	205
Researchers (No.)	53,100	14,500	5,700	4,400

Source: Pardey et al (1991)

On the basis of a congruence analysis between the share of each production sector in agricultural GDP and in research personnel, Pardey and Roseboom (1991) noted that the share of crops and livestock research was smaller than might be expected on the basis of their share in total production. They also noted that many national systems have yet to achieve a critical mass of researchers in forestry and fisheries.

4.2.6. Strategies for Areas with Different Resource Endowments

The success of the green revolution, with varietal improvement as the prime mover, has been restricted mainly to irrigated areas or areas with favourable rainfall patterns. In such areas, the major constraints to increasing production were agronomic and could largely be overcome through the increased use of chemical fertilizers and pest control. The necessary infrastructure required to deliver technology and market surpluses was largely already in place. However, the green revolution approach could not be transferred easily to agroecosystems with less favourable rainfall patterns, soils and land forms. In such systems, severe resource management problems have to be overcome before agronomic improvements can be effective. These problems relate to water

management, control of erosion, cropping systems and soil amelioration (acidity, alkalinity, toxicities, minor elements, etc.).

Although considerable investments may be required before resource management in these less well endowed areas can be improved, the cost of such investments in rainfed agriculture is well below those needed in irrigation systems. The extent to which the potential for increased production is actually used will depend on the economic and policy environment. The task of resource management research is to demonstrate the potential and to develop pathways for incremental improvements that meet increasing demands in an affordable manner for farmer and country. The latter requires support by policy research.

Strategies for the improvement of both intensive and extensive production systems must focus more directly on providing institutional and technical support for improved soil fertility, pest and disease control, and water management. The inevitable increase in fertilizer applications which will be the main source of future agricultural growth and food security must be balanced by efforts to improve the efficiency of fertilizer use and to maximize the contribution from organic sources of nutrients, legumes and soil microflora. Such efforts are needed to promote sustainability and to bring more productive practices within reach of resource-poor farmers and the landless poor.

Strategies for employment and income creation in the agricultural sector should be based on a thorough analysis of comparative advantage, including the production costs and the processing and marketing requirements of those crops that may be competitive.

Questions of economic and institutional stability and development are also central to a considerable number of strategic options for development. Most governments apply various policy instruments such as subsidies and fiscal measures to their agricultural sectors, but their purpose is often primarily to serve the interests of urban populations rather than those of farmers. Their impact on the well-being of the rural population, on sustainable resource use and on the environment is often negative.

4.3. Natural Resource and Socioeconomic Database

To allow priority setting on the basis of regions, agroecological zones, commodities and research activities, a database was developed in spreadsheet form containing primary and derived agroecological, demographic and economic information. The information originates mostly from FAO, the World Bank and the CGIAR Centres. The data base includes time series data by country, by agroecological zone, by regional agroecological zone and by region on both urban and rural population 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 (rainfed arable land, irrigated land, livestock, forests, etc), land-use patterns, soils and soil constraints, land form, lengths of growing periods and thermal conditions, vegetative resources and potential productivity.

Table 4.2. gives examples of information compiled by regional agroecological zone. It provides data on total land area, population in 1990 and 2010, population

Table 4.2. Land area, population, food demand, arable land and production by regional agroecological zone

RAEZ	Land Area (10 ⁶ ha)	Population 1990 (10 ⁶)	Population 2010 (10 ⁶)	Population Growth (%)	Food Demand 1990 (10 ⁶ tGE)	Food Demand 2010 (10 ⁶ tGE)	Production Food 1990 (10 ⁶ tGE)(B1)	Production Cash 1990 (10 ⁶ tGE)	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	3 996.5	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	195.1	171.0	113.2	71.3	100.1	10.29	110.4
3	1 631.3	714.1	959.6	2.15	159.6	276.1	157.9	121.2	67.3	14.94	82.3
4	387.8	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

GE = Grain Equivalent
Source: FAO data files

growth, demand for food in grain equivalent in 1990 and 2010, production of food and cash crops in 1990, rainfed arable land, irrigated arable land, and total arable land. Production of cash crops in grain equivalent was estimated by dividing the value of cash crops by the unit value for wheat.

Table 4.3. Selected socioeconomic indicators by region

Indicator	SSA	Asia	LAC	WANA	Absolute Number Million
Population (% of LDC total)	12.5	68.4	11.2	7.9	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)	2030	2600	2730	2960	
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)	115	736	133	104	1 088
Demand in 2010 for food crops (million tGE)	224	1 074	209	185	1 692
Production of cash crops (million tGE)	72	237	118	22	450
Production of food crops (million tGE)	104	733	142	65	1 044
Production of food and cash crops (million tGE)	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. labourer (US\$)	413	341	2 116	1 196	
Agr. GPD/total GDP (%)	34	24	10	16	
Agr. Land-labour 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

GE = Grain equivalent
Source: FAO and World Bank data files

An overview of some important socioeconomic indicators at the regional level is presented in Table 4.3. 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 much 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. Both in sub-Saharan Africa and Asia a significant amount of foreign exchange is generated through exports of industrial crops. 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 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 labourer amounts to US\$ 2,116, 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 Asia, where it is only 1 ha/worker. The use of fertilizers is highest in Asia and lowest in sub-Saharan Africa. The rate of deforestation is a source of concern throughout the developing world, but is particularly high in sub-Saharan Africa and Latin America.

4.4. Agroecological Zone Aspects

Crop and livestock productivity research must take into account the productivity potentials and constraints of target agroecological zones. The following sections highlight some of the major constraints in each of nine agroecological zones identified in Section 3.4.

4.4.1. Warm Arid and Semi-Arid Tropics

The warm arid and semi-arid tropics encompass very large areas of sub-Saharan Africa (1,246 million ha), and large areas of Asia (149 million ha) and Latin America and the Caribbean (191 million ha). The land available per caput is 7.5 ha, 0.32 ha and 5.1 ha respectively on a total area basis and 0.38 ha, 0.18 ha and 0.29 ha on an arable land basis. Rainfall is inadequate and uncertain. During short wet seasons, soils are susceptible to waterlogging or erosion, while wind erosion is a threat to sandy soils during the long dry season. The problems of erosion are exacerbated by overgrazing in rangeland areas.

In rainfed areas the major food crops are sorghum, millet, cowpea, pigeonpea, soybean, groundnut and sweet potato. The introduction of external inputs to increase crop production in these areas is risky. Consequently, the green revolution has largely bypassed these areas, whose large agricultural populations remain poor. Increasing food production in the rainfed areas in ways that conserve and enhance the resource base is an extraordinarily difficult task, given the uncertainty of rainfall.

Population growth and poverty in the ensuing decades will continue to put strong pressure on the resource base, especially in Asia and parts of Africa where there is no room to expand the land frontier. A particular problem in Asia and sub-Saharan Africa is the shortage of fuelwood, reflected in the data for area of forest and woodland per caput which are 0.17 ha and 0.88 ha in the two regions respectively.

The only region in this agroecological zone with significant areas of irrigated land (22 million ha) is Asia, although there is some potential to expand the 4 and

2 million ha of irrigated land in the semi-arid tropics of sub-Saharan Africa, Latin America and the Caribbean respectively. Irrigation overcomes the rainfall constraint and reduces risk, encouraging farmers to intensify production by adopting modern varieties and inputs. However, irrigated areas in the semi-arid tropics are prone to salinization unless water supply and drainage are carefully managed.

Soil constraints in some low-lying rainfed areas also include salinity, which can move to the soil surface when water tables rise due to the clearing of trees in re-charge areas. Another major soil constraint is acidity, which can develop in poorly buffered soils after they are cultivated and fertilized in an unbalanced way. Systems are needed for recycling nutrients, using legumes and external nutrient inputs. Organic residues will also help to reduce widespread physical constraints such as soil crusting and low infiltration rates.

The problems of the semi-arid tropics appear intractable, but in fact there is a great deal of scope for increasing production. Farming systems research is needed to develop low-resource, low-risk production systems appropriate for the harsh environment. Improved stress-tolerant crop varieties will be a key component of these systems, but low-cost soil and water conservation measures and innovative crop management technologies will be crucial to success. These technologies will be information- and management-based, so it is essential that they be developed with a full knowledge of the problems facing farmers in the zone. The needs of farmers are strongly location-specific, so in this zone as in others it is essential that national research agencies play a major role in applied and adaptive research.

4.4.2. Warm Subhumid Tropics

The total area of the warm subhumid tropics is 844.8 million ha, about half of which is found in Latin America (mainly Brazil). The length of the growing period is 180-270 days, adequate to support the open forests and moist savanna woodlands which are the most widespread form of natural vegetation. In some Asian countries, more than half the forests have been destroyed. The soils vary across the different regions, but acid soils are common in upland areas of all regions. Alluvial soils in the lowlands are more fertile and support intensive crop production systems.

The land availability ratio is much lower (0.8 ha per caput) in Asia (India, Myanmar, Sri Lanka and Thailand) than in sub-Saharan Africa (3.3 ha per caput) and Latin America and the Caribbean (7.4 ha per caput). Irrigated areas total 10.3 million ha, of which most (7.7 million ha) are in Asia. FAO states that there is scope to expand irrigation in Asia by 2.3 million ha. If realized, this expansion would reduce the pressure on upland areas, to which considerable migration is occurring at present. In most countries in sub-Saharan Africa and Latin America and the Caribbean the opportunity to expand crop cultivation onto new lands is being taken on a large scale. The Latin American moist savannas are also being used for extensive cattle grazing.

The major crops grown are rice, maize, sorghum, soybean, cowpea, cotton, cassava and sweet potato. Considerable yield advances have been made in irrigated areas, but the yields of rainfed crops have generally not improved. A common cause is the reluctance of farmers to invest in the lime and phosphate fertilizers needed to overcome soil acidity and phosphorus fixation. Where these investments have been made in response to market incentives, crop yields have increased and farmers have profited.

Livestock production varies considerably in different regions. The presence of the tse-tse fly limits the production of large ruminants in large areas of sub-Saharan Africa. In Latin America and the Caribbean, extensive cattle production is practised, but the sustainability of this system is uncertain. The introduction of ley systems based on the rotation of crops and legume-based pastures show promise. In Asia, the need for draught animal power, as well as milk and meat production, must be taken into consideration in research and development planning.

Coastal ecosystems, particularly in Asia, present special problems. Saline water incursion is a serious problem likely to increase if sea levels rise. Acid sulphate soils can be used for rice production, but increased use is being made of coastal mangrove areas for aquaculture. The products are a source of animal protein to local people as well as supplying lucrative international markets for shellfish.

4.4.3. Warm Humid Tropics

The warm humid tropics occupy a total land area of more than 1,630 million ha, of which just over 82 million ha is currently used for crops. This agroecological zone supports over 627 million people. Potential land availability per caput is high in sub-Saharan Africa and Latin America and the Caribbean, but is as low as 0.6 ha per caput (on a total area basis) and 0.09 ha per caput (on an arable land basis) in Asia.

The economies of most countries in the humid tropics are largely dependant on agriculture and forestry. Inland and coastal fisheries play an important role in some countries. Very few countries have explicit national policies for agriculture, forestry and fisheries.

Many national research systems in the humid tropics are weak with respect to institutional mechanisms, quality of human capital, adequacy and sustainability of operational funds, and links with the extension system. There are, however, notable exceptions in parts of Asia and Latin America and the Caribbean.

Population densities and per caput GNP are generally low. The population is largely rural except in Latin America and the Caribbean, where over 70% live in urban areas. About 70% of the population can be considered as poor. Diseases such as malaria and human trypanosomiasis (in sub-Saharan Africa) are endemic in this zone. The major livestock diseases include theileriosis and trypanosomiasis. The main crops grown are root crops (cassava and yam), maize, banana and plantain, rice, pineapple, and tree crops (coconut, cocoa and oil palm). The major livestock species are cattle, sheep, poultry, and the water buffalo. In the forest areas tropical hardwoods are produced.

4.4.4. Cool Tropics

Historically, cool areas in the tropics have attracted human populations because of the favourable climate for health and for crop and livestock production. Cool tropical areas cover 388 million ha and are particularly important in Latin America and the Caribbean (260 million ha), and East Africa (95 million ha). They have high population densities, having for centuries been intensively cultivated, grazed and deforested. In many cool tropical areas the land has been over-exploited, resulting in the long-term decline of soil fertility and in widespread soil erosion. Most farms are small and operate

with family labour and animal traction. The main food crops are maize, beans, sorghum, tea, coffee, potato, wheat, and barley. Livestock production, particularly for milk, is also important and offers substantial scope for development. Deforestation has been widespread, due to the ever increasing need to expand the area under crop cultivation. The major soil constraints are shallow soils, acidity and steep slopes. Soil conservation measures are necessary as well as the development of technology to improve the efficiency with which inputs are used. The regulating role of vegetation/soil relations in different ecosystems should be better understood. There is also a need to develop new, integrated land use systems and to improve the management of forests and agricultural land.

4.4.5. Warm Arid and Semi-Arid Subtropics with Summer Rainfall

Large areas of Asia (178 million ha) and Latin America and the Caribbean (103 million ha) comprise the warm arid and semi-arid subtropics with summer rainfall. However, while the arable land area in Asia (106 million ha) includes important areas of China, India and Pakistan with a total population of 457 million, the arable land area in Latin America and the Caribbean is only 8 million ha and the population 14 million. The climate is warm and solar radiation is high, but because of low and unreliable moisture availability the length of the growing period is generally less than 180 days. Arid areas are not conducive to productive rainfed agriculture. Low nutrient holding capacity and low buffering capacity are important constraints in the soils of this zone. In some irrigated areas of Asia, the high base status soils have salinity and alkalinity problems.

Much of the agricultural output of this zone is produced under irrigation (41% and 32% of the arable land in Asia and Latin America and the Caribbean respectively). The irrigated areas in India, Pakistan and China are among the most productive in the developing world. High yields of rice and wheat are obtained using modern varieties and high rates of purchased inputs. In many of these irrigated areas the rapid growth in yields of the past decades is no longer being sustained. Meeting the future food demand in this zone will require an annual increase in grain production of 3.65 million tonnes (or 2.5%). This will have to come largely from the intensification of production on existing cultivated land, which is currently available at a ratio of only 0.23 ha per caput.

Water scarcity is the major resource problem. In some areas, such as the North China plain, the growing demand for water from urban and industrial development is causing the level of the water table to drop at an alarming rate. Salinity is also a threat when drainage and water supplies are not efficiently managed. Another problem is pollution from external chemical inputs, which are used excessively in some areas.

The major cropping system of this zone in Asia is intensive irrigated rice-wheat production. Other crops include cotton, food legumes and sugar cane. Livestock are used for draught power as well as milk and, in some areas, meat production. Forest resources in the Asian part of this zone are particularly scarce, with wooded area less than 0.10 ha per caput.

FAO estimates of potential productivity of presently cultivated land are 150% higher than current production in Asia and 500% in Latin America and the Caribbean (FAO, 1984). Achieving such large production increases will require further investments in irrigation and much more efficient use of water resources.

4.4.6. Warm Subhumid Subtropics with Summer Rainfall

Most of the warm subhumid subtropics with summer rainfall lie in Asia (54 million ha of China, India and North and South Korea), where this zone has a population of 213 million. The only other significant area is 17 million ha of Argentina, with a population of 4 million. The climate is conducive to both rainfed and irrigated crop production. In the Asian part of the zone, large areas of fertile alluvial or loess-derived soils are used for irrigated crop production. The land availability ratio is 0.25 ha per caput in Asia and 4.4 ha per caput in the Argentinian part of the zone.

Population growth in the Asian part of the zone is expected to increase annual food demand by 1.6 million tonnes (2.35%) over the coming decade. The theoretical potential production on existing cultivated land is 141 million tonnes of grain equivalent, compared with the current 54 million tonnes. The main crops are rice and wheat, which are largely produced under irrigation with high levels of inputs. Industrialization is expected to reduce the proportion of the population involved in agriculture, so further intensification will require greater mechanization. Intensive agriculture and industrialization are already creating pollution problems, which are likely to become increasingly serious in the future.

4.4.7. Warm/Cool Humid Subtropics with Summer Rainfall

The growing period in the warm/cool humid subtropics with summer rainfall is between 270 and 365 days. The zone has a mean daily temperature greater than 20°C during the warm part of the growing period and less than 20°C during the cool part. It occurs in parts of Asia (China) and Latin America (Argentina, Brazil, Paraguay) and covers a total land area of about 257 million ha, of which about 110 million ha are arable. The zone has a population of 550 million people, which is projected to rise to 670 million by 2010. The potential productivity of presently cultivated land is high, and the average annual growth rate in production needed to meet projected demand is 1.3% for Asia and 1.9% for Latin America and the Caribbean. In Asia this zone comprises the most productive but densely populated areas of the world. Research is needed on intensive vegetable and aquaculture production. In Latin America, unlike China, 75% of the population living in this zone is urban.

4.4.8. Cool Subtropics with Summer Rainfall

The cool subtropics with summer rainfall comprise 1,085 million ha globally, supporting a human population of 443 million. Some 86% of the zone (936 million ha) is located in Asia, with 415 million people, covering Bhutan, Mongolia, Nepal and parts of China, India, and North and South Korea. The rest of the zone (150 million ha) is situated in Latin America, covering Uruguay and parts of Argentina, and supporting about 28 million people. This zone is therefore very diverse in terms of income, stage of development, topography and land use potential. In terms of elevation, some of the areas in Latin America and Northern China are low-lying, whereas elsewhere the zone is mountainous.

The population is projected to reach 548 million in 2010. The present population relies on 106 million ha of arable land, 16 million of which is irrigated. The area of arable land per caput in 1990 was 0.18 ha in Asia and 0.22 ha in Latin America. Food

production in 1990 totalled 136 million tonnes, of which 115 million tonnes were produced in Asia to meet a demand of 117 million tonnes. The remaining 20.6 million tonnes were produced in Latin America meeting a demand of only 9.5 million tonnes. However, to maintain the current balance in supply and demand, food production will have to grow at 1.44% per annum to meet new demand. The main crops grown in the zone are wheat, barley, maize, beans, Letaria millet, and soybean and rice in warmer areas.

The cool and often harsh climate, steep slopes (60% of soils in the zone outside China have slopes of over 30%) and remoteness of many of the zone's mountainous areas are major constraints to agricultural and infrastructural development. Where cropping is practised in such areas, shallow soil depth is a major limitation, while low clay and organic matter content are a further constraint, particularly in the heavily dissected areas. There is a high risk of long dry spells during the cropping season, and in areas with less than 400 mm annual rainfall it is difficult to produce satisfactory yields without supplementary irrigation or soil moisture conservation. Year to year variations in the thermal and moisture environments are high. In areas with dissected terrain, topographical shading, aspect and slope lead to a mosaic of growing environments. Due to low nutrient status and low clay content of the major soil types, traditional crop and livestock production systems are closely integrated to maintain soil fertility. Irrigated soils with low clay and organic matter content have an added problem of low nutrient retention. The need to cultivate steeper and steeper slopes increases the risk of soil erosion.

In the low-lying plains of northern China and Latin America, cold temperatures, a short growing season and drought are serious constraints to increased production. Some soils have high alkalinity and salinity, while others offer good agricultural potential, particularly in areas with adequate soil moisture.

4.4.9. Cool Subtropics with Winter Rainfall

The cool subtropics with winter rainfall cover 1,324 million ha, of which the bulk (82%) is located in the West Asia-North Africa region and the rest in Latin America (in Chile and Argentina). The zone is characterized by cool to cold winters and hot summers, and the agriculturally important rainfed land has a semi-arid moisture regime derived from winter rainfall. The ecological constraints and limits to rainfed production in both lowland and highland areas arise from the combined effects of short growing periods with large interseasonal variations, highly seasonal thermal conditions, and soils that are low in clay and organic matter, shallow and prone to erosion and degradation. In areas of irrigated production, salinity remains a serious risk.

There is limited potential in the West Asia-North Africa region for bringing new rainfed land into cultivation or expanding the irrigated area. Moreover, the agricultural resource base in the region is deteriorating, with widespread salinization and waterlogging occurring on irrigated land and serious erosion and degradation on rainfed land owing to uncontrolled mechanization and the extension of cultivation to marginal areas. The deterioration of the resource base is leading to yield stagnation and declining availability of feed for ruminant livestock. This is not so for the zone in Latin America, where there is room for significant area expansion and the land currently under use is comparatively well preserved and does not face major environmental problems.

In the West Asia-North Africa region, there has been some increase in wheat yields following the introduction and selective adoption of modern varieties, but the yields of most other annual crops - barley, pulses, oilseeds, vegetables and forage crops - have risen very little, partly because of the unavailability of appropriate modern varieties and partly because of discriminatory price policy. In Latin America, most of the area is planted with improved varieties, including fruits and vegetables.

On average, less than one crop a year is grown on rainfed land in the West Asia-North Africa region because the traditional cereal-fallow system relies on the fallow period for soil moisture conservation and for the maintenance of soil fertility. In irrigated areas, the cropping intensities are not much higher, mostly because of inadequate water management combined with insufficient drainage. Crop and livestock systems are not effectively integrated and diversified, and feed shortage, rather than disease, is the main factor limiting greater livestock productivity. Both the rainfed and irrigated sectors offer unexploited opportunities for diversification and intensification to meet the changing pattern of demand and to enhance the resource base. In Latin America, the zone appears to be responding positively to such opportunities, both domestic and export.

4.5. Regional Aspects

4.5.1. General Overview

TAC's report on a possible expansion of the CGIAR provided an analysis of the global context in which the CGIAR is likely to operate in the future. Particular attention was given to expected trends in world agriculture and forestry during the next two decades. The resulting challenges to agricultural development and resource management, and the implications for research in each of the major developing country regions (Asia and the Pacific, sub-Saharan Africa, Latin America and the Caribbean, and West Asia-North Africa) were discussed.

In all regions and zones there is an urgent need for strategic research on natural resource conservation and management, and on improved crop management. Cost-reducing technologies are necessary to promote nutrient-use efficiency. Research to increase the yield potential of major crops and to increase genetic adaptation to particular constraints (such as pests and diseases) should also receive high priority throughout the developing world. There is a need to increase livestock productivity through improved nutrition and health. Policies that promote land use planning with a sustainability perspective and that offer incentives to farmers to intensify land use, in addition to providing infrastructure for the distribution of inputs and the marketing of outputs, are also widely required. The need for strong collaboration between international centres, their national programme partners and advanced research institutions should be emphasized. In all four regions, there is also a continuing need to emphasize capacity building in national research systems.

Despite having many similar development problems and research needs, the four major regions also exhibit a number of differences with important implications for the allocation of CGIAR priorities. These are discussed in the following sections. Issues related to forestry are discussed in greater detail in Section 7.2.

4.5.2. Sub-Saharan Africa

In sub-Saharan Africa, agriculture remains the mainstay of the economy, providing almost half the region's GNP and export earnings. The majority of people farm or live in rural areas, and most of them are poor. Dryland agriculture and smallholder farming systems dominate. The use of irrigation is limited to a few countries and delta areas. Less than 2% of arable land in sub-Saharan Africa is irrigated. The subhumid/humid areas are the most important in terms of population.

About 57% of the livestock population is found in the drylands. Only trypanotolerant livestock are found in the humid zone. Although highland areas cover only a small proportion of the total land area, they have the highest human and livestock densities.

In East and Southern Africa, recurrent civil war and drought have frequently led to famine. Despite the potential for increased agricultural productivity, progress has been discouragingly slow because of poor infrastructure, the diversity of agroecological conditions, the lack of appropriate technology and the failure of most governments to formulate policies to support the smallholder sector. During the past 25 years, population has grown faster than agricultural production. As a result, imports of food now account for 10% of consumption, and food aid for 6% (FAO, 1991b).

National agricultural research systems throughout sub-Saharan Africa are often research-station oriented and insufficiently focused on farmers' needs. Only a few countries have the minimum critical mass required to undertake advanced applied research. The gap between actual and potential yields remains very large throughout the region. In sub-Saharan Africa, special emphasis on resource and crop management research will be required given the fragile nature of the region's ecosystems. There is scope for substantial productivity increases in agriculture through the increased integration of crop and livestock production. Demand for increased agricultural production is very high, but the prospects for self-reliance are poor except in a few comparatively well endowed countries. Sub-Saharan Africa has the largest area of forest and woodlands of any region, but also the highest rate of deforestation. Fisheries are of local importance in coastal areas and along major rivers.

4.5.3. West Asia-North Africa

In West Asia-North Africa, there is limited room for expansion of the rainfed land area, but some increase in the irrigated land area is possible. No increase in agricultural productivity from present land use will be sufficient to achieve long-term food self-sufficiency, a goal which remains well beyond the reach of most countries in the region. Significant increases in rainfed and irrigated production are possible through crop intensification and diversification, and the integration of livestock production with settled farming. Improvements in water conservation, crop and fallow management (including fallow replacement), nutrient and water-use efficiencies and irrigation system management are needed to increase productivity.

Feed shortage is the main factor limiting livestock productivity in the region. The integration of pasture and forage crops, livestock and trees into cropping systems would contribute significantly towards improving the sustainability of production, while at

the same time raising total productivity. The ratio between the price of meat and grains is such that the importation of concentrates to enhance the productivity of livestock systems is a viable option.

The West Africa-North Africa region has limited agricultural potential but many opportunities for trade, and these offer good prospects for achieving food security in the medium term. The national resources allocated to the development of the agricultural sector and of national research capacity are generally very limited.

4.5.4. Asia and the Pacific

In Asia, the main problem of development is the sheer size of the human population and the extent of its poverty, making food security vulnerable. More than half the world's population and two-thirds of that of developing countries live in this region. About 29% of the region's population, or 800 million people, are poor, while 22% are malnourished. The arable land available per caput is 0.2 ha, by far the lowest in the developing world. In most countries of the region there is no room for expansion of the area cultivated, so future productivity gains must come from intensification.

The Asia and the Pacific area is very diverse, although the region's statistics are overwhelmingly dominated by the two giant countries India and China. Both these countries have strong national research systems, while many other countries, particularly in the Pacific area have only limited national research capacity.

High priority must be given in Asia to research on soil and water conservation and nutrient-use efficiency. Irrigation is crucial to the region's food production. However, in the arid and semi-arid zone the productivity of irrigated areas is threatened by salinization. Improvements in the productivity of dryland farming are also needed. Landlessness and poverty are serious development problems. The yield gap is narrowing, and in some areas yields of wheat and rice are close to their agronomic potential. The yield potential of rice particularly will have to be raised, and this will require increased efforts in germplasm enhancement and breeding. In Asia, an expanded effort will also be required in policy research, particularly with respect to equity and sustainability issues.

Livestock are important, particularly pigs, cattle, poultry and buffalo. Shortage of feed is a major constraint to increasing productivity while demand for livestock products is growing rapidly.

Asia has relatively small areas of forest, but deforestation rates are high. Fisheries are important in terms of both income and employment as well as in their contributions to the diet.

4.5.5. Latin America and the Caribbean

Latin America and the Caribbean are slowly emerging from the deep economic crisis and crippling debt burden of the 1980s, now generally considered as a "lost decade". Many countries are currently undergoing structural adjustment and economic liberalization. More than two-thirds of the population live in urban areas. About 17% of the population live in absolute poverty. Although the number of poor people as a percentage of total population may be lower than in other regions, the proportion of poor

people in the rural population has been estimated at more than a third, a figure comparable to that of sub-Saharan Africa. Several countries have a high per caput GNP, but income distribution is highly skewed throughout the region. Efforts are needed to reduce the cost of staple foods for the urban and rural poor.

Latin America has large land reserves, but many areas are too marginal for sustainable agricultural production. The productivity of livestock and the demand for livestock products are the highest of any region in the developing world. The region has good prospects for increasing agricultural productivity rapidly without degrading the resource base, and thus for helping to solve global food problems. Resource degradation is often driven by poverty or by inappropriate government policies. The highlands require particular attention for equity reasons, while some savanna lands have potential for large productivity increases. The region has the largest area of tropical forest in the world, but the absolute area deforested annually is also very high, partly because forests are considered "unused" lands.

Although Latin America and the Caribbean have a cadre of well trained scientists working in different agroecological zones, many national research systems have a chronic lack of operational funds. The region has a strong private sector involved in agricultural research, and links are developing between the public and private sectors. The emerging regional research system needs assistance in preserving and exploiting the region's considerable biodiversity, through expanded research on genetic resources. Research should capitalize on recent developments in biotechnology, although the risk that such research might benefit only the larger scale production systems should be recognized and avoided.

4.6. Production Sectors and Commodities

To assess the importance of each of the broad commodity groups under consideration in this report - crops, trees, livestock and fish - the values of production of each of these groups in each of the major developing regions were estimated by aggregating the value of the respective commodities of each commodity group (Table 4.4). This value had been estimated for each commodity by multiplying its average annual production volume during 1987/89 as reported in the FAO production yearbook, with its corresponding price as reported in Annex 3. The table captures some interesting differences in the relative values of production among commodity groups and regions. It clearly shows the importance of crop production, which accounts for 57% of the total value of production of developing countries. Trees account for 19%, livestock for 19% and fish for 5%. The table also illustrates the predominance of the Asia and Pacific region, which accounts for 59% of the overall value of production. Latin America and the Caribbean accounts for 23%, sub-Saharan Africa for 10% and West Asia-North Africa for 8%.

Trees are the second most important commodity group. Although Asia contains only 19% of the total wooded area in developing countries, the region's tree products represent 61% of total forestry value. Largely because of the importance of fuelwood in energy supplies, tree products account for 29% of the overall value of production in sub-Saharan Africa. In absolute terms, livestock and fish are of primary importance in Asia

and in Latin America and the Caribbean. In relative terms, livestock are particularly important in the West Asia-North Africa region, where they account for 25% of the value of production.

There are seven major caveats associated with the valuation of commodities and of commodity groups. First, several commodities (e.g. yam, fuelwood, sweet potato, etc.) have no published price data sources. Second, it has proven difficult to account for intermediate products such as draught power, manure, fodder crops, pasture hay, and certain tree products, because these are not usually traded and have no international price. Nevertheless, these intermediate products are indispensable inputs to the production of some of the priced commodities. Third, prices of all commodities may vary considerably by region and over time. In this analysis we used one global international price and did not allow for regional differences. Fourth, the relative importance of commodities depends on how they are aggregated. For instance, each of the many species of vegetable may be relatively unimportant, but the group as a whole is important. A similar argument can be made for fisheries (more than 1,000 species are traded regularly) and fruits. Fifth, for several commodities the reported international price refers to only a minor share of the market but which is heavily distorted by subsidies and the effects of other government policies (e.g. sugar, rice, etc.). Sixth, there is no consistency in the way price data are reported (some are FOB, others CIF, others farm-gate, etc.). Seventh, available international prices usually refer to high quality items only (e.g. beef, lamb).

Table 4.4. Gross value of production of major commodity groups in developing countries by region, 1987/89 (US\$ billion/year)

Commodity Group	Region					Share (%)
	Asia/Pacific	SSA	LAC	WANA	Total	
Crops	222	35	74	33	364	57
Trees	73	19	25	2	119	19
Livestock	64	10	36	12	122	19
Fish	20	2	10	1	33	5
Total	379	66	145	48	638	100
Share (%)	59	10	23	8	100	

Despite these caveats, the gross value of production of commodities provides a useful initial indicator of the importance and potential pay off of research on them. Value of production allows for meaningful aggregation across commodities so that their importance can be expressed in a common value. Table 4.5 shows the gross values for major commodities for the developing world as a whole. Table 4.6 provides this

information for the 50 most important commodities in each of the four regions. These gross values are based on production and price data from FAO. The value of production by commodity and by RAEZ is presented in Annex 2 and the prices used in the calculations are listed in Annex 3. When FAO price data were not available, World Bank data were used. For non-tradeable commodities, the latest domestic prices in major producing countries were used. Production and price data use the 1987-89 annual average.

Table 4.5. Gross value of production of major commodities in developing countries (US\$ million, 1987/89)

OVERALL			
COMMODITY	TOTAL	COMMODITY	TOTAL
Rice	85998.6	Sawlog & Veneer (C)	7276.8
Fuelwood & Charcoal	60978.8	Tomato	5832.7
Sawlog & Veneer (NC)	52853.0	Beans	5491.0
Milk	45156.9	Coconut	5428.0
Wheat	31147.3	Apple	5106.3
Marine Capture	25179.6	Rubber	5103.2
Beef & Buffalo Meat	24140.7	Tea	4112.1
Pigmeat	23208.7	Sorghum	4038.0
Maize	19720.7	Cocoa	3846.0
Orange	17176.8	Onion	3666.6
Sweet Potato	14037.2	Palm Oil	3528.2
Potato	13790.0	Lemon & Lime	3339.9
Cotton	13578.5	Millet	3317.2
Eggs	13447.4	Barley	3117.9
Coffee	13224.6	Yam	2959.1
Sugar	12968.5	Pineapple	2573.3
Tobacco	12434.4	Chickpea	2242.4
Groundnut	12419.2	Broad Bean	2031.1
Grape	12326.2	Cabbage	2027.1
Soybean	12197.9	Cowpea	1102.6
Banana & Plantain	10334.6	Lentil	1066.4
Cassava	9847.7	Pigeonpea	1054.7
Poultry Meat	9378.2	Jute	864.0
Inland Capture	8461.6	Sisal	164.5
Sheep & Goat Meat	8102.3	Hemp	39.5

NC = Non-Coniferous; C = Coniferous

The most important agriculture commodity in developing countries, measured by value of production, is rice, followed by milk, wheat, marine capture fisheries, beef and buffalo meat, pigmeat and maize.

The three most important agricultural commodities in sub-Saharan Africa are cassava, milk and banana and plantain; in West Asia-North Africa: grape, wheat and milk; in Asia: rice, milk and wheat; and in Latin America: beef, milk and orange.

The economic importance of forestry should be emphasized. It is mainly due to the production of fuelwood and sawlogs, which are the second and third most important commodities in the developing world as a whole as well as for Asia, while in sub-Saharan Africa fuelwood and charcoal rank well ahead of any other commodity. As for other non-traded commodities, the data for fuelwood were derived from typical household consumption figures, local prices and population data, and should be regarded cautiously. However, the importance of fuelwood in relation to other commodities is well established.

Of the non-food crops, cotton, coffee and tobacco rank relatively high in developing countries as a whole. Livestock production is relatively important in every region. In sub-Saharan Africa, the starchy foods are important, particularly cassava, banana/plantain and sweet potato.

The importance of several non-food commodities in the agricultural sector emerges clearly. These commodities contribute substantially to the generation of income and employment and are potentially important for self-reliance.

Table 4.6. Gross value of production of major commodities in developing countries by region (US\$'million, 1987/89)

LAC		SSA	
COMMODITY	TOTAL	COMMODITY	TOTAL
Beef & Buffalo Meat	13809.1	Fuelwood & Charcoal	16974.1
Milk	12193.7	Sawlog & Veneer (NC)	4798.8
Fuelwood & Charcoal	11395.3	Cassava	4434.0
Orange	10708.3	Milk	3663.5
Sawlog & Veneer (NC)	10246.9	Banana & Plantain	3564.5
Marine Capture	9923.2	Beef & Buffalo Meat	3133.2
Coffee	8269.7	Yam	2858.1
Soybean	7966.2	Groundnut	2703.4
Sugar	6034.1	Coffee	2696.0
Maize	5569.4	Cocoa	2215.4
Grape	4567.8	Maize	2034.3
Banana & Plantain	3678.9	Rice	1534.0
Rice	3594.2	Sheep & Goat Meat	1455.7
Poultry Meat	3360.2	Millet	1371.8
Wheat	3178.8	Beans	1313.0
Sawlog & Veneer (C)	3086.4	Sorghum	1308.9
Eggs	3031.2	Cotton	1208.3
Beans	2641.0	Inland Capture	1208.0
Pigmeat	2530.3	Cowpea	1052.9
Potato	2281.9	Sugar	891.0
Cassava	2006.3	Marine Capture	862.5
Cotton	1994.9	Tobacco	717.5
Tobacco	1840.5	Sweet Potato	700.9
Lemon & Lime	1577.8	Poultry Meat	605.0
Tomato	1328.2	Palm Oil	593.8
Cocoa	1069.2	Eggs	582.0
Apple	1008.2	Tea	504.3
Sorghum	995.3	Potato	424.2
Sheep & Goat Meat	669.5	Rubber	310.0
Pineapple	648.8	Pigmeat	287.5
Onion	545.1	Pineapple	286.0
Groundnut	480.0	Orange	277.5
Inland Capture	426.4	Tomato	275.6
Coconut	387.4	Coconut	267.2
Sweet Potato	260.4	Wheat	254.1
Barley	199.4	Broad Bean	180.8
Palm Oil	196.2	Barley	146.2
Sisal	116.4	Sawlog & Veneer (C)	131.5
Cabbage	104.4	Onion	103.9
Tea	100.2	Lemon & Lime	95.2
Broad Bean	92.3	Soybean	66.1
Yam	76.5	Pigeonpea	64.2
Chickpea	56.4	Chickpea	59.8
Rubber	56.0	Sisal	40.4
Lentil	32.8	Grape	27.3
Cowpea	24.3	Cabbage	15.0
Pigeonpea	16.1	Lentil	13.0
Millet	9.6	Apple	4.5
Jute	5.8	Jute	1.1
Hemp	1.2	Hemp	0.0

Table 4.6. cont.d

WANA		ASIA	
COMMODITY	TOTAL	COMMODITY	TOTAL
Grape	6614.8	Rice	79948.9
Wheat	5907.0	Sawlog & Veneer (NC)	37441.2
Milk	4792.9	Fuelwood & Charcoal	31533.7
Tomato	2886.2	Milk	22506.7
Orange	2630.1	Wheat	21807.5
Sheep & Goat Meat	2411.6	Pigmeat	20364.3
Potato	2102.3	Marine Capture	13188.7
Beef & Buffalo Meat	2066.8	Sweet Potato	13067.0
Barley	2055.0	Maize	11330.3
Eggs	1565.5	Groundnut	9129.7
Cotton	1541.7	Tobacco	9120.6
Apple	1507.6	Potato	8981.5
Poultry Meat	1312.0	Cotton	8833.7
Marine Capture	1205.2	Eggs	8268.6
Fuelwood & Charcoal	1075.7	Inland Capture	6583.8
Lemon & Lime	978.8	Sugar	5198.8
Rice	921.5	Beef & Buffalo Meat	5131.6
Onion	859.7	Coconut	4773.3
Sugar	844.6	Rubber	4737.2
Maize	786.7	Poultry Meat	4101.1
Tobacco	755.7	Soybean	4060.2
Lentil	511.0	Sawlog & Veneer (C)	3675.0
Broad Bean	457.9	Sheep & Goat Meat	3565.5
Beans	429.0	Orange	3560.9
Sawlog & Veneer (C)	383.9	Cassava	3407.4
Sawlog & Veneer (NC)	366.2	Tea	3150.2
Tea	357.3	Banana & Plantain	3013.1
Chickpea	325.7	Palm Oil	2738.2
Inland Capture	243.3	Apple	2585.9
Cabbage	182.8	Coffee	2246.9
Sorghum	107.3	Onion	2157.9
Groundnut	106.0	Millet	1908.2
Soybean	105.3	Chickpea	1800.6
Banana & Plantain	78.0	Cabbage	1724.8
Millet	27.7	Pineapple	1638.5
Pigmeat	26.5	Sorghum	1626.5
Coffee	12.0	Tomato	1342.6
Sweet Potato	8.4	Broad Bean	1300.2
Cowpea	4.0	Grape	1116.3
Jute	1.6	Beans	1108.0
Hemp	1.6	Pigeonpea	974.4
Sisal	0.7	Jute	855.5
Yam	0.0	Barley	717.3
Cassava	0.0	Lemon & Lime	688.2
Palm Oil	0.0	Cocoa	561.4
Pineapple	0.0	Lentil	509.6
Rubber	0.0	Hemp	36.8
Cocoa	0.0	Yam	24.5
Coconut	0.0	Cowpea	21.4
Pigeonpea	0.0	Sisal	7.0

CHAPTER 5 - CROPS

5.1. Background

Crops and their products provide 57% of the total value of production of agriculture, forestry and fisheries in developing countries. In Asia this share amounts to 58%, in sub-Saharan Africa 53%, in Latin America and the Caribbean 51% and in West Asia-North Africa 69%.

Research to improve the productivity of the most important food crops in developing countries has been the central theme of the CGIAR since its inception. The CGIAR has a multidisciplinary research approach to increasing crop productivity. The research has four main objectives: to increase yield potential; to narrow gaps between potential and actual yields; to improve yield stability; and maintenance research to prevent the erosion of attained yield levels. Crop productivity research in the CGIAR consists of five activities: germplasm enhancement and breeding, cropping systems, plant protection, plant nutrition, and seed technology and production. (These five activities fall into two of the major categories of activities identified in Section 2.1, germplasm enhancement and breeding, and the development and management of production systems.)

The pay off to crop productivity research in the CGIAR has been large, and the impact of research on rice and wheat has been particularly impressive (Anderson et al, 1988). Significant farm-level impact has also been achieved through research on maize, millet (particularly in India), groundnut (in India) and phaseolus beans. Although encouraging progress in the development of technology for the other crops has been achieved, evidence of impact is still largely anecdotal. Progress has been particularly slow for grain legumes.

This chapter discusses important factors for the allocation of CGIAR priorities to particular crops. For each crop under consideration, the importance of the commodity in the diet and the production system, research opportunities and history, the strategic breeding goals, and the role of the CGIAR hitherto are highlighted. Implications with respect to the future priority ranking of each commodity are discussed in Section 12.3.5.

TAC acknowledges the importance of mixed cropping systems and the difficulty of allocating priorities to the crops involved, which are often of minor importance globally but can play a significant role in particular farming systems. In addition, for many crops, particularly roots and tubers, food legumes and vegetables, the database is weak. Estimates on their value of production and yield levels are often crude guesses, and in a quantitative analysis these crops may, therefore, get a lower priority ranking than they merit.

5.2. Cereals

5.2.1. Rice

Globally, rice is the most important crop in terms of its contribution to diet and value of production. Of the 147 million ha harvested globally in 1989, more than 142 million ha were in developing countries, producing 460 million tonnes of paddy. Asia is the primary producer, accounting for 91% of production in developing countries. Latin America and the Caribbean accounts for 4%, West Asia-North Africa for 3%, and sub-Saharan Africa for 2%. Rice provides between 35% and 60% of the calories consumed by 2.7 billion people in Asia, and 8% of food energy for 1 billion people in sub-Saharan Africa and Latin America and the Caribbean. Only about 4% of world rice production is traded on the international market; most countries rely almost entirely on domestic production to meet their demand. Price formation on the international market is heavily influenced by subsidies and other protective measures. In West Africa and Latin America rice is a relatively new staple in the diet. Per caput consumption in West Africa has doubled over the past two decades, while in Latin America it has increased by about 25%.

Rice production increased in varying degrees in all developing regions during the 1970s, by an average of 2.7% annually, and during the 1980s, with an overall average of 3.0%. About two-thirds of the increase can be attributed to higher yield levels in irrigated rice in Asia, attained through the widespread adoption of high-yielding varieties, fertilizer and irrigation. Production increases in Latin America and the Caribbean resulted largely from the spread of new varieties. However, in sub-Saharan Africa and West Asia-North Africa they resulted from an increase in the area cultivated rather than from increases in yields. Over the two decades, the rice areas of 11 green revolution countries in Asia showed a mean yield increase of 63% (from 2.03 to 3.31 t/ha). However, yields vary widely between countries in all developing regions. For example, in Asia the average yield of rice in India, which has one-third of the region's rice area, is only 2.13 t/ha, whereas it is 5.33 t/ha in China, which also has about one-third of the region's rice area. Yields in South Korea are about 7 t/ha.

If past trends in demand continue, world rice production will need to increase by 21% by the end of the century, and by 65% by 2020 (1.7% annually). While Asia has achieved marginal self-sufficiency in rice for the present, further increases through higher yields or increased cropping intensity will be necessary to keep pace with demand. The leading rice-growing countries in Asia will need to increase their rice production by 100% by 2020 (2.3% annually).

These escalating demand levels will require a concerted research effort to continue the development of improved technologies for production. To date, the pay off from CGIAR investments in rice research has been large. The internal rate of return from international rice research over the last 30 years can reach at least 80%, and during this period the new rice varieties allowed for an increase in rice production which was sufficient to feed about 600 million more people (IRRI, 1991). The impact of new technology has so far been confined primarily to irrigated areas - which make up some 50% of the world's harvested rice area - and to favourable rainfed areas. Further research must be conducted for these areas to protect and build on what has already been achieved. Recent work at IRRI has given strong indications that the high yield levels

obtained on farms with favourable management conditions are not sustainable due to a variety of factors such as poor quality of irrigation water, the lack of micronutrients, and the vulnerability of improved varieties to pests and diseases. In order to meet the problem of yield erosion, further efforts in maintenance research, as well as in lifting the yield ceiling, will be required. However, if rising demands are to be met, other rice growing systems will also have to receive attention. These include: shallow rainfed rice, which accounts for almost 25% of the harvested area in Asia; deep-water and floating rice, which accounts for about 13% of the harvested area in Asia; and dryland or upland rice, which accounts for 75% of the harvested area in Latin America and the Caribbean and 50% of that in sub-Saharan Africa.

In 1983, 25% of total CGIAR allocations were spent on rice. In 1985, TAC recommended that the overall effort for rice be reduced and that the existing shift in research emphasis away from applied research on irrigated systems be reinforced. TAC considered that the CGIAR System's future efforts on rice should concentrate more on non-irrigated systems, and in basic research on irrigated rice in collaboration with specialized institutions.

These recommendations reflected the successes that had already been achieved in rice research, especially in the more favourable environments. Today, more than two-thirds of the rice lands of developing countries are planted with high-yielding modern varieties. Furthermore, the CGIAR System's collaboration in rice research has significantly strengthened many national research programmes, allowing them to assume an increasingly large share of the responsibility for research. This is particularly true of some of the largest rice producing countries, e.g. India, Thailand, the Philippines, Bangladesh, China and Korea.

Non-irrigated wetland and dryland rice systems comprise almost half the global area under rice production. The production constraints of these systems are more complex than those of irrigated rice because of the lack of control in water management and the more limited knowledge base for research. In Latin America and the Caribbean and in sub-Saharan Africa, CGIAR emphasis has shifted to dryland rice research.

The 1986 recommendation for the movement towards basic research was made in the belief that the exploitation of genetic diversity was fundamental to achieving higher and more stable yields, resistance to major pests and disease, and better drought tolerance. For both irrigated and non-irrigated rice, it will be necessary to develop new and better breeding techniques, to increase knowledge of the factors determining resistance and tolerance, and to raise yield potential by using biotechnology. The CGIAR System should therefore emphasize strategic research. In so doing it will catalyze and support basic research in other institutes, and play an active role in encouraging the application of new techniques to the rice production problems of developing countries.

In considering future priorities for rice research, TAC should also consider the substantial impact obtained from CGIAR efforts in rice research, particularly in Asia, and Latin America and the Caribbean.

5.2.2. Wheat

After rice, wheat is the single most important food source in the developing world, contributing more calories to diets than all other cereals combined. It is higher in protein content than almost all other cereals. Within wheat, a distinction can be made between durum and bread wheats, and between bread wheats, between winter, facultative and spring wheats. Durum wheat accounts for 5% of developing country wheat production, and 70% of it is grown in West Asia-North Africa.

In 1989, developing countries accounted for 42% of world wheat production (538 million t) and 44% of world wheat area (226 million ha). Half the total increase in production in the 1970s and 70% in the 1980s came from the developing world. In 1989, Asia accounted for 71% of the developing world's production, West Asia-North Africa for 17%, Latin America and the Caribbean for 10% and sub-Saharan Africa for 2%. In the West Asia-North Africa region, wheat is the most important food crop in terms of its calorie contribution.

Wheat production in the developing regions as a whole increased by 5% annually in the 1970s and by 4.3% in the 1980s. The five largest producers - China, India, Turkey, Pakistan and Argentina - raised production at an average annual rate of 5.4% in the 1970s and 4.3% in the 1980s, largely through yield increases. In the remaining developing countries, the growth rate was only 1.5% during the 1970s, but increased to 3% during the 1980s. Trends in yield levels over the past two decades have varied considerably. China experienced an increase of 75% in the 1970s and 49% in the 1980s; India 25% in the 1970s and 45% in the 1980s; West Asia-North Africa 35% in the 1970s and 16% in the 1980s, sub-Saharan Africa 55% in the 1970s and 38% in the 1980s; Latin America and the Caribbean 37% in the 1980s. Improved varieties and associated technologies have had a major impact on wheat production in the developing world, causing an absolute yield increase from 1.64 t/ha to 2.23 t/ha in the past decade. Today, some 60% of the wheat lands in developing regions are sown with modern varieties.

Wheat imports by developing countries doubled in the 1970s and further increased substantially in the 1980s. Many countries financed their purchases of wheat with limited foreign exchange, indicating the high priority assigned to wheat as a food. Even the countries that produce wheat have become more reliant on imports during the past two decades. Among countries consuming 100,000 tonnes or more annually, per caput wheat imports declined only in Turkey, India, Pakistan and Zimbabwe.

Growth rates in consumption are closely linked to rising incomes and urbanization. The correlation with rising incomes reflects not only greater overall food consumption, but also a switch to wheat in preference to other starchy staples, and the use of wheat as animal feed. In West Asia-North Africa, where wheat originated, consumption is high at all income levels and in both rural and urban areas. Other factors contributing to increased wheat consumption are the lagging production of many other staple foods; and food aid and pricing policies, which lower wheat prices and create a bias in favour of wheat products.

For the developing regions as a whole, the annual demand for wheat is projected to grow at 3% over the coming decade. Demand will rise particularly rapidly in sub-Saharan Africa, at 5.1% per annum, and at 2.9% in other regions.

Expansion in wheat area has declined from 1.7% per year in the 1950s to under 1% currently, and is projected at 0.8% in the future. Consequently, wheat yields will need to rise by 2.2% each year to meet the projected demand growth of 3%. Semidwarf wheat varieties are already sown in most of the wheat area and fertilizer applications are relatively high on much of the irrigated land. However, in most developing countries absolute yields are still comparatively low, less than half the average yield in Europe. Even the current yield levels of the five largest producers cannot be considered high: China, 3.05 t/ha; India, 2.24 t/ha; Turkey, 1.97 t/ha; Pakistan, 1.86 t/ha; and Argentina, 1.85 t/ha.

Diseases, insect pests and environmental stresses, especially drought, are important constraints but they are not the only ones: crop and water management, socioeconomic factors and the policy environment are equally important for achieving further sustainable increases in yield. The impact of CGIAR investments in wheat research has been impressive. Varieties to which CIMMYT has contributed, now cover about 47 million ha, and between 50% and 70% of improved wheat varieties released during the last 30 years have been based on crosses made by CIMMYT.

In the West Asia-North Africa region, where most of the wheat is rainfed, winter rainfall is low and erratic and crop yields are limited by biological and environmental constraints as well as by management and socioeconomic factors. Except in Turkey, research in this region has not addressed the needs of high elevation areas, which require winter or facultative wheat varieties with tolerance to a range of environmental stresses, including cold. In the lowland areas of the West Asia-North Africa region, tolerance to heat and salinity, as well as to cold, are required. For the lowland irrigated areas of the semi-arid tropics and subtropics with summer rainfall, where the crop is grown during the cool season, varieties with better tolerance to relatively high temperatures are required. Aluminium toxicity is a constraint to bread wheat production in large areas of highly leached acidic soils in the subhumid and humid subtropical areas of southeast China. For the higher elevation areas of the cool tropics and subtropics with summer rainfall, spring wheat varieties with better adaptation to biotic and abiotic stresses are required. According to the ACIAR analysis, the highest pay off from future investments in wheat research can be obtained in the warm and seasonally dry subtropics with summer rainfall, and in the cool subtropics.

In its 1986 assessment of priorities, TAC considered the importance of wheat as a food crop and the increasing reliance of developing countries on wheat imports. It also considered the strong research programmes on wheat in developed countries and the growing strength of national programmes in Latin America, Turkey, India and China, as evidenced by the remarkable yield and production increases achieved in those countries during the 1970s and 1980s. The well organized international wheat trade, the export capacity of some developing countries, and the increasing demand for wheat in countries with unfavourable environments for its production make the concept of self-sufficiency inappropriate for many areas.

In 1986 TAC considered that the trend of the centres concerned to transfer a number of research functions to national systems while continuing to provide them with technical support was reasonable and should be accelerated. This led to the recommendation that the System's overall efforts in wheat research should be gradually reduced by 10% over the following five years. TAC also recommended that research

should concentrate on increasing production on marginal lands, including those in tropical areas.

A major share of CGIAR efforts on wheat are now allocated to maintenance research. The pay off from investment in wheat research has been very high, but further efforts are required to sustain the increased yield levels achieved.

5.2.3. Maize

Among the food crops, maize ranks third after rice and wheat both in terms of calorie contribution and in terms of value of production. Developing countries produce an estimated 39% of world production (470 million t) from about 81 million ha (63% of total maize area). The crop is grown in all the developing regions. Of the total for all regions, China alone accounts for 41%, Latin America and the Caribbean for 27%, the rest of Asia for 13%, sub-Saharan Africa for 9%, and West Asia-North Africa for 7%.

Where grown for human food, maize is an important source of calories for the poor. The crop is widely grown in mixed cropping systems by subsistence farmers. For all developing countries, annual per caput human consumption is only 20 kg, but in Latin America and the Caribbean (the homeland of maize) it is 80 kg, and in sub-Saharan Africa 60 kg; in some countries of both regions, per caput human consumption is as high as 100 kg per annum. Maize provides about one-third of the mean calorie intake in these two regions, but little more than 5% in the other regions. Maize stover is an important byproduct in many countries.

The use of maize for livestock feed has become increasingly important and now accounts for about 54% of consumption in developing countries. In the subtropical areas of South America, it is the main use, and it is important for this purpose in the rest of Latin America and the Caribbean, and in the West Asia-North Africa region. In the 1970s and the 1980s, the use of maize as feed in developing countries grew by 5.3% per annum, and in Asia and West Asia-North Africa it grew at three times the rate for direct human consumption. It grew at twice the rate for food use in sub-Saharan Africa, but from a low base, so that use of maize for feed is still relatively low in that region.

During the current decade, demand for food maize for the developing regions as a whole is expected to grow at 1.6% per year, for feed maize at 4.9%, and for food and feed maize combined at 3.5%. Total regional demand is projected to grow at 3.1% for sub-Saharan Africa, 3% for the West Asia-North Africa region, 3.8% for Asia and 3.3% for Latin America and the Caribbean.

During the past decade, developing countries achieved a 22% increase in yields. However, this average figure masks China's considerable gain of 50% (associated largely with the adoption of improved varieties) at one end of the scale, and a decline of almost 15% in West Africa at the other. The variation in yields per ha is equally dramatic: these range from more than 3 t in subtropical South America and China, through just under 2 in West Asia-North Africa, to about 1.6 in Central and tropical South America, about 1.5 in South and South-East Asia, about 1.1 in East and Southern Africa and India, and less than 1 in the other sub-Saharan African regions. Sub-Saharan Africa achieved some increase in production during the 1970s, but this was the result of an increase in the area harvested. During the 1980s, yield gains were 16% (from 1.96 to 2.28 t/ha) for the

developing regions as a whole, 12% for sub-Saharan Africa, 7% for Latin America and the Caribbean, 38% for West Asia-North Africa and 27% for Asia.

In the long term, the global pattern of use will continue to change with rising incomes and urbanization. Although consumers in developing countries will tend to spend less on maize as they switch to other foods, maize consumption will increase because of its increasing use as feed. In the low-income countries, particularly in sub-Saharan Africa, this scenario is likely to develop more slowly, and in the medium term the problem will be one of increasing demand for maize for human consumption against a background of declining per caput production. For example, in East and Southern Africa, where maize is the staple food and is grown on about 30% of the cultivated crop area, production will need to double by the year 2000 if the region is not to face massive bills for food imports. Increased production in sub-Saharan Africa will need to come mainly from increased yields.

The potential for increasing yields is quite high and the pay off from CGIAR investments in maize research has been substantial, particularly in the lowland tropics. The main constraints are environmental stresses (particularly drought), diseases and insect pests, and low levels of external inputs. Both improved open-pollinated varieties and hybrids are required, depending on local needs and the efficiency of national seed producers. In the lowland tropics, the development of better varieties and improved management practices relevant to farmers' needs and constraints would contribute considerably to improved production. In sub-Saharan Africa, low fertilizer rates and poor management currently pose a greater constraint than does the availability of high-yielding varieties. In East and Southern Africa, where there are extensive lowland and highland areas ideally suited to maize production, the pay off from the development of appropriate technology for small-scale farmers is exceptionally high, as the case of Zimbabwe shows. In some environments with bimodal rainfall, short-cycle maize outperforms both sorghum and millet.

In 1986 TAC considered that the CGIAR System's major effort in maize research was justified and should be maintained over the long term, and that some additional support should be given in the short to medium term to accelerate the promising results from work in progress. The recommendation took into consideration the crop's value as food, feed and a source of income for low-income groups and small-scale farmers worldwide; the projected increase in demand; and the expectation that strategic research could successfully address the constraints to higher yields in many developing countries. TAC recognized the urgent and specific needs of sub-Saharan Africa and recommended a shift of effort to those areas where maize is the staple food.

5.2.4. Barley

Barley is grown throughout the world and is tolerant of many soils and climates, but like wheat it is not well adapted to warm, humid conditions. It does, however, require less moisture than wheat. Its most important uses are for animal feed and making malt; little is used as human food, although average data conceal its local importance for food in some developing countries. The CGIAR System has not been involved with research for the improvement of malting barleys.

Developing countries account for about 14% (1.33 million t) of global production and 16% (16.2 million ha) of the harvested area. West Asia-North Africa accounts for

71% of the harvested area in the developing regions, Asia for 18%, sub-Saharan Africa for 7% and Latin America and the Caribbean for 4%. Some two-thirds of the production is in West Asia-North Africa, and in no other developing region is the crop as important relative to other commodities. Asia accounts for another 28% of production, China for 14% and India for 12%.

In West Asia-North Africa, barley is grown primarily as a feed crop and is inseparable from the production of sheep and goats. It is the principal crop in areas that receive 200-300 mm rainfall. It is estimated that barley provides almost half the annual digestible energy needs of sheep in such areas. Grain, straw and stubble all provide important sources of feed at different times of the year.

Current yields average 1.43 t/ha for all developing countries and 1.25 t/ha for West Asia-North Africa. In the 1970s, there was a decline in the area sown in developing countries, and the modest production increase of 13% over that period is attributed to increases in yield. The average yield increase was 30%, from 1.0 to 1.3 t/ha, but China's gain was an impressive 119%, from 1.1 to 2.4 t/ha, while that of West Asia-North Africa was only 15%, from 0.96 to 1.1 t/ha. During the 1980s there was an increase of about 4% in the harvested area and a 15% increase in production, so nearly three-quarters of the latter increase was due to yield gain. Average yield increase was 11% (from 1.09 to 1.43 t/ha) for all the developing regions combined, 28% for China, 41% for India, and 10% for West Asia-North Africa.

The livestock industry accounts for almost one-third of the value of agricultural production in West Asia-North Africa, and the increasing demand for meat will mean an increased demand for barley as feed.

The main constraints to improved production are environmental stresses (especially drought), and insect pests and diseases.

In 1986 TAC recommended that the overall allocation to barley research be reduced slightly, but that the effort for West Asia-North Africa be strengthened by phasing out research for other regions. The recommendation took account of the relatively low importance of barley elsewhere (excluding barley grown for malt) and the strength of many national agricultural research programmes.

5.2.5. Sorghum

Some 70% (62 million t) of the world's sorghum production and 89% (45 million ha) of its sorghum area are located in the developing regions. Sorghum is a major crop of the lowland semi-arid tropics and subtropics with summer rainfall, where it has a special importance, together with millet, as a staple food for millions of very poor people in drought-prone, high-risk areas. In West Africa, sorghum is an important crop in the subhumid areas, where it is intercropped with millet, maize and cowpea. Sorghum is also an important crop in the medium-altitude areas of Ethiopia. Sorghum tends to have a low or negative income elasticity of demand, and is usually substituted by other foods when income permits. In most areas, the stalks and foliage - used as fodder, fuel and construction materials - are more important than the grain.

Although the average contribution of sorghum to diets may be low in most developing regions, in semi-arid West Africa it contributes 13% of calorie intake and

over 11% of protein, making it the second most important food commodity after millet. In India, it accounts for almost 6% of calorie intake. In Latin America and the Caribbean, most of the crop is used for feed.

Of the area harvested in developing countries, Asia accounts for 46%, sub-Saharan Africa for 31%, West Asia-North Africa for 12% and Latin America and the Caribbean for 10%. India, the largest single producer, accounts for 39% of the sorghum area in the developing regions and China for 5%. In sub-Saharan Africa, some 60% of the sorghum area is located in West Africa, the rest in East and Southern Africa. However, there is little correlation between area harvested and production share because of the considerable regional variation in yields: these range from 3.5 and 3.2 t/ha in Peru and China respectively to 0.74 t/ha in India and 0.9 t/ha in West Africa, where many national averages are even lower.

In the 1970s, substantial yield increases were achieved in China, Latin America and the Caribbean, and India, from a very low level in the latter country. During the 1980s, sorghum area in Asia declined by 10% and production by 6%, the balance being offset by a 4% increase in yield. In sub-Saharan Africa, sorghum area increased by 17% during the 1980s, and this was associated with a yield increase of 9%. In Latin America and the Caribbean, there was a 12% decrease in the sorghum area, accompanied by a yield increase of 4%.

The world's most urgent food production problems lie in drought-prone areas such as those of India and the Sahelian zone of Africa, where sorghum and millet are the staple food crops. The events of recent years have demonstrated as never before the extreme vulnerability of such areas, where the effects of a series of bad years have led to famine and dependence on food aid.

Crop stands are usually poor in such areas, and a special problem is poor plant emergence because of low and erratic rainfall, soil crusts and attacks from shoot flies and stem borers. *Striga* sp. (witchweed) causes serious losses where the land is planted to successive crops of sorghum; and bird damage, especially due to *Quelea* sp., is a serious problem throughout sub-Saharan Africa. Storage pests are also a problem.

In 1986 TAC recommended that the level of effort on sorghum be increased immediately and that the main effort should continue to be directed to sub-Saharan Africa, where research needs and opportunities were greatest. India, China and Latin America and the Caribbean, due to either relatively strong national programmes or the development of the private-sector seed industry, had less need of assistance.

One of the major objectives of this recommendation was to bring research support on sorghum (and millet) in sub-Saharan Africa to a level comparable with that of maize, so that suitable varieties and other technologies of most value to some of the world's poorest people could be developed as quickly as possible.

5.2.6. Millet

In Asia and sub-Saharan Africa, pearl millet is the most important crop in the lowland semi-arid tropics and subtropical areas with summer rainfall, where it is a staple food together with sorghum (in sub-Saharan Africa), or with wheat (in Asia). Millet

provides food for some of the world's poorest countries and poorest people. It can produce under conditions too dry for sorghum, and its straw is a valuable livestock feed.

Because some countries combine their statistics for sorghum and millet, the data for millet tend to be overestimated, especially for sub-Saharan Africa. It would appear that the crop is harvested from about 40 million ha in developing countries, with India accounting for about 45% of that area and West Africa for about 32%. Millet is the staple cereal in the Sahelian zone of Africa. In semi-arid West Africa, it accounts for about half the daily calorie intake and one-third of the protein.

Average yields are only 500 to 700 kg/ha. Yields remained stagnant during the 1970s but showed a modest increase of 12% during the 1980s. Whereas developing world production declined during the 1970 (with a slight increase in West Africa), it increased by 13% during the 1980s, mainly due to yield increases (12%). In sub-Saharan Africa, the area under production increased by 18%, and this was accompanied by a 14% increase in yield. In Asia, the area decreased by 12%, but yields rose by 15%, leading to a 3% increase in production. However, unless millet yields can be further improved and stabilized, the future for rainfed food production in the semi-arid tropics will continue to look bleak. In India, ICRISAT's efforts have met with substantial success: more than 4 million ha or a third of the area cultivated is now planted with improved millet varieties that originated at ICRISAT.

The main constraints to production are the same as those for sorghum: environmental stress (especially drought), crop establishment, insect pests and diseases, and *Striga* sp.

In 1986 TAC recommended that the level of effort on millet be increased over the short term, with a greater concentration on the needs of sub-Saharan Africa. The recommendation was based on the crop's importance in meeting the needs of the poor in sub-Saharan Africa and India, the fact that people in the driest areas of the semi-arid tropics depend on it for survival, the short research history, and the weak national research programmes in the millet producing countries of sub-Saharan Africa. Continuing development of improved varieties and crop management practices is required. The control of *Striga*, drought tolerance, and germination and establishment in crusting soils should remain as areas of particular focus.

5.3. Roots, Tubers, Banana and Plantain

5.3.1. Cassava

Cassava is an important food crop in sub-Saharan Africa, particularly in the humid and subhumid tropics. It is also important in parts of Asia and Latin America and the Caribbean. The leaves are eaten as a green vegetable in sub-Saharan Africa and provide a cheap and rich source of protein and Vitamins A and B. The crop is grown mostly by small-scale farmers, mainly under subsistence or semi-subsistence conditions and on low-fertility soils. It tolerates drought and can be left in the ground as a food reserve for long periods. Cassava ranks among the 15 most important agricultural commodities in developing countries with respect to value of production, and is the most important in sub-Saharan Africa.

World production in 1989, all from developing countries, was about 148 million t from about 15 million ha - some 40% of the total area in developing countries devoted to root crops. This represents an increase in production of 19% and in harvested area of 8% during the past decade. Sub-Saharan Africa accounts for approximately 42% of world production, Asia for about 37%, and Latin America and the Caribbean for 21% (75% of this from Brazil, the world's largest producer).

Cassava is the most important root crop in sub-Saharan Africa, where it accounts for 70% of the harvested root crop area. It is used mainly as a fresh food, or as meal or flour after processing, and provides a major source of dietary energy for over 160 million people. Zaire and Nigeria are the largest African producers, accounting for 53% (33 million t) of production. In Asia, there are many more end uses and all the principal producing countries have starch industries. In Thailand, cassava is produced largely for export as cattle feed. In Latin America and the Caribbean, its principal use is as food, but some cassava is used to feed swine. During the 1980s, yield gains were about 10% (from 9 to 9.8 t/ha) for the developing regions as a whole, 10% for sub-Saharan Africa, 7% for Latin America and the Caribbean, and 14% for Asia. Current average yields for China, Thailand and India are 14, 15 and 19 t/ha respectively, compared with 6 to 7 t/ha in sub-Saharan Africa.

With real incomes increasing slowly or not at all in most sub-Saharan African countries, there seems likely to be a continuing demand for cassava as a human food, at least until the year 2010. Also, the crop has special significance as a food reserve. Besides the need to diminish the HCN content for safety reasons and to reduce the food preparation time required by women, cassava research in Africa should address the following principal issues: improvement of the role of cassava as a subsistence and famine relief crop; utilization of the crop's potential for income and employment generation; and the generation of marketable surpluses with significant added value to meet rising urban demand for new products. The decline in yields in sub-Saharan Africa during the 1970s was probably due to the spread of cassava mealy bug and green spider mite. The successful strategy applied during the 1980s for the biological control of mealy bug should be extended to the crop's other pests.

Cassava production in Asia has increased at an annual rate of over 5% during the past 20 years. Thailand is the region's largest producer, with 38% of total production, and has become an important exporter of cassava chips for cattle feed. The market in Asia seems likely to remain healthy due to the demand-led diversification of cassava's end uses. There is still a need for more high-yielding clones and improved management practices in Asia.

Cassava production in Latin America and the Caribbean declined during the 1970s, especially in Brazil. During the 1980s, production remained more or less steady against a background of a 65% decrease in the area harvested. Cassava remains a small-farm crop grown in marginal areas where soil fertility and moisture limit the production of other crops. Nevertheless, cassava farmers sell a high proportion of their production. Urbanization has led to decreasing per caput consumption, but the crop is increasingly being used in animal and shrimp feeds.

In 1986 TAC considered that, for sub-Saharan Africa, the potential for further pay off from research on cassava was high and that the region's young national programmes needed continued support. It therefore recommended that the research effort

be strengthened, with the emphasis on disease and pest control, the quality of leaves used as a vegetable, and the quality of roots for processing for food and industrial use. In Asia, demand was buoyant and national programmes, though relatively young, were strong. The main requirements from the CGIAR System seemed to be improved germplasm and consultation services on technical problems, especially production agronomy. With respect to Latin America and the Caribbean, the situation was considered more complex and future needs were felt to be unclear. TAC therefore recommended that in the short term the global effort be maintained but that there should be a slight shift of effort from Latin America and the Caribbean to sub-Saharan Africa.

Since 1986, studies carried out in Latin America and the Caribbean have shown that cassava is increasingly being used in animal and shrimp feeds. The rapid increase in demand for feed, coupled with the cereals deficit, suggests considerable future demand for dried cassava. In the absence of price distortions, cassava is highly competitive with cereal grains. Also, while urbanization has led to a decrease in the per caput consumption of fresh cassava, pilot studies indicate increased demand on the part of urban dwellers for new "convenience food" cassava products. Overall, the major areas for market expansion for cassava in Latin America and the Caribbean are seen to be "conserved fresh cassava", animal feed, refined flours and starch.

5.3.2. Potato

Approximately 27% (76 million t) of the world's potato crop is currently produced in developing countries, mainly by small-scale farmers, compared to only 15% two decades ago. Potato is a labour intensive crop. The nutrient value (including Vitamin C) of potato is high, and the crop is particularly useful as a source of energy and protein and as an infant weaning food. High yields are possible, demand is growing rapidly due to positive income elasticity of demand for the crop at low income levels, and potato has a high value as a cash crop. It ranks among the five most important food crops in developing countries with respect to gross value of production.

In 1989, developing countries accounted for about 34% of the area harvested. China is the largest producer, accounting for 40% of the 76 million t of potatoes produced in developing countries in 1989, while the rest of Asia accounted for 28%, Latin America and the Caribbean for 17%, West Asia-North Africa for 13% and sub-Saharan Africa for 2%. Yields vary from about 7 t/ha in sub-Saharan Africa to 13 t/ha in West Asia-North Africa and Latin America and the Caribbean, compared with an average of 17 t/ha in developed countries. During the 1980s, yields in the developing regions as a whole increased by 13%, from 10.9 to 12.2 t/ha.

Among the major constraints to increased production are the high costs of production, various diseases and pests, the perishability of the crop during storage, and the difficulty of developing varieties adapted to higher temperatures. As in the case of other roots and tubers, national research capacity in potato research was generally weak at the start of CGIAR activities with this commodity. Only 2% of the world's potato production is traded on international markets because of the perishability of the crop, whose high water content makes its transport over long distances risky. Quarantine regulations also restrict international trade in potato.

Potato has responded well to research, and plant breeding has already brought about significant improvements in the crop in developing countries. Virology research in

the potato has advanced greatly, and the safe movement of germplasm is now a reality. The adoption of improved potato varieties is often delayed by the absence of national seed or multiplication systems. There is also a need for greater attention to the integration of potato in sustainable cropping systems.

In 1986, TAC recommended that the level of support for potato research should continue in the short to medium term, given the short history of research for tropical and subtropical regions. TAC further recommended that, in view of the stronger national programmes then beginning to emerge and the spillovers from research in developed countries, CGIAR support be reduced in the medium to long term.

5.3.3. Sweet potato

Sweet potato is now widely grown as a staple food in developing countries outside tropical America, where it originated. Although sweet potato statistics are dominated by the production level of China (the world's largest sweet potato producer accounting for about 80% of production), the crop is also grown in many small countries with typically very low income levels. Sweet potato has very little research history, and outside the CGIAR only very little research is conducted on the crop. It is well adapted to warm tropical lowlands and produces relatively well under low-input conditions on good soils. Depending on variety, the crop can be harvested in three to six months. Sweet potato fits well into the multiple cropping systems of Asia. The protein content of the roots is marginally greater than that of cassava and about half that of potato and yam. Sweet potato provides large shares of calories, protein and Vitamin C, as well as Vitamin A in yellow cultivars to the diets of the poor. When eaten as a vegetable, the green leaves provide additional protein, vitamins and minerals. Production costs and labour inputs are low in terms of the yield and calories produced.

Per caput production of sweet potato has decreased during the past 20 years, and the area harvested has also diminished. As income levels have risen the consumption of sweet potato has fallen. There has also been diversification in the uses made of sweet potato. For example, in China, only about 26% of sweet potato production is now used for human consumption, as against 35% for livestock feed, 28% for industrial uses (starch and alcohol) and 11% for seed or processed snacks.

Of the 9.1 million ha of sweet potato harvested in 1989 in developing countries, Asia accounted for 91%, sub-Saharan Africa for 6%, and Latin America and the Caribbean for 3%. About 131 million t of sweet potato are produced altogether, of which 98% is from developing countries. China dominates world production, producing over 80% of developing country output, and this masks the importance of sweet potato in many small countries such as the Pacific Islands. In terms of gross value of production sweet potato ranks eighth among the major agricultural commodities in developing countries.

The demand for sweet potato is increasing in sub-Saharan Africa, where the harvested area is relatively small. Production is estimated to have increased by 25% in the 1970s and by 13% in the 1980s, and is now 2.6 times higher than that of Latin America and the Caribbean, where it declined during the 1970s but increased by 9% during the 1980s.

Although current yields in sub-Saharan Africa average only 6 t/ha, the crop's high yield potential has been demonstrated by the CGIAR System's research in that region, which has led to varieties that can produce more than 40 t/ha in four months when grown in the wet season. Similar results have been obtained from new Asian varieties. Current yields in the developing regions as a whole average around 14t/ha, with an average yield of about 18t/ha in China. Substantial potential exists for an expansion of the importance of sweet potato and its foliage as a livestock feed.

Pests and diseases, such as the sweet potato weevil, stemborer, viruses and mycoplasma-like organisms, are major production constraints. Unlike cassava, the crop cannot be stored in the ground beyond maturity, as it sprouts easily and is subject to pest attacks. Nor does it store well once lifted, although slicing and drying alleviate this problem to some extent.

In 1986 TAC considered sweet potato to be a neglected crop and recommended that the research effort be increased substantially. It recognized a need for greater collaboration between the CGIAR Centres and other institutions involved in research on the crop, such as AVRDC. The role of sweet potato in the development of new foods and food processing technologies could make it a highly valuable cash crop and employment generator in the medium to long term. In 1987, sweet potato was added to CIP's mandate, and in 1990, AVRDC decided to stop further work on sweet potato.

5.3.4. Yam

A crop of the warm humid and subhumid tropics, yam is a favoured food in sub-Saharan Africa, and in the Pacific and Caribbean islands. More than 90% (2.4 million ha) of the current global area under yam cultivation is in sub-Saharan Africa, where the crop accounts for about 21% of the area cultivated with root crops in the continent's root-crop belt. Nigeria alone accounts for about 70% (16 million t) of the world production of yam.

Yam is a preferred food and a food security crop in some sub-Saharan African countries. It makes major contributions to energy and protein requirements in the forest zone of West Africa, is a staple food and cash crop for millions of small-scale farmers in densely populated areas, and provides employment in transportation and sales at urban and rural markets. In West Africa, the white yam - *Dioscorea rotundata* - is the most highly prized type and the one that has received most attention from the CGIAR System.

The most important constraint to future production is cost. Production is carried out mainly with hand tools, and labour demands are high for planting, weeding, staking and harvesting. The cost of planting material is high: 20-30% of the previous harvest. In sub-Saharan Africa, maximum gross yields are 10 t/ha (7-8 t/ha net, after allowing for next season's planting material). Diseases threaten production and the crop's shelf life is short.

International research efforts on yam are fairly recent and small, but results are promising. Within the CGIAR System, non-stake lines capable of producing 20 t/ha have been produced and new techniques for the production of planting materials should reduce the drain on harvests. These techniques have already led to a small seed-yam production industry among yam growers in Nigeria. Research has also found ways of triggering flowering, thereby allowing plant breeding to begin.

In 1986, TAC recommended that the effort on yams be increased to a level sufficient to make a rapid impact on production and postharvest problems. TAC viewed the increased efforts devoted to yam as a short-term thrust to determine whether the apparent breakthroughs in seed propagation and the development of non-staking varieties could make the anticipated impact on production in farmers' fields.

5.3.5. Banana and Plantain

Banana and plantain are staple food crops for millions of people in developing countries. About 90% of production takes place on small farms and is consumed locally. Only 10%, mainly from commercial plantations in Latin America and the Caribbean, enters world trade. In terms of gross value of production, banana and plantain rank fourth after rice, milk and wheat.

Banana and plantain are grown in about 120 countries. Total annual world production is estimated at over 68 million t: 24 million in sub-Saharan Africa, 26 million in Latin America and the Caribbean, and 17 million in Asia. In parts of sub-Saharan Africa and Latin America and the Caribbean, average per caput consumption is 150 to 300 grammes per day, and the crop provides 25% or more of the daily calorie intake, in addition to being a source of Vitamin B, notably B6, and potassium. Plantains are extremely rich in Vitamin A and bananas are high in ascorbic acid. During the 1980s, total production in the developing countries increased by about 15%.

The main challenges to research include breeding for resistance to Black Sigatoka disease, Fusarium Wilt (Panama disease), Bunch Top Virus and banana weevil, and the development of improved production systems.

In 1990, the CGIAR decided to extend its support for banana and plantain research beyond the humid and subhumid tropics of sub-Saharan Africa, to include Asia and Latin America and the Caribbean.

5.4. Food Legumes

5.4.1. Chickpea

The chickpea originated in West Asia. The crop is grown on small-scale farms as a food and cash crop. It is used whole, dehulled or as a flour. The immature pods, shoots and seed may be used as vegetables. In 1989, world production was 7.4 million t from 9.9 million ha, of which 98% was from developing countries. Asia accounted for 83% of production, West Asia-North Africa 12%, Latin America and the Caribbean 3% and sub-Saharan Africa 2%. Yields have remained relatively stable over the past two decades, ranging from 0.6 to 0.7 t/ha in Asia and sub-Saharan Africa and from 0.9 to 1.1 t/ha in West Asia-North Africa and Latin America and the Caribbean.

The small-seeded desi types, which account for about 85% of world production, are grown on the Indian subcontinent, in Ethiopia and in parts of Afghanistan and Iran. The large-seeded kabuli types are grown in the Mediterranean region, Mexico, and to some extent on the Indian subcontinent. In the tropics and subtropics with summer rainfall, chickpea is grown on residual soil moisture or under irrigation. In the subtropics

with winter rainfall, the crop is generally sown during the spring. It usually receives few or no inputs other than labour and seed.

Chickpea is an important dietary item in South-East Asia, India and the West Asia-North Africa region. The protein content is 19.4% of the seed. The average yield for all developing countries is about 600 kg/ha, but the Central American yield is almost twice as high, and experiments in India with limited irrigation have produced yields five times the developing world average. The area harvested globally has remained stable (around 10 million ha). In most regions, changes in yield and production reflect climatic factors.

Consumption has followed production, and it is expected that demand will increase with population in India and in West Asia-North Africa, where chickpea is liked by all income groups.

Among the major constraints to production are the low yields of local varieties, variability in yield due to environmental stresses, diseases, pests and poor crop management. CGIAR efforts have already produced significant results, notably the combination of blight resistance and frost tolerance, which has enabled winter sowing (and a potential doubling of production) in the low-elevation areas of West Asia-North Africa region. This has led to yield increases of 50 to 100%. Higher yielding, disease- and pest-resistant lines are becoming available to breeders. New, more effective strains of rhizobia have been identified, leading to considerable increases in seed yields.

In 1986 TAC recommended that the overall level of resource allocation to chickpea research be maintained, but with a shift of effort to West Asia-North Africa and East and Southern Africa (mainly Ethiopia). In the former region, research should continue to be directed at increasing productivity and stability through varietal improvement and the development of better production technology. For East and Southern Africa, TAC encouraged research directed at expanded production of the desi type in suitable agroecological areas.

5.4.2. Cowpea

Cowpea is widely grown in the warm semi-arid and subhumid regions of sub-Saharan Africa, and to a lesser extent in Asia and Latin America and the Caribbean. Production is concentrated in West Africa, where about 80% of the African crop is grown. Nigeria accounts for over 50% of the region's production. Cowpea is locally important in several other regions, particularly the Caribbean islands, Brazil, PDR Yemen, the Indian subcontinent and southeast Asia.

Cowpea is usually grown by subsistence farmers and in mixtures with maize, sorghum, millet and cassava. The dry seed is an important source of Vitamin B and protein (22% edible protein) and provides an estimated 6.5% of total protein consumed in semi-arid West Africa. Cowpea haulm is also an important source of livestock feed.

Average yields in developing countries are about 240 kg/ha. However, the best short- to medium-duration varieties so far developed can yield 2,500-3,000 kg/ha in field conditions on research stations, and short-duration varieties can achieve over 2,000 kg/ha in 60-90 days. Farm yields are limited by poor plant types, poor husbandry and the crop's susceptibility to diseases and pests.

In 1986 TAC recommended that the resource allocation to cowpea be maintained for the medium term, but with an expansion of efforts in tropical America and Asia. The factors leading to this recommendation were: the importance of cowpea as a subsistence crop in sub-Saharan Africa; its qualities of genetic diversity, fast maturation, wide environmental adaptability, resistance to drought, ability to fix nitrogen, and easy placement in cropping systems which, if exploited, could make it the most valuable of the pulses in the semi-arid to subhumid tropics; the potential value in other regions of a short-duration legume; the rapid growth occurring in production and consumption; the already promising results emerging from cowpea's short research history; and the limited capacity of national research programmes. TAC also recommended that research supported by the CGIAR System continue to concentrate on increasing yields and their stability and on improving management practices.

5.4.3. Broad (faba) bean

Faba bean is a spring crop in temperate regions and a winter crop in subtropical regions with mild winters. It is grown at high elevations in tropical and subtropical regions. Two main subgroups exist: small-seeded types, found in Egypt, Sudan and Afghanistan; and large-seeded types, found in other parts of West Asia-North Africa.

Developing countries account for almost 90% of the global production of 3.8 million t. Of the developing country share, China accounts for 69%, West Asia-North Africa 26%, and Latin America and the Caribbean 5%. The protein content is high (25% of edible portion), and faba bean is a popular food in West Asia-North Africa, though it provides only 0.9% of the region's protein. Faba bean is also a source of Vitamin B. Developing country yields of mature seed average 1,100 kg/ha, more than double that of many other pulses. It is estimated that about 20% of the crop is consumed green and is not accounted for in production estimates. Demand is likely to increase as population rises: faba bean is a preferred pulse in North Africa and parts of West Asia, and provides variety to diets elsewhere.

The constraints to production include: soil salinity in some areas; diseases; field and storage pests; the parasitic weed, *Orobanche*; and poor crop management.

In 1986 TAC recommended that CGIAR support for faba bean research should be phased out for the following reasons: the crop is not important globally; China, the largest producer, has a strong national programme; and there are only 1 million ha under the crop in developing countries excluding China. The CGIAR should only support the conservation and management of faba bean germplasm collections. TAC understands that ICARDA will have phased out its faba bean improvement programme by 1992, but that the faba bean collection will continue to be maintained by the Centre's genetic resources unit.

5.4.4. Lentil

Lentil is grown in the subtropics with winter rainfall, in warm temperate regions, and in the tropics and subtropics with summer rainfall, either during cool dry seasons or at high altitudes. In no region does the crop make a large protein or calorie contribution to diet, although it is a preferred secondary food at all income levels where it is grown, and a traditional food in its centre of origin, West Asia. The vegetative parts are used for

forage and green manure. Two types of equal importance are recognized, large-seeded and small-seeded.

Developing countries account for about 85% of world production from 2.6 million ha. West Asia-North Africa and India contribute nearly 90% of that share, and several countries in Latin America and the Caribbean and in South Asia have small but locally significant production. In the drier areas of West Asia-North Africa, lentil is a key component of the traditional farming system, integrating barley, small ruminants and lentil.

The area under lentil production in the West Asia-North Africa region is 1.0 million ha and, except in Turkey, has remained more or less the same over the past 20 years. Yields are low - 500-600 kg/ha on average. A few countries have made gains in production, but these have come largely from an increase in the area harvested. Demand is expected to increase with rising population.

Constraints to production are low, unstable yields and high production costs, which cause many farmers to stop production. The harvest is labour-intensive, and a delayed harvest results in loss of seed yield from pod dehiscence and pod drop.

Good progress has been made in obtaining taller, more lodging-resistant lentil ideotypes that are suitable for mechanization. Lines have been found with greater cold tolerance and resistance to *Orobanche*. Yield stability in autumn-sown lentils has been enhanced through breeding for cold tolerance.

Despite the impressive progress made by ICARDA, it should be noted that the crop is of relatively minor importance in developing countries in terms of the total area under production. TAC endorsed the recommendation of ICARDA's second EPR in 1988 that continued CGIAR support for lentil improvement research beyond 1992 should be based on an in-depth assessment of the potential pay off from further research investments. Caution should be taken, however, to ensure the continued maintenance and management of the lentil germplasm collection and to continue to address the role of lentil in farming systems.

5.4.5. Phaseolus bean

The phaseolus bean originated in tropical South America and is the most widely consumed pulse in that region. Annual growth in bean production in Latin America and the Caribbean during the past two decades was slightly greater than 1%, well below the population growth rate of 2.4%. Beans are also important in parts of sub-Saharan Africa and Asia. They are grown predominantly by small-scale farmers in a wide range of cropping systems and a large number of agroecological zones. About 80% of the crop in Latin America and the Caribbean and in sub-Saharan Africa is intercropped, often on steep slopes and in low fertility soils. Beans are grown mainly for the mature seed. The immature pods are an important vegetable, especially in Asia, while the leaves are used as a vegetable in sub-Saharan Africa.

Phaseolus bean is a cheap source of high-quality protein, with highest consumption among the poor. It is the leading protein source in Brazil and in parts of equatorial Africa, sometimes contributing up to 30% of protein intake and 10-15% of calories. It is also a source of Vitamins A and B.

Available production data on this crop indicate that during the period 1984-86 about 6.8 million t were produced annually, in developing countries. Latin America and the Caribbean produced 4 million t annually with Brazil and Mexico accounting for about four-fifths of this. Sub-Saharan African production is largely concentrated in the highlands of East and Southern Africa, while East Asia is the centre of Asian production. Production in sub-Saharan Africa during the period 1984-86 was about 2.4 million t annually.

Yields of 500-600 kg/ha have persisted for the past 20 years, and per caput production is declining in parts of tropical South America. The crop's variations in yields and production result in considerable price fluctuations, from which the poor suffer most. Stabilization of yields through breeding and selection is difficult because of the wide variation in consumer preferences for seed colour, shape, etc. Nonetheless, CIAT has developed several improved varieties that have been widely adopted by smallholder farmers in Latin America and the Caribbean and in sub-Saharan Africa.

In 1986 TAC recommended that the level of effort on phaseolus bean be maintained, and welcomed the increasing attention being devoted to East Africa. Although work had been correctly directed towards the problem of stabilizing yields, TAC felt that more emphasis should be given to breeding for higher yield potential.

5.4.6. Pigeonpea

Pigeonpea is widely grown by subsistence farmers in the warm semi-arid and subhumid tropics. It is often grown on poor soils and with few inputs. It is an important food in India, and is popular in parts of East Africa and Central America. The seeds are used whole, dehulled or as a flour; and in the Caribbean and South America, immature seeds and pods are used as a vegetable. The woody stem is valuable as firewood, thatch and fencing, and the leaves are an important source of nitrogen for the soil.

World production is about 2 million t, most of which is grown in developing countries. The crop is an important source of protein (20% of mature seed) and Vitamin B. India accounts for 91% of world production, followed by sub-Saharan Africa (6%). The remainder comes from Latin America and the Caribbean and from Asia.

Average developing country yields are 700 kg/ha, but vary from 500-600 kg/ha in central and southern India, sub-Saharan Africa and Asia to 1,000-1,200 kg/ha in northern India and Central America when the crop is grown sole. The main production constraints are variable yields associated with abiotic stresses, diseases and pests and subsistence production conditions. The crop's potential for wider use in semi-arid areas with high temperatures and poor soils is considerable, making it a potential complement to phaseolus bean or chickpea in the drier and more marginal areas of East and Southern and equatorial Africa and Central America. Countries in Asia and in East and Southern Africa have shown an active interest in exploiting pigeonpea's multipurpose potential in farming systems where drought and heat tolerance are important considerations. Recently, ICRISAT achieved a major breakthrough by producing the first hybrid pigeonpea variety.

In 1986 TAC recommended that CGIAR support for pigeonpea research be increased and efforts extended to West Africa and East and Southern Africa. The crop appeared particularly adaptable to mixed cropping systems, either as an annual or

perennial; and its wide range of seed colour, size and shape made it potentially more acceptable to some populations. Furthermore, the research history was short and little had yet been done outside India.

5.4.7. Soybean

Soybean was originally domesticated in China, and is now cultivated throughout East and South-East Asia, the Americas (particularly the USA and Brazil) and to a very limited extent in sub-Saharan Africa and West Asia. In the northern hemisphere, its cultivation now extends from the tropics to 52°N.

Soybean has high protein (38%) and fat (18%) contents. The crop's main use is for oil and protein products in the food industry. The residue after oil extraction is used for flour, protein products and animal feed. Although soybean is an important food crop and an inexpensive source of protein and Vitamin B in East Asia, efforts to introduce it as a food crop elsewhere have met with limited success. However, it is gaining importance in many parts of sub-Saharan Africa. It requires special and relatively laborious processing since, when prepared in the same way as other legumes, it has an unattractive flavour and is indigestible.

About 40% of the global area harvested is in developing countries. Tropical and subtropical South America produces 49% of the developing country share (75% of this from Brazil, which has a large export trade), China 28%, temperate South America 13%, and southeast Asia 5%. The crop provides nearly 5% of protein consumption in China and southeast Asia. Its fat contribution to diet is 20% in Brazil, 6-7% in China, India and Thailand, and 4-5% in Indonesia. Latin America and the Caribbean produces 26 million t of soybean annually. In the past decade the region's area under soybean increased by about 1.4% per year while yields increased at 2%, reaching 1.8 t/ha (close to the world average of 1.9 t/ha). Among the major constraints limiting production in Latin America and the Caribbean are acid soils, aluminium toxicity, photoperiodism, and pests and diseases. Yields vary considerably, from 0.8 t/ha in sub-Saharan Africa to 1.8 t/ha in Latin America and the Caribbean.

Demand for oilseeds in developing countries is expected to grow at 2.9% annually until the year 2000, and production will need to increase accordingly. In sub-Saharan Africa, vegetable oil is already in short supply, and several countries of the region imported substantial quantities of both soybean cake and soybean oil during the 1980s. Most countries in Latin America and the Caribbean also have a deficit in vegetable oil. Furthermore, soybean has substantial potential as a source of livestock feed, particularly for poultry.

Soybean research has been under way for some time outside the CGIAR System, with AVRDC and INTSOY serving the needs of developing countries. Recently, good progress has been made in the development of multipurpose species. The System's own work, launched only recently, is based in sub-Saharan Africa, and has progressed well in addressing four specific problems: increasing the ability of soybean to nodulate with naturally occurring rhizobia; improving seed longevity; developing appropriate cultural and management practices for pure stands or mixed cropping systems; and resistance to pests and diseases. The principal objectives for future research in sub-Saharan Africa are to incorporate traits for promiscuous nodulation and seed longevity into otherwise agronomically superior lines, and to develop resistance to major diseases.

In 1986 TAC recommended that research support for soybean be increased, with efforts continuing to focus on sub-Saharan Africa, as the needs of Asia and Latin America and the Caribbean were being successfully met by strong national programmes. This recommendation was based on: the crop's importance, given increasing oilseed demand in sub-Saharan Africa and globally; the high level of interest in and apparent potential for the crop in sub-Saharan Africa; the high pay off from the modest research effort to date; and the excellent potential for developing solutions to some of the more important production problems in the tropics.

5.5. Oil Crops

5.5.1. Oilseeds

Oilseed crops are a large and diverse group. Soybean has already been discussed in this report under food legumes. Other important oilseeds are: coconut, groundnut, oil palm, sunflower, safflower, rapeseed, sesame, maize and olive. Cotton is also a major source of edible oil, but is grown primarily for its value as a source of natural fibre.

Oilseeds are an excellent source of protein and fat and make an ideal complement to root crops, which are predominantly carbohydrate. They are used as whole seed, vegetable oil and cake oil extraction (for animal feed), and their by-products are used for fuelwood, mulch and industrial purposes.

The production of oilseeds in the developing world kept pace with demand in the 1970s but, with the exception of soybean and oil palm, yields declined or remained stagnant during the 1980s. Total oilseed production will have to increase by an average of 3.3% annually to meet demand to the year 2000.

Besides soybean, the major tradeable oilseeds produced in the developing countries are coconut, groundnut and oil palm. Coconut and groundnut are discussed in separate sections below. Oil palm, a perennial, is a major world oil crop, grown largely on plantations in rain forest areas of southeast Asia, West Africa and Latin America and the Caribbean. Oil palm production is dynamic and highly competitive in response to the demand for vegetable oil. Intensive private- and public-sector research has led to considerable increases in yields and improved oil quality. Tissue culture has recently opened the way to raising large numbers of plantlets at low cost from elite clones. Colombia, Ecuador, Malaysia and Nigeria have strong national programmes, while international research is conducted by IRHO as well as by the private sector. In 1985 TAC considered that oil palm research needs were already being well addressed and did not require support from the CGIAR System.

The oilseeds which do not earn foreign exchange are less important. Sunflower is harvested from only 3 million ha, safflower from 1.2 million ha, and rapeseed from 7.4 million ha in the developing countries. Sesame is widely grown in the tropics and subtropics, mostly for domestic consumption. About 6.3 million ha are harvested in developing countries, and India, Mexico and Venezuela have strong national research programmes for the crop. Current production of olive oil is 1726 million t, of which only 18.5 t is produced in the developing world - 97% from West Asia-North Africa

where national and regional research programmes are strong. Maize oil is produced mainly in the developed world.

5.5.2. Coconut

The coconut palm is a pan-tropical crop, grown on approximately 11.6 million ha in 82 countries. Many producing countries are small islands in the Pacific and Indian Oceans and the Caribbean. Coconut is both their primary subsistence crop and their only significant source of export earnings. There are few, if any, alternative crops which can substitute for coconut in these countries. Coconut is the major tree-crop component in several agroforestry systems throughout the world. Its wide use in home gardens is probably not reflected in official production statistics.

At least 96% of the total world production of coconut comes from smallholdings. About 70% of the crop is consumed in the producing countries. Coconut can be grown in harsh environments such as atolls, and tolerates high salinity, drought and poor soils. It plays an important role in sustaining often fragile ecosystems in island and coastal communities. Coconut is used as a source of food, drink, fuel, animal feed and shelter. It is also a cash crop, used to produce many items for sale at either the local, national or international level. The main internationally traded products are copra, coconut oil, copra meal, and desiccated coconut.

In 1986 TAC identified coconut as a priority commodity for support through international research. The CGIAR then requested TAC to explore the desirability of establishing an international research initiative on coconut, and the form such an initiative might take.

There are four major constraints to increased coconut production in developing countries: the low productivity of many coconut trees due to old age and poor nutrition; the failure of many replanting programmes; fluctuating productivity due to variable environmental conditions; and inefficient handling and processing, with low farm-gate prices to smallholders. The productivity of the crop can be increased by the use of locally adapted high-yielding, pest- and disease-tolerant varieties in replanting or new planting schemes. To increase the productivity of existing plantations it would be necessary to apply better agronomic practices, including the control of diseases, insects and weeds and the use of fertilizers, and to identify and promote profitable and sustainable intercropping systems. There is a need to develop improved methods of handling and processing coconut, and to further diversify the coconut products traded.

Coconut breeding in several countries over the past 30 years has demonstrated that hybrids are capable of yielding up to 6 t copra/ha/year under favourable conditions improved with average world yields of 0.5 t/ha/year. Progress has also been made in identifying the causal agents of diseases of previously unknown etiology, such as cadang-cadang disease in the Philippines and lethal yellowing disease in the Caribbean. Nutritional studies have shown that coconut responds well to fertilizer application, particularly potassium and chloride. Intercropping and the grazing of cattle under trees have shown that the total productivity of coconut lands can be improved, without threatening the long-term sustainability of the system.

These findings suggest that a well organized and adequately funded international research effort could yield a high pay off. The long-term nature of coconut research, the

history of discontinuity and lack of support in its funding, the prospects of high returns from research investments, and the likely benefits to smallholder producers, make coconut particularly suitable for an international research initiative. The priority research areas for such an initiative would be: germplasm conservation and improvement; disease and pest control; sustainability of coconut-based farming systems; post-harvest handling and processing; and the socioeconomics of coconut production. It is to be noted, however, that in a number of countries research on coconut is funded by the private sector through levies on producers.

5.5.3. Groundnut

About 18 million ha are cultivated to groundnut in the world, of which 12 million ha are in Asia (India and China have 4 million ha each) and 5 million ha are in sub-Saharan Africa. North and Central America have 0.8 million ha. Groundnut is grown under a wide range of environmental conditions in areas between 40°S and 40°N of the equator. Most of the crop is produced where average rainfall is 600 to 1,200 mm and mean daily temperatures are more than 20°C. The main use of the seed is as a source of edible oil, but the high oil (45-50%) and protein (26%) contents also make it an important food crop. As a result, large quantities are consumed in the areas of production.

As a combined oilseed and food crop, groundnut ranks second only to soybean. It is a valuable source of B Vitamins (particularly Niacin which is low in cereals), and the cake, after extraction of the oil, is a high-protein animal feed. The green haulms provide good quality fodder and can be made into hay. Groundnut is a valuable cash crop for millions of small-scale farmers in the semi-arid tropics. It generates employment on the farm and in marketing, transportation and processing. It is a valuable source of foreign exchange when exported. It also makes an important contribution to the fat content of diets in India (28%) and sub-Saharan Africa (as high as 62% in Sudan, for example), and to the protein content of diets throughout sub-Saharan Africa.

India is by far the largest producer, accounting for 39% of annual developing country production; 60% of India's production is used for oil and the rest for cattle feed. China is the second largest producer with 15%, while sub-Saharan Africa produces 21%, Latin America and the Caribbean and West Asia-North Africa 8% each, and most of the balance is produced in southeast Asia. In sub-Saharan Africa groundnut is a major food crop and only part of the produce is marketed.

The average yield for all developing countries is about 900 kg/ha of unshelled nuts. Production in India has increased in recent years, while yields in semi-arid West Africa have declined by about 5% annually. Unless the latter trend can be reversed, a major deficit will occur in that region by the year 2000.

The major constraints to production are pests, diseases, poor management, erratic rainfall, the high labour/energy inputs the crop requires, and aflatoxin production in storage. Strong national programmes exist in India, Brazil and China. The pay off from CGIAR investment in groundnut research has been high, particularly in India.

In 1986 TAC supported the current research emphasis directed towards alleviating environmental stresses and major disease and pest constraints, improving nitrogen fixation, developing lines adapted to both high and low inputs, and exploring the potential of wide crossing, which had already led to the development of very promising

leaf-spot resistant material. TAC considered that the System's efforts on groundnut research had been modest and that they should be increased substantially. The factors leading to this recommendation were: the crop's important dietary contribution; its importance as a cash crop and income generator; its potential in meeting part of the global demand for vegetable oils; its secondary value as animal feed and fodder; its contribution to the sustainability of mixed cropping systems; and the belief that the crop's production constraints can be successfully solved through research. TAC supported the strengthening of efforts outside India, particularly in sub-Saharan Africa, and agreed with ICRISAT that the needs of Latin America and the Caribbean could be served through the provision of germplasm and advice. Although TAC recommended that increased efforts be devoted to soybean as well as to groundnut, the latter was considered to be of higher priority.

5.6. Vegetables

Many vegetables are grown in developing countries, and the kinds vary considerably from place to place, with strong social preferences dictating the choice of species used. Vegetables provide a valuable source of income to producers near large urban areas. As a group, they are high-yielding and are well adapted to small-scale operations if markets are close, and to large-scale operations as infrastructure improves and transportation and cold storage become available. All income groups need and prefer them as supplementary foods, and demand in developing countries is expected to increase by 3.4% a year throughout the 1990s.

Of the current production of 252 million t in the developing regions, Asia accounts for 70%, West Asia-North Africa for 18%, Latin America and the Caribbean for 8% and sub-Saharan Africa for 4%. Production during the past two decades has been growing at 3.2%. The four most important vegetables in terms of area harvested in the developing regions are tomato (1.6 million ha), onion (1.3 million ha), peppers (0.9 million ha) and cabbage (0.8 million ha).

Inclusion of a vegetable initiative in the CGIAR System would complete the commodity portfolio from a nutritional point of view. The major constraints are diseases and insect pests, and there is much scope for varietal improvement. Poor marketing facilities are also a constraint given the perishability of many vegetables. Modest increases in production can lead to temporary gluts, and a major research need in many areas is to extend the production period.

In 1986 TAC indicated that highest priority among new ventures within the CGIAR System should be assigned to research on vegetables. Research should be directed at the potential for increased vegetable production in both tropical and subtropical areas, with special emphasis on indigenous tropical vegetables. In 1988 TAC recommended that the CGIAR create and support an international entity which would help establish and coordinate regional collaborative vegetable research networks in Asia, sub-Saharan Africa and Latin America and the Caribbean. CGIAR support was to be limited initially to tomato, pepper, onion, and leafy green vegetables. However, TAC also recommended that studies and consultations with relevant institutions be carried out to determine the importance of other commodities such as okra and eggplant, and to identify the major constraints to production increases and marketing, as well as their research ability. The

new entity would then have the flexibility to phase new research topics into its programme as necessary.

TAC further recommended that the highest priority be assigned to supporting research for tropical environments, with activities for subtropical environments to be initiated once those for tropical environments had become operational.

Two important operational considerations in TAC's deliberations were the integration of this new initiative with the System's current efforts on commodities which either are vegetables (green bean, vegetable cowpea, potato, sweet potato and soybean) or produce vegetables as byproducts (bean leaves and cassava leaves); and the complementarity of a CGIAR initiative with the work of AVRDC.

In 1990 TAC recommended that vegetables were an appropriate subject matter for inclusion in the expanded CGIAR effort, and that collaborative vegetable research networks in sub-Saharan Africa and Latin America and the Caribbean be implemented.

5.7. Other Crops and the Issue of Self-Reliance

In low-income countries the process of development involves a net flow of savings and resources from the agricultural sector to the non-agricultural sectors. In developed countries there is a net flow (via price support or income support) from the industrial and service sectors to the agricultural sectors to ensure that the latter remain sufficiently large and strong to protect the natural resource base and ensure that food demands can always be met, even in times of political disruption. Taking this into account, the notion of sectoral self-reliance could be defined as the capacity of a nation to provide a sufficient staple food supply to all of its inhabitants either from domestic production or from the production of exportable goods to enable commercial imports to cover domestic deficits.

The original objectives of the CGIAR were stated in terms of "agricultural research", rather than research limited to food commodities only. Although the System has so far concentrated on food commodities, non-food commodities have long been recognized as important in research on production systems.

Commercial crops play an important role in many tropical farming systems in generating income. Most but not all of these crops are non-food commodities. Some are grown in large plantations for export (the plantations often employ poor, landless labourers), others are produced by small-scale farmers for sale on local markets. Historically, the CGIAR Centres have limited their germplasm enhancement activities to food crops. With the broadening of the CGIAR goal from food self-sufficiency to food self-reliance, commercial crops can be considered for CGIAR support if they contribute to income generation, especially of resource-poor farmers, in ways that enhance permanent well-being. The major crops involved include cotton, coffee, sugarcane, tea, rubber and cocoa. An overview of their importance and value of production globally and each of the regions has been provided in Tables 4.5 and 4.6. The importance of commercial crops in agricultural production in each of the regions is also well illustrated in Table 4.5 by comparing the production values of food crops with those of cash crops.

Recognizing the importance of income and employment generation, TAC has carefully considered a range of commodities that are important for cash as well as food. A potential new venture which is both an industrial crop and an oil crop is cotton. TAC recommended CGIAR support for cotton in its 1971 review of CGIAR priorities. Coffee is also an important cash crop for smallholders in many relatively high-potential areas of the developing world. While TAC has encouraged the centres to incorporate work on these crops within their research on farming systems, it has advised against embarking on a major commodity improvement programme for these crops. TAC considers the current portfolio of CGIAR activities already sufficiently broad, and has noted the lack of comparative advantage of the CGIAR for research on these crops. Crops such as coffee, cocoa, tea and rubber benefit substantially from private sector research, while cotton and fruits benefit from bilateral research programmes.

CHAPTER 6 - LIVESTOCK

6.1. Background

Livestock and their products contribute about 19% to the total value of production of agriculture, forestry and fisheries in developing countries. In sub-Saharan Africa their share amounts to 15%, in Asia to 17%, in West Asia-North Africa to 25% and in Latin America and the Caribbean to 25%. However, as previously noted (Section 4.6), these figures under-estimate the substantial contribution that livestock frequently make to crop production through draught power and manure.

Livestock products provide 6% of calorie intake and 19% of dietary protein consumed in developing countries. Animal products are the only reliable sources of Vitamin B12, zinc and iron. Meat and milk are highly income-elastic products. Their consumption increases with incomes and urbanization. Given economic growth and technological improvements in developing countries, livestock's contribution to agricultural production can therefore be expected to increase.

Domestic animals enhance the economic viability and sustainability of farming systems. They diversify production and management options, increase total farm production and income, provide year-round employment, and provide insurance in times of need. Sales of livestock products provide funds for purchasing critically needed crop inputs and for financing farm investments. Livestock often form the major capital reserve of farming households.

Among domestic livestock species, ruminants have special importance because they convert into edible products crop residues, byproducts, weeds and other biomass that cannot be directly consumed as food by humans. Ruminants provide the only practical means for using vast areas of natural grasslands in regions where low, unreliable or seasonally limited rainfall combined with poor, acid soils make crop production impractical. In crop producing regions, traction raises crop productivity while manure enriches the soil. In addition, ruminants provide farmers with the economic incentive required to plant nitrogen-fixing forage crops and maintain pastures in crop rotations, which reduce erosion, conserve soil moisture and enhance soil fertility. The key to enhancing these positive aspects of livestock production is good management. It should also be noted that poor management, and especially overstocking, can cause degradation. Population growth in semi-arid rangeland areas is exacerbating these problems. Expansion of grasslands is the major factor that leads to deforestation in Latin America and the Caribbean.

In general, the returns from smallholder livestock development projects in developing countries have been low (World Bank, 1985). This further highlighted the need for research to expand the knowledge base for more effective livestock development planning in the future. Although valuable progress has been made, to date pay offs from CGIAR investments in livestock research have been slow to materialize.

6.2. Regional Importance

Cattle are especially important in Latin America and the Caribbean, and in the warm semi-arid tropics and cool tropics of sub-Saharan Africa and India (for milk). Sheep and/or goats are important in West Asia-North Africa, East and Southern Africa, semi-arid West Africa and temperate South America. Although small ruminants provide only a small proportion of the global production of meat and milk, the aggregate data mask their importance in some regions. It is estimated that they provide 30% of the meat consumed in West Asia-North Africa and 20% of that consumed in sub-Saharan Africa. Small ruminants are also important generators of cash income.

The first major thrust of the CGIAR System's research programme on improving ruminant production has been to enhance nutrition through improved management practices and the development of better pastures, forages, and other feed sources. Inadequate year-round feed supply is the major constraint to ruminant production in many areas of Latin America and the Caribbean, West Asia-North Africa, and sub-Saharan Africa.

The second major research thrust is to control ruminant diseases, particularly tsetse-transmitted trypanosomiasis, which is a major constraint in large parts of sub-Saharan Africa, and a form of theileriosis, East Coast fever, a major constraint in East and Southern Africa. This research is of a basic and strategic nature. Progress being made in understanding the biology of these diseases, the nature of host defence mechanisms and novel means of vaccination provides a basis for developing improved methods of control for other economically important livestock diseases worldwide.

The CGIAR has focused its research on the most important ruminants in developing countries, i.e. cattle, sheep and goats and on sub-Saharan Africa, which accounts for more than two-thirds of the CGIAR's resources for livestock research. However, although located in sub-Saharan Africa, ILRAD has a worldwide mandate for animal disease research. About 21% of CGIAR investment in livestock research is allocated to CIAT in Latin America and the Caribbean, for pasture improvement research, and 11% to ICARDA in West Asia-North Africa, for the improvement of forage production systems. In general, CGIAR-supported livestock research has not yet led to significant farm-level productivity increases, but CIAT's technologies for pasture improvement on the acid soils of Latin America and the Caribbean are gradually being adopted, and ILRAD may be on the verge of a breakthrough with recent progress in the development of new vaccines to provide immunity to theileriosis.

TAC has recognized the importance of the domesticated buffalo in areas to which it is climatically adapted. However, since 85% of buffalo are found in only five countries of Asia, TAC's position to date has been that the research needs for this species could best be met through regional efforts. Similarly, TAC has recognized the importance of the camel in arid and semi-arid environments. Again, TAC feels that the research needs for these species could best be met through network activities or by regional institutions. TAC considers that the CGIAR has no comparative advantage to initiate activities on buffalo or camel research.

Poultry and swine account for almost half the monetary and nutritive value of livestock in developing countries. However, TAC has not considered their research needs to be of sufficiently high priority to justify their inclusion in the form of commodity

improvement programmes in CGIAR activities. Evidence from Asia and from Latin America and the Caribbean indicates that, as the demand for chicken and pigmeat increases, more intensive production systems are adopted, and technology from developed and other developing countries is rapidly and effectively applied in these systems. Both the poultry and pig sectors also benefit substantially from private sector research. However, consideration needs to be given to the production of feed crops to meet the rapid growth of demand caused by the expansion of poultry and swine production as population and urbanization increase in the next 20 to 30 years.

Demand for livestock products is rising rapidly in response to urbanization, population growth and income gains, while yields of both meat and milk are low compared with those of developed countries. Low productivity is associated with a number of interacting factors: poor nutrition and acute seasonal feed deficiencies, limited availability of water in arid and semi-arid areas, poor management, disease, and low genetic potential as feed and health constraints are removed. In some regions, sub-Saharan Africa in particular, the low productivity of cattle may also result from producers placing greater value on the number of animals owned than on their output of meat or milk, since animals are a means of storing wealth for future expenditures and as an insurance against drought. Overall, there is a significant need for research to increase ruminant production in developing countries.

6.3. Livestock Research in sub-Saharan Africa

As already noted, CGIAR efforts in livestock research have focused on sub-Saharan Africa. At present, livestock production systems in this region are predominantly subsistence oriented, and concentrated in areas that are tsetse free or only lightly infested. The majority of livestock is found on mixed smallholder farms, which account for approximately 60% of the region's ruminant animal units. The productivity of livestock in terms of milk and meat in sub-Saharan Africa is the lowest of any world region. Nonetheless, it has been amply demonstrated that sub-Saharan Africa can produce meat and milk at prices that are competitive with imports, provided that markets are not severely disrupted by dumping, artificial currency exchange rates, and other macroeconomic distortions.

Milk accounts for 38% of the value of sub-Saharan livestock production, beef for 32%, sheep and goat meat for 15%, pigmeat for 3%, and poultry for 12%. During the past two decades, increases in production have resulted largely from the expansion of herds and flocks, rather than from improved animal productivity.

The major constraints to improved productivity are natural resource limitations; technical barriers, such as inadequate feed supply, diseases, poor genotypes and inadequate management; and socioeconomic factors, such as inadequate government policies and marketing opportunities, and the lack of infrastructure.

Despite these constraints, there appear to be substantial opportunities for increasing livestock productivity throughout the region. It is felt that sub-Saharan African products can successfully compete with other foods in local markets and with imports.

Among the region's highly diverse agroecologies, the subhumid tropics (AEZ 2), the higher rainfall areas of the semi-arid tropics (AEZ 1), and the cool tropics (AEZ 4)

appear to have the greatest development potential for livestock production, particularly through integrated crop-livestock systems. In these systems, advances in dairy production, animal traction, poultry and pig production offer particularly promising opportunities for productivity and income gains. In the drier parts of the arid and semi-arid areas, pastoral systems continue to support a large number of ruminant livestock. The opportunities for technical intervention in such systems appear limited, but there is some potential for encouraging offtake through more favourable government policies, especially with regard to prices.

In the humid tropics (AEZ 3), the major stresses are pests and diseases, especially trypanosomiasis and dermatophilosis. Where pastures are established, the control of weeds presents a special difficulty. These problems are likely to constrain production in this zone, at least in the short term.

Cattle will continue as the predominant source of meat, milk and traction in sub-Saharan Africa. The importance of small ruminants, poultry and pigs is expected to increase rapidly during the next two decades. Camels will remain important in arid areas, donkeys and horses in the cool tropics, and wildlife for tourism and game/bush meat in arid and semi-arid zones.

CGIAR efforts should focus on four principal research areas: feed supply, animal health, genetics, and sustainable production systems, particularly for the warm subhumid, warm semi-arid and highland (cool tropics) zones.

6.3.1. Feed Supply

Highest priority should be given to improving the quality of animal feed and its year-round availability. To support the intensification and spread of smallholder mixed crop-livestock farming systems, research on the production and feed value of forages, multipurpose trees, crop residues, cereals, root crops, grain legumes and less conventional feeds is needed. Greater efforts are required to enhance crop-livestock interactions. For example, as shortage of feed is the major constraint to increasing livestock productivity, the latter could benefit substantially from an increase in crop productivity.

6.3.2. Animal Health

The vector-borne diseases, trypanosomiasis, theileriosis, cowdriosis, babesiosis, anaplasmosis, and dermatophilosis, as a group constitute the most serious constraint to increased animal production in sub-Saharan Africa. Existing chemical control methods are often too costly for widespread adoption, and are also unsustainable due to the development of resistance to drugs and pesticides. Cost considerations deter the development, testing, licensing and introduction of new chemical products for use in sub-Saharan Africa. Continued strategic research on host-parasite relationships and control methods is necessary to provide strategies for overcoming the reduced productivity caused by this complex of diseases.

As animal agriculture systems intensify, strategic and applied research will be needed to resolve animal health problems related to intensification.

6.3.3. Genetics

Sub-Saharan Africa has valuable indigenous livestock germplasm that needs to be identified, characterized, preserved and utilized to enhance the productivity of animals while retaining their adaptation to the region's environments. Strategic research to identify and manipulate genes that confer disease resistance, physiological adaptation to the environment, and productivity traits will grow in importance. Advances here will have global application.

6.3.4. Sustainable Production Systems

Research is needed to optimize the contribution of livestock to sustainable farming systems in each agroecological zone, particularly in the warm subhumid zone where production potential is high and the tsetse fly is retreating. Farming systems research must take into account agronomic, animal production, epidemiological and ecological factors. Policy research should give particular attention to macroeconomic issues related to natural resource use and the infrastructure needed to support the efficient development of animal agriculture.

The ability of governments to establish policies that foster the development of sustainable land use systems is hampered by serious deficiencies in livestock data. Databases on livestock, organized by agroecological zone, must be improved and expanded. National governments, the development community and the CGIAR should evaluate needs and develop improved methods for surveying and analyzing the current and potential role of livestock by agroecological zone in sub-Saharan African farming systems, especially by applying the new technologies of modelling and analysis provided by geographical information systems.

CHAPTER 7 - FORESTRY AND AGROFORESTRY

7.1. Background

The CGIAR System decided to incorporate forestry and agroforestry into its activities because of the seriousness of the issues associated with them and their direct bearing on the CGIAR's mission to increase the welfare of poor people in developing countries. Research has an important role to play in containing deforestation and reducing its negative effects, and in enhancing the contribution of trees and forests to food and energy security and to the creation of off-farm employment.

In its overview of the background factors to consider in devising an institutional framework for forestry and agroforestry, TAC noted that trees not only contribute to economic growth but also provide environmental services. TAC took particular note of the concern emerging worldwide over the impact of deforestation and forest burning on global warming, loss of biodiversity, soil erosion, changing water flow patterns, flooding, and fuelwood shortages.

The research needed to deal with these problems is multisectoral as well as multidisciplinary, involving a complex blend of atmospheric, meteorological, energy, agriculture, forestry, policy and other aspects. The CGIAR System has neither the capacity nor the comparative advantage to implement effective research in all of these areas. However, it could make a useful contribution in areas such as the conservation of germplasm of endangered woody species, and policy research to improve understanding of the underlying causes of deforestation and of the potential solutions. In agroforestry research, the CGIAR should aim at providing shifting cultivators with alternatives to slash-and-burn agriculture, and sedentary farmers with alternative sources of fuelwood, mulch and forage, and with more stable and fertile soils.

7.2. Regional Forestry Research Needs

7.2.1. Sub-Saharan Africa

About a quarter of the land area of sub-Saharan Africa is wooded or forested, while nearly half supports grass, with or without shrubs and trees. Much of the latter area is suitable for grazing. Some 135 million ha have been set aside as nature reserves or national parks, providing a habitat for wildlife. These areas play a key role in conserving germplasm and in contributing to the region's significant revenues from tourism.

The increasing human and livestock population pressure has led to overcutting and overgrazing of woodlands. This has drained nutrients from forest soils and has exacerbated soil erosion, accelerated water run-off and created serious local shortages of fuelwood and fodder. Overcutting of trees and shrubs at the farm level exposes soils and crops to wind and can depress yields significantly.

Although sub-Saharan Africa currently has 700 million ha of tree cover, only 210 million ha of this are closed forest. About 490 million ha are open savannah woodlands. Deforestation is proceeding at a rate of about 3.7 million ha a year.

In addition to the more obvious forest products, such as fuelwood, building poles, timber, furniture, pulpwood and paper, the productivity of sub-Saharan Africa's forests, woodlands and perennial tree crops can be measured by their direct contribution to cash income as well as their indirect contribution to agriculture through the maintenance of soil nutrients and the protection of soil and water resources. Non-wood commodities derived from forests, such as animal and fish protein, fruit, nuts and berries, are important foods and sources of income. However, it is obvious that the productivity of forest and farm trees in many areas is well below potential.

Future research strategies, which also apply to some other regions, have four main directions: first, towards improved understanding of the underlying causes of deforestation and the potential for policy reforms and the conservation of remaining forest resources; second, towards increasing the utilization intensity and productivity of natural closed forests and savannah woodlands; third, towards cost-effective incentive policies and technological improvements for encouraging farmer and community involvement in reforestation; fourth, towards the development of mixed crop-livestock-tree systems.

7.2.2. West Asia-North Africa

Deforestation in West Asia-North Africa has been going on for centuries, and not more than 25 million ha of closed forests remain (the lowest of all four regions). The main pressures on forest resources have been grazing, the demand for fuelwood, and the expansion of the cultivated area.

Palatable shrubs form an essential component of rangeland feed resources. They may extend the grazing season and help to reduce the impact of erosion, especially where it is impossible to maintain perennial grasses. They are often the main productive component in sheep husbandry systems. However, due to overexploitation much of the palatable woody vegetation of rangelands in West Asia-North Africa has been removed or replaced by unpalatable shrubs.

In Iran, Israel, Jordan, and Syria it has been demonstrated that it is possible to regenerate over-exploited rangelands through controlled grazing, contour furrowing, the construction of micro-catchments, the reseedling of perennial and annual grasses and legumes, protecting seedlings of wood perennials, and the removal of unpalatable species. The widespread application of such approaches depends on policies that will provide incentives to farmers and communities.

As in sub-Saharan Africa and Asia, a high research priority for West Asia-North Africa is increasing the productivity of selected higher yielding fodder trees and shrubs. The development of salt-tolerant and/or drought-resistant species for the reclamation of agricultural wasteland is particularly important.

7.2.3. Asia

As forests have been depleted, their contribution to economic growth has declined sharply in Asia during the past decade. Depletion has occurred despite the fact that Asia's rainforests are among the richest ecosystems on earth, containing nearly half its animal and plant species, many of which have not yet been described. Little research has been carried out to improve understanding of tropical forest ecosystems and their environmental and biological roles.

Large parts of the region's forest have already been converted to permanent agriculture or encroached upon by shifting cultivators. Although some production systems based on plantation crops have proven sustainable, many attempts to establish mixed crop-livestock production systems have led to widespread land degradation, including the spread of pernicious weeds such as *Imperata*, particularly when fire is extensively used. Population pressure has exacerbated the problem by forcing farmers onto marginal lands which are either too steep or infertile or too wet for continuous cultivation. Policy research is being directed towards the creation of incentives for local community and small-scale farmer involvement in the sustainable management of forest lands, and in improving the productivity and sustainability of agriculture on the forest margin.

Most of the past work on germplasm conservation in the region has focused on food crops. Despite the fact that tropical forest ecosystems supply many staple foods and contain wild relatives of modern food crops important for future breeding programmes, research programmes for collecting forest-based germplasm are weak.

Given the shortage of animal fodder, the demand for fuelwood, and the need to maintain soil fertility and reduce soil erosion, there is considerable potential for agroforestry in the region. There is a particular need for research on the selection and breeding of fast-growing multipurpose species, and on the development of sustainable agroforestry systems for the reclamation of saline and other agricultural wastelands, and for the reforestation of upland areas.

As industrial and social forestry move towards increasing dependence on fast-growing species, there will be a need for expanded research in such areas as soil microbiology (particularly the potential for inoculation with mycorrhiza to improve seedling survival and increase yields); tree selection, breeding and improvement; the potential of modern biotechnology to contribute to improved disease resistance; and the development of biological processes for making use of wood waste.

Industry-related policy research in countries that still contain significant areas of tropical forest is being directed towards improved timber concession, timber taxation and revenue collection systems. This research should be complemented by efforts to develop practices for the sustainable management of natural forests.

Policy research on forest management in upland watersheds is needed to harmonize agricultural, forestry and energy-related policies and to develop more sustainable land use systems. There is also an urgent need to develop a database on forest resources and their uses.

7.2.4. Latin America and the Caribbean

Indiscriminate deforestation is a major environmental concern in Latin America and the Caribbean. The problems associated with deforestation include soil degradation, siltation of water catchments, exacerbation of flooding, increased atmospheric CO₂, loss of natural habitats, and extinction of species. Policy research at present is mainly directed towards understanding the causes of accelerated deforestation and towards the creation of incentives for increased participation by farmers and local communities in forest conservation and reforestation. In particular, policies encouraging deforestation for pasture development are being reassessed because, in 50% of the large areas now under pasture, weeds are encroaching and the land is reverting to secondary forest.

In the eroded uplands of the Andean countries, agroforestry research is being directed towards the identification of tree species that can meet basic needs for fuelwood, fodder, building poles, fruits and other products.

Tree improvement programmes and soil microbiology research could contribute significantly to the enhanced productivity of logged and secondary forests. The plantation sector has recently expanded in some countries and already supplies about 30% of the region's industrialized wood requirements in addition to sustaining a major export trade.

National services seeking farmers' cooperation in onfarm agroforestry research and development must ensure the supply of improved seeds of multipurpose trees and shrubs.

In many areas, incorporating trees in pastures (silvopastoral systems) may provide a valuable source of protein during the dry season, in addition to a number of environmental benefits such as shade for ruminants.

Priority areas from a regional perspective include: the development and testing of simple experimental designs and analytical techniques for assessing the contributions of trees and shrubs to mixed production systems; the development of effective seed exchange systems; and improved understanding of the interactions between soil conditions and tree nutrition, including the role of fertilizer in intensifying production in plantations.

7.3. Research Needs of Common Concern

From the above review of regional developments and research issues, TAC developed a list of priority research thrusts of common concern to several regions. The thrusts included:

- agroforestry, with special reference to research methodology, the improved quantification of tree/crop/livestock interactions, and the development of improved agroforestry practices;
- conservation of woody germplasm, especially of important commercial agricultural and forest tree crops;

- selection, breeding and improvement of multipurpose trees for agroforestry/fuelwood/industrial and other uses; this includes emphasis on seed and clonal propagation, and on tissue culture research;
- natural forest management and conservation; this includes research on growth and yield modelling, silvicultural techniques for the sustainable production of multiple products, and the management of secondary natural forests for multiple products; in particular, research is needed on non-wood products and on the management of secondary and swamp forests;
- man-made forest management; this includes selected areas of silvicultural research relevant to increasing productivity and improving reforestation techniques, particularly growth and yield modelling studies and research on thinning and pruning regimes; special attention would be given to reforestation techniques for the reclamation of wastelands and for increasing fuelwood/forest biomass output, especially in the arid and semi-arid zones; in addition, research on the environmental services of forests is needed;
- soil microbiology, nitrogen fixation, mycorrhizal and associated soil nutrient relationships; and selected aspects of pathology and entomological research, especially for plantations;
- policy, forestry management and socioeconomic research, including research directed toward improved understanding of the underlying causes of deforestation and of policies that would encourage the involvement of people in the conservation of natural forests and in accelerated rural reforestation. This would also include studies on the knowledge of native or local community groups that live in tropical forests.

The above priorities largely correspond with the priorities of the 1988 Bellagio Task Force on Forestry Research.

7.4. Current Status of Forestry Research

Investment in research on forestry and forest products in developing countries has been relatively low. FAO has prepared a list of 538 organizations in developing countries that are formally involved in tropical forestry research, of which 45% can be found in Latin America and the Caribbean, 36% in Asia and the Pacific, 14% in sub-Saharan Africa and 5% in West Asia-North Africa (FAO, 1986b). Many of these organizations have few staff (sometimes no scientists), and more detailed information is available on only 238 (or 44%) of them. National/provincial public research bodies (107) make up almost half the total, while universities (67) provide the second largest category, and forestry services branches (37) the third. Few agricultural research institutes (9) or private bodies/development projects (18) carry out research on tropical forestry.

FAO has estimated that, in the organizations for which information was available, the total numbers of forestry research scientists in developing countries amounted to 6,716, of which 53% were located in Asia and the Pacific, 32% in Latin American and the Caribbean, 11% in sub-Saharan Africa and 4% in West Asia-North Africa (FAO, 1986b).

Expenditure on forestry research in developing countries in 1981 amounted to US\$ 186 million, of which 60% was allocated to Asia, 21% to sub-Saharan Africa and 19% to Latin America and the Caribbean (Mergen et al, 1988). More recent data are not available, but if past trends are an indication, current annual expenditures may be in excess of US\$ 200 million.

Developing countries account for only 12% of total investment in forestry research worldwide. Forestry research intensity in developing countries is considerably less than one-tenth of agricultural research intensity. Forest research expenditures as a percentage of the value of production have been estimated at 0.019 for low-income developing countries, 0.059 for middle-income developing countries and 0.070 for semi-industrialized countries. The corresponding ratios for agricultural research expenditures were estimated at 0.451, 0.863 and 0.816 respectively (Mergen et al, 1988).

7.5. Future Directions of CGIAR Forestry Research

To date, there have been no systematic or quantitative analyses of the likely pay off from regionally supported forestry/agroforestry research programmes.

Additional investment in the priority research areas listed above has the potential for making major contributions to human welfare and to sustaining development efforts in fields other than forestry, such as agriculture, hydropower and industrial development. It is impossible to quantify the benefits over time, although the work done by ACIAR has given some indication of the substantial pay off possible from research on fuelwood, and on saw and veneer logs. Nevertheless, it is possible to provide a qualitative assessment of the benefits in terms of the numbers of people who might be affected by an expanded research programme.

For example, people in the Sahel and the Himalayan regions rely on trees as a significant source of livestock fodder. In these areas, the potential exists for some 120 million people to benefit from improved fodder production in addition to fuelwood gains. In these same regions, shelterbelt research could contribute significantly to increasing food security for people living in some of the world's most fragile and hostile agricultural environments. Crop productivity increases of 15-20% can be achieved by planting windbreaks. High priority research thrusts in these regions include above- and below-ground competition for light, water and nutrients; root symbioses (particularly nitrogen fixation); and tree management options for maximizing aboveground leafy biomass production (e.g. via pollarding and coppicing techniques).

In addition to fodder, fuel and shelter benefits, the potential exists to reduce erosion and negative downstream impacts on irrigated agriculture, power production, fish production, etc., by combining the results of tree improvement research with those of policy research on integrated watershed management. Key areas of policy and socioeconomic research that can contribute to improved upland watershed management include tenure and infrastructure policies, the cost-effectiveness of alternative approaches to soil conservation in steep uplands, and incentives for people's participation.

As developing countries expand their reliance on irrigation to increase agricultural productivity and food security, the need to improve upland watershed

management also increases. Often, the prevention of future losses (due to watershed deterioration) does not receive the same attention as the expansion of present benefits.

Many of the 300 million people who live in moderately or severely desertified arid regions could benefit from an expansion of research on the management of arid zone woodlands. Effective low-cost management of natural savannah woodlands could provide fuel, fodder and many other locally important products in greater abundance and on an ecologically sound and sustainable basis. Research priorities for arid zone woodlands include appropriate silvicultural technologies for multiple end uses (fodder, fuelwood, honey, medicinal products, timber, charcoal, etc), tree/grassland competition for moisture and nutrients, and the effect of savannah woodland on microclimate.

Research on tree selection, improvement and establishment could more than double the average productivity of trees used for fuelwood in the tropics over the next 15 to 20 years. The application of such research results could benefit at least 200 to 400 million people out of the more than 3,000 million people projected by FAO to face fuelwood shortages past the turn of the century (FAO, 1983). The selection and evaluation of multipurpose species and provenances for fuelwood and other uses will require database development, herbarium collections, the development of methods for matching species and sites; assessment of genetic variation (isozymes) in natural and derived populations; studies on biochemical, calorific, fodder and food values; studies on tolerance to a range of environmental stresses; and studies on physical properties (e.g., fibre quality, moisture content, charcoal acceptability).

Although the benefits are very difficult to quantify, research on the conservation and management of tropical forest ecosystems could make an invaluable contribution to safeguarding a major proportion of the world's genetic diversity. This would ensure that present and future generations will be able to broaden the genetic base for food crops, medicines, industrial products, and other useful goods yet to be discovered among the millions of unknown plant and animal species in tropical forests. Past experience with the domestication of tropical plants suggests that tropical forests are a critical resource which merits protection. The more research can discover additional benefits to be derived from this resource, the better the arguments for protecting it and improving its management.

Research related to industrial development could reduce import bills for forest products in developing countries and, in some cases, increase export revenues. Chile and Brazil are examples of countries which have successfully developed major export markets for their forest products. In 1990 Chile exceeded US\$ 700 million in exports of forest products. In addition to species and provenance selection and improvement, plantation-related research priorities include growth and yield modelling studies to increase biomass output under intensive management systems, soil microbiology, soil mycorrhizal research related to fast-growing species, soil fertility, nutrient cycling, and studies on the hydrological implications of plantation forestry.

Tree selection and improvement research has already shown the potential for substantially reducing the cost of producing wood in the tropics. Lower costs, if passed on to consumers, imply lower prices for products such as paper. Low-cost paper available to educational programmes could help raise the literacy levels of hundreds of millions of people. ACIAR has recently estimated the benefits to consumers of such research, and found them to be substantial.

Policy research to improve understanding of the underlying causes of deforestation would study the impact of agricultural settlement, fiscal incentives, road building and land tenure policies on expansion of the agricultural frontier. Such research could lead to revised timber taxation, concession licenses and revenue collection systems that would encourage local community and private-sector participation in improved natural forest management and plantation forestry.

A major objective of all CGIAR activities in forestry and agroforestry must be to ensure that the benefits of research reach the poor. Research to integrate conservation and production at the local level is bound to be unsuccessful unless this is achieved.

CHAPTER 8 - FISHERIES

8.1. Background

Fisheries play an important role in food production, income generation and the provision of employment in developing countries. The number of full-time fishermen in developing countries has been estimated at 12.9 million, of whom 80% live in Asia, 12% in sub-Saharan Africa, 6% in Latin America and the Caribbean and 2% in West Asia-North Africa (ICLARM, 1991). In addition, there are many millions of part-time fishermen. Water covers 70% of the earth's surface, and the total production of aquatic commodities amounts to 95 million tonnes annually, of which 85% is in the form of finfish, 4% crustaceans, 7% molluscs and 4% seaweeds. Fish and fish products provide 20% of animal protein and 4% of dietary protein in developing countries, but these averages mask the fact that in several countries this share is at least twice as high. The total gross value of world fisheries production is almost US\$ 25 billion per year, of which 52% originates from marine capture fish, 18% from inland capture fish, 16% from inland culture fish and 14% from marine culture fish. Fish account for 4% of the total value of production of agriculture, forestry and fisheries. Approximately 55% of the gross value of fish production originates in Asia, 32% in Latin America and the Caribbean, 8% in sub-Saharan Africa and 5% in West Asia-North Africa (TAC/CGIAR, 1990).

Of the global aquatic production, only 12% originates from aquaculture, but in value terms this share amounts to 29%. Aquaculture differs from capture fisheries just as agriculture does from hunting and gathering. Aquaculture, as in the case of agriculture, and even more than in capture fisheries, requires ownership or control over the aquatic resources (commodity) and space. It implies action to direct energy flows in the ecosystem towards the commodity produced. During 1986, total world aquaculture production amounted to 11 million tonnes, of which 50% consisted of finfish, 4% crustaceans, 21% molluscs and 25% seaweeds. About 82% of world aquaculture production originates in Asia, but in terms of value this share amounts to 97%. The value of culture fisheries exceeds that of many 'traditional' CGIAR commodities such as beans, sorghum, milk and groundnuts.

8.2. Research Needs

The demand for fish and fish products has been growing rapidly in recent decades, but most of the traditional sources of fish, such as marine stocks, are already being fully exploited and in many cases overexploited. Capture marine fisheries appear to be reaching a production plateau, despite a sharp growth in capture capacity. If so, more research on stock assessment and management will be required to sustain production at its current levels. As supplies have levelled off, prices have started to rise rapidly. The increasing demand for fish and fish products will have to be met by expanding aquaculture production and improving fisheries management. Recent attention to fisheries has been fuelled by increasing concern for the conservation of coastal and freshwater environments.

Attempts to introduce aquaculture to resource-poor farmers with no previous fish farming experience have met with little success. The major constraints to technology adoption appear to be socioeconomic, but there is a lack of appropriate technology for small-scale production.

Previous TAC reports, as well as a recent study undertaken on behalf of several donor agencies, have stressed the need for more research on fisheries (CEC/FAO/UNDP/World Bank, 1991). An international effort on fisheries research would contribute significantly to the CGIAR mission and goals, by leading to sustainable increases in productivity which improve the nutrition and economic well-being of low-income people. Fisheries research could also contribute to the CGIAR goals of better managing and conserving natural resources, improving the policy environment and strengthening national research systems.

At least 1,000 species of fish are captured or cultured, and fish production systems in developing countries are usually multispecies. A commodity approach for setting priorities is therefore inappropriate. Instead, a resource system could be used. ICLARM (1991) has distinguished seven resource systems which reflect aquatic habitats and the people who rely on them. The freshwater systems are catchments, reservoirs and lakes, floodplains, and swamps. The marine systems are estuaries, bays and lagoons, coral reefs, soft-bottom shelves, and upwelling over-shelves.

Coral reefs offer good potential for increases in the yield of capture fisheries through improved management. New management systems for upwelling over-shelves and reservoirs also offer potential. The sustainability of current capture systems, particularly in coastal areas, is a major concern, however. The major gains in aquaculture could come from catchments, lakes and reservoirs.

Despite the potential for increased production, the gap between supply and demand for fish is expected to widen between now and the year 2000.

CGIAR efforts should focus on strategic research to improve the management of fisheries for sustainable increases in production, with special emphasis on the biological and social bases for increasing the potential of both capture fisheries and aquaculture.

TAC's report on the expansion of the CGIAR outlined the needs for international research on fisheries in each of the world's major developing regions. With respect to resource conservation and management, there was a need to examine fisheries management in all regions. Priority areas in fish productivity research included studies on fish nutrition, particularly the nutritional requirements of cultured species, the nutritional constraints in extensive and semi-intensive systems, and the development of alternative feedstuffs. The development of appropriate small-scale fish production systems was of particular relevance to Asia, but with spillover potential for other regions. Such studies should focus on pond productivity and nutrient dynamics, especially in semi-intensive systems, and on the carrying capacity of open aquatic systems. Improving germplasm and maintaining the quality of stocks of key species was also a priority area. There was a need for constraint analysis on pests and diseases, and for studies on seed propagation methods. Research on policy and socioeconomics should also receive high priority. Given the weakness of national fisheries institutions, a major effort to strengthen these is necessary.

On the advice of TAC, the CGIAR has requested ICLARM to develop a strategic plan for fisheries research in the CGIAR. The Centre was also the subject of an External Programme and Management Review. The report of this review was discussed at TAC 57 together with a draft strategic plan for international fisheries research. TAC's views on the priorities for fisheries research were formulated at that time. The analysis of ACIAR (Fearn and Davis, 1991) on priorities among fisheries commodities was also used as an additional aid to TAC's deliberations.

CHAPTER 9 - THE ANALYTICAL PROCESS: AGROECOLOGICAL, REGIONAL, PRODUCTION SECTOR AND COMMODITY PERSPECTIVES

9.1. Introduction

This chapter is the first of three describing the approach used by TAC to develop an analytical framework for the priority setting exercise. The approach began with agroecological zones, which were disaggregated by region before modifiers were applied to take into account concerns of efficiency, equity, sustainability, strength of national systems, self-reliance, and agroforestry. The results provide insights by agroecological zone, regional agroecological zone, region, production sector and commodity. The analysis is done in three parts - agriculture, forestry and fisheries. The next two chapters (Chapters 10 and 11) present TAC's analysis of needs and issues to be addressed by the CGIAR in institution building, and of public policy, public management and socioeconomic research issues.

The current chapter is structured as follows. Section 9.2 describes the nature of a congruence approach to priority setting. The approach requires the establishment of a baseline value for each production sector - agriculture, forestry and fisheries - in each agroecological zone. TAC selected a composite base made up of value of production, number of poor people and land area (agriculture and forestry only). This is described in Section 9.3. The rationale and mechanisms for modifying the baseline, and the modifiers chosen, are described in Sections 9.4 and 9.5. Section 9.6 provides the raw data for the modifiers chosen, while Section 9.7 discusses the weights to be attached to each modifier. Section 9.8 describes the quantitative impact on the baseline of each modifier. The results of the analysis using a uniform weight for the modifiers are presented in Section 9.9. Section 9.10 provides a sensitivity analysis of the impact of modifiers, first when all weights are changed and second when selected weights only are changed. Section 9.11 presents a discussion of inputs received from CGIAR Centres on the progress that can be expected from investment in research on particular commodities in particular agroecological zones, given critical mass. The chapter concludes (Section 9.12) with a brief review of another approach to quantitative priority setting, namely the framework developed by ACIAR.

9.2. The Congruence Approach

The congruence approach is one in which research resources are allocated according to the relative value of production by region or commodity. The approach is commonly used to assist in priority setting for resource allocation in agricultural research. 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 usefully be applied to the initial distribution of CGIAR priorities among agroecological zones, regions or regional agroecological zones.

However, care must be taken to restrict the analysis to parameters that measure extensity. Examples of such parameters are the value of production, the number of poor people or the area of agricultural land. Other parameters measure intensity. Examples are GDP per caput, or value of production per hectare. The congruence approach cannot be applied when intensity parameters are used because they cannot meaningfully be aggregated across regions.

9.3. Initial Priority Setting

9.3.1. An Overview

TAC proposed to assign relative priorities by region and by agroecological zone initially on the basis of a weighted average of some important extensity parameters that reflect the three main concerns expressed by the CGIAR in its mission statement: the contribution of research to productivity, to the well-being of low-income people and to sustainability. To the extent that productivity is a major concern, relative priorities can be distributed in proportion to the value of production in each regional agroecological zone. If the well-being of low-income people is a major concern, priorities can be assigned in proportion to the number of poor people in each regional agroecological zone. To the extent that sustainability of land use is a major concern, priorities can be assigned in proportion to land in use (whether for agriculture, forestry, or both) in each regional agroecological zone.

The congruence approach, whether applied to value of production, number of poor people or area of land in use, should 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 in use.

Such an initial assignment of priorities is based on broad demand considerations and does not reflect the many other important factors that have to be taken into account, such as need for research, potential for impact, capacity of national research systems to use the outputs of international research, or advantages of the research being undertaken by the CGIAR. Furthermore, the approach 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 use of intensity parameters. This procedure is discussed in Section 9.4.1. In the rest of the current section, the three extensity parameters that will determine the baseline for initial priorities are further considered.

9.3.1.1. Value of production

In Section 4.6, the value of production of the different production sectors and commodities in developing countries was discussed, both globally and by region. 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 regional agroecological zone is presented in Table 9.1. The total value of

production of three groups in developing countries amounts to about US\$ 600 billion. In subsequent analysis, the values of crops and livestock have been aggregated into a common production value for agriculture. Crops and animal husbandry systems are interrelated to such an extent that the initial analysis is better applied to agriculture as a whole rather than to separate components.

Table 9.1. Annual gross value of production of crops, livestock, forestry and fisheries by region, AEZ and RAEZ (developing countries only, 1987-89)

	CROPS		LIVESTOCK		FORESTRY		FISHERIES ^{1/}	
	US\$'Mil.	SHARE %	US\$'Mil.	SHARE %	US\$'Mil.	SHARE %	US\$'Mil.	SHARE %
SSA	34644.9	9.5	9717.9	8.0	19349.3	16.3	2070.6	6.1
1	7968.8	2.2	5077.8	4.2	5585.1	4.7	426.0	N/A
2	10384.6	2.9	1538.7	1.2	4842.7	4.1	369.3	N/A
3	11757.6	3.2	1181.9	1.0	8653.6	7.3	267.9	N/A
4	4533.9	1.2	1919.5	1.6	267.9	0.2	144.8	N/A
WANA 9	33108.2	9.1	12175.0	10.0	1825.7	1.5	1448.5	4.3
ASIA	221922.4	61.0	63937.9	52.6	72585.6	61.3	19772.5	58.8
1	21299.1	5.9	9409.4	7.8	5673.7	4.8	575.5	N/A
2	17503.9	4.8	4155.7	3.4	7925.4	6.7	409.3	N/A
3	44274.1	12.2	5739.2	4.7	34713.3	29.3	1702.5	N/A
5	46203.3	12.7	14607.2	12.0	4205.4	3.6	796.9	N/A
6	26594.4	7.3	5601.7	4.6	2525.4	2.1	481.7	N/A
7	51033.7	14.0	13241.7	10.9	4773.7	4.0	1432.1	N/A
8	15013.9	4.1	11183.0	9.2	12768.7	10.8	1185.9	N/A
LAC	73705.9	20.3	35593.2	29.3	24725.1	20.9	10349.6	30.8
1	5260.1	1.4	2774.2	2.3	862.2	0.7	34.5	N/A
2	16213.9	4.5	5478.7	4.5	5086.5	4.3	69.3	N/A
3	14255.8	3.9	5632.5	4.6	9134.8	7.7	79.1	N/A
4	7676.4	2.1	6345.4	5.2	3339.3	2.8	145.4	N/A
5	3337.6	0.9	2128.3	1.8	91.5	0.1	19.2	N/A
6	2059.6	0.6	1035.2	0.8	124.9	0.1	0.9	N/A
7	15877.3	4.4	5557.6	4.6	4236.4	3.6	70.3	N/A
8	6994.5	1.9	5590.9	4.6	653.1	0.6	6.3	N/A
9	2130.7	0.6	1050.4	0.9	1196.4	1.0	1.4	N/A
OVERALL AEZ	363381.4	100.0	121424.0	100.0	118485.7	100.0	33641.2	100.0
1	34528.0	9.5	17261.4	14.2	12121.0	10.2	1036.0	N/A
2	44102.4	12.1	11173.1	9.2	17854.6	15.1	847.9	N/A
3	70287.5	19.3	12553.6	10.3	52501.7	44.3	2049.5	N/A
4	12210.3	3.4	8264.9	6.8	3607.2	3.0	290.2	N/A
5	49440.9	13.6	16735.5	13.8	4296.9	3.6	816.1	N/A
6	28654.0	7.9	6636.9	5.5	2650.3	2.2	482.6	N/A
7	66911.0	18.4	18799.3	15.5	9010.1	7.6	1502.4	N/A
8	22008.4	6.1	16773.9	13.8	13421.8	11.3	1192.2	N/A
9	35238.9	9.7	13225.4	10.9	3022.1	2.6	1449.9	N/A

^{1/} Regional values of fisheries refer to inland and marine capture, while RAEZ and AEZ values only include the value of inland capture fisheries.

9.3.1.2. Poverty

The second factor contributing to initial priority setting is an estimate of the number of poor people by region and agroecological zone. Regional data were obtained from a recent World Bank study, which estimated that the number of people living in absolute poverty, defined as having per caput incomes less than US\$ 370 per year, amounted to 1,110 million, of whom 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 agroecological zone. An analysis by IFPRI (Broca and 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.

In addition, because of migration, any estimate of the number of poor people by agroecological zone would have to be treated with caution. For example, recent studies conducted by IRRI in several locations of Asia suggest that, because of migration, there are only marginal differences in wage rates between areas that have benefited from the green revolution and other areas. In Latin America, many resource-poor farmers of the high Andes have moved 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 agroecological zone was therefore estimated on the basis of the regional estimates by the World Bank, disaggregated by regional agroecological 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 to TAC.

9.3.1.3. Land use

The third parameter used to determine initial priorities in agriculture and forestry was land use. Three categories of land 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, agroforestry and fallowing. All three land-use categories have major sustainability problems (TAC/CGIAR, 1988). The weight attached to each of these categories in the land use parameter of the baseline would vary according to the production sectors. For the agriculture baseline, total area of usable land defined as arable land plus land with perennial crops plus grazing land plus forest and woodland, would be used. For the forestry baseline, only the area of forest and woodland would be incorporated in the land use component. For fisheries, land use would not be part of the baseline. Statistical information on the area of each land use category is presented in Annex 4.

9.3.2. Baseline for Agriculture

The next step in the analysis was to determine the weight to be attached to each component of the base. TAC did not wish to weight the value of production unduly because the data available were of widely varying quality. Value of production on a global basis is heavily influenced by the degree to which the commodity is traded (e.g.

wheat versus yam) and by the price chosen to value output. Several commodities have no published data sources, while for others the international price reflects only a minor share of the market which is often distorted by subsidies and other government policies. International prices usually refer to high quality items. The prices used were the best available but varied from prices in the exporting country to wholesale prices in the importing country. The outcome of the analysis of value of production, therefore, has to be treated with considerable caution.

On the other hand, TAC could find no reason for giving undue weight to the other two parameters - the number of poor people and the land area. Since each is an indicator of efficiency, it was decided to weight all three equally. In terms of CGIAR goals, the highest pay off will be obtained by developing new technology where: (i) there is the highest level of production; (ii) it will benefit the largest number of poor people; and (iii) the land area available for more sustainable use is greatest.

Table 9.2 presents the results for agriculture across the 21 regional agroecological zones used in the analysis. Value of production across the regions is normalized to sum to 1000, as is the number of poor people and the total land area. These three sets of data are then averaged (equal weights) to determine a baseline value.

Table 9.3 presents the same data by region. In both tables it is clear that value of production and number of poor people favour Asia, whereas useable land shifts the emphasis more towards sub-Saharan Africa and Latin America.

Table 9.2: Baseline for priority setting by RAEZ in agriculture and its determinants (per thousand of total)

RAEZ	Weight = 0.33			Baseline
	VOP ^{1/}	Poor ^{2/}	Total usable land ^{3/}	
AFRS 1	26.91	52.81	131.45	70.35
AFRS 2	24.60	35.77	52.62	37.65
AFRS 3	26.69	42.72	88.74	52.69
AFRS 4	13.24	30.70	20.91	21.61
WANA 9	93.41	54.00	75.06	74.18
ASIA 1	63.35	147.89	23.31	78.17
ASIA 2	44.68	58.27	21.52	41.49
ASIA 3	103.17	110.81	64.04	92.68
ASIA 5	125.44	142.70	32.52	100.24
ASIA 6	66.42	35.08	14.89	38.82
ASIA 7	132.59	112.05	40.31	95.02
ASIA 8	54.04	114.21	82.72	83.63
LAC 1	16.57	5.19	27.68	16.48
LAC 2	44.75	9.13	77.77	43.88
LAC 3	41.03	12.39	107.11	53.50
LAC 4	28.92	20.28	42.11	30.44
LAC 5	11.07	1.84	12.16	8.36
LAC 6	6.38	0.48	6.43	4.43
LAC 7	44.22	8.15	36.03	29.48
LAC 8	25.96	3.37	32.78	20.71
LAC 9	6.56	2.17	9.83	6.19
	1000.00	1000.00	1000.00	1000.00

^{1/} VOP = Value of Production

^{2/} As estimated by the World Bank by region (World Bank, 1990). Subsequent distribution by AEZ pro rata with population adjusted with GDP/caput.

^{3/} Total usable land defined as arable land plus land with perennial crops plus grazing land plus forest and woodland

Table 9.3. Baseline for agriculture: distribution by region (%)

Weight = 0.33				Baseline
Factor	VOP	No. of Poor	Usable Land	
<u>Region</u>				
SSA	9.1	16.2	29.4	18.2
WANA	9.3	5.4	7.5	7.4
ASIA	59.0	72.1	27.9	53.0
LAC	22.6	6.3	35.2	21.4
WORLD	100.0	100.0	100.0	100.0

9.3.3. Baseline for Forestry

TAC debated thoroughly the appropriate weights for the baseline in forestry. Equal weighting, as in agriculture, was initially proposed, but three arguments eventually persuaded TAC to adopt different weights. First, in adopting the recommendations of Bellagio II the CGIAR has agreed that its focus in forestry and agroforestry should be limited to areas which largely exclude large-scale commercial forest production and utilization. Given that much of the global value of production comes from commercial log and timber production, TAC felt less weight should be given to value of production. Second, it is very difficult to value forest products used by the poor, such as fuelwood and charcoal. There was a concern that these and other products and services may be undervalued, again biasing research towards areas with commercial timber production and exports. Third, multiple use of the forest, and the opportunities for preserving it, are both much enhanced by the area of wooded land available.

TAC therefore decided that the weighting for the number of poor people should be the same, 0.33, that half the total weight, 0.5, should go to wooded area, and that the residual, 0.17, should be allocated to value of production. These weights are arbitrary but are based on TAC's best judgement. The results by regional agroecological zone are presented in Table 9.4 and by region in Table 9.5. Value of production and the number of poor people favour Asia, whereas wooded area emphasizes sub-Saharan Africa and Latin America and the Caribbean.

Table 9.4. Baseline for priority setting by RAEZ in forestry and its determinants (per thousand of total)

Weight	0.17	0.33	0.50	Baseline
RAEZ	VOP	Poor	Forest and Woodland	
AFRS 1	46.14	52.81	101.00	75.77
AFRS 2	40.01	35.77	56.00	46.61
AFRS 3	71.49	42.72	139.00	95.75
AFRS 4	23.31	30.70	11.00	19.59
WANA 9	15.08	54.00	27.00	33.88
ASIA 1	46.87	147.89	14.00	63.77
ASIA 2	65.48	58.27	27.00	43.86
ASIA 3	286.79	110.81	102.00	136.32
ASIA 5	34.74	142.70	9.00	57.50
ASIA 6	20.86	35.08	7.00	18.62
ASIA 7	39.44	112.05	9.00	48.18
ASIA 8	105.49	114.21	57.00	84.12
LAC 1	7.12	5.19	39.00	22.42
LAC 2	42.02	9.13	118.00	69.16
LAC 3	75.47	12.39	178.00	105.92
LAC 4	27.59	20.28	46.00	34.38
LAC 5	0.76	1.84	10.00	5.74
LAC 6	1.03	0.48	2.00	1.33
LAC 7	35.00	8.15	23.00	20.14
LAC 8	5.40	3.37	13.00	8.53
LAC 9	9.88	2.17	12.00	8.40
	1000.00	1000.00	1000.00	1000.00

Table 9.5. Baseline for forestry: distribution by region (%)

Weight	0.17	0.33	0.50	Baseline
Factor	VOP	No. of Poor	Forest and Woodland	
Region				
SSA	18.1	16.2	30.7	23.8
WANA	1.5	5.4	2.7	3.4
ASIA	60.0	72.1	22.5	45.2
LAC	20.4	6.3	44.1	27.6
WORLD	100.0	100.0	100.0	100.0

9.3.4. Baseline for Fisheries

TAC has far fewer data on fisheries than on forestry and agriculture. Further, land area is less relevant to most fisheries research issues, and the terrestrial agroecological zones identified for agriculture and forestry are much less applicable to fisheries. Thus the base for fisheries consisted of two factors only - value of production and number of poor people - each weighted equally (0.5). The results by region are presented in Table 9.6.

Having determined the baseline values for agriculture, forestry and fisheries, TAC then turned to the question of modifiers.

Table 9.6: Baseline for fisheries: distribution by region (%)

Factor	Weight = 0.5		Baseline
	VOP	No. of Poor	
<u>Region</u>			
SSA	8.0	16.2	11.2
WANA	4.0	5.4	4.9
ASIA	56.0	72.1	65.4
LAC	32.0	6.3	18.5
WORLD	100.0	100.0	100.0

9.4. Modification of the Baseline

9.4.1. Standard Procedure

The initial allocation of priorities based on value of production, number of poor people and land area does not take into account several other important factors that also determine CGIAR priorities. A standardized approach was therefore developed for modifying the initial baseline by the use of intensity parameters. As an example, GDP per caput is used as a possible equity modifier for agriculture.

The CGIAR is particularly interested in improving the welfare of low-income people. Although the number of poor people by region and agroecological zone is one of the three elements that compose the baseline, there are good reasons for modifying this baseline 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 9.7. Example of a modifying step

		SSA	WANA	ASIA	LAC	TOTAL
1	Baseline relative priority (agr.)	182.3	74.18	530.06	213.47	1000.00
2	GDP/caput (US\$)	294.0	1544.0	448.0	1847.0	
3	Standardized max. at 1 (row2/max.value row2)	0.16	0.84	0.24	1.0	
4	Take complement (1-row3)	0.84	0.16	0.76	0.0	
5	Attach weight .5 (.5*row4)	0.42	0.08	0.38	0.0	
6	Gross redistribution (row1*row5)	75.6	5.9	202.2	0.0	283.7
7	Baseline reduction (row1*total row6/1000)	51.1	21.0	150.9	60.7	283.7
8	Net change to baseline (row6-row7)	+24.5	-15.1	+51.3	-60.7	0.0

Table 9.7 shows how the modifier GDP per caput affects the allocation of priorities by region. The modifier is weighted at 0.5. The initial baseline for agriculture is given in row 1. The values for GDP per caput by region are presented in row 2. In row 3, the range is then standardized by dividing the values in row 2 by the highest value of GDP per caput in row 2. Because in this particular case highest priority will be 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 .5 (row 5). The values are only half 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 numbers in row 5 to give row 6, which estimates the gross redistribution. The baseline reduction is estimated in row 7 and the net change to the baseline in row 8. The value obtained in row 8 indicates the difference and the effect of the modifier by region.

The relative priorities of Asia and sub-Saharan Africa, where GDP per caput is low, increase by 51.3 and by 24.5 respectively, while the priority rankings of West Asia-North Africa and Latin America and the Caribbean are reduced. It should be stressed that Table 9.7. is for illustrative purposes only and is simplified, as it only takes into consideration regional values. As will be discussed in Section 9.8, the analysis has been done for each modifier by agroecological zone, by region and by regional agroecological zone.

The values obtained through this procedure for each modifier are then aggregated for each agroecological zone, region, and regional agroecological zone and added to the initial distribution of relative priorities, keeping the overall total constant at 1,000. As a result, the modified baseline is also obtained on an overall total of 1,000. The order in which modifiers are applied does not influence their impact.

The effect of a modifier depends on the weight it has been assigned and on the spread or variability of its value across regional agroecological zones. One may attach a large weight to a certain modifier, but if its values do not differ much among regional agroecological 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 data set therefore gives a certain implicit weight to the effect of a modifier.

Another issue is the direction in which intensity parameters are weighted. In the example of Table 9.7, 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 germplasm 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. A good example is the number of poor people. This was used as an important extensity parameter in calculating the baseline, but it can be logically transposed into an intensity parameter by expressing it as a percentage of the total population in the region. Using the data on the number of poor people in both parameters is not double counting, for it expresses two different concerns. Using the absolute number of poor as an extensity parameter would ensure that higher priority was given to areas with large numbers of poor. Using the proportion of poor people out of the total population in a region could ensure that higher priority is given direct 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 arrived at, and the process remains transparent. TAC is then in a better position to engage in reasoned dialogues with other stakeholders in the process. A more detailed discussion of the use of this analytical framework is provided in De Wit, Gryseels and Van Kraalingen (1992).

9.4.2. Selection of Modifiers

TAC considered over 20 possible modifiers for agriculture and 10 for forestry that might be used to take 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; (4) the nature of self-reliance; (5) concerns for the efficiency of research; (6) equity issues; (7) sustainability; and (8) special issues.

In the end TAC retained 10 modifiers, 9 of which were used for agriculture, 6 for forestry and 1 for fisheries. The evaluation first attempted to determine whether or not the modifier was appropriate for the task. For example, a modifier for the share of urban population was proposed but rejected because it was not clear why urban dwellers should get more or less attention than other members of the population. Secondly, TAC discarded modifiers which duplicated others. For example, agricultural GDP per labourer as a measure of rural poverty is already captured by GDP per caput as a measure of overall poverty. Some modifiers were deemed appropriate but inadequate data were available to quantify them, particularly, for example, with respect to sustainability issues.

Since the baselines already represented considerations of efficiency, only one further efficiency modifier was chosen. This is the yield gap, or in other words the difference between potential yields and actual performance. Where that gap is narrow, it was judged that higher priority should be given because strategic research would be

critical to raising the yield potential. Two modifiers - intensity of malnutrition and GDP per caput - reflect different concerns about equity. Three - "urgency", magnitude of deforestation, and soil degradation risk - address issues of sustainability. Two attempt to deal with issues of strength of national research systems - capacity of national system and country size. One attempts to address the issue of self-reliance and one the preservation of forest resources and the potential for agroforestry. Each of these modifiers is described in more detail in the next section.

In its selection of modifiers, TAC chose those which in its judgement best reflected the multifaceted character of the CGIAR's mission and goals. For example, sustainability is multifaceted and involves soil erosion, agricultural encroachment on forests, siltation of reservoirs, inappropriate deforestation and many other problems. TAC chose three modifiers to reflect these multiple dimensions, recognizing that the intensity of particular dimensions would vary across agroecological zones. The selection of more than one dimension lessens the regional distortions that might occur if one modifier only was relied on.

9.5. Modifiers Chosen

9.5.1. Efficiency Indicator

9.5.1.1. Yield gap or scope for growth

In developing countries, the actual productivity of agricultural land is well below its sustainable potential. Potential crop productivity can be defined as the productivity of cropping systems with varieties that are optimally adapted to the prevailing agroecological conditions, free of insects, pests, diseases and weeds, and under optimal nutrient conditions. The larger the difference between potential and actual productivity, the greater the opportunity to obtain yield increases. When the difference approaches zero, efforts are needed to increase the stable biological yield ceilings of crops. On the basis of studies by FAO, an estimate was made of the ratio between actual and potential land productivity by region and by agroecological zone.

It was assumed that production potentials reflect maximum attainable productivity using current production technologies. Maximum attainable yields vary by crop and by agroecological zone, and the total current productivity potential for each zone is conditioned by the current crop mix. Estimates of production potentials of presently cultivated land in each agroecological zone (Table 9.8) were derived from the FAO Agriculture Towards 2000 information base, using current cropping patterns. Estimates of productivity potentials (C) vary from 22 million tonnes in AEZ 9 of Latin America and the Caribbean to 406 million tonnes in AEZ 7 of Asia. At the aggregate regional level, C varies from 229 million tonnes in West Asia-North Africa to 1,841 million tonnes in Asia.

Information on the current production of food crops (B1) and of cash crops has already been provided in Section 4.3 (Table 4.2). Setting current food production (B1) against production potentials (C) permits a quantification of how much additional food production is possible without further expansion in the cultivated area. The ratio $(C-B1)/C$ therefore provides an estimate of the "yield gap" or scope for growth of food production on presently cultivated land. The yield gap is generally greater in sub-Saharan

Africa (0.82) and in Latin America and the Caribbean than in Asia (0.60) and West Asia-North Africa.

Table 9.8. Potential productivity (C), scope for growth in food production (C-B1)/C, Production of Food and Cash Crops in 1990 (B2), annual growth in food demand over the period 1990-2010 (D) and the need for production growth (U) by RAEZ

RAEZ	C (10 ⁶ GE)	(C-B1)/C	B2 (10 ⁴ t GE)	D (%)	U (%)
SSA	574.3	0.82	176.5	3.38	2.21
1	117.2	0.72	42.0	3.30	2.98
2	183.7	0.88	35.9	3.45	2.37
3	210.1	0.84	69.1	3.50	1.83
4	63.3	0.77	31.5	3.16	1.77
WANA	229.0	0.72	87.6	2.93	3.47
1	0.6	0.48	0.4	4.02	15.07
4	4.4	0.80	1.2	3.90	6.80
9	224.0	0.71	86.0	2.89	3.37
Asia	1 840.7	0.60	969.3	1.91	1.45
1	206.6	0.45	127.5	1.89	1.71
2	128.7	0.46	95.3	2.03	1.27
3	309.5	0.60	182.9	2.55	1.72
5	329.0	0.64	183.0	2.32	1.53
6	141.3	0.62	91.1	1.71	1.15
7	406.0	0.66	169.5	1.33	1.08
8	319.6	0.64	120.4	1.44	1.40
LAC	669.3	0.79	260.5	2.28	1.17
1	30.0	0.61	16.0	2.06	1.41
2	129.6	0.84	53.4	2.38	0.99
3	103.4	0.77	50.6	2.32	1.15
4	70.5	0.53	61.4	2.49	1.54
5	27.6	0.84	6.1	2.27	1.71
6	29.5	0.90	4.0	1.35	0.44
7	111.9	0.82	42.0	2.36	1.06
8	144.8	0.86	22.7	1.42	0.60
9	22.0	0.82	4.3	1.89	1.93
Overall	3 313.3	0.68	1 493.9	2.23	1.63
1	354.4	0.55	185.9	2.28	2.00
2	442.0	0.74	184.5	2.46	1.40
3	519.6	0.70	279.1	2.78	1.66
4	133.8	0.64	91.2	2.70	1.62
5	356.6	0.66	189.1	2.32	1.53
6	170.8	0.67	95.1	1.70	1.12
7	517.9	0.69	211.5	1.46	1.08
8	464.4	0.71	143.0	1.44	1.27
9	246.0	0.72	90.3	2.85	3.41

- GE - Grain equivalent
 C - Potential productivity of presently cultivated land.
 B1 - Present annual production of food crops.
 B2 - Present annual production of food and cash crops.
 D - Annual growth in demand for food over the period 1990-2010.
 U - Increase in food demand as a percentage of 1990 food and cash crop production.

The CGIAR takes an interest in both situations. In sub-Saharan Africa there are many opportunities to obtain improvements in crop productivity through the application of technology resulting from applied and adaptive research. In Asia there is a much greater need for strategic research that aims at fundamental biotechnological breakthroughs that increase yield potentials.

Given the capacity of the CGIAR to conduct strategic research, TAC considers that, among regions and agroecological zones, higher priority should be given to those in which the scope for growth is low. This would particularly favour all the regional agroecological zones of Asia (except RAEZs 7 and 8), and RAEZs 1 and 4 of Latin America and the Caribbean. All the regional agroecological zones of sub-Saharan Africa and West Asia-North Africa would be assigned lower priority as a result. TAC considers that in the latter areas there is a particular need for greater efforts in institution building. The yield gap or scope for growth modifier is therefore particularly useful in providing guidelines on the type of activity that could be undertaken by the CGIAR.

9.5.2. Equity Indicators

9.5.2.1. Malnutrition

The CGIAR mission statement stresses that the System's activities should enhance nutrition and well-being in developing countries, especially among low-income people. In determining the baseline values, the absolute number of poor in each region and agroecological zone was therefore explicitly considered.

TAC considers that, in addition, higher priority should be assigned to areas where poverty and malnutrition are particularly severe. Malnutrition is reflected in the number of children under five that are underweight, defined as two standard deviations below desirable weight for age. According to UNICEF, about 36% of children under five in developing countries excluding China, or 150 million children, are malnourished by this criterion. About 39% of children are stunted, as measured by height for age, while 8.4% or 35 million children are wasted, as measured by desirable weight for height (Carlson and Wardlaw, 1990).

Thus, in the developing world, more than one child in three is suffering from malnutrition. In the case of wasting, which indicates acute malnutrition, one child in 12 is affected. Of the 150 million children that are malnourished (excluding China), 75% live in Asia, 19% in sub-Saharan Africa and 6% in Latin America and the Caribbean. Data for West Asia-North Africa and data on the intensity of this measure (number of children malnourished as a proportion of total number of children in each region) are not available.

Pending the availability of a more appropriate data set, TAC considered that the number of malnourished people in proportion to total population for each region would serve as an adequate proxy. This proportion has been estimated at 35% in sub-Saharan Africa, 22% in Asia, 9% in West Asia-North Africa and 14% in Latin America and the Caribbean (FAO, 1991b).

9.5.2.2. GDP per caput

GDP per caput is generally accepted as an indicator of the income status of a country. To allow its use as a modifier, an analysis was made of GDP per caput by regional agroecological zones. For reasons of equity, TAC considers that higher priority should be given to areas where GDP per caput is low. This would favour areas with generally low income levels.

There was a second reason why TAC considered that GDP per caput would be an appropriate modifier. The CGIAR is only one component of the global agricultural research system. Many other institutes and agencies conduct research, in both the public and the private sectors. In assigning priorities to geographic areas, the existence of these other suppliers of research should be taken into account, since the CGIAR should conduct only those activities that it can undertake more effectively than any other agency. It is difficult, however, to quantify the extent of alternative sources of supply. The data are incomplete, relate to certain countries and commodities only, and particularly to the public sector.

In view of the lack of a quantitative indicator of alternative sources of research supply, TAC considered that an appropriate alternative would be an indicator that would reflect the ability of an area to finance its own research services. GDP per caput is a suitable indicator for this purpose. Where it is low, the area has limited capacity to finance its own research services. Such areas should receive higher priority.

The use of GDP per caput as a modifier favours all the regional agroecological zones of sub-Saharan Africa and Asia, except RAEZ 6 in Asia. On average, GDP per caput amounts to US\$ 294 in sub-Saharan Africa, US\$ 448 in Asia, US\$ 1544 in West Asia-North Africa and US\$ 1847 in Latin America and the Caribbean.

9.5.3. Sustainability Indicators

9.5.3.1. Urgency of need for production growth

An important factor determining priorities among different geographic areas is the pressure on agricultural production to meet future demand. As already discussed, the sustainability of agricultural production is at risk in many developing countries as a result of population growth, increased and changing demand for food, and the depletion of natural resources.

In Section 4.3, an estimate was made of the increases in agricultural output required between 1990 and 2010 to achieve food self-reliance for each regional agroecological zone. Information was also presented on present (year 1990) and future (year 2010) demand for food, as estimated on the basis of population size and demand per caput. Given the production of food and cash crops in 1990 (B2 as shown in Table 9.8), an estimate can now be made of the annual growth in food demand over the period 1990-2010 (see D in Table 9.8). Growth in demand varies from 3.38% in sub-Saharan Africa to 1.91% in Asia.

Increases in food demand in grain equivalent as percentages of food and cash crop production in 1990 can now also be estimated (see U in Table 9.8.). This parameter reflects the urgency of the need for production growth. The value of U is calculated by using the value of D to estimate the actual demand for food in 1990 and stating this as a

percentage of the present annual production of food and cash crops (B2). The value of U averages 1.63% when all developing countries are combined, but varies from 3.47% in West Asia-North Africa, to 2.21% in sub-Saharan Africa, to 1.45% in Asia and to 1.17% in Latin America and the Caribbean. Urgency also varies considerably within each region. In sub-Saharan Africa, for example, it is 2.98% in the semi-arid tropics but only 1.83% in the humid tropics. In Latin America and the Caribbean, it ranges from 0.6% in AEZ 8 to 1.93% in AEZ 9. The higher the value the more urgent the need for growth in production, the greater the pressure on marginal and fragile land, and the higher the priority of the area.

When taken together, the parameters U (urgency) and (C-B1)/C (yield gap or scope for growth) reveal the different nature of the production challenge in different agroecological zones. An urgent need for production increases in an area with relatively small scope for growth (e.g. in AEZ 9 of West Asia-North Africa and AEZ 1 of sub-Saharan Africa) will probably lead to a food crisis and to heavy pressure on natural resources. For areas where high demand for growth is combined with relatively high scope for growth, as in AEZs 6 and 8 of Latin America and the Caribbean, the prospects are more favourable.

9.5.3.2. Deforestation

Research has an important role to play in combatting deforestation. Often, it is not practical to preserve forest on good agricultural land because cultivation would provide a higher return, but trees in farmland play important roles in sustaining agricultural production. In many cases, deforestation can be slowed down by improving productivity and resource management in adjacent agricultural areas. However, this approach is unlikely to halt deforestation altogether.

The higher the rate of deforestation, the higher the priority that should be assigned to a particular area. Deforestation rates vary considerably, from 1.7% in sub-Saharan Africa, through 1.4% in Latin America and the Caribbean, to 1% in West Asia-North Africa and 0.9% in Asia.

However, the absolute area deforested is much larger in Latin America and the Caribbean than elsewhere. TAC considers that, rather than rate of deforestation, a more appropriate indicator of CGIAR priorities would consist of the share of each region's deforested area in the total area deforested in developing countries annually. It has been estimated that a total of 16.8 million ha are deforested in developing countries every year, 45% of this in Latin America and the Caribbean, 38% in sub-Saharan Africa, 15% in Asia and 2% in West Asia-North Africa. The modifier is estimated as the total area deforested in each region each year divided by the priority baseline.

9.5.3.3. Soil degradation risk

The sustainability of agricultural production is a key issue in considering CGIAR priorities. Soil degradation is a major threat to sustainability in several areas of the developing world. A case could be made that the higher the degree of degradation of arable land in a given area, the higher the priority that should be assigned to that area.

Distilling a single quantitative indicator of the state of soil resources in different regional agroecological zones was difficult. Soil constraints data could not be used because they concern total rather than arable land area. Furthermore, it is necessary to

select particular constraints because the sum of all constraints is not useful in discriminating amongst different regional agroecological zones. The latter problem is also presented by the data on human-induced land degradation, which are, in any case, only partly quantitative.

It was therefore decided to use estimates of the effects of water and wind erosion on the productivity of rainfed land; these are based on the FAO population supporting capacity study (FAO, 1982). This model uses climatic (rainfall and wind erosion) indices, soil, terrain, texture and vegetation/land use factors under situations where no conservation measures are applied. It overcomes some of the problems mentioned above.

Over the four developing regions as a whole, the area of potential rainfed cropland is reduced in the long run by 24.7% if the full rate of soil erosion remains unchecked. At the regional level, the highest risk of degradation exists in Asia (35.6% decrease in cropland), followed by West Asia-North Africa (20.1%) and sub-Saharan Africa (16.5%). Latin America and the Caribbean are less at risk from soil erosion (11.4%).

Within the tropics, the humid zones carry the highest risk of soil erosion, followed by the subhumid zones. Cool tropical zones and the warm semi-arid tropics carry similar levels of risk. In the subtropics with summer rainfall, the warm humid zone and the cool zone in Asia are at high risk. In Latin America and the Caribbean, all the subtropical zones are at low risk.

9.5.4. Strength of National Research System Indicators

9.5.4.1. Capacity of national research systems

The effectiveness of the CGIAR depends on the ability of national research systems to identify a priority research agenda, use the products of international research, and conduct collaborative research. The CGIAR mission to help resource-poor farmers implies a need to build capacity in national research systems, so that they can do an effective job in bringing new technology to these ultimate clients. However, the equity consideration implied by the objective of strengthening weak national systems may compromise short-term economic efficiency by diverting resources away from servicing strong national research systems which are already effective partners.

The CGIAR works with both strong and weak national research systems. The strength of a national system to some extent determines the kind of collaborative activity it undertakes with CGIAR Centres. Traditionally, research activities with weak national systems have involved a higher level of collaborative applied and adaptive research - partly as a means of transferring technology, partly as a form of capacity building and technical assistance. Work with stronger national systems tends to be more strategic in nature. However, although conducted in collaboration with stronger systems, strategic research nevertheless produces results that eventually reach smaller, weaker systems.

TAC has considered both quantitative and qualitative information to incorporate the status of national research systems by region and agroecological zone into its priority setting. Some of this information is contained in a background paper from ISNAR (Pardey and Roseboom, 1991).

It proved difficult to select a single indicator for the strength of national research systems, but one good proxy is the number of scientists by regional agroecological zone. This was estimated also by Pardey and Roseboom (1991), and of the total number of 76,174 scientists in developing countries, 6% were located in sub-Saharan Africa, 72% in Asia, 12% in Latin America, and 10% in West Asia-North Africa.

The ratio of number of scientists by RAEZ represents the density of scientists in each area. The strengthening of national research systems is an important mission of the CGIAR. TAC therefore considers that greater weight should be given to areas with lower densities.

9.5.4.2. Small countries

Large countries such as India and China have strong national research systems. However, many small countries lack the resources and the capacity to set up a comprehensive research system of their own. To provide effective research services, they rely especially on networks and on collaboration with other national and international research institutions. The smaller the country, the greater the difficulty in achieving a critical mass of resources and scientists for a given research activity.

TAC considers that higher priority should be given to areas that consist predominantly of small countries. The modifier used was the average size of countries within a regional agroecological zone, related to the baseline value of priorities. This indicator particularly favours Central America and the Caribbean, West Africa, and West Asia-North Africa.

9.5.5. Food Import Gap

The CGIAR has included the notion of self-reliance in its mission statement to replace the previous implicit goal of self-sufficiency. TAC wished to introduce a modifier to reflect this new consideration. A comprehensive measure would require a complex analysis of each country's comparative advantages across sectors to determine whether it had a resource base sufficient to feed its population either by domestic production or by exports to pay for imported food. This could not be done. However, TAC was aware of a recent IFPRI study (Ezekiel, 1989) which projected food aid needs by country and region for the year 2000. The study used standard methods to make linear projections of potential production. It projected aggregate demand based on population and income growth rates weighted by the income elasticity of demand. Agricultural (food) exports were projected to increase at the rate of production growth while commercial imports were projected to grow at the same rate as GNP. Thus, the difference between production plus imports and demand minus exports was identified as the gap that would need to be filled by food aid. The gap indicates the potential magnitude of import needs after taking into account potential agricultural exports.

TAC used these estimates by region as an indicator of the difficulty the region would have in feeding itself. In the analysis, regions with larger food aid gaps were given greater weights.

9.5.6. Preservation of forest resources

As already discussed in Section 9.5.3.2, deforestation can often only be slowed down by improving productivity and resource management in adjacent agricultural areas. The encroachment on forests by agriculture not only has unfavourable environmental consequences, but also causes fuelwood scarcity. In such areas, high priority should be given to agroforestry. TAC considered wooded area per caput to be an appropriate indicator of the pressure on forest resources. Greater weight should be given to areas where the wooded area per caput is low. Wooded area per caput amounts to 2.15 ha in Latin America and the Caribbean, 1.33 ha in sub-Saharan Africa, 0.19 ha in West Asia-North Africa and 0.18 ha in Asia. This indicator particularly favours the Asia and West Asia-North Africa regions, as well as the cool tropics of sub-Saharan Africa.

9.6. Data for Modifiers

Table 9.9 presents an overview of the values of the data used to estimate the modifiers chosen, by region and agroecological zone. Data on malnutrition and deforestation were available only at the regional level.

TAC acknowledges 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 agroecological zone framework. However, TAC considered that, as priority setting is a continuing activity, well informed "guestimates" could be used when more reliable data were not available. The Committee will seek to improve the quality of the data set over time.

9.7. Modifier Weights Chosen

Having selected the modifiers listed above it remained for TAC to decide what weights should be attached to each.

In the debate on weights, TAC had three major concerns. First, different weights among modifiers could re-introduce undesirable distortions. Second, the level of a weight directly impacts on the baseline in a particular agroecological zone in proportion to the inter-regional differences in the value of the basic indicator. Thus, there are already implicit differences in the impact that each modifier will have on the base. And third, unless compelling reasons could be found to weight modifiers differently, equal weights would be the least distorting option.

At the end of the debate it was TAC's collective judgement that weights should be equal across modifiers. The remaining question was, at what level should those weights be fixed? The initial approach was to assume a weight of 1 as it seemed the most neutral. But clearly, any weight, including zero, is arbitrary in the absence of objective explanatory variables. TAC decided that weights in excess of 1 would give undue importance to modifiers that strongly discriminated among regional agroecological zones. In its analysis, the Committee 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.

Table 9.9. Value of Modifiers by Region and Agroecological Zone

	SSA	1	2	3	4	WANA
1. Yield gap or scope for growth	0.82	0.72	0.88	0.84	0.77	0.72
2. Malnutrition (% population malnourished)	35					9
3. GDP/caput (US Dollars)	294	291	255	379	185	1544
4. Production growth needed to meet demand (% p.a.)	2.21	2.98	2.37	1.83	1.77	3.47
5. Deforestation ('000 ha)	6400					300.0
6. Soil degradation hazard (% rainfed cropland)	16.5	10.8	15.2	28.8	10.6	20.1
7. Capacity of NARS (no. of scientists)	4917	1974	1150	1101	612	7836
8. Size of countries (no. of countries)		26	16	15	8	21
9. Food import gap by 2000 (MMT)	25.95					19.07
10. Wooded area/caput (ha)	1.33	1.32	1.14	1.98	0.31	0.19

	ASIA	1	2	3	5	6	7	8
1. Yield gap or scope for growth	0.60	0.45	0.46	0.60	0.64	0.62	0.66	0.64
2. Malnutrition (% population malnourished)	22							
3. GDP/caput (US Dollars)	448	298	424	490	304	1043	504	368
4. Production growth needed to meet demand (% p.a.)	1.45	1.71	1.27	1.72	1.53	1.15	1.08	1.40
5. Deforestation ('000 ha)	2500							
6. Soil degradation hazard (% rainfed cropland)	35.6	29.2	31.1	63.0	17.9	17.9	46.0	46.2
7. Capacity of NARS (no. of scientists)	54558	4436	2630	6095	9884	4772	14416	12325
8. Size of countries (no. of countries)		2	4	17	3	4	2	7
9. Food import gap by 2000 (MMT)	2.55							
10. Wooded area/caput (ha)	0.18	0.07	0.26	0.47	0.05	0.07	0.04	0.30

Table 9.9. cont.d

	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)	1847	1887	2061	1758	1504	2029	2458	2109	2422	1750
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)	7600									
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 (no. of scientists)	8861	636	1664	1702	1367	392	169	1831	2813	289
8. Size of countries (no. of countries)		9	14	21	9	2	1	3	2	2
9. Food import gap by 2000 (MMT)	6.3									
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

In the tables that follow in Section 9.8 the impact of each modifier by agroecological zone, region and regional agroecological zone is explored using a uniform weight of 0.5. In Section 9.10 the sensitivity of the results to different levels of uniform weights and different weights among modifiers are presented. 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.

9.8. Quantitative Impact of Each Modifier

9.8.1. Agriculture

In Table 9.10, the actual impact of each modifier when weighted at 0.5 is displayed by region, by agroecological zone and by regional agroecological zone. Looking down a column shows two things: (i) whether the modifier had a positive or negative impact on the distribution of priority; and (ii) by how much.

For example, modifier 1 (yield gap) has a relatively small negative impact on all four agroecological zones of sub-Saharan Africa (AFRS 1-4) and a large positive impact on Asia 1. Looking across a row shows how a regional agroecological zone is impacted by a modifier and by how much. For example, looking across WANA 9 we see that yield gap (modifier 1) subtracts 1.9 from the West Asia-North Africa baseline, malnutrition (2) subtracts 13.46, GDP per caput (3) subtracts 11.0, but that urgency (4) adds 18.9 to the base, and so on across the row. The net effect of all of the modifiers is to increase the West Asia-North Africa base by 6.34, despite the fact that six of the nine modifiers subtract from it. Clearly the largest impact on the West Asia-North Africa base comes from modifier 9 (food import gap).

The table also allows the reader to compute what would happen to a regional agroecological, regional or agroecological base 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.

Table 9.11 displays the quantitative impacts (plus or minus) of each of the modifiers on each of the regional agroecological zones, regions and agroecological zones. Several things are clear. First, the various modifiers impact differently on each agroecological zone and region: no agroecological zone or region is favoured or disfavoured by all modifiers. That is, looking across any agroecological zone or region one does not find a consistent pattern of all pluses or all minuses. Second, the net effect of all modifiers is positive for all tropical agroecological zones (AEZs 1-4) and negative for all subtropical agroecological zones (AEZs 5-9) except AEZ 9, which is found mostly in West Asia-North Africa. Third, it follows from the agroecological impacts that the sub-Saharan Africa base is increased by the net effect of all modifiers because this region contains only tropical agroecological zones. The West Asia-North Africa base is also increased by the application of all the modifiers.

Table 9.10. Quantitative impact of agricultural modifiers at weight = 0.5

BASELINE RELATIVE PRIORITY	NUMBER	1	2	3	4	5	6	7	8	9	NUMBER
	NAME MODIFIER	YIELD GAP	MAL- NUTRITION	GDP/ CAPUT	URGENCY	DEFORES- TATION	SOIL DEGRADA- TION	STRENGTH OF NARS	AV. SIZE OF COUNTRY	FOOD IMPORT GAP	NAME MODIFIER
	WEIGHT POS./NEG.	0.5 NEG.	0.5 POS.	0.5 NEG.	0.5 POS.	0.5 POS.	0.5 POS.	0.5 NEG.	0.5 NEG.	0.5 POS.	WEIGHT POS./NEG.
70.3	AFRS1	-1.8	13.37	7.5	13.0	18.5	-9.5	11.1	7.9	6.0	AFRS1
37.7	AFRS2	-4.3	7.15	4.3	3.6	9.9	-3.8	5.7	4.6	3.2	AFRS2
52.7	AFRS3	-4.8	10.01	4.7	-1.0	13.8	0.4	9.3	6.7	4.5	AFRS3
21.6	AFRS4	-1.1	4.11	2.8	0.2	5.7	-2.9	3.1	2.3	1.8	AFRS4
74.2	WANA9	-1.9	-13.46	-11.0	18.9	-13.5	-4.5	-7.1	8.0	30.9	WANA9
78.2	ASIA1	9.8	0.34	8.3	0.1	-13.1	0.9	5.0	-16.1	-5.6	ASIA1
41.5	ASIA2	5.0	0.18	3.3	-2.6	-6.9	1.1	1.8	2.4	-3.0	ASIA2
92.7	ASIA3	3.8	0.40	6.2	0.2	-15.5	25.9	3.3	9.8	-6.6	ASIA3
100.2	ASIA5	1.9	0.43	10.5	-2.5	-16.8	-7.9	-7.3	-18.8	-7.2	ASIA5
38.8	ASIA6	1.2	0.17	-1.8	-3.1	-6.5	-3.0	-5.9	4.2	-2.8	ASIA6
95.0	ASIA7	0.8	0.41	6.0	-8.5	-15.9	13.7	-23.5	-34.1	-6.8	ASIA7
83.6	ASIA8	1.6	0.36	7.6	-3.6	-14.0	12.2	-19.5	1.0	-6.0	ASIA8
16.5	LAC1	0.6	-1.81	-3.6	-0.7	4.2	-2.1	2.1	2.2	-0.7	LAC1
43.9	LAC2	-4.0	-4.83	-11.1	-4.5	11.2	-3.7	6.3	5.7	-1.7	LAC2
53.5	LAC3	-2.8	-5.88	-10.2	-4.3	13.6	-0.8	7.9	7.2	-2.1	LAC3
30.4	LAC4	2.4	-3.35	-4.3	-0.7	7.7	-4.2	1.8	3.4	-1.2	LAC4
8.4	LAC5	-0.8	-0.92	-2.1	0.0	2.1	-1.2	0.8	0.9	-0.3	LAC5
4.4	LAC6	-0.6	-0.49	-1.5	-0.8	1.1	-0.6	0.6	0.4	-0.2	LAC6
29.5	LAC7	-2.4	-3.24	-7.7	-2.7	7.5	-5.4	1.4	1.4	-1.2	LAC7
20.7	LAC8	-2.1	-2.28	-6.8	-3.3	5.3	-3.7	2.6	0.2	-0.8	LAC8
6.2	LAC9	-0.5	-0.68	-1.2	0.2	1.6	-1.0	0.6	0.8	-0.2	LAC9
1000.0	SUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	SUM
182.3	SSA	-12.0	34.6	19.3	17.8	47.9	-15.8	29.2	21.5	15.5	SSA
74.2	WANA	-1.9	-13.5	-11.0	18.9	-13.5	-4.5	-7.1	8.0	30.9	WANA
530.1	ASIA	24.1	2.3	40.1	-20.0	-88.7	42.9	-46.2	-51.6	-38.0	ASIA
213.5	LAC	-10.2	-23.5	-48.5	-16.8	54.3	-22.7	24.1	22.2	-8.4	LAC
165.0	AEZ1	8.6	11.9	12.2	12.4	9.6	-10.7	18.1	-6.0	-0.3	AEZ1
123.0	AEZ2	-3.4	2.5	-3.5	-3.4	14.1	-6.4	13.8	12.7	-1.5	AEZ2
198.9	AEZ3	-3.8	4.5	0.6	-3.0	11.9	25.6	20.6	23.7	-4.3	AEZ3
52.0	AEZ4	1.3	0.8	-1.5	-0.5	13.4	-7.1	4.9	5.7	0.6	AEZ4
108.6	AEZ5	1.2	-0.5	8.4	-2.5	-14.6	-9.1	-6.4	-17.9	-7.5	AEZ5
43.3	AEZ6	0.6	-0.3	-3.3	-3.9	-5.4	-3.6	-5.4	4.6	-3.0	AEZ6
124.5	AEZ7	-1.6	-2.8	-1.7	-11.2	-8.4	8.4	-22.2	-32.7	-8.0	AEZ7
104.3	AEZ8	-0.5	-1.9	0.9	-6.9	-8.7	8.5	-17.0	1.1	-6.8	AEZ8
80.4	AEZ9	-2.4	-14.1	-12.1	19.1	-11.9	-5.5	-6.5	8.8	30.7	AEZ9

Table 9.11. Relative impacts of agricultural modifiers by agroecological zone and region (weight 0.5)

AEZ/ Region	MODIFIER									Net Effect of all Modifiers
	(1) Yield Gap	(2) Malnu- trition	(3) GDP/ Caput	(4) Urgency	(5) Deforestation	(6) Soil Degradation	(7) Cap. of NARS	(8) Small Country	(9) Import Gap	
AEZ										
AEZ 1	+	+	+	+	+	-	+	-	-	+
AEZ 2	-	+	-	-	+	-	+	+	-	+
AEZ 3	+	+	+	-	+	+	+	+	-	+
AEZ 4	+	+	-	-	+	-	+	+	+	+
AEZ 5	+	-	+	-	-	-	-	-	-	-
AEZ 6	-	-	-	-	-	-	-	+	-	-
AEZ 7	-	-	-	-	-	+	-	-	-	-
AEZ 8	-	-	+	-	-	+	-	+	-	-
AEZ 9	-	-	-	+	-	-	-	+	+	+
Region										
SSA	-	+	+	+	+	-	+	+	+	+
WANA	-	-	-	+	-	-	-	+	+	+
ASIA	+	+	+	-	-	+	-	-	-	-
LAC	-	-	-	-	+	-	+	+	-	-

9.8.2. Forestry

The same results for forestry are displayed in Tables 9.12 and 9.13. For the forestry analysis six modifiers were used (five are the same as for agriculture). Again, it is clear from Table 9.12 that no agroecological zone or region is consistently

Table 9.12. Quantitative impact of forestry modifiers (w = 0.5)

WEIGHT = 0.5							
DIRECTION		-1	1	-1	1	1	-1
GROSS REDISTRIBUTION		125	191	333	255	263	247
BASELINE RELATIVE PRIORITY	NAME MODIFIER	GDP/ CAPUT	DEFORES- TATION	SOIL DEGR. HAZARD	WOOD- LAND/ CAPUT	MAL- NUTRITION	AV. SIZE COUNTRY IN RAEZ
70.5	AFRS1	8.4	13.6	-11.1	-0.4	13.6	4.6
37.7	AFRS2	5.5	8.4	-5.2	0.6	8.4	3.0
52.8	AFRS3	8.9	17.2	-0.4	-6.7	17.2	6.5
19.0	AFRS4	2.6	3.5	-2.9	1.8	3.5	1.2
74.4	WANA9	-4.9	-4.5	-2.5	4.0	-6.5	1.2
78.3	ASIA1	7.0	-12.8	0.0	6.3	-0.4	-10.2
41.6	ASIA2	3.7	-8.8	0.6	3.4	-0.3	1.3
92.9	ASIA3	9.7	-27.3	36.5	16.2	-0.9	8.0
100.6	ASIA5	6.2	-11.5	-5.2	6.7	-0.4	-13.0
39.0	ASIA6	-0.8	-3.7	-1.7	2.2	-0.1	0.7
95.3	ASIA7	3.3	-9.6	6.4	4.6	-0.3	-20.5
83.8	ASIA8	8.0	-16.8	11.3	10.4	-0.5	0.9
16.5	LAC1	-4.8	4.2	-3.1	-3.0	-2.7	1.6
44.0	LAC2	-17.2	13.1	-6.7	-8.2	-8.3	4.7
53.6	LAC3	-19.8	20.1	-2.8	-39.8	-12.8	7.6
30.5	LAC4	-4.7	6.5	-5.2	1.7	-4.1	2.1
8.4	LAC5	-1.4	1.1	-0.9	-0.2	-0.7	0.3
4.4	LAC6	-0.4	0.3	-0.2	0.0	-0.2	0.0
29.6	LAC7	-5.2	3.8	-3.9	0.5	-2.4	0.0
20.8	LAC8	-2.7	1.6	-1.6	0.2	-1.0	-0.6
6.2	LAC9	-1.6	1.6	-1.5	-0.4	-1.0	0.6
1000.0	SUM	0.0	0.0	0.0	0.0	0.0	0.0
180.0	SSA	25.5	42.7	-19.6	-4.7	42.6	15.4
74.4	WANA	-4.9	-4.5	-2.5	4.0	-6.5	1.2
531.6	ASIA	37.2	-90.5	47.9	49.9	-2.9	-32.8
214.1	LAC	-57.8	52.3	-25.8	-49.2	-33.3	16.2
165.3	AEZ1	10.7	5.1	-14.2	2.9	10.5	-4.0
123.3	AEZ2	-8.0	12.7	-11.3	-4.2	-0.3	9.1
199.3	AEZ3	-1.2	10.0	33.3	-30.3	3.5	22.2
49.5	AEZ4	-2.1	10.0	-8.1	3.5	-0.6	3.3
108.9	AEZ5	4.9	-10.4	-6.1	6.5	-1.1	-12.7
43.4	AEZ6	-1.2	-3.5	-1.9	2.3	-0.3	0.7
124.9	AEZ7	-1.9	-5.8	2.5	5.1	-2.7	-20.5
104.6	AEZ8	5.3	-15.2	9.6	10.6	-1.6	0.2
80.6	AEZ9	-6.4	-2.9	-3.9	3.6	-7.5	1.8

discriminated against or favoured by all modifiers. The net effect of the forestry modifiers is to increase the base in all tropical agroecological zones (AEZs 1-4) and reduce it in all subtropical ones (AEZs 5-9). This again favours sub-Saharan Africa.

Table 9.13. Relative impacts of forestry modifiers by agroecological zone and region

AEZ/ Region	MODIFIER						Net Effect of all Modifiers
	(1) GDP per caput	(2) Deforestation	(3) Soil Deg. Risk	(4) Woodland/ Caput	(5) Mal- nutrition	(6) Small country	
AEZ							
AEZ 1	+	+	-	+	+	-	+
AEZ 2	-	+	-	-	+	+	+
AEZ 3	-	+	+	-	+	+	+
AEZ 4	-	+	-	+	+	+	+
AEZ 5	+	-	-	+	-	-	-
AEZ 6	-	-	-	+	-	+	-
AEZ 7	-	-	+	+	-	-	-
AEZ 8	+	-	+	+	-	-	-
AEZ 9	-	-	-	+	-	+	-
Region							
SSA	+	+	-	-	+	+	+
WANA	-	-	-	+	-	+	-
ASIA	+	-	+	+	-	-	-
LAC	-	+	-	-	-	+	-

9.8.3. Fisheries

The baseline value for fisheries was modified by only one variable, the malnutrition modifier, and only on a regional basis. The results are presented in Table 9.14. The malnutrition modifier increases the base for sub-Saharan Africa and reduces it in each of the other regions. This modifier had the same impact on each of the regions for agriculture and forestry as well.

Table 9.14. Impact of modifier on fisheries base (weight 0.5)

Region	Base	Modified Base
SSA	11.2	13.9
WANA	4.9	4.2
ASIA	65.4	64.4
LAC	18.5	17.5

9.9. Impact of Modifiers

9.9.1. Agriculture

9.9.1.1. Priorities by region, agroecological zone and regional agroecological zone

The effect of all the nine modifiers (all weighted at 0.5) on the priority analysis for agriculture is shown in Table 9.15. The most striking cumulative effect of the modifiers is the shift in priority from the subtropical to the tropical agroecological zones. The only subtropical agroecological zone whose priority rating increased significantly was the cool subtropics with winter rainfall (AEZ 9), which predominates in West Asia-North Africa.

One of the main consequences of this shift is to boost the priority for sub-Saharan Africa by more than 80% relative to the baseline. Asia, on the other hand, declines by almost 30% relative to the baseline. The other regional changes are relatively minor - an increase of 9% in West Asia-North Africa and a decrease of 14% in Latin America and the Caribbean.

On a regional basis, the analysis results in a final ranking of Asia at 395, sub-Saharan Africa at 340.24, Latin America and the Caribbean at 184.10 and West Asia-North Africa at 80.66. On an agroecological basis, the warm humid tropics (AEZ 3) receive the highest ranking at 274.64, the semi-arid tropics (AEZ 1) rank second with 220.78, while the subhumid tropics (AEZ 2) score third with 148. According to the analysis, the lowest priority zone appears to be AEZ 6, the warm subhumid subtropics with summer rainfall.

9.9.1.2. Priorities by commodity and region

Setting priorities by region and agroecological 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 agroecological 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 agroecological zone as given in Table 9.15 by the value of production by regional agroecological zone as presented in Table 9.2. If modifier weights change, the ratio will have to be adjusted also. The ratio ranges from a high of 5.07 in RAEZ 1 of sub-Saharan Africa (AFRS1) to a low of 0.20 in RAEZ 7 (ASIA7) of Asia.

Next, the value of production of each commodity in each regional agroecological zone is multiplied by the ratio obtained for that zone. This means that a crop with a high production value grown mainly in an area that is accorded low priority may end up with lower priority than a crop with a low 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 reduce by more than four-fifths. These adjusted values of production of a commodity can then be aggregated by region and by agroecological zone. The results are shown in Tables 9.16 and 9.17, which show the unadjusted and adjusted values respectively, globally and by region.

Table 9.15. Outcome of agriculture analysis (w = 0.5)

RAEZ/AEZ/ REGION	BASELINE	FINAL
RAEZ		
AFRS1	70.35	136.41
AFRS2	37.65	68.01
AFRS3	52.69	98.31
AFRS4	21.61	37.51
WANA9	74.18	80.66
ASIA1	78.17	67.66
ASIA2	41.49	42.82
ASIA3	92.68	120.15
ASIA5	100.24	52.75
ASIA6	38.82	21.20
ASIA7	95.02	27.17
ASIA8	83.63	63.26
LAC1	16.48	16.71
LAC2	43.88	37.17
LAC3	53.50	56.18
LAC4	30.44	32.12
LAC5	8.36	6.86
LAC6	4.43	2.47
LAC7	29.48	17.15
LAC8	20.71	9.68
LAC9	6.19	5.75
Total	1000.00	1000.00
AEZ		
AEZ1	165.00	220.78
AEZ2	123.03	148.00
AEZ3	198.87	275.64
AEZ4	52.05	69.63
AEZ5	108.60	59.62
AEZ6	43.26	23.67
AEZ7	124.50	44.31
AEZ8	104.34	72.94
AEZ9	80.36	86.41
Total	1000.00	1000.00
Region		
AFRS	182.30	340.24
WANA	74.18	80.66
ASIA	530.06	395.00
LAC	213.47	184.10
Total	1000.00	1000.00

The last column of Table 9.16, labelled "Global VOP", shows the percentage share of each commodity in the global value of production of 35 major agricultural commodities. The total is standardized at 100. Thus rice represents 17.8% of the global value of production, wheat 6.4%, etc. The first part of the table illustrates the regional distribution of this value of production by commodity. Since regional price differences were not used in calculating the total value of production, this regional distribution reflects production only. For example, 2% of rice is produced in sub-Saharan Africa, 1% in West Asia-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 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 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 rice, sweet potato, chickpea, coconut and cabbage, which are all either CGIAR commodities already or else under consideration. Rubber and pigmeat are also of particular importance in Asia. The bulk share of sweet potato and pigmeat is produced in China.

Table 9.17 presents the outcome of the weighting process. The first column repeats the basic share of each commodity in unadjusted value of production. The second column represents the adjusted share in value of production of each commodity (with modifiers weighted at 0.5). 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 right hand side of the table shows the distribution of this adjusted value of production by commodity and by region.

The weighting process generally shifts the ranking of commodities in favour of sub-Saharan Africa and away from Asia, as might be expected from the analysis above (Section 9.9.1.1). Overall, rice shifts from 17.8 to 13.2%, and on a regional basis rice in sub-Saharan Africa increases from 2% to 9%. Similar regional shifts can be seen in the cases 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 26%. Other significant regional shifts include large improvements in the ranking in sub-Saharan Africa of cassava, sweet potato, bananas and plantain, phaseolus beans, broad beans, groundnuts, beef and buffalo meat, sheep and goat meat, and milk.

9.9.2. Forestry

The results of the analysis for forestry are summarized in Table 9.18. The impact of the six modifiers on the allocation of priority by regional agroecological zone is quite variable. For example, the warm humid tropics (AEZ 3) increase in importance in sub-Saharan Africa and Asia but decrease in Latin America and the Caribbean. The impact on the allocation to global agroecological zones is little changed. The situation is different for the regions, however. The allocation to sub-Saharan Africa increases significantly (up 102), while the allocation to Asia increases slightly, and that to Latin America and the Caribbean decreases (up 9 and down 102 respectively). The analysis suggests that Asia should receive a ranking of 461.2, sub-Saharan Africa of 339.6, Latin

Table 9.16. Value of production by agricultural commodity and its regional distribution not adjusted for RAEZ priorities (% of total)

COMMODITY	VOP	AFRICA	WANA	ASIA	LAT. AM	SUM
Rice	17.8	1.8	1.1	93.0	4.2	100.0
Wheat	6.4	0.8	19.0	70.0	10.2	100.0
Maize	4.1	10.3	4.0	57.5	28.2	100.0
Barley	0.6	4.7	65.9	23.0	6.4	100.0
Sorghum	0.8	32.4	2.7	40.3	24.6	100.0
Millet	0.7	41.3	0.8	57.6	0.3	100.0
Cassava	2.0	45.0	0.0	34.6	20.4	100.0
Potato	2.8	3.1	15.2	65.1	16.5	100.0
Sweet Potato	2.9	5.0	0.1	93.1	1.9	100.0
Yam	0.6	96.6	0.0	0.8	2.6	100.0
Banana & Plantain	2.1	34.5	0.8	29.2	35.6	100.0
Chickpea	0.5	2.7	14.5	80.3	2.5	100.0
Cowpea	0.2	95.5	0.4	1.9	2.2	100.0
Pigeonpea	0.2	6.1	0.0	92.4	1.5	100.0
Broad Bean	0.4	8.9	22.5	64.0	4.5	100.0
Lentil	0.2	1.2	47.9	47.8	3.1	100.0
Beans	1.1	23.9	7.8	20.2	48.1	100.0
Soybean	2.5	0.5	0.9	33.3	65.3	100.0
Groundnut	2.6	21.8	0.9	73.5	3.9	100.0
Coconut	1.1	4.9	0.0	87.9	7.1	100.0
Tomato	1.2	4.7	49.5	23.0	22.8	100.0
Onion	0.8	2.8	23.4	58.9	14.9	100.0
Cabbage	0.4	0.7	9.0	85.1	5.2	100.0
Orange	3.5	1.6	15.3	20.7	62.3	100.0
Lemon & Lime	0.7	2.8	29.3	20.6	47.2	100.0
Pineapple	0.5	11.1	0.0	63.7	25.2	100.0
Grape	2.5	0.2	53.7	9.1	37.1	100.0
Apple	1.1	0.1	29.5	50.7	19.7	100.0
Sugar	2.7	6.9	6.5	40.1	46.5	100.0
Coffee	2.7	20.4	0.1	17.0	62.5	100.0
Tea	0.8	12.3	8.7	76.6	2.4	100.0
Cocoa	0.8	57.7	0.0	14.6	27.6	100.0
Tobacco	2.6	5.8	6.1	73.4	14.8	100.0
Rubber	1.1	6.1	0.0	92.8	1.1	100.0
Cotton	2.8	8.9	11.4	65.1	14.7	100.0
Jute	0.2	0.1	0.2	99.0	0.7	100.0
Hemp	0.0	0.0	3.9	93.1	2.9	100.0
Sisal	0.0	24.5	0.4	4.2	70.9	100.0
Palm Oil	0.7	16.7	0.0	77.7	5.6	100.0
Beef & Buffalo Meat	5.0	13.0	8.6	21.3	57.2	100.0
Sheep & Goat Meat	1.7	17.9	29.8	44.0	8.3	100.0
Pigmeat	4.8	1.2	0.1	87.7	10.9	100.0
Poultry Meat	1.9	6.5	14.0	43.7	35.8	100.0
Milk	8.9	8.5	11.1	52.2	28.3	100.0
Eggs	2.8	4.3	11.6	61.5	22.5	100.0
Sum	100.0	9.1	9.3	59.0	22.5	100.0
Grain crops	30.4					
Starchy crops	10.5					
Leguminous crops	7.8					
Vegetables & Fruits	10.7					
Other Crops	15.5					
Livestock	25.0					

Table 9.17. Value of production by agricultural commodity adjusted for priorities by RAEZ (% of total)

WEIGHT 0.5 AND BASELINE PRIORITY			AFRICA	WANA	ASIA	LAT. AM	SUM
COMMODITY	VOP	ADJUS- TED					
Rice	17.8	13.2	9.0	1.2	84.8	5.0	100.0
Wheat	6.4	4.0	4.3	26.4	60.3	8.9	100.0
Maize	4.1	4.2	36.1	3.3	39.0	21.5	100.0
Barley	0.6	0.6	13.4	63.7	17.9	5.1	100.0
Sorghum	0.8	1.5	72.6	1.3	15.4	10.7	100.0
Millet	0.7	1.5	80.8	0.3	18.9	0.1	100.0
Cassava	2.0	4.5	74.7	0.0	16.3	9.0	100.0
Potato	2.8	2.1	12.3	17.9	51.9	17.9	100.0
Sweet Potato	2.9	1.4	34.2	0.1	62.7	2.9	100.0
Yam	0.6	1.9	98.7	0.0	0.3	1.0	100.0
Banana & Plantain	2.1	3.6	62.0	0.4	16.2	21.4	100.0
Chickpea	0.5	0.4	9.2	14.4	73.7	2.8	100.0
Cowpea	0.2	0.9	98.8	0.1	0.5	0.6	100.0
Pigeonpea	0.2	0.2	20.6	0.0	77.9	1.5	100.0
Broad Bean	0.4	0.4	31.2	21.9	42.5	4.5	100.0
Lentil	0.2	0.2	3.8	46.5	46.9	2.7	100.0
Beans	1.1	1.6	54.4	4.9	12.0	28.8	100.0
Soybean	2.5	1.5	3.5	1.2	23.9	71.3	100.0
Groundnut	2.6	3.7	62.5	0.5	35.2	1.8	100.0
Coconut	1.1	1.4	15.1	0.0	79.4	5.4	100.0
Tomato	1.2	1.2	19.2	44.9	15.7	20.2	100.0
Onion	0.8	0.7	13.2	23.3	49.2	14.3	100.0
Cabbage	0.4	0.3	3.3	11.1	77.6	8.1	100.0
Orange	3.5	3.0	7.1	15.9	15.7	61.3	100.0
Lemon & Lime	0.7	0.6	12.9	27.3	19.4	40.4	100.0
Pineapple	0.5	0.7	30.9	0.0	49.7	19.4	100.0
Grape	2.5	1.9	1.0	62.7	7.0	29.4	100.0
Apple	1.1	0.7	0.4	41.1	37.3	21.2	100.0
Sugar	2.7	2.9	27.2	5.2	27.9	39.6	100.0
Coffee	2.7	3.8	44.1	0.1	13.0	42.8	100.0
Tea	0.8	0.9	31.1	7.3	60.4	1.3	100.0
Cocoa	0.8	2.0	81.4	0.0	6.6	12.0	100.0
Tobacco	2.6	1.9	30.2	7.3	45.9	16.6	100.0
Rubber	1.1	1.3	18.2	0.0	80.9	0.9	100.0
Cotton	2.8	2.6	40.6	10.7	34.9	13.9	100.0
Jute	0.2	0.2	0.7	0.2	98.5	0.7	100.0
Hemp	0.0	0.0	0.0	7.4	87.0	5.6	100.0
Sisal	0.0	0.1	62.9	0.2	1.0	35.9	100.0
Palm Oil	0.7	1.1	36.8	0.0	58.5	4.8	100.0
Beef & Buffalo Meat	5.0	5.9	42.5	6.3	14.6	36.6	100.0
Sheep & Goat Meat	1.7	2.3	53.5	19.0	23.0	4.5	100.0
Pigmeat	4.8	3.3	6.6	0.1	78.7	14.6	100.0
Poultry Meat	1.9	2.0	23.7	11.9	32.5	31.8	100.0
Milk	8.9	9.7	33.5	8.9	36.2	21.4	100.0
Eggs	2.8	2.4	18.5	11.5	46.2	23.8	100.0
Sum	100.0	100.0	33.665	8.10681	39.7228	18.5053	100.0
Grain crops	30.4	25.0					
Starchy crops	10.5	13.6					
Leguminous crops	7.8	8.9					
Vegetables & Fruits	10.7	8.9					
Other Crops	15.53	18.07					
Livestock	25.05	25.5					

Table 9.18. Outcome of forestry analysis (w = 0.5)

RAEZ/AEZ/REGION	BASELINE	FINAL
RAEZ		
AFRS1	75.77	104.51
AFRS2	46.61	67.27
AFRS3	95.75	138.52
AFRS4	19.59	29.34
WANA9	33.88	20.74
ASIA1	63.77	53.67
ASIA2	43.86	43.84
ASIA3	136.32	178.62
ASIA5	57.50	40.45
ASIA6	18.62	15.25
ASIA7	48.18	31.98
ASIA8	84.12	97.42
LAC1	22.42	14.71
LAC2	69.16	46.54
LAC3	105.92	58.40
LAC4	34.38	30.69
LAC5	5.74	3.84
LAC6	1.33	0.84
LAC7	20.14	13.00
LAC8	8.53	4.28
LAC9	8.40	6.10
Total	1000.00	1000.00
AEZ		
AEZ1	161.97	172.89
AEZ2	159.62	157.65
AEZ3	337.99	375.54
AEZ4	53.98	60.03
AEZ5	63.23	44.29
AEZ6	19.96	16.08
AEZ7	68.32	44.98
AEZ8	92.65	101.70
AEZ9	42.28	26.84
Total	1000.00	1000.00
Region		
AFRS	237.72	339.64
WANA	33.88	20.74
ASIA	452.38	461.22
LAC	276.02	178.40
Total	1000.00	1000.00

America and the Caribbean of 178.4, and West Asia-North Africa of 20.7. The most important zone appears to be the warm humid tropics (AEZ 3), which receives 375.5, while the warm subhumid subtropics receive only 16.08.

9.9.3. Fisheries

The impact of the malnutrition modifier on the priority allocation across regions for fisheries is shown in Table 9.19. The modifier increases the ranking of sub-Saharan Africa but decreases that of the other three regions. The analysis suggests an allocation to sub-Saharan Africa of 138.8, to West Asia-North Africa of 42.43, to Asia of 643.83 and to Latin America and the Caribbean of 174.9.

Table 9.19. Outcome of analysis on fisheries with weight = 0.5

	INITIAL	FINAL
SSA	111.77	138.81
WANA	48.53	42.43
ASIA	654.37	643.83
LAC	185.32	174.92
TOTAL	1000.00	1000.00

9.10. Impacts of Changing Modifier Weights

9.10.1. All modifiers increased and decreased equally: agriculture, forestry and fisheries

So far, TAC has reported the values of the baseline adjusted by all modifiers weighted at 0.5. TAC also conducted analyses using weights of 0.25 and 1.00. Because the model is linear, three observations are sufficient to enable the reader to extrapolate to further weighting levels.

The results for the regional distribution of priority for agriculture, forestry and fisheries are presented in Table 9.20. The modifiers have significant impacts on regional distribution. For example, agriculture in sub-Saharan Africa has a base priority of 18.0. Weighting all modifiers at 0.25 increased that to 25.8. Weighting at 0.5 increased it still further to 33.7; and a weight of 1 increased it to 47.4. Choosing a weight of 1 nearly doubles the African value over its level at a weighting of 0.25. The agricultural modifiers favour both sub-Saharan Africa and West Asia-North Africa, so their share rises as the weights are increased. In contrast the share of Asia is almost cut in half when the modifiers are weighted at 1.

In forestry, the modifiers favour sub-Saharan Africa at the expense of all other regions. In this region the importance of forestry rises from 28.9% at a weighting of 0.25, to 44.1% at 1. All other regions decline, but more slowly than for agriculture. This results from using only six modifiers instead of nine.

The analysis of fisheries used only one modifier. It favours sub-Saharan Africa, but not heavily. The result is that the redistribution across regions when weights are adjusted is much less pronounced.

Clearly, the choice of the level of weight to be attached to modifiers changes the priority ranking considerably.

Table 9.20. Impact of changing all modifier weights equally: regional distribution for agriculture, forestry and fisheries

Region/Production Sector	Baseline (%)	0.25 (%)	0.50 (%)	1.00 (%)
SSA				
Agriculture	18.2	25.8	34.0	47.4
Forestry	23.8	28.9	34.0	44.1
Fisheries	11.2	12.5	13.9	16.6
WANA				
Agriculture	7.4	7.8	8.1	8.4
Forestry	3.4	2.7	2.1	0.8
Fisheries	4.8	4.5	4.2	3.6
ASIA				
Agriculture	53.2	46.4	39.5	29.1
Forestry	45.2	45.7	46.1	47.0
Fisheries	65.4	64.9	64.4	63.3
LAC				
Agriculture	21.4	20.0	18.4	15.1
Forestry	27.6	22.7	17.8	8.1
Fisheries	18.5	18.0	17.5	16.4
Total	100	100	100	100

9.10.2. Sensitivity to Changing One Weight

TAC also explored the sensitivity of the results to changing the weight attached to a single modifier. The framework for agriculture was changed for each of five modifiers receiving a weight of 2 while all others stayed at 0.5. The analysis was done one at a time for the following modifiers: GDP per caput, deforestation, soil degradation, small country, and import gap. The results are reported in Table 9.21.

The analysis is very enlightening. Heavily weighting one of the modifiers causes substantial changes in the regional distribution of priority. Weighting GDP per caput at 2 more than doubles sub-Saharan Africa's share, while cutting Latin America and the Caribbean by a factor of 3. On the other hand, weighting deforestation at 2 doubles Latin America and the Caribbean and cuts Asia by more than half. Weighting soil degradation risk at 2 reduces sub-Saharan Africa and Latin America and the Caribbean but increases Asia substantially. Weighting the small country modifier at 2 slashes Asia and increases the other three regions. Finally, weighting the self-reliance modifier at 2 doubles West Asia-North Africa's allocation, mostly at the expense of sub-Saharan Africa.

The results reinforced TAC's initial decision to select uniform weights. Trying to determine different weights for each modifier would open the process to special interest

Table 9.21. Sensitivity of regional baselines to change in the weight of a single modifier (agriculture)

	Baseline	Modified Baseline all at 0.5	GDP/Cap = 2 Others = 0.5	Defores. = 2 Others = 0.5	Soil Deg. = 2 Others = 0.5	Small C = 2 Others = 0.5	Imp. Gap = 2 Others = 0.5
	%	%	%	%	%	%	%
SSA	18.2	34.0	38.7	46.9	29.0	37.1	38.3
WANA	7.4	8.1	4.7	4.0	6.7	9.8	17.4
ASIA	53.0	39.5	50.9	14.9	52.5	29.7	28.3
LAC	21.4	18.4	5.7	34.2	11.8	23.4	16.0
TOTAL	100	100	100	100	100	100	100

groups, each campaigning for higher weights on a modifier known to benefit its own region. For the remainder of the analysis, uniform weights are therefore used.

9.10.3. Sensitivity of adjusted commodity values, and their regional distribution, to modifier weights: agriculture

The method by which the value of production of agricultural commodities was adjusted for priorities by region and by agroecological zone was outlined in Section 9.9.1.2. The results there reflected the use of a uniform weight across modifiers of 0.5. To explore the sensitivity of the distribution of adjusted values of production of commodities, TAC tested the impact of weighting all modifiers at 0.25 and at 1.

Table 9.22. Sensitivity of modified relative commodity value to baseline and modifier adjustment (selected CGIAR commodities - % global value)

Selected CGIAR Commodities	Value of Production (VOP)	Baseline Weighted VOP ^{1/}	Modified Baseline VOP with weights of:		
			0.25	0.50	1.00
Rice	17.8	15.6	14.4	13.2	11.6
Wheat	6.4	5.7	4.9	4.0	2.5
Maize	4.1	4.4	4.3	4.2	4.1
Barley	0.6	0.6	0.6	0.6	0.6
Sorghum	0.8	1.1	1.3	1.5	1.9
Millet	0.7	1.0	1.2	1.5	1.9
Cassava	2.0	2.9	3.7	4.5	5.9
Potato	2.8	2.7	2.4	2.1	1.6
Sweet Potato	2.9	2.3	1.9	1.4	1.0
Bananas	2.1	2.6	3.1	3.6	4.4
Beef and Buffalo	5.0	5.3	5.6	5.9	6.3

^{1/} Columns will not add up to 100 because only selected CGIAR commodities are included

The results for selected CGIAR commodities on a global basis are presented in Table 9.22. Some commodities are very sensitive to the weight given to all modifiers while others are not. The higher the weight attached to modifiers the smaller the shares 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 sub-Saharan African commodities. However, it should also be noted that other commodities are redistributed less by the analysis: the relative values attached to maize, barley, beef and buffalo meat change little at different weights.

The regional analysis for five CGIAR commodities is contained in Table 9.23. Comparing unweighted values of production by region to modified values weighted at 1 reveals that modification in some cases causes enormous shifts among regions. The most extreme is in sweet potato, where the share with modifiers weighted at 1 is 69% for sub-Saharan Africa compared to levels of 5% for unweighted value of production and 12% for weighted baseline. 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 (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.

Table 9.23. Sensitivity of regional distribution of commodity VOP unweighted, baseline and modified (selected CGIAR commodities: distribution across regions)

Selected CGIAR Commodities	Region	Value of Production (VOP)	Baseline Weighted VOP	Modified Baseline VOP with weights of:		
				0.25	0.50	1.00
RICE	SSA	2	4	6	8	14
	WANA	1	1	1	2	2
	ASIA	93	90	88	85	79
	LAC	4	5	5	5	5
WHEAT	SSA	1	2	3	4	10
	WANA	19	17	21	26	44
	ASIA	70	72	67	60	38
	LAC	10	9	9	9	8
SORGHUM	SSA	32	53	64	73	84
	WANA	3	2	1	1	1
	ASIA	40	29	21	15	8
	LAC	25	17	13	11	7
SWEET POTATO	SSA	5	12	20	34	69
	WANA	0	0	0	0	0
	ASIA	93	86	77	63	27
	LAC	2	2	2	3	3
BEEF AND BUFFALO	SSA	13	25	34	43	56
	WANA	9	6	6	6	6
	ASIA	21	19	17	15	11
	LAC	57	49	43	37	26

9.10.4. TAC's Conclusions Regarding Weights

The sensitivity analysis helped TAC reach two conclusions on weights. First, as noted above, TAC firmly believes that all weights across modifiers should be equal. Second, given the sensitivity of the regional, agroecological and commodity distributions of priorities to higher weights, TAC in its analysis used a uniform weight across modifiers of 0.25 and 0.5.

9.11. Expected Productivity Gains

The rate of progress that can be achieved by a centre in raising the stable biological yield ceilings of its mandated commodities is an important factor to take into account when setting CGIAR priorities by commodity.

The centres have provided TAC with an estimate of the productivity gains they hope to achieve in each of the regional agroecological zones for their mandate commodities (Annex 5). The rates range from less than 1% per annum for unfavourable environments to more than 3% for favourable environments.

For cereals, the expected productivity gains in most zones are 1-2% per annum, but exceed 3% in the case of wheat and maize for some zones in all four regions. For roots and tubers, the expected gains in general are less than 2% per annum, and in some zones less than 0.5%.

Estimates for cassava and sweet potato differ markedly depending on the centre concerned. For banana the expected gains in all zones are less than 1%, except in the humid tropics in sub-Saharan Africa where they are 1-2% per annum. For grain legumes and oilseeds, expected gains are generally 0.5-1% per annum or lower, except for cowpea and soybean in the subhumid zone, and cowpea in the semi-arid zone, where gains of 1-3% per annum are expected. (However, the AVRDC estimate for soybean in the subhumid zone of sub-Saharan Africa is much lower, less than 0.5% per annum. For vegetables, expected gains are generally in the range 0.5-2% per annum. For livestock products, the expected gains estimated by ILCA are generally in the range 0.5-2% per annum, but estimates from ILRAD are generally 0.5-1% higher.

These estimates have to be considered with caution. The agroecological zonation used by the centres is generally very different to that used by TAC, making the estimates problematic. The difficulty of disaggregating the progress made by the centres from that made by other agencies such as national research institutes and extension services further complicates the estimating process.

9.12. Importance of Particular Commodities for the Poor

In allocating priorities by agricultural commodity, an important criteria is the importance of particular commodities for the poor, either as a staple food, as a source of income or within farming systems. In order to incorporate such an equity perspective in CGIAR priority assessment, TAC made substantial efforts to collect information on the location of the poor and the use they make of particular commodities. Some of this information was compiled for TAC in a background paper prepared by IFPRI (Broca and Oram, 1991).

In sub-Saharan Africa, poor people depend heavily on millet and sorghum, and, to a lesser extent, on maize (especially in Eastern Africa) and on wheat and barley (in the highlands). Groundnuts and beans are the main source of non-cereal protein. Cassava, plantains, sweet potatoes and potatoes also contribute to the diet. Livestock and their

products are particularly important for income and employment generation, in addition to providing high quality protein.

In South Asia, rice and wheat are the most important staples of the poor, although millet and sorghum remain the staples of the poorest in the driest areas. Pulses are important sources of protein, and consumption of potato is increasing rapidly. Milk and fish are also of importance, for nutrition and income generation.

In Southeast Asia, rice is the dominant food crop, followed by maize and cassava. Coconuts, oil palm and sweet potato are important energy sources. Pulses, groundnut, soybean, poultry and fish are major sources of non-cereal protein for the poor also.

In South America, diets of the poor are dominated by maize and rice. Cassava in the warm tropics, potatoes in the highlands and banana/plantain are also important sources of energy. Pulses, particularly phaseolus beans, are the main source of protein for the poor together with cereals, meat and milk. Vegetable oil and sugar are also important energy sources.

In Central America, maize is even more dominant in the staple diet of the poor. Banana and plantain are the main starchy staple, phaseolus beans an important source of energy and protein, together with sugar and fats and oils.

The study by Broca and Oram (1991) highlights the importance of key cereals in the diet of the poor. These are millet, sorghum and maize in Africa, rice and wheat in South Asia, rice and maize in Southeast Asia, and maize and rice in South and Central America. Information on the West Asia-North Africa region was not available. In addition to rice and maize, cassava, coconut, sugar and plantain are dietary staples in the more humid zones; in the drier zones cereals are supplemented by cassava, bananas, sweet potatoes, groundnuts and pulses. Potatoes are increasing in importance, and surveys show that horticultural crops, and oil seeds make a significant and probably under-rated contribution to the nutrition of the poor. While the rising productivity of rice and wheat has increased their dominance in the diet in Asia and in the warm tropics and subtropics of South America, surveys also indicate a trend toward greater diversification of the diet, with increasing contribution of pulses, vegetable oils, horticultural and livestock products over time.

It is difficult to assess the importance of particular commodities for the poor in a quantitative way. One possible indicator would be the value of income elasticity of demand by commodity. Where this value is low, the commodity is likely to be consumed mainly by low-income groups. The indicator does have an important conceptual weakness however. Many commodities with high income elasticity of supply, such as beef, are also preferred commodities of the poor and are often important staples.

Each CGIAR mandate commodity is important for the poor in at least one of the regions, and there is not really a basis for discrimination among them while allocating global CGIAR priorities. It should also be recalled that the selection of particular crops as CGIAR mandate commodities has usually been based largely on the criterion of their importance for the poor.

Although other commodities under consideration, particularly industrial crops, may not appear to be directly important for the diet or farming system of the poor, they may contribute substantially to an income and employment generating capacity for landless labourers.

While TAC had no quantitative basis in priority setting to discriminate between commodities on the basis of their importance for the poor, it incorporated this perspective in a qualitative way.

9.13. Spillovers

An important consideration in the planning of international research is the likely size of spillover effects that will result from a research activity, i.e. benefits of research undertaken in one region or agroecological zone but applicable to other areas, especially in those with similar agricultural environments. Spillovers are one of the prime justifications for international agricultural research. They are particularly relevant at the strategic and, though less so, the applied research levels. They constitute the CGIAR's primary comparative advantage. An efficient CGIAR programme will seek spillover effects and avoid duplication of strategic and applied research activities.

The only spillover coefficients available to TAC are those derived by ACIAR for their research priorities framework as discussed in the following section. Spillovers are most valid for research done in an RAEZ across the rest of the same AEZs. The criterion of spillovers is not relevant to adaptive research (not a major activity of the CGIAR) or directly to capacity building where the impact is restricted to the country or region concerned. The spillover effects by commodity by RAEZ, as estimated by the ACIAR framework, were considered by TAC in its consideration of priorities by commodity.

9.14. Additional Inputs: The ACIAR Framework

ACIAR has developed an information system to assist with 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 commodity and regional research portfolios. Its starting point is the research expenditure needed to 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, includes all major production and consumption regions of the world and is based on FAO's agroecological zone concepts. Details on the system and its results are provided in Davis et al (1987), Ryan and Davis (1990), Davis et al (1988), Fearn and Davis (1991) and Ryan et al (1991).

Table 9.24 shows the results of an analysis using the ACIAR framework for 24 different agricultural commodities for the developing world as a whole.

Table 9.24. Expected returns from commodity research in developing countries according to ACIAR

1	2	3
Commodity	Research located in zone with number	Expected present value of research US\$ million
Rice	5	828
Milk	4	249
Wheat	4	206
Potato	4	176
Maize	5	171
Sweet Potato	5	171
Sugar	1	105
Cotton	4	98
Soybean	5	89
All Pulses	4	88
Beef/Buffalo Meat	5	77
Oil Palm	2	69
Sheep/Goat Meat	4	51
Bananas/Plantains	2	49
Coffee	2	44
Rubber	2	40
Oranges/Tangerines	4	33
Cassava	2	32
Groundnut	1	25
Coconut	2	24
Sorghum	1	23
Millet	4	19
Cocoa	2	18
Wool	4	16

Agroecological Zones (as used in ACIAR framework):

- 1 = Warm, seasonally dry tropics
- 2 = Warm, humid tropics
- 3 = Cool tropics
- 4 = Warm, seasonally dry subtropics (summer rain)
- 5 = Warm, humid subtropics (summer rain)

Source: Compiled from Ryan et al., 1991

Research on rice has, by far, the highest expected economic benefits to producers and consumers. The expected benefits are more than three times those for milk, the second most important commodity. Research on wheat, potato, maize and sweet potato also generates large economic benefits.

With respect to tree products, the analysis shows the attractiveness of fuelwood as a high priority research commodity, even when compared with agricultural commodities. Substantial benefits could also be derived from research on saw and veneer logs.

Taking all the developing countries together, only rice, potato and sweet potato seem to have less investment by the CGIAR than suggested by ACIAR's analysis. The other CGIAR commodities appear to receive more resources than merited. This applies especially to ruminant livestock, pulses, sorghum, millet, banana/plantain and cassava.

ACIAR also notes that there are many commodities receiving no CGIAR support yet which could be expected to generate economic benefits to developing countries far in excess of some of the current commodities included in the CGIAR portfolio.

ACIAR has also assessed research priorities by commodity assuming that maximization of regional benefits would be the primary objective. The table that reports the results of this analysis is attached as Annex 6. The commodities used in this analysis are separated into six research priority groups for each region. The allocation of a commodity to a priority group in a specific region is based on the estimated economic benefits of research on it, relative to the benefits of research on the commodity which has the highest expected benefits for that region. For example, in West Asia-North Africa, investment in wheat research is expected to provide the greatest benefits. If the benefits for this commodity are divided by the expected benefits for each other commodity in the same region, an indication of relative benefits is obtained. Using the West Asia-North Africa example again, the benefits to the region of investment in wheat research are twice as high as those resulting from milk research, eleven times those of maize research, and 641 times those of groundnut research. According to ACIAR, priority ranking 1 is allocated when the range of break-over relativity is between 1 and 3, priority ranking 2 when between 3 and 7, priority ranking 3 when between 7 and 15, priority ranking 4 when between 15 and 25, priority ranking 5 when between 25 and 40, and priority ranking 6 when over 40. When the priority ranking is 1 or 2 it is considered high, when 3 or 4 medium, and when 5 or 6 low.

Table 9.25 summarizes the results of this analysis for selected CGIAR commodities and regions. According to these results, investment in rice research should receive high priority in every region except sub-Saharan Africa. Investment in wheat research should be high priority in West Asia-North Africa, Latin America and the Caribbean, and South Asia. The table reveals some interesting differences between the ACIAR analysis and that of TAC. For example, TAC's analysis suggests a high ranking for banana research in sub-Saharan Africa, while ACIAR allocates only medium priority to banana research. TAC's analysis also allocates greater priority to millet and groundnut research in sub-Saharan Africa than does the ACIAR analysis.

ACIAR has also investigated the relationship between the share of each commodity in each region in total CGIAR commodity research and the relative

contributions research on each commodity can be expected to make to the generation of regional economic benefits (Ryan and Davis, 1990).

In Asia, there appears to be significant overinvestment in millet, sorghum and groundnut, and some overinvestment in pulses and rice. These commodities benefit at the expense of wheat and livestock. In addition, non-CGIAR commodities such as cotton, sugar, palm oil, demersal and small pelagic fish, rubber, herring, soybean and coconut appear to be neglected given their potential to contribute to economic growth.

In Latin America and the Caribbean, pulses, sweet potato and millet would appear to have an over-generous share of CGIAR funding, while ruminant livestock, banana/plantain and cassava, rice and sorghum seem relatively underfunded.

Table 9.25. Priority ranking by commodity with maximization of regional benefits as research objective according to ACIAR

Commodity	South Asia	South East Asia	SSA	WANA	LAC
Rice	H	H	M	H	H
Wheat	H	L	L	H	H
Maize	M	M	M	H	H
Sorghum	H	L	L	L	M
Millet	H	L	M	M	L
Cassava	M	L	H	L	H
Potato	H	L	L	H	M
Sweet Potato	L	L	L	L	L
Banana	M	H	M	M	H
Groundnut	H	L	M	L	L
Soybean	M	L	L	M	H
Beef & Buffalo	M	M	H	H	H
Milk	H	L	H	H	H
Sheep	H	M	H	H	H
Pulses	H	L	L	H	H

H = high priority ranking,
M = medium priority ranking,
L = low priority ranking

Source: Ryan et al., 1991

In sub-Saharan Africa, most CGIAR commodities with the exception of banana/plantain and cassava, millet and groundnut appear to have shares of funding considerably in excess of their likely contributions to economic growth. This applies especially to livestock, rice, pulses, sorghum and maize. Again, the opportunity costs of neglecting other, non-CGIAR commodities are substantial.

In West Asia-North Africa, there would appear to be an overemphasis on wheat and pulse research, especially on the latter. Rice research appears to deserve some attention, but currently there is little CGIAR investment in this crop, no doubt because ICARDA's mandate precludes irrigation research. As in the other regions, there are

several non-CGIAR commodities that offer equal or better prospects of enhancing economic growth than do current CGIAR commodities.

9.15. Conclusion

This chapter reports on the quantitative analysis TAC has undertaken to supplement the more qualitative analysis of Chapters 4 to 8. The aim of the quantitative analysis was not to derive conclusions but to clarify the implications of making particular choices. The results provide further inputs for TAC's consideration prior to making recommendations on CGIAR priorities. How TAC has arrived at its recommendations is reported upon in Chapter 12.

CHAPTER 10 - INSTITUTION BUILDING

10.1. Introduction

The CGIAR was created as an international mechanism for funding technological research at specialized institutes (the centres), with the aim of transferring the products of that research to the developing countries. As the CGIAR System has evolved, however, the centres have devoted an increasing share of their efforts to strengthening national research systems. In so doing, they have fostered a multiplicity of relationships with these systems that contribute directly to research and, indirectly, to institution building.

CGIAR support for centre activities appears to be increasingly influenced by the policies of some of the System's donor members, who seem to believe that the CGIAR should be used as a mechanism for direct support to national research systems. More than a quarter of the System's resources are now allocated to institution building, while the other CGIAR activities also directly contribute to strengthening natural research capacity. The involvement of the CGIAR in strengthening national research systems has reached a ceiling. TAC's view is that the CGIAR should not be directly involved in technical assistance but focus on its complementary role through technology development and partnership. TAC stresses that, to maintain the momentum of its achievements, the CGIAR must not allow its support for a balanced approach to international research and institution building to become distorted by activities that are more appropriately undertaken by development agencies than by research institutes. The alternative could be to restructure the centres so that they are better equipped to fulfil a development role.

10.2. Training

The centres have made a major contribution to strengthening national research capacity through training. Broadly defined, training receives high priority in CGIAR efforts and in 1990 accounted for more than 8% of total CGIAR resources. Table 10.1 provides information on the number of CGIAR trainees by type of training by region. During the past five years alone, more than 25,000 professionals have been trained through CGIAR efforts. More than a third of these came from sub-Saharan Africa. More than 80% of people trained were group trainees, while 8% received graduate training.

Training in the CGIAR serves two purposes: transferring technology from the centres to national research systems, and building national capacity to identify problems, conduct research, and develop and adapt technology. The System's contribution is enhanced by the intimate link it provides between training and technology development. Due to the heterogeneity in national capacities and needs, there is a wide spectrum in the types of training offered. Centres provide courses on the production and breeding of a broad range of commodities. In the more specialized courses, a broad range of disciplines and skills is encompassed, such as onfarm research methods, sophisticated techniques for strategic research, and the management of research programmes and institutions. The CGIAR System also provides degree-related and mid-career training for

Table 10.1. Regional training in the CGIAR (1985-89)

Region	Post Doc	Ph. D.	M. Sc.	Visiting Scientists	Group Trainees at HQ	Group Trainees in Regions	TOTAL
SSA	94	297	252	408	4465	3500	9016
Asia	189	406	461	526	2274	2925	6781
LAC	54	52	221	1090	1037	4218	6672
WANA	11	31	78	142	1075	1436	2773
Global Totals	348	786	1012	2166	8851	12079	25242

Source: CGIAR Secretariat

individuals. It considers these to be vital, both to the process of technology transfer and to the process of forging more fruitful collaboration between centres and national research systems, universities and other specialized institutions.

TAC's views on training have largely been shaped by the outcome of its training study (TAC/CGIAR, 1986). In 1985, TAC recommended that training should continue to receive high priority within the CGIAR System. However, there should be some shifts in emphasis in the long term corresponding to the changing roles of partners in the global research system.

As the System's training efforts have progressed, some programmes (mainly production courses) have been successfully transferred to national institutions, with backstopping from the centres. TAC encourages this process as an effective way of expanding the impact of the centres' training efforts, and recommends that it be intensified in the future. To this end, centres should collaborate with national systems to help them strengthen their capacity to organize and conduct production-oriented courses.

TAC has already advised that the centres should scale down their production and breeding courses at headquarters. Decentralized training is more applicable to national needs and conditions, as well as less expensive. Instead, centres should concentrate on the training of trainers to work at the national level, and on the preparation of training materials. In 1985, TAC recommended that the centres should continue to offer at headquarters the short, highly focused courses in research methods and specialized skills. In both of these areas, TAC encouraged greater inter-centre cooperation, which would result in enhanced cost-efficiency. TAC considered that mid-career training should continue and that the degree-related programmes should be strengthened, primarily at the M.Sc. and Ph.D. level.

For most commodities and regions, there is a need to continue to reduce CGIAR involvement in production-oriented courses. Such courses should not be funded through core resources of the CGIAR. Complementary funding for courses is readily available from bilateral donors. Responsibility for the organization of production-oriented courses should be transferred to regional mechanisms or to strong national programmes willing to accept regional responsibilities. CGIAR Centres have already provided training

to a high proportion of national programme scientists, and diminishing returns to further investments may be experienced.

In the future, the CGIAR will have to give greater attention to training that will equip national scientists to deal with the mounting concern for sustainability and resource management issues. It will also have to develop training activities in fisheries, forestry and agroforestry, as national capacities in these areas are very weak at present. With respect to agricultural research, the System should give higher priority to training in research management, possibly through close collaboration between ISNAR and the centres, and to postdoctoral fellowships. Although efforts will be required in the new areas of forestry and fisheries and the management of natural resources, it must be recognized that there is a need for lead time for research to develop a training capacity.

10.3. Information

In any research institution, information is required as a key input into its activities (as data, methods, techniques, etc), but it is also an output of those activities (as published results of experiments, annual reports, etc). The CGIAR Centres have a requirement for information inputs similar to those of other research institutes, but they have a much more important information output function. They exist to serve the developing countries in research and training; they have a commitment to assist them in strengthening their own capabilities; and they also have a truly international role to play in bringing national research programmes closer together to promote collective activities, including the free exchange of knowledge, information and genetic resources.

Advances in information technology provide unprecedented opportunities for increasing the speed and reducing the cost of conducting agricultural research. New ways of collecting, storing, processing, communicating and disseminating information have already begun to influence how agricultural researchers practise their profession. New communication technology has opened new avenues for collaborative research, providing links among programmes that are scattered around the globe.

The individual CGIAR Institutions and the System as a whole need to take full advantage of the opportunities offered by the information revolution. Not only do individual centres need to adjust their internal information management mechanisms to take full account of advances in technology, but the System needs to examine its component mechanisms to ensure appropriate inter-centre "coupling" and information compatibility. As part of the same process, centres also need to examine how their systems could be coupled to those of national institutions in the developing countries, as well as to those of other actors on the international scene such as FAO and CABI.

In the long term, national research systems in developing countries should be able to participate as fully fledged actors in the global research effort. To do so, they need to narrow the widening gap in information technology between themselves and their partners in international research. In the short and medium term, the centres have an obligation to collaborate with others in helping the national systems to build or upgrade their information management capacities.

Also in the long term, emerging information and communication technology will enable the components of the global agricultural research community to be linked to

each other more closely than at present. As the demand for new information products and services increases, cost-effective ways of meeting that demand will be sought. Whether under the CGIAR umbrella or not, there will probably be a need for an international mechanism to coordinate global information products and services, using decentralized nodes around the globe.

10.4. Organization and Management Counselling

The needs and demands on the CGIAR System for assistance in organization and management counselling are great - well beyond its capacity to respond. The most pressing needs arise in the poorer and smaller countries, particularly in sub-Saharan Africa, where research capacity must be strengthened if the current problems are to be solved.

The CGIAR System's response to national needs for institution building, although modest in terms of resources, is broadly based. The centres have all played important roles in institutional development including, the organization of research networks, the provision of consulting services, and the creation of links between national systems and specialized research institutes. The impact of these efforts has been somewhat uneven, however, as much of it has been limited to the context of specific activities determined by individual centre mandates.

For almost ten years, the centres' efforts have been complemented, however, by those of the lead centre ISNAR, which provides, on a country-by-country basis, a comprehensive, integrated and systematic approach to strengthening national agricultural research systems. The impact of this approach has not yet been systematically evaluated, but its appeal has been demonstrated by the number of demands for assistance received from national systems, which outrun ISNAR's capacity to respond. With its limited resources, ISNAR plays an essentially catalytic role, focusing on the diagnosis and analysis of institutional constraints and the development of management approaches to overcome them. ISNAR's objective is to help national systems to help themselves, in cooperation with other centres and with multilateral and bilateral development assistance agencies.

ISNAR is currently revising its strategy and has recently undergone an external review. The report of the external review will be presented to the CGIAR in 1992. At that time TAC will make specific recommendations on the role of ISNAR in an expanded and restructured CGIAR.

In 1986, TAC considered that institutional weaknesses would continue to place major limitations on technology generation and adaptation in the national systems of many countries in the short to medium term. This would reduce the potential impact of CGIAR research, which relied on further applied and adaptive research at national levels to facilitate technology adoption. TAC therefore recommended that institution building should remain a high priority area for the CGIAR System in the future.

TAC considered that the essentially catalytic role of the CGIAR in institution building was highly appropriate for the challenges ahead. It recommended that the System should continue to play a lead role in developing closer links and more effective collaboration between national systems, the centres themselves, and external sources of

expertise and funding, such as the multilateral and bilateral development assistance agencies. Experience had shown that innovative approaches to institution building on a comprehensive country-by-country basis will be necessary for strengthening agricultural research in the poorer countries. TAC believed that the CGIAR System should play a lead role in stimulating and organizing such approaches.

Building national research capacity is one of the goals of the CGIAR. As the Impact Study and the external reviews have indicated, the CGIAR Centres have made enormous contributions to strengthening national research systems through their activities in training, information and the development of technology. In future, collaborative relationships between the CGIAR Centres and national research systems will increasingly augment the System's more traditional contribution to institution building.

10.5. Relationships between CGIAR Centres and National Research Systems

The term national research system is now used by TAC to include all those institutions in the public and private sectors, including universities, that are potentially capable of contributing to research related to the development of agriculture, forestry and fisheries. These institutions vary greatly in their strengths and weaknesses in a multiplicity of ways and for a wide variety of reasons.

Research capacity in national research systems may suffer from deficiencies such as an insufficient number of trained scientists, the quality of their education, or the effectiveness of their leadership. The suitability of the environment to engender productive research may also vary enormously. Research may be inhibited by deficiencies such as lack of adequate research facilities, lack of access to information, lack of prospects for career development, or unstable budgetary support. By inference there is a large array of potential weaknesses in national research systems. In this document the terms "stronger" and "weaker" national research systems are used to imply that the stronger are more likely, and the weaker less likely, to deliver a worthwhile research output, whatever the causes might be.

Currently, there is no comprehensive statement of CGIAR policy on the relationships between CGIAR Centres and national research systems in the developing countries. The policies applied by TAC in assessing centre programmes and budgets are based on the series of policy documents that have come before the Group from time to time. Among these, the most relevant are the First Review of the CGIAR (1976), the Second Review of the CGIAR (1981), and the 1985 TAC Review of CGIAR Priorities and Future Strategies (TAC/CGIAR 1987b).

The documents are consistent in that they regard the CGIAR Institutions, with the exception of ISNAR and IBPGR, as being primarily research institutions, but with additional roles in closely related aspects of training, information services and, in some instances, the dissemination of germplasm. They are also consistent in recommending that the centres should not become directly involved in national research programmes, except when there is a clear need to do so, on a selective basis, in order to fulfil their mandates.

None of these earlier documents has penetrated deeply into such questions as the extent to which centres should or should not become directly involved in strengthening national research systems. Nor have they discussed in detail the extent to which the international research funded by the CGIAR might be undertaken by the national systems themselves rather than by the centres.

10.5.1. Appropriate Roles for CGIAR Centres

Individual scientists and research institutions collaborate in many different ways to undertake research. Any of these relationships can also involve an international organization, or a donor agency, not in the role of research, but in a facilitating or strengthening role. Because of the involvement of centres in roles of this type, TAC has distinguished among several different, but inter-related types of activity, some of which it regards as entirely legitimate for CGIAR Centres while others appear more controversial.

It is important to distinguish between strengthening the relationships among the participants in collaborative research, and strengthening the research capacity of one or more of them. Examples of strengthening relationships in research may be seen in the ways in which many different international organizations seek to fulfil their mandates.

For example, most of the organizations operating under the auspices of the ICSU function in this way. Typically, an ICSU organization acts as a catalyst to collaborative research by convening symposia, paying travel expenses, assisting in the publication of conference proceedings and, generally, encouraging or strengthening the relationships among the participants. The CGIAR Centres do likewise for the networks they support. To function effectively in these roles, the centres have often outposted staff members to regional offices to act as liaison scientists and in coordinating and consultancy roles.

TAC defines this type of assistance as "catalytic assistance" - aimed at increasing output through stimulating the reaction, rather than by augmenting one of the reagents. Strengthening the relationships among scientists and institutions in developing countries, and between them and the centres, through catalytic assistance has an important institution-building function. In this respect, catalytic assistance can make important contributions to strengthening national research capacity.

Other forms of assistance are designed to augment national research capacity more directly. This type of assistance to national research systems comprises various forms of technical and financial assistance. Financial assistance in this context includes capital grants for laboratories, equipment, vehicles etc, as well as any funding designed to supplement the normal research budget of a developing country, or the emoluments of its staff.

Most donors define technical assistance as the provision of expertise that is a substitute for national expertise. It is sometimes difficult, however, to distinguish clearly between substituting for national expertise in a "technical assistance" role and working with national scientists in an "institution-building" role. In general, outposted centre scientists are regarded as fulfilling an institution-building role when they work with a group of countries, rather than with a single country. But working with individual countries on a strictly temporary or consultancy basis can also be regarded as a contribution to institution building, especially if training or scientific exchange is

involved. TAC has used the term "research assistance" to include technical assistance, financial assistance, or any combination of the two. It uses other terms only when they are essential for clarity.

"Research assistance", as defined above, is central to the controversy surrounding what the CGIAR Centres should or should not do. It hinges on the extent to which centres should become involved in the provision of research assistance, or its administration, within bilateral projects. Although research assistance directly strengthens national research capacity, it does not necessarily do so on a sustainable basis.

TAC's view is that the CGIAR Centres should make their main contributions to strengthening national research systems through scientific collaboration, and by providing the outputs of their work in the form of information and improved genetic material. As they were created to serve the needs of developing countries, however, they are also expected to contribute to institution building through training and other activities.

As already described, their training activities extend well beyond those associated with post graduate degrees into specialized training courses for scientists at all stages of their careers, reflecting changing needs and perspectives. The centres are also expected to provide catalytic assistance to strengthen collaboration among scientists and institutions in every way that is possible and appropriate. Some or all of these activities might also involve the outposting of centre scientists to work with groups of countries in the most important regions served by that particular centre. All these functions of the centres are largely uncontroversial and are supported by TAC.

None of the above measures can be effective, however, unless there is a certain minimum capacity within the national system to do research, as well as to establish effective links both with the centres and with local producers through the extension services. Where this minimum capacity is lacking, the centres have collaborated with bilateral donors in the provision of research assistance, rather than face the frustration of not being able to transfer the benefits of their work.

The issue of strengthening national research systems is very much broader, however, than finding appropriate mechanisms for administering research assistance. It involves all the considerations with which ISNAR and IFPRI, among many others, are especially concerned and also involves several different mechanisms for collaboration.

10.5.2. Mechanisms for Collaboration

10.5.2.1. Types of collaboration

In any research relationship, whether between scientists or institutions, two fundamental questions are: (i) "Who sets the research agenda?"; and (ii) "Who provides the financial resources and through what channels?". In the continuum of possible relationships between two hypothetical institutions, A and B, TAC sees two extremes. In one, the aims of the research are mutually agreed by A and B. They share the work; they fund their own participation; they share the results; and there is no net flow of financial resources, either from A to B or from B to A. TAC defines this type of relationship as "cooperative".

At the other extreme, A determines what the aims of the work should be and pays B to do it. This TAC calls "contract" research, or a "contractual" relationship. In this relationship, B is usually described as the contractor (the one who does the work) and A the customer (the one for whom the work is done). If both A and B are research institutions, A could equally be a contractor for B.

Clearly, there are many variations between these two extremes in the ways in which institutions collaborate with one another. The term "collaboration" is used in this general sense. Where these collaborative arrangements are neither wholly cooperative nor wholly contractual, they usually contain elements of both.

These terms can also be used when several institutions are linked in a networking mode. The relationships can be described as cooperative, when the participants jointly define the aims and share the costs, or contractual, when a customer determines the aims and pays the other institutions to do the work. The customer could be a single institution or a group of institutions working collaboratively. Moreover, all these relationships can be further analyzed taking into account the two types of assistance already identified above, namely, "catalytic assistance", designed to strengthen relationships and thereby contribute to institution building, and "research assistance", designed to strengthen national research capacity more directly.

10.5.2.2. Cooperative research

The motivation for cooperative research is primarily one of self-interest. Individual scientists or institutions agree to participate so that the results of their own research can be interpreted within a broader context.

In the developed countries, cooperative research of this type may involve organizations in both the public and private sectors. It is often organized under the auspices of an international organization or scientific society, and may involve no external input of funding whatever. Frequently, all the participants fund their own attendance at meetings and share the organizational and analytical work among themselves. In other instances, catalytic assistance may be provided by the organization acting as the umbrella for the cooperation.

In the developing countries, only a small proportion of research institutions are able to muster the financial resources to operate without the external injection of at least some catalytic assistance. In many instances, however, even the provision of catalytic assistance is not enough. There are many national institutions which would like to participate but cannot do so without some additional funding, defined here as research assistance.

10.5.2.3. Contract research

The main advantage of contract research is that it provides a means of exploiting specialized capabilities or special circumstances and, consequently, of doing research in a cost-effective manner. In the context of the CGIAR, the principle of contracting to institutions, in both the developed and developing countries, has already been applied by the centres to take advantage of special skills or particular environmental conditions within a national system that can be used to further the purpose of the international programme.

With respect to the developing countries, such contracts provide opportunities for making use of well trained personnel, giving them greater motivation and helping generally to strengthen national research capabilities. The direct costs involved might be less than those of doing the work at an international centre, but the administrative costs of awarding contracts, monitoring their progress, and evaluating their success tend to be high, especially when large numbers of small contracts are involved. Further, contract research precludes the involvement of weaker national systems. And even those with well trained scientists may not be able to undertake contracts because of the lack of basic facilities for laboratory or field research. Consequently, many potentially important institutions, in terms of the agroecologies or ecosystems they represent, might be excluded from undertaking contracts unless they could also be provided with research assistance.

10.5.3. Linking Centre Activities to Research Assistance

While TAC strongly supports the involvement of the centres in both cooperative and contractual relationships with national research systems, it has reservations on the extent to which the centres should become involved in the administration of bilateral research assistance. Clearly, there is considerable diversity of views on this issue among members of the CGIAR, especially because there are organizations other than the centres that specialize in what are, essentially, the activities of development agencies.

Within the matrix of activities relating to international research and the adoption of its results, there is a need to define the framework within which the centres should operate. Ultimately, such a framework must be defined by consensus, otherwise it will simply evolve as a result of the ways in which donors express their preferences through their selective support of centre activities. TAC can assess the appropriateness and balance of core programmes and make recommendations to the Group accordingly. It is less well placed, however, to assess complementary programmes, which are influenced by a great diversity of needs, relationships and sources of funding.

TAC therefore considers that the centres themselves should determine the extent of their involvement in research assistance, taking a pragmatic view of the opportunities for productive collaboration with national systems, and keeping their activities within the boundaries of their agreed strategic plans. Centre Boards should be held accountable to the Group for all complementary programmes, especially with respect to safeguarding the integrity of unrestricted core funding. TAC assumes that both the Group and the centres would wish to guard against centre strategies becoming distorted by the wishes of individual donors or groups of donors.

CHAPTER 11 - RESEARCH ON SOCIOECONOMICS, PUBLIC POLICY AND PUBLIC MANAGEMENT

11.1. Background

The mission and goals of the CGIAR are unlikely to be achieved without a conducive policy environment. National policies in developing countries have to strike a delicate balance between the interests of different groups, but they must be favourable enough towards small-scale producers to persuade them to adopt the technology produced by research. Government policy must also favour the strengthening of national research systems, if CGIAR efforts in this direction are to succeed. Well managed public-sector research systems are more likely to gain the confidence and hence the support of government. This is the foundation of the Group's commitment to research on socioeconomics, public policy and public management.

The effects of policies on innovation and thus on research and development are profound and multifaceted. The designation of policy beneficiaries, the setting of economic goals and ranking of national priorities, the regulation and de-regulation of product, input and credit markets, the raising and allocation of government revenues - each has implications for the relative importance of new technology in different sectors and in the different enterprises of each sector, and for the ease of technology mobilization and adoption. Policy issues in each of these areas carry major implications for targeting and priority setting in research.

National policies interact in the international arena. Developed country policies, and increasingly regional policies, with the EEC and the Inter-American trade agreements as examples, affect the export and production opportunities of developing countries. Restrictive policies mask their true comparative advantage, distort their priorities for research and inhibit their development.

It can be argued that on the whole, with some exceptions to meet the need for equity targeting, a policy environment that seeks to exploit long-term comparative advantage will provide a sound basis for identifying research priorities. Policies disguising comparative advantage may radically distort priorities and may render long-term research programmes unsustainable.

The CGIAR's main group of beneficiaries, small-scale producers, have frequently been neglected and even disadvantaged by the policy environment in developing countries. Political considerations have biased policies towards meeting the needs of the more vocal urban populations, at the expense of agriculture. In addition, much of the stagnation in developing countries dependent on agriculture has its roots in the unfavourable terms of trade, national and international, for their agricultural products. Structural adjustment programmes are now promoting the role of agriculture as the engine of development in such economies.

New technology is widely perceived as the fuel for the engine of agricultural development. The CGIAR, as an international agricultural research organization, has an unrivalled overview of both the agricultural technology needs in developing countries and

of the global technological opportunities in agriculture relevant to those needs. This overview, and the importance of equity in the mission and goals statement of the System, are primary components of the perspective which the CGIAR brings to policy research.

At the country level, policy research institutions are primarily driven by national considerations. At the international level, the UN agencies, the World Bank, the regional banks, and some developed country universities which do policy research, have missions and intended beneficiaries in common with the CGIAR. They lack, however, the CGIAR's capacity to identify and generate new agricultural technologies to meet developing country needs. It is this capacity, together with its political independence and its established reputation and track record, that allows the CGIAR a unique stance in policy research.

The CGIAR recognizes that its capacity for policy research will of necessity remain modest. TAC has emphasized that the CGIAR will remain no more than a catalyst in the field, as the resources invested will continue to be but a fraction of the total national and international resources invested. Where there is no advantage from its unique perspective, the CGIAR should rely on other agencies. Its main inhouse tasks are to understand the interactions between government action and human behaviour in relation to agriculture, technology, natural resources, and consumption, and to collaborate with national systems in identifying policy options that will improve the welfare of the System's beneficiaries.

11.2. Policy Research to Date

The CGIAR System's lead centre in policy research is IFPRI. Many other centres, notably ISNAR and IIMI, but also the 11 commodity and regionally mandated centres, cover certain policy topics. The policy focus in these centres is always closely related to their mandates, while IFPRI addresses situation- and country-specific questions to which the research approaches and findings of other centres can provide only partial answers.

IFPRI implements research at global, regional, national, community and household levels to determine the impact of policies on small-scale farmers and low-income people generally. Five programme divisions reflect the current emphases in IFPRI's research: Environment and Production Technology, Markets and Structural Studies, Food Consumption and Nutrition, Trade and Macroeconomics, and Special Studies.

New global and regional economic trends and the evolving role of the CGIAR bring changing emphases for policy research as well as for other research activities. In increasing the priority for policy research in 1986, TAC emphasized that problems arising from policy distortions of comparative advantage were likely to grow more acute with the increasing pressure of population on finite natural resources and the continually escalating demand for food. These problems call for new priorities in policy research, with greater attention to the issues of environmental degradation and its relation to poverty.

11.3. Global Change and Evolution in the CGIAR: the Implications for New Policy Research Priorities

The new emphasis on generating income streams for poor people widens the horizons of the CGIAR from the earlier, narrower objective of self-sufficiency in food. However, the ripple effects of new technology have always required research beyond the immediate, explicit policy dimensions. Important work has already been done in these wider policy areas in the CGIAR. For example, IFPRI has completed a number of studies which found no evidence of negative impacts from the introduction of cash cropping on household food supply and family nutrition. Embracing the goal of self-reliance does not, therefore, require new CGIAR priorities in policy research, which has always ranged over a wider field to understand interactions at each level from the farm to the global.

As noted, the CGIAR expansion into forestry, and possibly into fisheries, and the new priority given to research on natural resource management imply new priorities in policy research. Historically, the CGIAR has focused mainly on commodities, with some incursions into research on farming systems. In 1990 TAC concluded and the CGIAR accepted that effective research in natural resource management must address both the technical and the human sides of the problem at both the farm and community levels. It is clear from the forestry research agenda that small-scale cultivators must have a say in deciding optimum land use strategies for forestry or agriculture. The forests themselves are a subset in the common property issues raised by land and water. They too warrant policy research to improve our understanding of alternatives for their management.

An early priority is to understand more about how people degrade the natural resource base - and especially the effects of poverty on the environment. Degradation in the marginal agricultural areas and at the forest edges highlights the need to reduce the human pressures on them. This need brings with it an important set of policy research issues:

- the creation of alternative employment opportunities in both the farming and non-farming sectors;
- the management of migration, both intra- and internationally;
- the management of community resources;
- the balance between research to generate technology and the development of marketing channels and investment in infrastructure;
- the choice between investments in the high-, medium- and low-potential agricultural areas.

These issues have major implications for the future focus of agricultural research efforts, at both national and international levels. There are considerable differences in the research needs for high- and low-potential agricultural areas. At one extreme, in the high-potential irrigated areas of Asia, biological limits are beginning to constrain further development. In some areas even the current high yields may not be

sustainable. At the other extreme, managing risk in the variable rainfall conditions of the vast semi-arid and subhumid areas of Africa remains a challenge to both technical and policy research.

Policy is a key tool for influencing human behaviour at the farm and community levels. Centres involved with forestry and natural resources research will increasingly be involved in the analysis of policy options for dealing with resource management problems. Policy research, including better understanding of the ways of using policy to promote technology diffusion, will receive increased priority in the CGIAR and will be a vital component in the search for sustainable natural resources management. This increased priority will be manifest in greater policy research capacity, particularly at those centres taking on ecoregional mandates.

The role of international trade in providing food security for developing countries is gaining in importance. This leads to greater reliance on international markets, the need to encourage the development of exports, and an obligation to develop appropriate policies regarding food aid. Intraregional trade is also gaining in importance. These areas of policy research merit continuing attention by the CGIAR.

11.4. Policy Research and Formulation Capacity in Developing Countries

In its 1986 priorities and strategies report, TAC highlighted the need to build a capacity for policy research in developing countries. The emphasis was placed on training in methods of policy analysis useful in developing countries. Capacities remain limited, particularly in sub-Saharan Africa, with the result that training in policy analysis should remain a priority.

A new priority is research to identify policy processes and organizational models which are friendly to disadvantaged groups. The disadvantaged have always faced difficulties in having their voices heard and making their needs felt. That is why they remain disadvantaged. Women in agriculture face special difficulties, often because authority and wealth, in both the rural community and the research and extension system that is intended to serve it, remain in the hands of men. A lack of grassroots information on disadvantaged groups distorts policy formulation. Policy processes should allow policymakers to weigh the needs of such groups and, after decision, implementation channels should take programmes to the intended beneficiaries without dilution or distortion by stronger interest groups.

Policy research can also play a role in securing sustained funding for national research services. Research budgets are always cut in times of recession; those in developing countries have been particularly vulnerable in recent years, owing to structural adjustment. Highlighting the link between research in agriculture and national economic development can be a powerful tool for convincing politicians of the need to reverse this trend.

Impact studies can serve this purpose and satisfy other needs at the same time. If focused on technologies that the international centres have helped to generate, such studies can also meet some of their needs for evidence of impact.

11.5. Human Linkages

Research on human linkages, particularly the analysis of human nutrition and of gender issues, merits continuing attention. To incorporate nutritional objectives into agriculture, forestry and fisheries research programmes, functional classifications of target populations are required. There is also an urgent need to identify more robust indicators of malnutrition, and to collect relevant information on time and labour allocation of members of the household. Decision-making processes are often still poorly understood, as well as factors that influence adoption of improved technology. The CGIAR should support research on household food consumption linked with key social and economic variables, spanning the seasons within regional agroecological zones. National research systems should provide information on food production and consumption by rural households as a component of onfarm research studies. Nutrient content, value and bio-availability can be modified by plant breeding and agronomic practices. The goal of CGIAR research should be to retain or improve the content of key nutrients and minimize content of anti-nutritional or toxic factors. In general, the CGIAR also needs to pay greater attention to the structures and processes by which its research products reach and are utilized by rural producers and rural and urban consumers.

11.6. Public Management Research

Concern about the ineffectiveness and inefficiency of public-sector organizations has spawned substantial programmes of research on this problem, especially in developed countries. In the CGIAR context, research in this field is needed to underpin the strengthening of national research systems and to improve the management of common property resources such as irrigation. Research is needed on the policy context of national research and on the organization and management of national research systems. Examples of specific research topics are the development and analysis of a knowledge base on national research systems, and the development of improved management concepts and tools, including methods for research priority setting and management information systems. To ensure that the research is relevant, close collaboration with national research agencies is required.

In terms of agricultural productivity, irrigation water is undoubtedly the most important common property resource. Poor management of irrigation systems by government and farmer organizations leads to the wastage of water through leakage, poor control and timing of water delivery, and commonly to the inequitable distribution of water. Field research is needed to diagnose constraints to effective irrigation management and to develop management innovations to overcome the problems. TAC believes that some of the principles developed from research on the organization and management of irrigation systems may be applicable to other common property resources under public or communal management, such as wastelands and some types of rainfed farming. This is an area for further consideration in the future.

CHAPTER 12 - IMPLICATIONS OF TAC'S ANALYSIS FOR CGIAR PRIORITIES

12.1. Introduction

As demonstrated in the preceding analysis, the task of priority setting for the CGIAR is multidimensional, complex and not easily reduced to a single analytical approach. As one element in the analysis, TAC attempted to use a framework allowing the formal consideration of a range of issues reflecting the nature of the CGIAR's mission and goals. The advantages of the spreadsheet approach used are many: it allows both sequential and simultaneous analysis of modifiers; it requires TAC at every stage to recognize that increasing some activities means decreasing others; and it is fully transparent since if, for example, TAC is asked how sustainability was taken into account and what were its impacts, the results are clear from the analysis.

But there are also disadvantages to the approach. Transparency brings with it the temptation to choose modifiers and weights to yield particular outcomes. The database on which TAC had to rely had many limitations. The many caveats associated with the estimation of value of production of commodities already gave strong indications of the utmost care that has to be taken in interpreting the results of the analysis. The spreadsheet does not maximize any goal function. It simply reallocates relative weights in proportion to previous levels when a modifier, change of base or weight is introduced. It is therefore a mechanical means of accounting. Finally there is always the danger that in an analysis producing numbers - i.e. relative allocations to commodities - those numbers will be given greater credence than they deserve.

Thus TAC presents its current views on future priorities for the CGIAR with a strong request that the whole analysis, not just the spreadsheet analysis, be taken into account.

Priority setting in the CGIAR has been and should continue to be an interactive process. Major stakeholders in the process have had the opportunity for reasoned input. TAC has consulted with a significant number of leaders of national programmes in Latin America and the Caribbean, in sub-Saharan Africa, in Asia and West Asia-North Africa. In each of these regions, meetings were held under the auspices of regional institutions (IICA, SACCAR, CORAF, AARINENA and APAARI) to discuss TAC's draft proposals on CGIAR priorities and strategies with representatives of national research systems. Board, management and staff of CGIAR Institutes have major stakes in the outcome and have made most valuable contributions. Members of the CGIAR and other interested parties commented on an earlier draft at ICW'91 and provided further comments in writing. TAC has carefully considered these inputs prior to finalizing its views. This process of consultation was very valuable but in no way does it imply an endorsement by its participants. This final document is the responsibility of TAC alone.

We begin this chapter by reviewing how the Committee proceeded. We then discuss TAC's views on: (a) priorities by category of research activity; (b) the implications of the agroecological and regional agroecological analysis for CGIAR priorities; (c) the implications of the analysis for the distribution of CGIAR resources

across regions; (d) the implications of the analysis for the distribution of resources across production sectors; and (e) the implications of the analysis for the distribution of resources across commodities within production sectors. This sequential approach allows the Committee to put before the Group the multidimensional results of its analysis.

12.2. The Analytical Framework

The approach taken by TAC can be depicted in two diagrams (Figures 12.1. and 12.2). Figure 12.1 lists, on the left-hand side, the five major activity categories TAC has used. These are:

1. conservation and management of natural resources, including germplasm conservation (biodiversity);
2. germplasm enhancement and breeding;
3. development and management of production systems for agriculture, forestry and fisheries;
4. socioeconomic, public policy and public management research;
5. institution building (including training, information, organization/management counselling and networks to strengthen national research capacities).

TAC's analysis began by adopting an agroecological zone approach using nine agroecological zones defined in the main by moisture and temperature regimes. These agroecological zones were then rationalized into 21 regional agroecological zones - four for sub-Saharan Africa (SSA), one for West Asia-North Africa (WANA), seven for Asia and nine for Latin America and the Caribbean (LAC). These appear across the top of Figure 12.1. The same numbers refer to the same agroecological zones. For example SSA 1, Asia 1 and LAC 1 are all in agroecological zone 1, which is the warm arid and semi-arid tropics. The regional agroecological zone became the basic building block for both quantitative and qualitative analysis. The vertical lines indicate that the regional agroecological zones were most useful for developing TAC's analysis under activities 1, 2 and 3, whereas regions were used for all five activities. In this analysis, TAC could look across both regions and agroecological zones by activity, and down a regional agroecological zone or region across activities.

The next stages of the analysis are depicted in Figure 12.2. Again beginning with activities, TAC considered production sectors and commodities in the light of the analysis by agroecological zone and region. Under activity 1, certain resource management issues transcend production sectors, while others are specific to a single production sector and germplasm conservation is specific to commodities. Activity 2, germplasm enhancement and breeding, is necessarily commodity- and production-sector specific. Activity 3, development and management of production systems, can focus at several levels: (1) commodity-based cropping systems; (2) multiple cropping systems; (3) crop-livestock systems; (4) agroforestry systems, including crops and trees, livestock and trees, or crops, livestock and trees; and (5) integrated production systems involving crops, livestock, trees and fish. The diagram implies that production sectors and commodities are less important divisions for activities 4 and 5, socioeconomic, public

FIGURE 12.1. CGIAR PRIORITIES I: ACTIVITIES/REGIONAL AEZ, REGION, GLOBAL

ACTIVITIES	REGIONS AND REGIONAL AGROECOLOGICAL ZONES (RAEZ)																				
	SSA				WANA	ASIA								LAC							
	1	2	3	4	9	1	2	3	5	6	7	8	1	2	3	4	5	6	7	8	9
1. Conservation and Management of Natural Resources - including Germ-plasm Conservation																					
2. Germplasm Enhancement and Breeding																					
3. Devt. and Mgt. of Production Systems for Agriculture, Forestry & Fisheries																					
4. Socioeconomic, Public Policy and Public Management Research																					
5. Institution Building a. Training b. Information c. Org/Mgt. Counsel. d. Networks																					

**FIGURE 12.2. CGIAR PRIORITIES II: ACTIVITIES/RESOURCE MANAGEMENT.
PRODUCTION SECTOR AND COMMODITY**

ACTIVITIES	RESOURCE MANAGEMENT, PRODUCTION SECTOR, COMMODITY, ETC.									
1. Conservation and Management of Natural Resources Including Germplasm Conservation	RESOURCE MANAGEMENT									
	PRODUCTION SECTORS									
	AGRICULTURE								FORESTRY	FISHERIES
	CROPS					LIVESTOCK				
	COMMODITIES					SPECIES				
	Rice	Wheat	Sorghum	Cassava	etc.	Cattle	Sheep	etc.		
2. Germplasm Enhancement and Breeding										
	(1) COMMODITY-BASED CROPPING SYSTEMS									
	(2) MULTIPLE CROPPING SYSTEMS									
	(3) CROP-LIVESTOCK SYSTEMS									
	(4) AGROFORESTRY SYSTEMS									
3. Development and Management of Production Systems for Agriculture, Forestry and Fisheries	(5) INTEGRATED PRODUCTION SYSTEMS <-----LAND USE CONTINUUM----->									
4. Socioeconomic Public Policy and Public Management										
5. Institution Building - training - information - org./mgmt. counselling - networks										

policy and public management research, and institution building, though clearly some activities under this category are differentiated by production sector and commodity.

12.3. The Status of TAC's Priority Analysis

12.3.1. By Activity Category

TAC began its priority analysis by considering, in Systemwide terms, what should be the relative distribution of CGIAR efforts among the five broad activity categories. The Committee acknowledged that there is no clear dividing line between these categories and that in many instances activities may overlap into several categories. Furthermore, a number of CGIAR objectives cross-cut all these categories, such as the strengthening of national research systems, and improvement of the sustainability of production systems.

TAC was also mindful of the fact that the categorization of activities differed from that of the 1986 priority analysis in two major ways. First, in 1986, TAC had differentiated the activities relating to germplasm and production systems by production sector. Second, in 1986, separate categories had been used for product utilization and human linkages. For the reasons already discussed in Chapter 3, TAC felt that, given the addition of agroforestry, forestry and possibly fisheries to the CGIAR mandate, integrated categories were preferable with differentiation by production sector being a subsequent component of analysis. The little utilization work that is done by the System could be considered as one of the activities under the production systems category. Human linkages are considered as part of socioeconomic, public policy and public management activities.

However, the overlapping and the cross-cutting nature of CGIAR activities, and this redefinition of activity categories make a precise determination of current CGIAR efforts by activity category difficult. TAC's best estimate, based on analysis of the CGIAR Secretariat, is that in 1991, approximately 13% of CGIAR resources were in natural resource conservation and management (including germplasm conservation), 21% in germplasm enhancement and breeding, 33% in the development and management of production systems, 9% in socioeconomic, public policy and public management research and 24% in institution building. These estimates take account of the recent expansion of the CGIAR and include activities with respect to agroforestry, irrigation management and banana and plantain.

Setting current levels aside, an assessment was made of the optimal future balance of CGIAR core resources between activity categories, across production sectors by the year 2010. Throughout this report, considerable thought has been given to the challenges faced by the CGIAR during the next two decades, and their implications for research emphasis. In Chapter 4, an assessment was made of the international research needs by region and agroecological zone. Furthermore, in discussing important factors that determine CGIAR priorities by region and agroecological zones, attention was given to the implications of the weights attached to particular modifiers.

In all regions and agroecological zones, there was a perceived need for an expanded effort in research on natural resource conservation and management. These

Table 12.1. Priorities by activity category by region (core resources only)

Activity Category	1991 Base	2010 Rec.	Region ^{1/}			
			SSA	WANA	Asia	LAC
1. Conservation and Management of Natural Resources Including Germplasm Conservation (Biodiversity)	13	17-19	+	+	-	+
2. Germplasm Enhancement and Breeding	21	21-23	-	-	+	0
3. Devpt. and Mgmt. of Production Systems	33	28-30	+	0	-	-
4. Socioeconomic, Public Policy and Public Management Research	9	10-12	-	-	+	+
5. Institution Building (incl. Training, Information, Org./Mgt. Counselling and Networks) ^{3/}	24	19-21	+	+	-	-
TOTAL	<u>100</u>	<u>100^{2/}</u>				

- 1/ + = more than the new System level priority but possibly lower than current allocation
0 = equal to new System level priority
- = less than new System level priority but possibly higher or lower than current allocation

2/ the mid points of the ranges add to 100

3/ networks of category 5 refer to capacity building networks only. Research networks are included in the other categories.

additional efforts refer both to activities in ecosystem conservation and management (currently receiving 7% of core resources) and germplasm collection and conservation (currently at 6% of core resources). This need emerged even more strongly when modifiers such as yield gap, soil degradation risk, and deforestation were considered. TAC therefore recommends a substantial increase in CGIAR efforts in this category, from 13% to between 17 and 19%. However, the analysis suggests that, relative to the new level, more attention should be paid to resource management in sub-Saharan Africa, West Asia-North Africa and Latin America and the Caribbean and less in Asia. Nevertheless,

the investment in research in natural resource management should be increased in all areas.

Germplasm enhancement and breeding has been the central thrust of the CGIAR since its inception. Increased emphasis is warranted on this activity in Asia, where substantial efforts are now required to lift the yield ceiling, particularly of rice. In West Asia-North Africa and sub-Saharan Africa, the emphasis on germplasm enhancement and breeding could be somewhat reduced where a greater effort on resource management is required. Overall, the conclusion is that research on germplasm enhancement and breeding should continue at the marginally higher Systemwide level of between 21 and 23% of total activities.

Overall, in the long term, there should be a reduced need for CGIAR research on the development and management of production systems, because of increasing national capacity to deal with this category, which consists mostly of applied research. It is important to note, however, that the results obtained from applied research activities in this category feed into the planning of, for example, strategic resource management research. Continued emphasis is warranted in West Asia-North Africa, and more emphasis relative to the reduced System level is needed in sub-Saharan Africa, particularly to exploit the scope for growth. In Asia and in Latin America and the Caribbean, the resources devoted to this activity could be reduced below the new System level. As national research systems assume greater responsibility for research on the development of production systems, the modes of operation should evolve towards greater use of networks and consortia. Overall, TAC tentatively concludes that at the System level, efforts in this category could be reduced from 33% to between 28 and 30% of total activities.

Throughout this report, reference has been made to the need for an expanded effort in socioeconomic, public policy and public management research. In all regions and in most agroecological zones, there was a need for greater emphasis on policy research with respect to land use and sustainability issues, poverty alleviation and equity (particularly gender equity), irrigation management, and issues related to self-reliance. It is therefore proposed to increase CGIAR efforts in socioeconomic, public policy and public management research, from 9% to between 10 and 12% of System activities. Even more emphasis relative to the new System level may be needed in Asia and in Latin America and the Caribbean, because of pressing problems of sustainability, deforestation and equity.

TAC considered whether, in the long term, the resources allocated to institution building could be reduced. It is to be recalled that this category of institution building refers only to specific activities and that CGIAR Centres also contribute to strengthening national research systems through their work in the four previously discussed categories of activities in natural resources, germplasm enhancement, production systems and policy.

The study by Pardey and Roseboom (1991) has revealed the considerable increase in trained human resources in national programmes. For many national systems, the major constraint is now a shortage of operational funds rather than of trained manpower. As already noted in Chapter 10, TAC's view is that the allocation of CGIAR resources to institution building has reached a ceiling and that the CGIAR should focus on its complementary role of strengthening national research systems through technology development and partnership.

Although additional efforts in training will be required in the new and expanded areas of CGIAR activity (forestry, fisheries, natural resources and irrigation management), the overall emphasis on training can be reduced in the medium and long term from its present level of 9% to about 7%. However, in the medium term, a continued strong effort in training will be required in sub-Saharan Africa. In the area of information services, TAC considered that the current level of activity (8%) could only be reduced slightly since these are essential activities for partnerships with national research systems. In the area of organization and management counselling (now 2%), efforts should clearly increase. The responsibility for networks intended to strengthen national research capacity could increasingly be handed over to national programmes and the level of support to this type of activity could, therefore, be reduced from its present level of about 5% to 4%.

In TAC's view, therefore, the overall proportion of CGIAR activities in the category of institution building should be reduced from 24% to between 19 and 21%, but with less in training, information and capacity building networks, and more in organization/management counselling.

These judgements are displayed in Table 12.1, which shows the proposed shifts among activity categories, with an indication of differential efforts by region relative to the new proposed level of activity. These judgements were then used as indicators as TAC proceeded to evaluate other dimensions of the matrix.

12.3.2. By Agroecological Zone and Regional Agroecological Zone

TAC evaluated carefully the analysis of research priorities by agroecological zone developed in Chapter 4, along with the results of the analysis in Chapter 9, in making judgements as to whether or not the shifts in emphasis implied by the analysis were appropriate. It should be recalled that the analysis had suggested that in agriculture, the relative emphasis should increase for tropical agroecological zones (AEZs 1-4) and the cool subtropics with winter rainfall (AEZ 9), while in forestry the relative emphasis should increase for the tropical agroecological zone in general (AEZs 1-4), with greater increases in sub-Saharan African agroecological zones than in those of other regions. TAC supported these shifts in emphasis because the other areas benefit to a much greater extent from ongoing research in developed countries.

The current allocation of CGIAR resources by agroecological zone or regional agroecological zone is not available. The proposed new allocations cannot therefore be compared with existing allocations. However, based on its knowledge of current efforts, TAC felt that the shifts in emphasis implied by the analysis were already well under way in the CGIAR System. There is some evidence to support this perception in the regional analysis which follows.

12.3.3. By Region

In the 1986 analysis of priorities, TAC began at the global level, made recommendations with respect to priorities among activities and among commodities, and then evaluated the regional implications. The current exercise began with regional agroecological zones and, therefore, allowed a more comprehensive analysis of the regional distribution of CGIAR resources. The details of the regional analysis are given

in Chapter 9. Here, TAC summarizes the changing pattern of regional allocations that the use of a modified base and the application of modifiers suggest.

Table 12.2. Impacts of Baseline and Modifiers on Regional Distribution of Values Relative to Current Allocation: Agriculture

	Baseline Components			Baseline	Modified Baseline			Current (1991) Allocation of Core Resources
	VOP %	Number of Poor %	Usable land %		0.25	0.5	1.0	
Weight	0.33	0.33	0.33					
Region								
SSA	9.1	16.2	29.4	18.2	25.8	34.0	47.4	43.0
WANA	9.3	5.4	7.5	7.4	7.8	8.1	8.4	13.0
ASIA	59.0	72.1	27.9	53.0	46.4	39.5	29.1	29.0
LAC	22.6	6.3	35.2	21.4	20.0	18.4	15.1	15.0
TOTAL	100	100	100	100	100	100	100	100

Table 12.2 summarizes the previous analysis and adds a column containing TAC's estimate of the 1991 regional allocation of CGIAR resources. As pointed out in Chapter 9, the effect of using a three-part base (incorporating land use and the number of poor people, as well as the more usual starting point, value of production) already substantially shifted baseline values in favour of sub-Saharan Africa and away from West Asia-North Africa, Asia and Latin America and the Caribbean (value of production only, 9.1; three-part baseline value, 18.2). Applying the modifiers and increasing their weights further shifted resources towards sub-Saharan Africa, and also towards West Asia-North Africa. For example, with the modifiers weighted at 0.5 each, the sub-Saharan African modified baseline value is almost four times the original value of production. One might conclude that modification had gone too far.

However, when one considers 1991 estimates of CGIAR allocations by region, one discovers that the allocation to sub-Saharan Africa in fact lies between the analytical results obtained with modifiers weighted at 0.5 and 1.0. Applying the modifiers with a weighting of 0.5 reduced Asia's percentage share in value of production from 59.0% to 39.5%. A weighting of 1.0 suggests that Asia's share should be similar to the current allocation. A weighting between 0.5 and 1.0 would give a result resembling the current CGIAR allocation, except for the West Asia-North Africa region. As noted in Table 12.2, current regional allocation of CGIAR core resources is as follows: 43% to sub-Saharan Africa, 13% to West Asia-North Africa, 29% to Asia and 15% to Latin America. It should be noted here, however, that the benefits of research are not necessarily only accrued by the region where the investment occurs. The benefits of

research investments often spillover into other regions and agroecological zones particularly with respect to investments in strategic research.

TAC considered the implications of the analysis for the balance of allocations between regions very carefully. TAC is aware of the strongly divided opinions held both within and outside the CGIAR on the special needs of agriculture in sub-Saharan Africa. Some argue that the CGIAR has gone much too far in reallocating resources towards sub-Saharan Africa, given the massive needs in Asia. Others argue that even more resources should be transferred to sub-Saharan Africa because of that region's rapid population growth rates, pervasive poverty, severe sustainability problems and lack of progress to date in improving the productivity of crops and livestock important to the poor.

The analysis presented here supports neither of these extreme views. TAC feels that the 0.5 weighting should be the maximum one used if undue influence by particular modifiers in favour of any given regional agroecological zone is to be avoided. Thus, using the analysis only as a rough guide, the Committee is of the view that there is no substantial case for a further shift of CGIAR resources towards sub-Saharan Africa. As the forestry analysis also suggests, there are pressing problems in Latin America and the Caribbean and Asia, as well as in sub-Saharan Africa. In considering the results of the analysis, TAC expressed a preference for the use of 0.5 weighting as a guide for allocating priorities by region by the year 2010. A case could then be made that the regional reallocation, which has taken place over the past 10 years may already have gone too far towards both sub-Saharan Africa and West Asia-North Africa.

As noted, rapid population growth rates, coupled with declining per caput food production in sub-Saharan Africa, make a compelling case for that region. The fragility of its tropical agroecological zones, the generally limited national research capacities and the slow rate of progress in productivity improvement to date add to the apparent urgency. Many of Africa's development problems are also political in nature however, and cannot be solved through research alone. On the other hand, the magnitude of population numbers, the extent of the poverty problem, the narrowing yield gap and the limited scope for land expansion all argue strongly for more long-term strategic and applied research in Asia. In addition, TAC is concerned about the generally low rate of progress in obtaining impact from international research efforts in sub-Saharan Africa. Although significant breakthroughs have been achieved (such as biological control of cassava mealy bug, and the adoption of improved wheat and maize varieties), in general the impact obtained in the region has been below expectations.

TAC's position is that in the medium term a modest reduction in resources allocated to sub-Saharan Africa and West Asia-North Africa, and an equivalent increase in resources allocated to particularly Asia and also Latin America should be scheduled, moving the CGIAR toward a distribution of resources by the year 2010 not unlike the priority index suggested by the modified baseline (weight 0.5). TAC recommends that, for the purposes of guiding the resource allocation process, by 1998 the target distribution by region should be 39% to sub-Saharan Africa, 11% to West Asia-North Africa, 33% to Asia and 17% to Latin America.

TAC recognizes that the analytical basis of this recommendation refers mainly to the agricultural sector, but on balance considered this proposed distribution appropriate for the System as a whole. Within the forestry and fisheries production sectors, the regional emphasis could be shifted more towards the distribution suggested in Tables 9.18

and 9.19, which calls for a much greater emphasis on the Asia region, particularly in the fisheries sector.

12.3.4. By Production Sector

The analysis undertaken to date gives much less insight into the question of what ought to be the relative balance of CGIAR efforts among agriculture (crops and livestock), forestry and fisheries. This is so for two main reasons.

First, for valid analytical reasons, different baselines were chosen for agriculture, forestry and fisheries. The results of the modification analysis cannot therefore be added together. As a result, one can compare relative distributions within sectors but not across them. There is no obvious way of obtaining cross-comparability unless one reverts to annual gross value of production as a basis. But TAC had rejected value of production as a direct congruence indicator for a variety of reasons, one of which was the fact that it includes a large number of commodities not covered by the CGIAR mandate. Non-CGIAR commodities account for approximately one-third of the value of crop production and for 45% of the value of livestock production in developing countries. In addition, about 60% of the value of production of forestry is from sawlogs and veneer, which are not priority items for CGIAR research, while approximately 55% of fisheries production is from deep sea or ocean fishing which, according to TAC, should be outside the scope of the CGIAR.

Second, CGIAR activities in forestry are only just beginning and those in fisheries have yet to be finally accepted. The current allocation of CGIAR resources across sectors cannot therefore be used as the starting point for analysis.

What can be said is that TAC's detailed analysis of the research needs in agriculture, presented in previous chapters of this report, does not provide grounds for an absolute decline in support for agricultural research. On the contrary, it portends increasingly urgent needs to meet the rapidly rising demand for food. TAC's judgement at this juncture is that, whatever the level of support earned by the yet to be proposed long-term research programmes in agroforestry, forestry and fisheries, these should not be funded at the expense of critical research needs in crops and livestock. TAC will review the issue of balance between sectors as further information becomes available on research needs in agroforestry, forestry and fisheries.

12.3.5. By Commodity Within the Agricultural Sector

The final dimension of the analysis relates to the relative priority to be assigned to specific commodities. TAC carefully considered the information on particular issues related to each individual commodity as presented in Chapter 5 on crops and Chapter 6 on livestock, and the outcome of the in-depth quantitative analysis on modified value of production of commodities discussed in Chapter 9. It is very important to recall that through the process of modification of the baseline and the development of priority indices by RAEZ, several indicators related to efficiency, equity, sustainability, strength of national research systems, and food import gap were incorporated explicitly already in the quantitative analysis related to each individual commodity.

In developing its recommendations on assigning priorities by commodity, TAC also took into account, qualitatively, appropriate additional considerations such as:

- projected growth of demand for that commodity between 1990 and 2010;
- importance of the commodity for the poor;
- alternative sources of research supply, particularly the role of the private sector, universities and advanced institutes;
- regional distribution of production;
- concentration of production in one country;
- impact achieved through previous and ongoing research on the commodity;
- possibilities for technical breakthroughs;
- comparative advantage of the CGIAR;
- expected productivity gains as discussed in Section 9.11;
- size of spillover effects as discussed in Section 9.13.

TAC began its analysis by comparing the modified values of production of the top 45 agricultural commodities of importance in developing countries with the current list of CGIAR commodities (Table 12.3). First, TAC addressed the portfolio issue. The question asked was: Are there strong candidates, with high modified values of production, that should be considered for inclusion in CGIAR activities? TAC then looked carefully at current CGIAR commodities which have relatively low modified values of production but which are important for limited subsets of regions and/or countries. This led to a discussion of whether any current activity should be discontinued. Next, TAC looked at the congruence between the modified values of production and current allocations to determine if there was a need to consider altering the relative distribution of resources among agricultural commodities. The following sections present the information TAC considered and the recommendations of the Committee.

12.3.5.1. The commodity portfolio

Of the 45 commodities listed in Table 12.3, 22 are already CGIAR commodities, and tomato is on the list of vegetables recommended by TAC for inclusion in 1988. Three major vegetables (tomato, onion and cabbage) were explicitly considered in the analysis discussed in Chapter 9. The modified value ranking (2.1%) for the three vegetables combined (Table 9.17) would place vegetables within the top 16 commodities, thus further supporting TAC's earlier recommendations that they be included in the CGIAR portfolio (TAC/CGIAR, 1990).

Table 12.3. Ranking of commodities based on value of production, weighted baseline and modified baseline

VOP (%)		Weighted Baseline (%)		Modified Baseline (%) (W = 0.5)		
1.	Rice*	17.7	1. Rice*	15.6	1. Rice*	13.2
2.	Milk*	8.9	2. Milk*	9.5	2. Milk*	9.7
3.	Wheat*	6.4	3. Wheat*	5.7	3. Beef & Buffalo*	5.9
4.	Beef & Buffalo*	5.0	4. Beef & Buffalo*	5.3	4. Cassava*	4.5
5.	Pigmeat	4.8	5. Pigmeat	4.7	5. Maize*	4.2
6.	Maize*	4.1	6. Maize*	4.4	6. Wheat*	4.0
7.	Orange	3.5	7. Orange	3.3	7. Coffee	3.8
8.	Sweet Potato*	2.9	8. Coffee	3.1	8. Groundnut*	3.7
9.	Cotton	2.8	9. Groundnut*	3.0	9. Banana*	3.6
10.	Eggs	2.8	10. Cassava*	2.9	10. Pigmeat	3.3
11.	Potato*	2.8	11. Eggs	2.8	11. Orange	3.0
12.	Coffee	2.7	12. Sugar	2.8	12. Sugar	2.9
13.	Sugar	2.7	13. Cotton	2.7	13. Cotton	2.6
14.	Groundnut*	2.6	14. Potato*	2.7	14. Eggs	2.4
15.	Tobacco	2.6	15. Banana*	2.6	15. Sheep & Goats*	2.3
16.	Grape	2.5	16. Sweet Potato*	2.3	16. Potato*	2.1
17.	Soybean*	2.5	17. Tobacco	2.2	17. Cocoa	2.0
18.	Banana*	2.1	18. Grape	2.1	18. Poultry	2.0
19.	Cassava*	2.0	19. Soybean*	2.1	19. Grape	1.9
20.	Poultry	1.9	20. Poultry	1.9	20. Yam*	1.9
21.	Sheep & Goats*	1.7	21. Sheep & Goats*	1.9	21. Tobacco	1.8
22.	Tomato	1.2	22. Phas. Bean*	1.3	22. Phas. Bean*	1.6
23.	Phas. Bean*	1.1	23. Coconut*	1.3	23. Millet*	1.5
24.	Coconut*	1.1	24. Cocoa	1.2	24. Sorghum*	1.5
25.	Apple	1.0	25. Sorghum*	1.1	25. Soybean*	1.5
26.	Rubber	1.0	26. Tomato	1.1	26. Coconut*	1.4
27.	Cocoa	0.8	27. Yam*	1.1	27. Sweet Potato*	1.4
28.	Onion	0.8	28. Millet*	1.0	28. Rubber	1.3
29.	Sorghum*	0.8	29. Rubber	1.0	29. Palm Oil	1.1
30.	Tea	0.8	30. Apple	0.9	30. Tomato	1.1

Table 12.3. cont.d

VOP (%)		Weighted Baseline (%)		Modified Baseline (%) (W = 0.5)	
31. Lemon & Lime	0.7	31. Palm Oil	0.8	31. Cowpea*	0.9
32. Millet*	0.7	32. Tea	0.8	32. Tea	0.9
33. Palm Oil	0.7	33. Lemon & Lime	0.7	33. Apple	0.7
34. Barley*	0.6	34. Onion	0.7	34. Onion	0.7
35. Yam*	0.6	35. Barley*	0.6	35. Pineapple	0.7
36. Chickpea*	0.5	36. Pineapple	0.6	36. Barley*	0.6
37. Pineapple	0.5	37. Chickpea*	0.5	37. Lemon & Lime	0.6
38. Broad (Faba) Bean*	0.4	38. Cowpea*	0.5	38. Broad (Faba) Bean*	0.4
39. Cabbage	0.4	39. Broad (Faba) Bean*	0.4	39. Chickpea*	0.4
40. Cowpea*	0.2	40. Cabbage	0.4	40. Cabbage	0.3
41. Jute	0.2	41. Lentil*	0.2	41. Lentil*	0.2
42. Lentil*	0.2	42. Pigeonpea*	0.2	42. Pigeonpea*	0.2
43. Pigeonpea*	0.2	43. Jute	0.1	43. Jute	0.1
44. Hemp	0.0	44. Hemp	0.0	44. Sisal	0.1
45. Sisal	0.0	45. Sisal	0.0	45. Hemp	0.0
	99.5		100.1		100.0

* CGIAR Commodities

Of the remaining commodities, coffee, pigmeat and cotton rank within the top 15 commodities. However, as noted in Sections 5.7 and 6.2, TAC's view on these and the other non-CGIAR commodities (eggs, pigmeat, cocoa, poultry, sugar, tobacco, rubber, tea and fruit of different types) is that for a variety of reasons (such as the existence of private sector research or other sources of research supply), there is no compelling case for considering major commodity improvement efforts in these commodities at this time. TAC recognizes the importance of these commodities for smallholder farming systems and for incomes of landless labourers, but would encourage centres to undertake research on these commodities within the framework of production systems research. Furthermore, the CGIAR is now in the process of giving much greater attention to resource management issues which implies a shift away from the original focus on plant breeding that characterized the CGIAR. TAC considers that the CGIAR should consolidate its commodity portfolio before embarking on new initiatives.

12.3.5.2. The congruence between the modified values of production and current allocations

TAC considered the relative distribution of resources among existing CGIAR commodities. It looked at the results of TAC's modified congruence analysis and of the analysis by ACIAR. The modified values for CGIAR commodities and estimates of current (1991) actual allocations of core resources in the expanded CGIAR are presented in Table 12.4. The regional breakdown of the modified values with weights of 0.5 is given in Table 9.17 (Section 9.9.1.2) and with weights of 0.25, 0.5 and 1.0 for selected commodities in Table 9.22 (Section 9.10.3).

For all the developing regions combined, the relative modified values of commodities are: cereals 36.3%; roots and tubers 14.5%; food legumes 13.0%; oil crops 2.0%; vegetables 3.2%; banana and plantain 5.2%; and livestock 25.8%. These figures compare with 1991 core resource allocation of cereals 44.3%, roots and tubers 11%, food legumes 16.3%, banana and plantain 2.3% and livestock 26.1%.

In the strictest sense of congruence analysis, divergences between allocations and modified values could be used to raise the question of whether CGIAR resources should be reallocated from cereals and food legumes towards roots and tubers and bananas. In so doing, TAC also recalled the caveats associated with the estimation of value of production of commodities, and prior to making recommendations the outcome of each analysis was therefore considered with great care.

Cereals

Actual allocation to cereals is approximately 2% higher than indicated because investment in rice breeding networks has been considered within the category of institution building. TAC notes that in 1986, it had recommended that the relative emphasis given to rice should be reduced. TAC had based its recommendation both on the over-emphasis on rice relative to the commodity's importance in global food supplies and on the strength of national programmes in Asia. For a variety of reasons well known in the CGIAR, the relative funding for rice has not declined as much as recommended by TAC. This reflects increases in nominal expenditures in both Asia and sub-Saharan Africa.

The Committee debated reaffirming the earlier recommendation to reduce the relative allocation to rice, particularly in Asia, primarily because of now even stronger national programmes. The West African question is more complex. Rice is rising rapidly as a component of diets, substituting for traditional staple cereals and roots and tubers, especially in urban areas. Further, weaker national programmes and higher research costs make African research in general more expensive. Finally, the CGIAR has already decided to have a major upland rice improvement effort in sub-Saharan Africa. TAC had, therefore, recommended a minimum effort that has a reasonable chance of success.

TAC recognizes the importance of rice as the staple food of a large number of people in developing countries and the substantial pay off from CGIAR efforts on rice research in Asia and Latin America. TAC has also considered the large benefits from rice research that accrue to consumers and producers. TAC therefore recommends a continuation of current levels of CGIAR investment in rice research, but a shift in focus

Table 12.4. Modified values of production and 1991 estimated allocation of core resources among CGIAR agricultural commodities^{1/}

Commodity	Modified VOP Baseline (w = 0.5) (%)	1991 Allocation (%)
Cereals	36.3	44.3
Rice	19.2	18.4
Wheat & Barley	6.7	10.8
Maize	6.1	9.7
Sorghum	2.2	3.2
Millet	2.1	2.2
Roots & Tubers	14.5	11.0
Cassava	6.6	5.4
Potato	3.1	4.3
Sweet Potato	2.0	1.1
Yam	2.8	0.2
Food Legumes	13.0	16.3
Beans	2.3	5.4
Broad Beans & Lentil	0.9	2.2
Chickpea	0.6	2.2
Cowpea	1.3	3.2
Groundnut	5.4	2.2
Pigeonpea	0.3	1.1
Soybean	2.2	N/A
Oil Crops	2.0	
Coconut	2.0	-
Vegetables	3.2	-
Banana & Plantain	5.2	2.3
Livestock	25.8	26.1
Beef & Buffalo Meat	8.5	N/A
Sheep & Goat Meat	3.3	N/A
Milk	14.0	N/A

N/A not available

^{1/} commodity research only

of rice research towards more strategic germplasm research necessary to lift the yield ceiling of the crop, and to sustain current yield levels.

TAC is mounting an inter-centre review of rice in the CGIAR in conjunction with external reviews of IRRI and WARDA. This inter-centre review will also consider

ongoing efforts on rice research at CIAT, IITA, IBPGR, IIMI and at the stronger national programmes. Thus TAC will continue its discussion of relative rice priorities in its March 1993 meeting and provide the Group with updated views at that time.¹

With respect to wheat, TAC has been impressed by the continued large pay off and impact in the farmers' fields of CGIAR investments in this commodity. While a comparison of modified value of production with current CGIAR resource allocation would suggest an over-investment in wheat research, TAC recognizes the many distortions in the marketing and trade of wheat. It noted the existing of wheat research programmes in developed countries but reaffirmed the special role of the CGIAR in catering for the needs of developing countries. TAC also took into account the higher costs associated with strategic research and the need to maintain efforts in maintenance breeding. TAC recommends that CGIAR efforts on wheat should give primary attention to strategic germplasm research. Overall, TAC recommends a continuation of efforts in CGIAR investment in wheat research in the medium term, recognizing the potential for further gains to be made in increasing the productivity of wheat. In the long term, the priority of wheat is likely to decline given the growing importance of alternative sources of research supply.

TAC recommends, in the short to medium term, maintaining current efforts in maize research, given the importance of the crop in mixed cropping systems of resource poor farmers. TAC has noted that the private sector is rapidly becoming involved in the maize seed industry, particularly with respect to hybrid maize varieties. In the long term, a reduction in the priority of maize research is therefore likely.

Pearl millet is an important crop in sub-Saharan Africa, particularly in Sahelian West Africa, where approximately half the world's production is found. Millet is generally an important crop for the poor and is grown in farming systems in less endowed regions. In Asia, millet is mainly produced in India. In 1986, TAC recommended a greater concentration of effort in pearl milled on sub-Saharan Africa over the short term. This was because of the short research history and the weakness of national programmes in the millet producing countries of sub-Saharan Africa, compared with the programme of India. ICRISAT responded positively to this recommendation by transferring some of the millet responsibilities from the ICRISAT Centre to West Africa and the SADCC region.

The pay off from CGIAR investments in research on pearl millet has been substantial, particularly in the more endowed farming areas of India. ICRISAT is now shifting its focus towards the drier areas of more limited potential, and towards more strategic issues. TAC endorses this view and recommends to maintain current CGIAR efforts on millet research.

With respect to barley and sorghum, TAC saw on balance no reason to alter ongoing CGIAR efforts and recommended that the level of investment in these commodities should continue. Research on these commodities should continue to focus on those areas where poor farmers are heavily dependent on these crops.

¹ TAC/CGIAR, 1993. Investment in Rice Research in the CGIAR: A Global Perspective - Report of the Inter-Centre Review of Rice.

Roots and tubers

With respect to investment in roots and tubers, TAC noted the divergence between modified value of production and CGIAR allocations. Nevertheless, TAC recommends maintaining current efforts in cassava and the other root and tuber crops.

The Committee recognized the rapid rate of progress in cassava research, and the importance of cassava for low income consumers and producers. It also considered the negative income elasticity of cassava in most regions, and the need for the development of post-harvest technology. On balance, TAC recommended a continuation of efforts in cassava research.

TAC noted that over 80% of the global production of sweet potato is in China (which has a relatively strong national research system), that there has been a steady decline in the importance of sweet potato as a staple food, and that there have been shifts in product utilization towards livestock feed in Asia. The Committee recognizes that very little research on sweet potato is conducted outside the CGIAR, that ongoing CGIAR efforts are of very recent origin, and that outside China sweet potato is a very important crop in a large number of small countries typically with very low income levels. For the medium term, TAC therefore recommends that CGIAR efforts be maintained at their current level.

The relative importance of another root and tuber, potato, fell in the modified ranking, mainly because the crop is predominantly grown in the subtropics and cold tropics. The production and consumption of potato is growing rapidly in developing countries, and good rates of progress have been obtained from CGIAR investments in potato research. Furthermore, potato is an important crop for low-income farmers and consumers. TAC recommends that, in the medium term, current efforts in potato research be maintained.

TAC noted that yam is produced mainly in West Africa, with Nigeria accounting for 70% of world production. In its 1986 review of priorities, TAC had recommended the continuation of efforts on yam in the short term, followed by a performance review in five years. The assessment of the Third External Review of IITA was that the comparative advantage in crop management research related to yam lay with the Nigerian national research system. IITA should concentrate on germplasm conservation and focus its research on the critical constraints to germplasm improvement. TAC endorses this view, and suggests 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.

Food legumes

In 1986, TAC had recommended that investments in research on faba bean (broad bean) and lentil be phased out. A CGIAR involvement was to be limited to the maintenance of genetic resource collections. The responsibility for faba bean research is in the process of being transferred to a national programmes. While ICARDA's efforts in this regard have been successful, it will take more time than expected before its responsibilities can be fully discharged. ICARDA has also been requested to undertake an in-depth assessment of the potential pay off from further research on the improvement of lentil. The outcome of the assessment will be considered by TAC when ICARDA's

next medium-term plan is presented. TAC notes that lentil is an important crop in farming systems of resource poor farmers of the West Asia-North Africa region, and that outside the CGIAR very little research is carried out on lentil. In the short term, therefore, current efforts in lentil could continue, while reaffirming TAC's view that in the long term the role of the CGIAR in faba bean and lentil research should be primarily in maintaining genetic resource collections.

In view of the progress made by the centres concerned on phaseolus beans in Latin America and the Caribbean, and sub-Saharan Africa, and on pigeonpea in India, TAC proposes to reduce the emphasis on these two commodities. CIAT has successfully developed several improved varieties of phaseolus beans that are being widely adopted by farmers. The pay off from CGIAR investment in research on this crop has been substantial. TAC also recognizes that phaseolus beans are an important crop for poor farmers and of substantial significance in the diets of low income consumers. On the basis of congruence criteria, the CGIAR is overinvesting in phaseolus beans however (Table 12.4). CIAT is already proposing a substantial reduction in the scale of its research programme on phaseolus beans. TAC endorses this trend, and recommends a modest reduction in the priority of this crop.

Pigeonpea is an important crop in one country only (India) which in addition has a strong national research programme. The rapid progress achieved by ICRISAT in developing a hybrid pigeonpea variety, adds further weight to the argument that responsibilities for pigeonpea research, particularly in India, can now gradually be transferred to the national research programme. TAC recommends that CGIAR efforts in pigeonpea research be progressively reduced in the long term to limit its activities to maintaining genetic resource collections only, and be diminished significantly in the medium term.

Chickpea is an important dietary item for poor consumers in southeast Asia, India and the West Asia-North Africa region. In the short to medium term, the priority of this crop could be maintained.

TAC recalled that cowpea was largely produced in Nigeria, but that the crop could be an important commodity for resource poor farmers throughout different agroecological zones and cropping systems of West Africa, where national systems are generally still weak. TAC concluded that it would therefore be appropriate to continue CGIAR support for this commodity in the short to medium term.

TAC noted that soybean ranked above several other legumes and the rapid progress of research on soybean conducted in Asia, particularly with respect to multipurpose varieties. TAC recognizes that soybean has substantial potential in developing countries and that the demand for livestock feed is growing rapidly. The Committee recommends an increased resource allocation to this commodity in sub-Saharan Africa, in view of the likelihood of rapid progress, particularly with respect to its potential as a nutritious food, cash crop, and protein-rich livestock feed.

Among food legumes, the only commodity that appears underfunded is groundnut. TAC has noted the substantial pay off from CGIAR investments in groundnut research in Asia as reported by the Third External Review of ICRISAT. In sub-Saharan Africa, progress has been slow. TAC recommends increasing current efforts in

groundnut research modestly given the opportunities for further gains to be made through research on this commodity.

Oilcrops

The modified ranking of coconut is only 2.0% (Table 9.17). However, TAC observed that its earlier recommendation to include coconut in the CGIAR portfolio was based on its importance as a smallholder multipurpose tree crop in several farming systems throughout the tropics. TAC hereby notes the prospects of high returns from research investments, the benefits to low-income producers, and the lack of continuity in historical research efforts. Coconut is also an important crop for the sustainability of agricultural production in coastal ecosystems.

The priority ranking of another oilcrop, groundnut, has been considered within the category of food legumes.

Banana and plantain

The CGIAR has recently expanded its activities in banana and plantain research through the incorporation of INIBAP. Most of the investments of this Centre are not incorporated in the allocation figure given in Table 12.4 because they have been classified as network expenditures. Actual CGIAR efforts in banana and plantain are thus substantially higher than indicated. TAC recommends maintaining current efforts in CGIAR research on these commodities.

Vegetables

The analysis undertaken for assessing a possible expansion of the CGIAR and for the current review of CGIAR priorities, confirms TAC's 1988 recommendation that research on vegetables is a high priority for the CGIAR.

Livestock

TAC has carefully considered the relative priority assigned to livestock research. In particular, TAC noted that while congruence on livestock research appears close, in practice the modified value of production figure has to be treated with considerable caution. The figure includes the value of all cattle meat and milk, and small ruminants across all regions. The CGIAR does not conduct any livestock research in Asia however, nor does it conduct research on small ruminants in Latin America or on large ruminants in the West Asia-North Africa region. When adjusting the modified production value for these factors, the figure would be reduced from 25.8% to 16.5%, with a distribution of 40% to sub-Saharan Africa, 9% to West Asia-North Africa, 27% to Asia and 24% to Latin America. Actual resource allocation to livestock research amounts to more than 26%, distributed as 73% to sub-Saharan Africa, 9% to West Asia-North Africa, 16% to Latin America and only 1% to Asia. This would, in turn, suggest that the CGIAR is substantially overinvesting in livestock research, even when considering the important role of intermediate livestock products such as traction and manure. A disproportionate share of CGIAR resources for livestock research is allocated to sub-Saharan Africa. In addition to the regional emphasis, major questions remain about the distribution of species emphasis and between animal production and health research. Furthermore, it is now increasingly clear that in the future, much greater emphasis will

have to be given to enhancing crop-livestock interactions. The major constraint to increasing livestock productivity is a shortage of feed, and this could, to a greater extent, effectively be addressed through more adequately focused crop productivity research. TAC is also concerned about the generally slow rate of progress in obtaining impact from CGIAR investment in livestock research. TAC, therefore, recommends a modest reduction in the priority the CGIAR currently allocates to livestock research. In the medium term, the allocation to livestock research in sub-Saharan Africa could be reduced substantially. When the livestock study, currently being undertaken by Winrock International, and the external reviews of ILRAD and ILCA are completed, TAC will revisit livestock research priorities.¹

12.4. Conclusions

With respect to the assessment of priorities, in Systemwide terms, by activity category, TAC recommended a substantial increase in the priority allocated to conservation and management of natural resources including germplasm conservation, and of socioeconomic, public policy and public management research. The Committee recommended a reduction in the priority allocated to development and management of production systems and of institution building, while the current priority ranking of germplasm enhancement and breeding is to be maintained.

TAC considered that in the medium term the share of resources allocated to sub-Saharan Africa and to West Asia-North Africa should be reduced modestly, while the share allocated to particularly Asia and Latin America should be increased. The Committee did not make a recommendation on the level of priority by production sector, but notes that the proposed new programmes in forestry and fisheries should not be funded at the expense of critical research needs in crops and livestock.

TAC reaffirmed the priority it is currently allocating to the cereal and root and tuber crops. Among food legumes, it proposes to reduce the level of priority of phaseolus bean modestly, and that of pigeonpea significantly.

The priority ranking of groundnut and soybean should be increased, while that of faba bean and lentil, chickpea and cowpea should be maintained. The current level of effort on banana and plantain will also be maintained, and TAC reaffirmed its views on the priority level for research on vegetables and coconut. Finally, TAC considered the priority ranking of livestock and noted that the CGIAR is currently overinvesting therein, particularly in sub-Saharan Africa.

With respect to recommendations on forestry and fisheries, TAC reaffirms the outcome of the analysis made in Chapters 7 and 8. Furthermore, TAC is pleased with the good progress that is being made in the implementation of a new forestry research initiative in the CGIAR through the establishment of the Centre for International Forestry Research (CIFOR) and in ICLARM's efforts to develop a strategic plan for international fisheries research in the CGIAR.

¹ TAC/CGIAR, 1993. Priorities and Strategies for Livestock Research in the CGIAR.

12.5. Final Observations

The approach taken by TAC to this priority analysis is more comprehensive and a great deal more quantitative than previous TAC efforts. We have attempted to bring into the analysis quantitative indicators of the most important dimensions of the CGIAR mission and goals. We have also carefully reviewed the outputs of similar efforts such as those of ACIAR. A major conclusion arising from TAC's analysis is that the current constellation of activities in an expanded CGIAR is largely congruent with present and future research and research-related activity needs but that much greater emphasis still needs to be given to natural resource conservation and management. Although in the medium term further changes will be required in the overall balance of effort, these will not require a dramatic departure from current activities. Stated another way, TAC's review of activity balance, regional distribution of resources and commodity congruence suggests that the "founding fathers" of the CGIAR, and its changing membership since, have charted a course that allows for evolution and change and continues to address high priority issues.

This should not be surprising, because the challenges that faced the CGIAR at its birth have, if anything, become more serious since 1970. Population growth continues at high rates, particularly in sub-Saharan 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 severe. Thus TAC finds that the focus on applied and strategic research of international importance focused on the twin needs of productivity improvement and sustainable resource management for agriculture, forestry and fisheries is indeed more important now than it was in 1970. Despite a broadening commodity portfolio and additional interests in natural resource management (particularly in agroforestry and forestry), the CGIAR remains a highly focused organization. The System still devotes critically 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.

The ability of the CGIAR to continuously adapt to changing circumstances should be seen as a strength of the CGIAR. The Group has always been forward looking. The CGIAR in 1991 is both similar to, and different from, the innovative model created in 1971. 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.

CHAPTER 13 - IMPLICATIONS OF TAC'S RECOMMENDATIONS ON PRIORITIES FOR FUTURE CGIAR STRATEGIES AND STRUCTURE

13.1. Introduction and Conceptual Background

13.1.1. TAC's Sequential Approach to Priorities, Strategies and Structure

The approach taken by TAC in its analysis of priorities and strategies proceeded in three stages. The first step was to develop an analytical framework to address the question of what research should be supported by the CGIAR and what should be the relative emphasis attached to the identified activities. The determination of what to do in relative terms is the setting of priorities. The second step asked the question of how the identified priorities should be addressed. This is the issue of determining the appropriate strategy for the CGIAR to follow in implementing its priorities. The third step, once priorities and strategies were agreed upon, was to ask who should do the research and how should it be organized, by centre, network or consortium. This is the question of structure. Each step preceded the other.

The future structure of the CGIAR will evolve according to the collective views of the CGIAR, centres, and national partners. TAC sees that its role is to provide reasoned input to the debate, not to recommend a particular structure. This chapter does not, therefore, contain a single set of specific recommendations for the future structure of the CGIAR. Rather, TAC is sharing with the CGIAR how it analysed what is, in the Committee's judgement, a plausible set of alternatives. The Committee is also providing a coherent proposal on how it intends to undertake, during the next five years, a strategic analysis of different research activities and commodity groups supported by the CGIAR with the aim of recommending more cost-effective ways of organizing CGIAR efforts in those areas.

The analytical framework developed by TAC to translate the complex dimensions of the CGIAR mission and goals into an array of relative priorities among activities, agroecological zones, regions, production sectors and commodities has been described in Chapter 12 of this report. The results of the analysis are TAC's recommendations on future priorities. In this chapter, TAC addresses issues of strategy and structure.

In approaching its task, TAC drew on previous work done in the analysis of the potential CGIAR expansion ('A Possible Expansion of the CGIAR', AGR/TAC: IAR/90/24). In that analysis TAC developed medium/long and long-term visions of the CGIAR (Chapter 8) and discussed possible institutional (structural) options (Chapter 11)¹. In addition TAC over the past four years has considered many centre strategic plans, external reviews, medium-term proposals and inter-centre commodity and other special purpose reviews.

¹ To prevent confusion in terminology between medium-term programme and budgets (five years) and TAC's medium-term vision (2010), the term medium/long is used for the 2010 target.

Using these as a basis, as well as Chapters 1 to 12, TAC presents in this chapter some further thoughts on strategies and structure. The analysis reaches tentative conclusions with regard to strategies. For example, the issue of ecoregional approaches is addressed directly - which ecoregions merit CGIAR programmes, can priority ecoregions be combined to reduce the number of mechanisms needed, and how well do current centres match with ecoregional needs. Similarly TAC addresses more fully the medium/long-term needs for global mechanisms. The Committee also addresses issues related to restructuring the CGIAR.

This chapter proceeds as follows. TAC first reviews briefly the major conclusions of the priority exercise and updates the Group on its emerging medium/long- and long-term visions of the CGIAR. This is followed by a further elaboration of the ecoregional concept and a possible medium/long- and long-term model for the CGIAR in, say, 2010 and beyond. TAC then presents the key strategic principles it used in its analysis and updated views on the ecoregional approach to research. It proceeds by making a proposal on how the ecoregional approach could be implemented and presents current views on the organization of global activities. The chapter concludes with some thoughts on linkages between ecoregional and global entities, and on the implications for existing centre mandates.

13.1.2. Main Conclusions of the Priority Exercise

TAC's analysis of CGIAR priorities, in Systemwide terms and by activity category, led the Committee to recommend a significant increase in the research efforts on natural resources conservation and management, and on socioeconomics, public policy and public management. It recommended that the current priority ranking of germplasm enhancement and breeding should be slightly increased. The Committee also recommended that CGIAR investment in research on the development and management of production systems and on institution building should be reduced because of increasing strength of national programmes and lack of special advantage for the CGIAR.

TAC considered that in the medium term the share of resources allocated to sub-Saharan Africa and to West Asia-North Africa should be modestly reduced, while the share allocated to Asia, in particular, and LAC should be increased. The Committee did not make a recommendation on the level of priority by production sector, but considered that the proposed new programmes in forestry, agroforestry and fisheries should not be funded at the expense of critical ongoing research in crops and livestock.

In the agricultural and forestry sectors, the analysis indicated that, relative to the baseline, emphasis should increase in the tropical AEZs 1-4 and, for agriculture, additionally in the cool sub-tropics with winter rainfall AEZ 9. In both cases, greater increases were suggested for the tropical AEZs of SSA relative to those of Asia and LAC. However, it is noted that TAC does not have adequate information on the current distribution of CGIAR efforts by AEZ and therefore did not make recommendations on the distribution of effort by agroecological zone.

TAC reaffirmed the priority currently given to the cereal and root and tuber crops. Among the food legumes, it proposes reducing the level of priority of phaseolus beans modestly, and that of pigeonpea significantly. The priority of groundnut and soybean should be increased, while that of lentil, chickpea and cowpea should be maintained. The current level of effort on banana and plantain should also be maintained.

TAC reaffirmed its views on the priority level for research on vegetables and coconut. With respect to livestock research, the balance of the CGIAR effort should be redirected from its current focus on sub-Saharan Africa to a more global programme.

13.1.3. TAC's Medium/Long- and Long-Term Visions of the CGIAR

In its report 'A Possible Expansion of the CGIAR', TAC outlined a medium/long (2010+) and long-term (2025+) vision for the evolution of the CGIAR System which was endorsed in principle by the CGIAR in 1990. Realization of that long-term vision would depend heavily on improvements in the capacity of national research systems and the development of effective regional and transnational mechanisms of cooperation. The long term was defined in terms of the period when most national research systems in developing countries would be strong enough to meet their own national research needs. The underlying assumptions are that, in the long term, the capacity of NARS would become stronger; that there would be strong and effective regional and transnational mechanisms for research collaboration; that research and information networks would become a major mode of operation; that sharing of research responsibilities as well as joint planning of research between NARS and IARCs would increase; and that the private sector would become an important alternative supplier of research. Consequently, the CGIAR System would be expected to be smaller and quite different from what it is at present. TAC, recognizes, however, the continuing particular needs of sub-Saharan Africa where, in general, national research systems continue to be weak, and in some cases are even getting weaker.

It is TAC's judgement, based on considerations of international public goods, economies of scale, and spillovers, that there would be a continuing need for international efforts in the long term in:

- germplasm collection, conservation, characterization, evaluation and enhancement, and basic genetic manipulation of plants and animals of transnational and/or global significance;
- strategic research on global issues of natural resources conservation and management;
- strategic research on public policy and public management issues of global significance; and
- global information services related to research in agriculture, forestry and fisheries.

Currently, many CGIAR Centres are involved in applied, and even adaptive, research on germplasm improvement and breeding and on the development and management of production systems. This type of research is properly the province of national systems in the long term. To get from where the CGIAR System is now to the long term, a transitional period is essential. The challenge confronting the CGIAR is how to manage the transition period in ways that ensure effective coverage of the spectrum of urgently-needed research, while helping to strengthen NARS' capacity. TAC has therefore developed a medium/long-term vision, in terms of concepts, activities and mechanisms. In Chapter 8 of the Expansion Report and in the elaboration papers 'An Ecoregional Approach to Research in the CGIAR' (1991 b) and 'Relationships between

CGIAR Centres and NARS' (1991 a), TAC attempted to define a possible evolutionary path from the present situation through the medium/long term to the long term, in the context of possible institutional arrangements.

In the medium/long term TAC envisages the CGIAR as having two major types of activities: global and agroecological, regionally defined (for which TAC has used the term 'ecoregional'). Global activities would comprise strategic research on selected commodities and subject-matter areas while ecoregional activities would focus on applied and strategic research on conservation and management of natural resources, the development and management of production systems, and on applied aspects of commodity improvement. These views provided the basic framework for what TAC called 'the ecoregional approach to research' which is elaborated upon in Section 13.1.5.

13.1.4. Key Strategic Principles

Priority setting was TAC's starting point in strategic planning for the CGIAR. The implementation of priorities by activity, region, agroecological zone, and commodity is a major consideration in developing the strategy for the CGIAR in the medium/long term. However, TAC is aware that the priority analysis covers a broad spectrum of research needs, and recognizes that the CGIAR, as only one relatively small actor in the international research system, must be very selective.

The strategic approach must take account of the important role of NARS, advanced institutions in developed countries, and other relevant research organizations. The role of the private sector must also be considered, particularly in the light of recent developments in biotechnology, postharvest technology, plant breeders' rights, and intellectual property rights. Such developments contribute to the complexity and dynamism of the task facing the CGIAR. Although TAC has taken these issues into account in developing the CGIAR strategy, it has to be recognized that major breakthroughs in particular fields, and dramatic changes in institutions or policy regimes, are unpredictable and cannot therefore be factored into the strategy.

It should also be noted that TAC has focused its consideration of strategic principles largely on research programmes and institutional matters. However the Committee has been cognizant of the limits in funding and has therefore preferred to recommend adjustments to existing institutions rather than proposing the creation of new ones in restructuring the System to achieve its goals.

Among the guiding principles for translating TAC's medium/long- and long-term visions into strategies and structures is the idea of building on the current strengths of the CGIAR. These include the System's:

- apolitical and international character;
- decentralized management (independent centres, autonomous donors and a system of checks and balances through reviews);
- concept of critical mass;
- hands-on research capability;

- relationships with partners;
- stable but flexible funding; and
- sound experience in research with a commodity and subject matter focus.

However, the CGIAR System should also make every effort to overcome its own shortcomings, such as:

- overlapping commodity responsibilities;
- overlapping resource-management mandates;
- lack of a clear designated responsibility for strategic research on resources management issues;
- uncoordinated decentralization of a variety of activities;
- lack of coordination of centres' capacity-building efforts and national research systems; and
- inadequate accountability to partners.

In the medium/long term, a major challenge for the CGIAR Centres will be to improve their collaboration with NARS, particularly their contribution to strengthening national programmes, devolution of activities to the stronger NARS, and development of transnational mechanisms for scientific cooperation. While there is wide recognition that the CGIAR is not equipped to play a direct and leading role in these types of activities, it should, in association with other actors, actively support efforts focused on strengthening NARS and transnational collaborative mechanisms. ISNAR is expected to play a major role through its research-based services in a restructured CGIAR.

Joint work between CGIAR Centres and NARS through networks, consortia and other collaborative programmes of the proposed ecoregional mechanisms will certainly help strengthen NARS' capacity at the scientific level. However, the CGIAR efforts should not be a substitute for institution-building or capacity-strengthening activities in national research systems by governments and development agencies.

Among the concerns expressed by NARS' leaders about the nature of CGIAR-NARS relationships are: the unbalanced resource endowments; the top-down priority-setting mechanisms; the stratification of tasks, resulting in frustration of NARS; competition between centres for NARS collaboration, which has at times overburdened national scientists and caused internal fragmentation of NARS programmes. There has also been a tendency for bilateral one-on-one initiatives between centres and NARS, which have sometimes been set up at the cost of integrated regional cooperation between NARS.

In TAC's judgement, some of the main weaknesses of the CGIAR could be overcome by a sharper delineation of responsibilities between CGIAR global and ecoregional mechanisms, and this is the key organizing principle in TAC's options for restructuring the CGIAR System. As pointed out in the 'Report of the TAC/Centre

Directors Working Group on the Ecoregional Approach to Research in the CGIAR' (1993), the ecoregional approach will entail a deliberate move along the following lines:

- filling gaps and minimizing overlaps in the coverage of research relating to natural resources conservation and management;
- rationalizing overlapping commodity responsibilities;
- providing focal points within an organized agroecological framework for coordinating decentralized research activities; and
- streamlining interactions between NARS and CGIAR Centres to avoid confusion at the national level, by coordinating institution-building efforts and other activities.

TAC notes that these principles are all consistent with the CGIAR mission and goals, but that given the current realities of the CGIAR System and its components, and the present and potential heterogeneity in the capacity of national research systems, they may not be easy to follow. A pragmatic rather than a doctrinaire approach must therefore be taken in applying them.

In approaching the delicate issue of recommending future structures for the CGIAR, TAC debated three possible approaches, all of which were aimed at achieving the medium/long- and long-term visions of the System. The first was the 'clean slate' approach in which a structure for the System at a funding level of US\$ 240 million is devised, with no attention being paid to the current structure. The second approach suggests only the minimum necessary changes to the current structure in order to accomplish the inclusion of the specific new activities. The third 'pragmatic' approach was intermediate between the first and second approaches, in which the possibilities of restructuring were considered with respect to the existing structure.

TAC adopted the third approach, and emphasized that the CGIAR should:

- Build on the high-quality and efficiently-operated parts of the System.
- Keep firmly in mind the medium/long-term vision and the objective of delineating responsibilities for activities and reducing the potential for conflict and confusion.
- Clearly distinguish between an activity and an institution. TAC is pressing for clear responsibilities for tasks but sees no particular reason why an institution could not undertake two activities, one global and one ecoregional. The guiding principle for a centre with dual responsibilities should be that each activity brings its own clear priorities and that neither activity should dominate the other, either intellectually or in terms of resource availability.
- Maintain the principle that an institution is an organizational form with governance, management and operational functions. There can be varying degrees of decentralization, both of decisions and the geographic location, of the management and operations.

- Use the most appropriate forms of decentralization to achieve a balance between maintaining a critical mass for the effective pursuit of particular research projects and the possible diseconomies of very large congregations at single sites.
- Ensure that scientists at all levels have opportunities to collaborate directly or indirectly with the ultimate partners, the national programmes, and have access to necessary global discipline and basic research links. The global centres must not become basic research enclaves isolated from applied and adaptive problems. Nor can the ecoregional mechanisms become provincial islands isolated from advances in science. Fostering effective collaboration is a key to the future success of the CGIAR.

13.1.5. The Ecoregional Approach to Research

The ecoregional approach to international research was first introduced by TAC when considering the possible expansion of the CGIAR System, within the context of the development of its medium/long and long-term visions of the evolution of the CGIAR. The ecoregional approach was proposed by TAC as a vehicle: (i) to achieve sustainable improvements in agricultural production by balancing commodity improvement research with increased research on natural resources management; and (ii) to rationalize relationships between CGIAR Centres and NARS. Since the ecoregional approach is a new, key organizing principle for the CGIAR, the main concepts and implementation considerations are reiterated here.

TAC had presented its views on ecoregional approaches to research and the priorities for a CGIAR involvement in this area at MTM'92. At that meeting, members of the CGIAR had expressed a strong desire for a mechanism that would assist in developing a coherent CGIAR approach. As a result, TAC and the Centre Directors' Committee for Sustainability and the Environment worked together to develop proposals for such a mechanism, and a joint TAC/Centre Directors Working Group was commissioned to prepare a discussion document¹. The report of this Working Group was submitted in February 1993 and was discussed by both TAC and the Centre Directors, who each issued a commentary on it. The report was also distributed to heads of national research systems and members of the CGIAR, and was further considered at a workshop on 29 May 1993 in San Juan, Puerto Rico, and by heads of national research systems in sub-Saharan Africa at a meeting organized by the Special Programme for African Agricultural Research (SPAAR) on 29-30 April 1993.

The ideas presented in the remainder of this section are drawn from the various materials developed by TAC and the joint TAC/Centre Directors Working Group as the concepts evolved.

¹ TAC Secretariat, 1993. The Ecoregional Approach to Research in the CGIAR. Report of the TAC/Centre Directors' Working Group. FAO, Rome.

13.1.5.1. Concept

The TAC concept of an ecoregional approach is that of a strategy for bringing a new balance to international agricultural research in order to enhance the sustainable improvement of productivity, and for gradual transition in the organization of the global agricultural research system to meet the sustainability challenge.

TAC recognized the inherent advantages of organizing research on the physical and biological aspects of the conservation and management of natural resources, including biodiversity, along agroecological zones. In contrast, the Committee recognized that the socioeconomic circumstances shaping such research, and the support needs of national programmes, are better differentiated by national and regional boundaries. TAC therefore developed the idea of regionally-defined agroecological zones, and coined the phrase 'ecoregional' to describe them.

There are three aspects of the ecoregional approach to research:

- conducting applied and strategic research on the foundations of sustainable production systems in the ecoregion;
- improving productivity in the ecoregion by drawing in appropriate global research activities; and
- strengthening the cooperation with national partners and developing transnational mechanisms for collaboration.

The global community does not yet have an effective paradigm for the sustainable improvement of productivity. Identifying such a paradigm and making it operational is an urgent goal of truly international relevance and significance.

New modes of operation will be needed for both the implementation of the ecoregional approach and for closer collaboration with other international sources of expertise. These include expertise in the biophysical resource base of the ecoregion, in policy or institution-building capacity, and expertise in the improvement of crops, livestock and trees which do or could contribute to the production systems under research. The complexity of the task will demand a wider range of skills than currently resides in the CGIAR Centres, and thus the need for a wider range of partnerships, including other international and national institutions. The policy dimension of the approach will require not only strong sociopolitical understanding but political support in participating countries. Consortia of institutions are one possible mechanism for collaboration.

CGIAR success will continue to depend on close working relationships between centres and the NARS. TAC is aware of difficulties persisting in these relationships (many caused by the existence of global and regional mandates for the same commodity at different centres), and of their often one-sided nature. As the CGIAR restructures, TAC stresses the need to rationalize overlapping centre mandates, resolve the duplication of efforts in capacity building, and modify CGIAR-dominated planning processes, all of which have aggravated relationships and overburdened weaker NARS. Such rationalization will bring greater effectiveness to the global research system.

During the transition from the medium/long to the long term and as national systems become stronger, CGIAR ecoregional activities will be progressively replaced by work in national programmes and transnational mechanisms. As regional entities take on a greater share of responsibility, the winding down of its ecoregional initiatives will leave the CGIAR as a set of global activities, justified by the wide spillover of results throughout the developing world. The nature and pace of such change will depend on a strengthened political commitment to research in the developing countries and cooperation between the countries of a region. Such commitment will grow from a better understanding of the importance of new agricultural technology to human survival and development, and of the benefits of transnational collaboration in agricultural research.

13.1.5.2. Implementation

No single organizational model will serve the needs of all ecoregions; the diversity in NARS' capabilities, the varying mandates of the CGIAR Centres and the location-specific manifestations of the degradation problem preclude uniformity. However, the following set of broad guidelines provides for a pragmatic, non-overlapping set of coordinated programmes, and a new dimension for the CGIAR. These programmes would: operate on a regional basis; focus on an important agroecological zone with a potential or actual sustainability problem; combine natural resources management and productivity objectives; employ a multidisciplinary approach; include both natural and social sciences; involve national research institutions and other partners in a synergistic way; adopt flexible systems of governance and priority setting; ensure global coherence in System strategies; and utilize flexible funding mechanisms.

(a) *Operational mechanisms for the ecoregional approach*

The mechanism adopted or preferred by the centres to implement natural resources management initiatives is the consortium, defined as the partnership of diverse institutions to accumulate critical mass and to jointly plan and implement an integrated research programme of common interest.

The formation of the consortium has to be catalysed and supported by a convening agency, sometimes a centre, which provides seed money to support early planning activities. Within the consortium, a steering committee could be established for priority setting, further fund raising and task allocation based on the inherent advantages of the respective partner institutions.

When a centre is convenor, it is usually because it is located in the ecoregion with a sound knowledge of the institutions of the countries in the region. It may or may not become the research leader. Since systems concepts drive the research approach, centres and institutes which have a major research role in the ecoregion are obvious candidates as consortium partners. Early diagnostic work bringing a closer understanding of the problem will be important in finalizing membership. The need to integrate the activities of a number of international collaborators at in-country sites requires innovative thinking on country agreements.

Collaborative programmes with NARS and other relevant research agencies are the obvious mode for implementation. The regional specificity of the research, and the necessary links with community organizations, national institutions and policy makers will

demand political support at the highest national level, and funding support for both research and key complementary activities.

Ecoregional mechanisms should adopt organizational forms appropriate to the type and level of research needed and the strength of collaborating national systems. Where national systems are weak, the ecoregional mechanism will need to implement research through the full continuum, from strategic understanding of physical processes down to the introduction of technology on farms at the selected field sites in the region.

Each ecoregional mechanism will have the capacity to conduct research at only a limited number of sites. Each site should represent a defined area, often a watershed, and the unit of social cohesion, usually the community which manages it. The research approach will seek to understand the physical and biological processes critical to sustainability in this unit. It will also seek to understand the influence on the management of these processes from human decisions made at the farm, community, institutional and policy levels. These same human decision points will be fundamental to finding solutions for the sustainable management of the physical and biological resources. Research at each site will require close collaboration between CGIAR Centres, the national research system, national policy agencies and NGOs and farmers' associations working with local communities at the grassroots to cope with the many dimensions of the challenge of evolving sustainable production systems.

As well as contributing to the search for a research paradigm for the sustainable improvement of productivity, outputs from the research sites will be of immediate value at both the local and the AEZ level: at the local level, in the communities represented by the field sites, implementation of the approach will provide technology guidance on changes in social organization and policy needed for the sustainable improvement of productivity in the existing farming systems; at the same time the better understanding of the soil, water and biological processes from the representative field sites will be relevant to the whole agroecological zone beyond the immediate ecoregion. The need to share experiences from several locations demands coordination in site selection, collaboration in operation and the synthesis of results on themes common to these locations to provide aggregated research outputs.

The same sites will offer a training forum for scientists from the countries of the region, who will gain first-hand experience of the dimensions of natural resources management research including the national and transnational coordination required for its planning, implementation and the mobilization of the research outputs into farmers' fields.

(b) Future CGIAR/NARS relationships

Ecoregional mechanisms should build on the range of useful experiences already gained from the evolving relationships with national research systems across the world¹. A major aim in relations with NARS will be to move towards the implementation of priorities for research determined by regional or subregional associations of countries or scientists, organized in an appropriate way, enjoying support and approval from the relevant scientific communities and government. The aim is to achieve coherence in the CGIAR response to the needs of the countries in the subregion to replace individual and often duplicate initiatives by a number of different centres.

Contractual relationships, required either by ecoregional or commodity mechanisms to meet the needs of their own programmes, could be facilitated through the same consultative procedure. TAC suggests that existing mechanisms of transnational collaboration should be used where they are available, although there may sometimes be a need for modification of these mechanisms. Beyond the medium/long term, TAC's view is that CGIAR ecoregional mechanisms should pass greater responsibility to national systems and transnational collaborative mechanisms as these mature.

The major gain expected from restructuring the CGIAR into global and ecoregional dimensions is the greater coherence in the System's continuing roles of bridging and gap filling in agricultural research for developing countries. Bringing the concept of sustainable improvement of productivity to operational reality, and moving towards a closer integration of national needs with the global research agenda, will both add coherence to System strategies and streamline relations with national research systems. As noted, addressing national needs with a coordinated effort across subregions should mean more effective support and training and less burden on weak national systems from the continued interaction of each country with independent initiatives from several IARCs.

13.2. Future Strategies and Structure for the CGIAR

13.2.1. Ecoregional Activities

TAC approached the question of translating the ecoregional concept into operational structures in two stages: assessing the CGIAR priorities and activity needs in each ecoregion and, with results of that analysis in hand, assessing the institutional options for priority ecoregions.

All ecoregions have areas in which population levels have exceeded the ability of communities to sustainably manage their natural resource base according to traditional knowledge. While TAC acknowledges the importance of sustained production from the

¹ TAC thereby adopts ISNAR's broad definition of a national research system which is as follows: "A national agricultural research system comprises all of a country's entities responsible for organizing, coordinating, or executing research that contributes explicitly to the development of its agriculture and the maintenance of its natural resource base." Under this broad definition of NARS, non-governmental and private sector organizations would also be included in addition to governmental organizations and universities.

high potential lands, particularly the irrigated ecosystems forming the breadbaskets of Asia, it also notes that many countries must depend on inherently less productive resources to ensure food security.

The assessment of CGIAR priorities by ecoregions involved three steps:

- first, combining ecoregions for purposes of programme definition, since the individual ecoregions were considered to be too fine a classification for defining operational research programmes;
- reviewing the relative priority index generated by the priority exercise for combinations of ecoregions;
- reviewing the intensity of research needs in each ecoregion (or combination of ecoregions) as outlined in Chapter 4, and assessing whether each combination of ecoregions resulting from the analysis should have a formal CGIAR programme.

Once the priorities and activity needs had been assessed, TAC explored institutional options that might be used to deliver a CGIAR ecoregional programme. TAC's assessment included comparing identified ecoregional needs with existing centre capacity to determine if centre programmes might be adjusted to meet future needs.

13.2.1.1. Priorities by ecoregion

TAC's priority analysis was based on nine agroecological zones (AEZ) and four regional groupings of developing countries: sub-Saharan Africa (SSA), West Asia-North Africa (WANA), Asia and the Pacific, and Latin America and Caribbean (LAC). Ultimately, 21 ecoregions were used in the priority-setting exercise. As TAC reviewed research needs, centres' strategic plans and commodity distribution across ecoregions, it was noted that CGIAR Centres do not normally distinguish between the tropics and subtropics in programme definition since there are great similarities in cropping patterns in both. TAC concluded, therefore, that the tropical and subtropical ecoregions with similar moisture regimes should be considered together. Thus, the pairs of AEZs 1 and 5, 2 and 6, 3 and 7, and 4 and 8 were combined for further analysis. The result of this first strategic choice was to reduce the number of consolidated ecoregions from 21 to 14: 4 in Asia, 4 in SSA, 5 in LAC and 1 in WANA.

TAC then reviewed the relative priority index for each of the 14 consolidated ecoregions. The results of this analysis are presented in Table 13.1. The values in the table add up to a total of 1000 which results from the application of nine modifiers to the composite base line.

Table 13.1. Distribution of relative priority indices by AEZs and geographic regions, within agriculture*

Consolidated AEZs	SSA	WANA	Asia	LAC
Warm arid and semi-arid tropics and sub-tropics with summer rainfall (AEZs 1+5)	136.8	-	121.1	23.7
Warm sub-humid tropics and sub-tropics with summer rainfall (AEZs 2+6)	68.2	-	64.4	39.9
Warm humid tropics and sub-tropics with summer rainfall (AEZs 3+7)	98.6	-	148.2	73.7
Cool tropics and sub-tropics with summer rainfall (AEZs 4+8)	33.1	-	63.6	42.0
Cool sub-tropics with winter rainfall (AEZ 9)	-	81.1	-	5.8

*Derived from Table 9.15 (all modifiers weighted 0.5)

TAC also reviewed the distribution of values of commodity production across ecoregions to determine whether commodity production patterns crossed boundaries between consolidated ecoregions (Table 13.2). An analysis of Table 13.2 suggested that there was merit in consolidating ecoregions on the basis of similarity in cropping patterns and commodities produced. Clearly, many commodities such as rice and maize are grown in most ecoregions, while others such as pigeonpea and barley, are relatively important to particular ecoregions. This information was useful in analysing whether a particular ecoregion would be better served by a commodity-focused as opposed to a full ecoregional programme.

Table 13.2 : Values of commodity production, modified by the relative priority index, of CGIAR commodities (modifiers at 0.5) across ecoregions (values as a proportion of a total of production of 10,000)

commodity	ECOREGIONS														TOTALS (%)
	SSA				WANA	ASIA				LAC					
	1	2	3	4	9	1+5	2+6	3+7	8	1+5	2+6	3+7	4+8	9	
RICE	57.7	38.8	79.8	0.6	24.7	499.2	309.5	846.1	22.0	11.9	20.9	56.6	8.3	0.9	19.8
WHEAT	12.4	0.2	0.1	15.1	158.7	117.1	27.3	37.9	178.7	10.2	2.0	11.3	21.4	7.8	6.0
MAIZE	106.5	51.4	36.7	37.7	21.1	34.6	21.1	69.7	121.3	20.5	28.1	52.7	31.4	2.5	6.4
BARLEY	0.6	*	*	12.5	55.2	3.5	1.6	0.0	10.2	0.7	0.1	0.3	3.1	0.3	0.9
SORGHUM	115.0	34.0	7.4	10.0	2.9	26.6	8.1	0.1	*	7.8	4.6	0.6	11.1	0.1	2.3
MILLET	115.3	42.2	4.8	0.2	0.8	30.7	9.4	0.3	0.9	0.0	0.0	*	0.1	*	2.0
CASSAVA	148.8	109.6	241.3	6.5	*	11.6	26.4	72.3	*	7.4	21.3	32.0	*	0.0	6.8
POTATO	7.1	8.6	5.2	20.5	56.5	36.5	13.3	27.7	86.2	5.1	1.4	5.4	40.2	4.4	3.2
SWEET POTATO	24.5	21.2	12.6	16.3	0.2	39.2	20.6	73.5	*	2.4	1.4	1.6	0.6	0.1	2.1
YAM	5.8	125.5	153.1	0.1	*	*	*	0.9	*	0.4	0.5	1.9	*	*	2.9
BANANA & PLANTAIN	8.8	144.6	119.4	66.8	2.1	0.4	27.9	58.4	0.0	18.5	20.4	51.8	23.9	0.1	5.4
CHICK PEA	1.7	1.3	*	3.0	8.8	32.8	9.0	1.1	1.7	0.5	0.2	0.4	0.6	0.1	0.6
COW PEA	77.9	30.5	22.5	*	0.1	*	0.4	0.3	*	0.7	*	0.0	*	*	1.3
PIGEON PEA	2.7	4.0	*	*	*	19.6	5.4	0.0	0.2	0.1	0.3	0.2	*	*	0.3
BROAD BEAN	6.7	1.4	*	10.7	12.3	2.5	1.3	3.4	16.8	0.3	0.5	0.6	1.0	*	0.6
LENTIL	0.2	0.1	*	0.9	13.7	7.1	1.8	2.9	2.0	0.1	0.0	0.1	0.3	0.3	0.3
BEANS	32.8	36.5	21.8	42.4	11.5	13.2	5.8	5.8	3.6	10.2	15.1	28.1	12.8	1.6	2.4
SOYBEAN	4.4	2.2	1.0	0.2	2.8	16.9	10.6	27.0	*	17.6	43.1	81.6	17.1	1.0	2.3
GROUNDNUT	218.9	57.0	66.1	5.2	2.8	121.8	48.7	24.5	*	4.0	4.5	0.6	0.1	0.4	5.5
COCONUT	12.1	5.9	13.7	*	*	21.6	13.7	131.9	*	2.8	2.7	5.9	*	*	2.1
BEEF & BUFFALO MEAT	215.8	51.6	55.6	58.0	55.5	28.9	17.2	52.0	30.4	49.8	54.3	102.9	103.4	10.0	8.9
SHEEP & GOAT MEAT	121.9	18.2	19.6	25.2	64.8	30.3	6.4	14.3	27.2	2.3	1.9	3.7	6.6	0.9	3.4
MILK	386.8	30.4	9.1	66.8	128.7	358.8	88.9	25.2	49.9	46.9	55.2	107.9	87.5	10.8	14.5
TOTALS (%):	16.8	8.2	8.7	4.0	6.2	14.5	6.7	14.8	5.5	2.2	2.8	5.5	3.7	0.4	100

* value < 0.5

While TAC did not adopt a minimum value for the relative priority index, it did carefully review those ecoregions with a relative priority index less than 50.0. At this stage, TAC ruled out, on the basis of low-priority ranking, separate programmes for LAC-AEZ 9 and LAC-AEZs 1+5. In other cases, TAC considered that further amalgamation of ecoregions could be necessary to justify a formal programme.

Finally, TAC's analysis of research priorities showed that more research on the conservation and management of natural resources was needed in every region and agroecological zone, although the size of the increase and the type of research needed differed across the regions as discussed in Chapter 4. TAC recognized the need for greater CGIAR ecoregional involvement in applied research on production systems development and management in the areas where NARS are weaker, despite the general recommendation that activities in this category should be reduced.

Based on all these analyses, TAC's assessment of the need for ecoregional activities in different ecoregions is as follows:

- (i) **Sub-Saharan Africa** - An ecoregional programme in the warm arid and semi-arid tropics appeared to be justified by the analysis which resulted in a priority ranking of 136.8 for this ecoregion. The combined priority index for the warm humid tropics (AEZ 3) and the warm sub-humid tropics (AEZ 2) is 166.8, which would also justify an ecoregional programme. The cool tropics (AEZ 4), basically the East African Highlands, has a priority index of only 33.1 which is less compelling for a stand-alone programme. However, TAC considers that the research needs in this ecoregion are important and that national programmes in this area are particularly weak with respect to resources management research.
- (ii) **West Asia-North Africa** - The cool subtropics with winter rainfall (AEZ 9) in this region has a priority index of 81.1. The geographic contiguity of the region and its pressing resources management needs justify a continuing ecoregional research programme. TAC noted that irrigated systems are important in this region and suggested that, where appropriate, irrigated ecosystems could constitute specific research domains of ecoregional programmes.
- (iii) **Asia and the Pacific** - The Asian region is large and diverse in all respects. The warm semi-arid tropics and subtropics with summer rainfall (AEZs 1+5) have a relatively high priority index (121.1), which reflects the major issues in resources management, population and poverty which, in the short term, would suggest a continued CGIAR effort in this ecoregion. TAC notes, however, that virtually all of this ecoregion is contained in two countries, India and Pakistan, both of which are judged to have relatively strong national programmes. In the longer term, this ecoregion would be an early candidate for the transfer of CGIAR efforts to regional mechanisms or national programmes. The warm humid and sub-humid tropics and subtropics with summer rainfall (AEZs 2, 3, 5, 7) have a combined priority index of 212.6, dominated by AEZ 3 (120.7) and AEZ 2 (43.0). This is a vast area with serious resource degradation problems and a burgeoning population.

Although the major crop is rice, upland crops, agroforestry, forestry and coastal ecosystems are also important, suggesting a need for ecoregional approaches to research. Institutional options for this area are discussed in the next section. The cool tropics and subtropics (AEZ 8) has a lower priority index (63.6) and is almost all contained in China and the adjoining border areas. TAC concluded that a major CGIAR ecoregional programme was not justified in this area.

- (iv) **Latin America and the Caribbean** - The warm arid and semi-arid tropics and subtropics with summer rainfall (AEZs 1+5) of LAC have a low relative priority index (23.7), are widely dispersed geographically and are sparsely populated with a limited number of commodities; maize, wheat and cattle. There could be spillovers from ecoregional programmes in SSA and Asia that could partially serve this region. In TAC's judgement, a separate ecoregional programme was not justified. TAC considered an amalgamation of ecoregions 2, 3, 6 and 7 because of geographic proximity, overlapping cropping patterns and similar natural resources management problems. The combined priority index of 113.6 for such an amalgamation suggests justification for one CGIAR programme to cover the important research domains. TAC did not consider RAEZ 9 because of its low priority index (5.8) and its concentration in two relatively advanced countries, Chile and Argentina. The remaining aggregate is AEZs 4 + 8, the cool tropics and subtropics with summer rainfall (the highlands of Latin and Central America) which, like the highlands of Africa, has a relatively low priority index (42.0) and is geographically diverse. However resources management issues are particularly acute in mountainous regions and poverty is pervasive. In TAC's view, the CGIAR would be well advised not to ignore highland ecosystems, though the establishment of separate major core funded programmes in Latin America and Africa is probably not justified. Institutional options are discussed in the following section.

In summary, TAC concluded that six ecoregional programmes were justified: two in SSA in the warm arid and semi-arid tropics (AEZ 1) and the warm humid and sub-humid tropics (AEZs 2 +3); one in WANA in the cool subtropics with winter rainfall (AEZ 9); two in Asia in the warm arid and semi-arid region (AEZs 1+5), and the warm humid and sub-humid tropics and subtropics (AEZs 2, 3, 6 + 7); and one in LAC in the warm humid and sub-humid tropics and subtropics (AEZs 2, 3, 6 + 7). In addition, there may be justification for programmes in the cool tropics in LAC and SSA if either inter-regional mechanisms were possible or if the programmes for each region were institutionally combined with other mechanisms.

13.2.1.2. Institutional options

At the special workshop on ecoregional approaches in San Juan on 29 May 1993, members of the CGIAR requested that TAC develop a proposal for the implementation of the ecoregional approach that would ensure the orderly evolution of the System towards greater coherence and rationalization. The CGIAR was supportive of TAC's proposal to select a limited number of ecoregional initiatives for funding on a programme basis. During the medium-term resource allocation process, TAC formulated a comprehensive proposal in this regard, and funds have been allocated to several ecoregional programmes in order to promote inter-centre collaboration and partnership with national research systems and other institutes. A convening centre has been

identified for each initiative but as discussed in Section 13.1.5.2, this would not be necessarily the research leader. The 'convening' role is essentially a servicing and initiating role. The convener would be a catalyst for the formation of a consortium and channel seed money to stimulate early planning activities, and provide financial accountability to donors. In all cases the research would be conducted by relevant CGIAR Centres, NARS and other institutions or agencies. TAC's institutional recommendations for each region are as follows¹:

Sub-Saharan Africa: TAC considered that support for two ecoregional programmes would be justified in the warm semi-arid tropics, and the warm humid and sub-humid tropics.

- In the warm humid and sub-humid tropics of sub-Saharan Africa, IITA would be the convening centre through its continuum, moist savanna, and forest zone programmes in West, Central and Eastern Africa. IITA would work collaboratively with WARDA within the framework of a consortium arrangement for the inland valleys in West Africa, in which WARDA currently plays a lead role.
- In the warm arid and semi-arid tropics, ICRISAT would be the convening centre, both through its Sahelian programme and its programme in Bulawayo in collaboration with the Southern African Centre for Cooperation in Agricultural Research (SACCAR).

ICRAF is currently leading an initiative on integrated natural resources management for the highlands of eastern and central Africa, in close collaboration with national programmes and several CGIAR Centres. TAC noted that while the cool tropics of sub-Saharan Africa was not considered to be a high-priority ecoregion, this highlands initiative merited support because of its innovative approach, which involved centres and NARS from the outset, and because of the weakness of national research systems in the region. This highlands initiative is currently supported with complementary sources of funding, but would be a candidate for CGIAR System programme support. ICRAF would be the convening centre for an ecoregional programme.

WANA: TAC proposes an ecoregional programme for the subtropics with winter rainfall, with ICARDA as the convening centre. It is assumed that the new programme on water management in the WANA region, for which IIMI has been designated the convening centre, will also be closely involved in this initiative.

Asia and the Pacific: TAC proposes two ecoregional programmes in Asia, one in the warm semi-arid tropics and subtropics, and another one for the warm humid and sub-humid tropics and subtropics.

¹ It is assumed that global subject matter centres such as ISNAR (institution building) and IFPRI (policy research) will be involved in most of these initiatives.

- In the warm arid and semi-arid tropics and subtropics, ICRISAT would be the convening centre. Elements of the CIMMYT-IRRI rice-wheat cropping system would also be included in this initiative.
- In the warm sub-humid and humid tropics and subtropics, IRRI would be the convening centre for an ecoregional programme particularly through its upland farming systems consortium and upland rice research programme.

Latin America: TAC considered that a programme would be justified for the humid and sub-humid tropics and subtropics of Latin America. CIAT would be the convening centre and the programme would include relevant parts of CIP's Andean programme. TAC considered whether CIP's proposed ecoregional programme for the Andean region would merit separate support. The Committee considers that the resource-management research aspects of the proposed Andean programme would more appropriately fit in CIP's complementary programme. TAC recognizes the importance of the Andean region and the need for research to overcome the urgent problems of poverty and resource degradation in the area. The Committee supports CIP's research on genetic resource conservation of lesser known roots and tubers as a core element under the Andean programme and hopes that relevant parts of the Andean programme can be integrated in the proposed ecoregional programme for Latin America. That programme may also incorporate relevant parts of CIAT's ecosystems programmes on hillsides, forest margins and savannas.

Cross-ecoregional: TAC considered there was justification for programme support to the 'alternatives to slash-and-burn agriculture' initiative which already exists and in which several centres and national programme partners are actively involved. The initiative addresses a major cross ecoregional issue. ICRAF would be the convening centre and work in close collaboration with IITA, CIAT, CIFOR, and IRRI.

TAC is prepared to receive concrete proposals through the convening centres for implementing the ecoregional programmes, with specific roles outlined for each contributing partner. The Committee stresses the importance of involving national programmes and relevant other non-CGIAR partners in these initiatives from the outset.

13.2.2. Global Activities

In section 13.2.1, TAC presented key strategic principles in approaching the question of strategy and structure of the CGIAR. These principles were applied to the consideration of both ecoregional and global strategies and structures. In approaching the issue of ecoregional activities, an intermediate step of determining which ecoregions merited CGIAR programmes was necessary before institutional options could be discussed. In the global context, such a step is unnecessary because the priority exercise has already highlighted which proposed commodities and activities merit CGIAR support and their relative priorities.

In discussing institutional options for the System's efforts on commodities research, TAC continued to aim at achieving the medium/long- and long-term visions of the CGIAR. TAC argued that research with a global perspective should be strategic and sharply focused on selected commodities and subject matters of global significance. In analysing future strategies and structure, TAC addressed a number of strategic issues: the evolving role of the CGIAR in priority-ranked commodities; the way in which form and

magnitude of their research effort should develop; and the possibility of aggregating commodity activities. The nature and scope of non-commodity global activities and the links between global activities and ecoregional mechanisms were also discussed. Finally, TAC carefully considered the optimal future structure of the CGIAR, with respect to the current shortfalls in funding to the CGIAR. As discussed elsewhere, if the situation of budget stringencies persists, the CGIAR may not be able to sustain current structures. TAC therefore discussed structural changes at the institutional, activity, regional, commodity, production sector and programme levels.

13.2.2.1. Global commodity/production sector research

TAC considered several alternative institutional possibilities for global commodity/production sector research responsibilities in the CGIAR, taking into account the preceding analysis and the recent decisions by the CGIAR with respect to institutional forms for livestock, rice, and banana and plantain. Among the criteria considered by TAC in looking at institutional options were:

- proven record and impact;
- economies of scale and existing infrastructure for research;
- possibility of spillover effects;
- centres of origin/biodiversity of the commodities;
- compatibility of research approaches among commodities; and
- existing research links between centres.

TAC considered that recent developments in CGIAR policy on intellectual property rights, plant genetic resources and biotechnology should be taken into account in the formulation of institutional strategies. The facilities needed for genetic resource conservation and for research using some molecular biology techniques are very costly, and more cost effective use of such facilities and techniques should constantly be sought.

Subsequent to the decision by the CGIAR at MTM'87 that evaluation of CGIAR priorities should be a continuing activity, TAC initiated a series of strategic analyses of CGIAR commodities. However, the process was interrupted during 1988 and delayed to allow time for the assessment of the non-associated centres.

In TAC's view a reasoned, sequential approach is likely to be more manageable than an across-the-board consideration of options despite the obvious merits of a comprehensive review. The clarification on global commodity organization provided by CGIAR decisions regarding livestock and banana and plantain research at the Mid-Term Meeting of the CGIAR in Puerto Rico in 1993, provides a useful example.

As TAC continued its analysis it considered, in a stepwise approach, options for the following groupings of commodities: cereals, roots and tubers, legumes, vegetables, coconut, banana and plantain, trees, large and small ruminants, and fish, each of which is discussed in turn below.

Cereals: The allocation of CGIAR responsibilities for rice research was largely resolved by the inter-centre review of rice, and the most recent TAC strategy statement on rice research in the CGIAR, which was generally endorsed at MTM'93.

Recent external reviews such as those of CIMMYT and ICARDA in 1993, and discussions associated with the second round of the MTP process, have highlighted the need to revisit issues related to shared responsibilities among CGIAR Centres for wheat, maize and barley, as well as the role of the CGIAR in research on other cereals specifically sorghum and millets. TAC intends to conduct strategic analyses of these commodities during 1996 in order to continue the process initiated in 1988 with maize, and in 1993 with rice, to determine whether there is a basis for re-allocating the primary responsibility for these cereals among centres. These analyses will also serve as an input into the next major revision of CGIAR priorities and strategies in 1997.

Roots and Tubers: Current responsibility for production improvement programmes in roots and tubers is dispersed across several institutes: potato and sweet potato - CIP; cassava - CIAT and IITA; and yam - IITA. Each of these three centres will be subject to an external review during 1995. At the same time, TAC will organize an inter-centre review to assess the possibilities of a more optimal organization of roots and tubers research in the CGIAR.

Legumes: Current CGIAR activities in legume research are dispersed across four centres: chickpea, pigeonpea and groundnut - ICRISAT; beans - CIAT; cowpea and soybean - IITA; and lentil and chickpea - ICARDA. As a result of its priorities analysis, TAC recommended a reduction in effort in pigeonpea and phaseolus bean, the maintenance of effort for lentil, chickpea and cowpea in the short term, and increased emphasis on groundnut and soybean. The number of species involved, the localized importance of some food legumes (see Table 13.2), the relatively low total CGIAR effort in food legumes and the integral importance of legumes in complex farming systems have led to the current situation of dispersion. TAC considers that there are no strong arguments to centralize legume research within a single global entity and there is, therefore, no need to change current arrangements for legume research. Much of legume research will continue to be conducted within an ecoregional framework.

Vegetables: TAC's recommendation on vegetables is unchanged from that made in the Expansion Report. Vegetables are considered to be a priority commodity for a CGIAR involvement, but currently there is no acceptable institutional mechanism through which CGIAR support could be organized.

Banana and plantain: As agreed at MTM'93, the CGIAR is placing highest priority on *Musa* germplasm improvement and related activities and a second priority on information and communication. Germplasm improvement activities will be conducted through a consortium, facilitated by INIBAP, under the governance and administrative structure of IBPGR. IITA will also continue its work on banana and plantain.

Coconut: TAC's recommendation of 1990 for a global programme on coconut germplasm conservation and improvement did not contain a parallel recommendation for a new institution. Rather, the emerging efforts to form a coconut germplasm network (coordinated by IBPGR) and the inclusion of coconut as a multipurpose tree in the mandate of ICRAF seems appropriate. TAC has recommended core support for IBPGR's coconut germplasm network.

Livestock: TAC and a CGIAR working group have recently considered future priorities and strategies for livestock research. On the basis of these, the CGIAR concluded that:

- Livestock research should be planned as a global programme within a Systemwide framework involving those CGIAR Centres whose work impinges on livestock development.
- A global livestock research centre should be established into which relevant components of ILCA and ILRAD would be integrated, in a manner and timeframe that will cause minimal disruption to the priority research areas of the two centres. The major components of the global livestock research programme will include: animal health, animal nutrition and physiology, animal genetics, feed resources, livestock production systems, natural resources management and policy analysis. Priority will be given to integrated crop-livestock systems, the exploitation of the adaptability and disease tolerance of indigenous livestock breeds, and expansion of the livestock feed base. CGIAR research will focus exclusively on ruminant livestock, although research on livestock feed resources may have relevance to monogastric species. The global livestock research programme will include increased collaboration with research institutes in Africa, Asia and Latin America and will foster and exploit the complementarity natures of, and synergy between, the global and ecoregional programmes.

A CGIAR steering committee on livestock research has been set up in order to follow up on these recommendations and to further efforts to integrate livestock related research across the CGIAR.

Trees: Two major tasks have been undertaken by TAC since the admission of ICRAF into the CGIAR System in 1991 and the creation of CIFOR in 1992: the external programme and management review of ICRAF, and the assessment of the Medium-Term Plans (MTPs) of both centres. These have provided fresh opportunities to critically appraise the direction of forestry/agroforestry research in the CGIAR.

The MTPs of the two Centres showed a high degree of complementarity and potential overlap. Common ground was evident in their tree-improvement and policy-research programmes. Both Centres emphasized the need to undertake research in agroforestry: and both are involved in global initiatives aimed at rehabilitating *Imperata* grassland in South East Asia; forest margins of Latin America, and finding alternatives to slash-and-burn agriculture in Africa, Latin America and South East Asia.

Both CIFOR and ICRAF have found it expedient to consider integrating some of their field activities and envisage sharing facilities in Bogor (CIFOR Headquarters) and Nairobi (ICRAF Headquarters). There is also cross-representation at Board level.

ICRAF's External Review Panel carefully considered the form which the relationship between ICRAF and CIFOR should take, in terms of the appropriate balance in the 'trees-in-land-use' research activities, and the resolution of the differing views concerning which part of the forestry-agriculture continuum should appear in the mandate of each centre; since both are committed to the same target group, i.e., 'poor people', with emphasis on non-timber, non-market output from secondary forests or reclamation of degraded lands. The Panel's prescription was that ICRAF should take the global lead in

developing and disseminating agroforestry technology, while CIFOR should take on the same role for those activities that clearly fall within the forestry domain. Both centres would collaborate in activities falling towards the middle of the continuum with ICRAF focusing more on Africa and CIFOR focusing more on Asia.

At TAC 61, the Committee addressed the ICRAF-CIFOR relationship at length, both in considering the MTP proposals of the Centres and as part of the Systemwide analysis of the implications for CGIAR structure of different funding scenarios. While the viability of ICRAF and CIFOR may be assured at higher funding levels, there was a consensus that separate institutional existence could not be justified at the lowest funding scenario. If the current low level of resources were to be sustained, the logical development would be towards greater Systemwide integration of agroforestry and forestry research. The planned collaborative activities specified in the MTPs of ICRAF and CIFOR can be widened to effect a complete integration of research programmes which already exhibit many basic similarities in terms of strategic objectives and operational modalities. As an example, CIFOR's forest margin research, its strategy for the control and reclamation of *Imperata* grasses in southeast Asia, and the multipurpose tree improvement as well as policy research, share many commonalities with ICRAF's parallel programmes. The integration of forestry and agroforestry research appears to be logical, in this segment of land use continuum, both from the viewpoint of resource savings and in terms of sustaining a critical mass and research advantage for the CGIAR System as a whole. TAC therefore respectfully suggests a careful reconsideration of the two-centre model if funding levels continue to stagnate or decline further.

Fisheries: Research on fisheries has been integrated in the work of the CGIAR through the incorporation of ICLARM in the System. As indicated in Chapter 8 of this report, fisheries research is of high priority to the CGIAR. A strategic plan for fisheries research in the CGIAR was endorsed by the Group at MTM'92, and a medium-term plan for ICLARM was endorsed at ICW'93.

13.2.2.2. Global non-commodity research

TAC considered several institutional and operational mechanisms for addressing global strategic and methodological issues in plant genetic resources, socioeconomic, public policy and public management research including irrigation and research management. The suggestions ranged from mechanisms for closer working relations among centres to mergers between centres with overlapping of responsibilities.

(a) Genetic resources

Genetic resources is the primary responsibility of IBPGR and a significant scientific activity in at least 10 of the 18 CGIAR Centres. In 1992 the CGIAR allocation for germplasm collection, conservation, characterization and utilization activities was US\$ 23 million in core funds, supporting 63 SSY, of which IBPGR's share was US\$ 9 million and 22 SSY. TAC's long-term vision of the CGIAR foresees a continuing need for an international effort in the collection, conservation, characterization and utilization of genetic resources and there is therefore an urgent need for a CGIAR Systemwide strategy and programme for plant genetic resources. TAC is undertaking a strategic stripe review of the issues and activities at the CGIAR Centres during 1993/94 to facilitate the development of a Systemwide strategy and programme for plant genetic resources.

(b) Institution building, public policy and public management research

The major research issues in CGIAR public policy and public management activities are addressed by several centres. Public policy research is the major activity of IFPRI but also an important area of work of ISNAR, ILCA, ICLARM, ICARDA, CIAT, CIFOR, ICRAF and other centres. Research on common property attributes of resources management is shared by IFPRI, IIMI, ICRAF, CIFOR and ICLARM. ISNAR and IIMI are the lead centres for research on institutional structure and public management. IFPRI, IIMI, CIFOR and ISNAR all conduct research on production and input policies.

These research fields have major areas of overlap and are addressed by CGIAR Centres both at the global and the ecoregional level. In order to assist TAC in defining a System strategy and structural options for issues relating to research on institutional structure, public policy and public management, a strategic stripe review of public policy, public management and institution building activities in the CGIAR will be undertaken during 1994. This review will have to be conducted within a broad perspective of other related global commodity and subject-matter activities at the CGIAR Centres.

(c) Water management research

Several centres are currently involved in different aspects of water management research. While research on irrigation management is addressed mainly by IIMI, important aspects of irrigated cropping systems in Asia, Africa and West Asia-North Africa are included in the work of IRRI, WARDA, CIMMYT and ICARDA. Similar research is likely to be needed on irrigated agriculture in Latin America where the need will have to be met by cooperation with NARS using special project funding. However, there is a need to study the efficiency with which increasingly scarce irrigation water is used for crop production, along with resource degradation issues such as salinization and waterlogging. Also, several centres, through cooperative arrangements with external agencies, have found the need to take into account watershed management, human health and downstream environmental considerations related to irrigated and wetland farming systems.

There may be a need to bring all these different elements together through an inter-centre programme so that the capacities and interests that already exist in other CGIAR Centres, including CIAT, CIFOR and ICLARM can be integrated. The first external review of IIMI as a CGIAR Centre will be conducted in early 1994 and will assist in highlighting some of the inter-centre issues related to irrigated cropping systems research as well as those issues that may be addressed through cooperative arrangements with external agencies. This could be a firm step towards a Systemwide strategy.

13.2.2.3. Inter-centre/global initiatives

In its consideration of the medium-term resource allocation process, TAC noted that this process was limited in its ability to appropriately deal with concerns of particular importance at the System level, but transcending centres' own interests. Recognizing that the CGIAR was only one component of the global agricultural research system for developing countries, and that enhanced collaborative efforts would allow for greater efficacy of CGIAR activities, TAC considered that there was a need to promote further collaboration not only among CGIAR Centres but also with national programme partners and other relevant institutions and agencies. TAC, therefore, recommended programme

funding to support inter-centre initiatives in several important areas of work: implementing the ecoregional approach to research, water management research, global livestock research, fisheries research and genetic resources conservation. TAC considers that the proposed programme funding is an effective mechanism to facilitate inter-centre collaboration, and represents a new but experimental approach to funding in the CGIAR. The approach raises additional issues which will need to be addressed as experience is gained, such as those related to accountability.

13.2.3. Structural and Delivery Issues

13.2.3.1. Study of CGIAR delivery mechanisms

The comprehensive and simultaneous review of 18 MTP proposals has given TAC and the CGIAR a complete snapshot of the CGIAR in all of its dimensions. One of these dimensions is geographic and one of the things that stands out is the growing number of CGIAR activities, facilities and programmes that exist side by side in many regions. Each taken separately no doubt can be explained rationally by the centre involved. However, looked at from a System perspective one must ask the question as to whether there are not more cost-effective ways of organizing the CGIAR presence in many regions.

Therefore TAC has proposed to undertake a regional inventory of CGIAR facilities, personnel, programmes and activities in West Africa. This type of study, if found useful, could be conducted for other regions as well. There is nothing ominous about the selection of West Africa. TAC chose it because many centres have a physical presence in the region - IITA, WARDA, ICRISAT, ILCA, CIMMYT, IFPRI, CIP, IIMI and ICRAF, to name only some. The study would identify physical locations of facilities, personnel resident in the region, programme expenditure and level of capital investment. In a period of sustained resource shortfall, all possible avenues of sharing and cost saving need to be explored. TAC proposes to initiate the study in 1994.

13.2.3.2. Other structural issues

TAC may also undertake further reviews of the System's capacity to sustain current CGIAR efforts by region, activity, commodity, production sector and programme if funding levels continue to stagnate or decline. TAC stands ready to advise on other institutional options as it has already done in Chapter 11 of its report on the Expansion of the CGIAR System, and in the draft Chapter 13 of the 1992 Report on CGIAR Priorities and Strategies, Part II.

13.2.4. Timetable

As indicated in previous sections, TAC will conduct a comprehensive review of research on several commodity groups and CGIAR activities between 1994 and 1996, according to the timetable shown below. TAC believes that this sequential component approach may be a more fruitful way to proceed, in terms of both decision-making and implementation, than through complete System reviews. These reviews should provide options for a more cost-effective organization of CGIAR research in those areas. The outcome of these reviews will also be used as an input for the next review of CGIAR priorities and strategies scheduled for 1997.

Timetable for Commodity, Activity and Other System Reviews

Review	1993	1994	1995	1996	1997
Genetic resources	X	-----	X		
Public policy and public management research		X			
CGIAR delivery mechanisms		X	-----	X	
Roots and tubers			X		
Cereals				X	
CGIAR priorities and strategies					X

13.3. Relationships between Global and Ecoregional Mechanisms

TAC considered that, programmatically, the commodity-specific activities of the global programmes and the production-system and resource-management activities of the ecoregional mechanisms are entirely complementary. Placing commodity-specific research entirely at a global commodity centre in the past has sometimes isolated the work from the broader agricultural and socioeconomic context of the real world of the farmer. This is not to say that the multidisciplinary commodity approach has failed, but rather that it may have been adopted in too narrow a form, neglecting important aspects such as conservation and management of natural resources and user considerations important to the acceptance of technology by small farmers. It is important that centres learn from their experience in dealing with these problems, as the framework of ecoregional and global operating procedures evolve across the CGIAR System and in collaborative partnerships with NARS.

TAC sees a need for very close ties between global and ecoregional mechanisms. Ecoregional entities should develop and build the store of knowledge of the natural resource base in their regions and human interactions with that base, including a detailed understanding of the important biotic and abiotic stresses constraining productivity and sustainability of production in agriculture, forestry and fisheries. This understanding would be shared with global commodity centres which would factor it into their genetic enhancement and breeding programmes. To complement these programmes, ecoregional entities would serve as the major sites for testing, evaluation of methodologies, and technological packages generated by the global centres.

The development of clear modes of collaboration and material transfer will be particularly important for research on germplasm enhancement and breeding and there is a good case for outposting plant breeders employed by the global commodity entity at strategic locations in the ecoregions. In this way, experienced breeders would gain from exposure to the problems at the field level. The ecoregional entities/mechanisms could also host scientists from the global centres working on specific problems in the ecoregion with transnational or global significance. IBPGR might, for instance, outpost staff at ecoregional entities which could be used as a base to collect germplasm and organize *in situ* conservation of genetic resources. This issue is addressed in more detail in recent

TAC/CGIAR policy and strategic papers on genetic resources and intellectual property rights¹. In its medium-term plan, IBPGR has also made specific suggestions on its proposed modes of operation.

ISNAR staff based at ecoregional entities could help NARS in the region to define their needs in research management and assist them in priority setting and programme planning. IFPRI could also outpost staff at ecoregional entities to conduct collaborative research on key policy issues.

Research on production/farming systems that cut across production sectors would, by necessity require a multidisciplinary team, requiring inputs from more than one global centre. TAC considers that the best approach is a joint programme with a task force involving the main actors: global centres, the ecoregional mechanisms, and the participating NARS.

Consultation between centres and NARS should be based on a continuing dialogue on collaborative research with, where appropriate, involvement from other partners. As stated earlier, centres and NARS scientists should be given every opportunity and encouragement for greater interaction and collaboration. In the medium/long term, this is likely to occur mostly through the ecoregional mechanisms. However, NARS scientists should have unimpeded contact with other scientists at those institutions dealing with global activities. Where ecoregional and global activities are combined in one institution, relations with NARS should not present any particular problem in terms of coordination. This mix of both global and ecoregional responsibilities should evolve as a common institutional approach in some CGIAR Centres in the medium/long term.

Finally, TAC notes that research on natural resources management research is both ecoregional and global in nature. As pointed out in Section 13.1.3, the Committee sees in the long term a continuing need for strategic research on global issues of natural resources conservation and management.

13.4. Implications for Mandates of Existing Centres

The formal mandates of CGIAR Centres have been incorporated into their constitutions. These legal charters have in many cases required an act of parliament in the host country of a centre's headquarters. Changes in the formal mandates of current centres, which may be brought about as a result of the restructuring exercise, would therefore involve extensive legal processes. As the CGIAR System and its centres evolved over the last two decades, the operational mandates of most of the centres have also changed, and this process of change should be encouraged. The CGIAR already has an informal but effective process of supporting only those activities which have been collectively ranked as high priority.

¹ "The Role of CGIAR in Plant Genetic Resources: Towards a System-wide Strategy" and "Changing Responsibilities and Roles of PGR within the CGIAR System".

With the encouragement of TAC, a number of centres with overlapping mandates (particularly between regional and global mandates) have in the past been able to agree on how to delineate responsibilities among themselves. TAC has been monitoring the implementation of agreements reached between centres on the sharing of responsibilities. The proposed inter-centre commodity and activity reviews will provide another mechanism to advise on unnecessary overlaps between centres. A further mechanism is the external review process.

13.5. Concluding Remarks

This chapter has provided an update of TAC's views on the ecoregional approach to research and how progress can be made in its implementation. The Committee has re-emphasized the twin objectives of expanding the CGIAR research on natural resources conservation and management to increase sustainable production, and at the same time streamlining CGIAR collaboration with national programmes. TAC has also made proposals on how the ecoregional concept can be implemented including institutional and funding mechanisms. The Committee is prepared to receive proposals from the participating institutions on the various initiatives that have been assigned programme support if the CGIAR endorses its recommendations. It has also outlined the process by which TAC will consider global activities and structural adjustments in the CGIAR.

The CGIAR and its institutes have always adopted a dynamic approach to meeting the CGIAR mission and goals. The strategic approach proposed by TAC in assessing major groups of commodity and subject-matter research offers further possibilities for constructive change. The pace at which this change occurs will depend on the rate at which individual centres, in dialogue with their donors and NARS, can change their programmes and institutional structures to meet the challenges. TAC has not developed a masterplan or blueprint for the restructuring of the Group but will formulate over the next three years further options to assist the CGIAR in this process.

CHAPTER 14 - IMPLICATIONS OF TAC'S RECOMMENDATIONS ON PRIORITIES AND STRATEGIES FOR RESOURCE ALLOCATION

14.1. Introduction

The priority analysis contained in Chapters 1-13 had four objectives. The first was to review future needs and to suggest the role the CGIAR should play. The second was to determine, within the domain of CGIAR activities, what should be the relative distribution of CGIAR activities (Chapter 12). The third was to discuss the implications of changing needs and priorities for CGIAR strategies and structure (Chapter 13). The fourth was to provide a basis for formally linking priorities to the allocation of financial resources to CGIAR institutions over the next five years' planning period. The linkage between priorities and resource allocation, in the context of strategies and structure, proceeded in two steps. First, relative priorities by activity, production sector, region and commodities were translated into resource allocation targets at the System level. In the second step an indicative core resource envelope was proposed for each of the CGIAR Centres. This indicative envelope will provide the beginning point for the next phase in programme development for the CGIAR, namely centres' preparation of medium-term plans (MTPs). The envelopes contain a target with a 10% range around it, so as to give centres some flexibility in preparing detailed programmes in the context of System priorities.

14.2. CGIAR Medium-Term Planning Process

The CGIAR resource allocation process has evolved over time. Initially, centres' programmes and budgets were prepared annually, complemented with multiyear projections, and were reviewed by TAC and approved by the Group. Centre programmes and budgets were based on centres' strategic plans. Starting in 1987, centres prepared five-year MTPs broadly based on CGIAR priorities as proposed by TAC and endorsed by the Group, as well as on their long term strategic plans. At ICW'90, the Group reviewed a report ("Review of the Resource Allocation Process", ICW/90/33) which examined the experience with the five-year allocation process. The Group endorsed its recommendations. One recommendation suggested a more transparent linkage between System priorities and centres' operational programmes; another recommendation urged the introduction of constrained supply considerations in a so far largely demand-driven resource allocation process. The completion by TAC of the CGIAR priorities, strategies and structure, and resource allocation analysis offers an opportunity to improve further on the linkage between System priorities and centre resource allocation in the framework of the development of new MTPs by centres.

14.2.1. First Round of MTPS - 1987-89

Using TAC's 1986 priorities paper as a reference, the construction of centre MTPs became the mechanism to translate System's priorities into operational programmes. Since the development of centre MTPs was, from a core resource point of view, open-ended, centres were able to present the full potential of their core programmes

and activities in an environment of unconstrained core supply. However, the initial round of MTPs had two major limitations.

Firstly, the review and approval of centre MTPs was phased over a three-year period, causing the MTP time horizon of individual centres to vary from 1988-92 to 1990-94. This reduced the scope for a comprehensive monitoring of the achievement of System priorities resulting from the implementation of individual centre MTPs.

Secondly, the sum of centres' core resource requirements was substantially in excess of actual core funding during the implementation of the MTPs. Consequently, each year centre core requirements needed to be adjusted downward mechanically which generated increasing discrepancies between approved MTP programmes and centres' actual operational programme levels.

14.2.2. Second Round of MTPs - 1992-93

Consistent with the recommendations of the review report and in order to ensure the operational character of the System priorities and strategies, the CGIAR has requested TAC to extend its priority analysis to include indicative allocations of limited core resources to CGIAR Centres consistent with the System priorities TAC proposes.

In the framework of the second round of MTPs, the linkages between the System priorities, prospective System resource availability and centre MTPs will be more systemic and made more explicit. Developing such linkage through an iterative and interactive process, involving TAC, the CGIAR membership and the centres, will result in providing all parties concerned a better insight into the connections between System priorities and centres' operational programmes.

The consolidation of all centre final MTPs with a uniform time horizon (1994-98) into a System five-year plan should contribute to an improved implementation of the System priorities, and provide as well an adequate monitoring tool at the System level.

Finally, drawn against an assumption of limited core supply for the System as a whole, centre MTPs will thus be constrained in their core resource requirements. This should enhance the relevance and credibility of individual and collective MTPs for CGIAR donors, who may use them as effective inputs in their own process of allocating resources to the System and to individual centres.

14.3. Setting the Context for TAC's Recommendations on Core Resource Allocation

In order to respond to the CGIAR request regarding the allocation of resources consistent with its recommendations on priorities and strategies, TAC reviewed a number of options with regard to the methodology to follow, the time horizon in which to formulate allocation recommendations, and assumptions on availability of core resources.

14.3.1. Resource Allocation Methodology

In order to arrive at 1998 resource envelopes which are consistent with the System priorities, there were conceptually two alternative approaches. The first possible approach would consist of designing an ideal 1998 CGIAR System, with programmes and an implementing structure of institutions that would be the most cost-effective/efficient to implement the priorities in all their dimensions - i.e. by category of activity, by production sector and commodity, and by region based on TAC's analysis of the agroecological zones each region comprises. The alternative approach would consist in considering the current state of affairs (i.e. current programmes, institutional set up and resource allocation) and modifying it to ensure that the System priorities are gradually but effectively approached in the medium term.

The first alternative would have allowed the explicit recognition of expected research products - whether or not currently pursued - and in a way that is not biased by existing structural arrangements, or by current cost structures and differentials. Though intellectually attractive and most appropriate for strategic planning, this alternative was judged to be less adequate for resource allocation: its end-product would appear artificial in that it would not bear a direct relationship with current allocation realities; and, in any case, it would have required a translation into the existing structure, i.e. the existing centres which would need to develop their programmes and budgets. In addition, this approach would have required the compilation of assumptions on research costs which may not necessarily reflect current structural and institutional realities. Finally, it would have required the use of common standards of research outputs, a complex task for a multifaceted institution like the CGIAR.

The second alternative - which has been selected - is by its very nature quite practical. It begins by taking the current situation as the point of departure. It is evolutionary, rather than revolutionary, by indicating how, and how fast, modifications have to be made in the current array of programmes and entities to meet the medium/long- and medium-term priorities. It underscores the productivity as well as the value of the existing institutions, and nurtures the existing positive factors in the donor-centre and centre-centre relationships which underpin the CGIAR System. This approach entails the risk of constraining the resource allocation process to what exists now in terms of programmes and organizational entities. Thus it runs the risk of appearing to be unable to handle innovations or radical changes, some of them possibly already contemplated or implemented by centres. This limitation inherent in the chosen alternative is, however, largely offset by the strategic approach followed in the priority setting exercise. On the other hand, this constraint implies the explicit and pragmatic consideration of the implications of evolving from an existing to a different, desired situation.

14.3.2. Time Horizon

In principle, there are two obvious options for setting a time horizon for the resource allocation. A first option is to retain the time horizon used by TAC for the priority setting, i.e. 20 years or the year 2010. A second option is the timeframe of the CGIAR funding cycle, i.e. one year. For the purpose of operational planning, the 20-year horizon was considered too long and the one-year horizon too short.

Consequently, an intermediate five-year time perspective was retained. This horizon is reasonably appropriate for operational planning and implementation of programme changes, as well as for the funding decision process and the implementation of changes in resource allocations, which may be called for by the medium-term resource allocation process.

The five-year horizon offers a reasonable degree of flexibility, always necessary in planning, provided a mechanism can be put in place to correct discrepancies between planning assumptions and reality (e.g. with regard to funding). Also needed is the possibility of intermediate reassessments of five-year plans to take into account externalities (e.g. fundamental changes in operating cost structures) or other circumstances which could not be foreseen at the time of the priority setting and the development of MTPs (e.g. new research opportunities).

14.3.3. Availability of Core Funds

In principle, the assumption with regard to the future level of core funding could be open ended in an environment in which the demand for resources should drive the supply of funds. However, past experience has demonstrated that this assumption is not tenable. Therefore, a supply-driven approach needs to be adopted which will inevitably constrain the demand side. This, however, raises the other issue that constrained plans represent potentially a disincentive for growth of the supply beyond the level assumed. In order to balance the two sides of the equation, several assumptions with regard to future supply of core resources were examined in conjunction with the CGIAR Secretariat: growth in constant dollar terms; constant supply in nominal dollar terms or some growth in nominal dollar terms only, both of which would imply a significant reduction of the supply in real terms; or, finally, a combination of maintenance of supply in constant dollars with real growth in selective areas.

Based on donor indications so far, the global real growth assumption seems optimistic. Also, there are no indications that the Group intends, over the medium term, to decrease its support in real terms (though fluctuations from year to year are to be expected). Thus, the no-real-growth assumption in long standing activities combined with selective real growth, for forestry and fishery activities in particular, was retained as the most reasonable.

This rather conservative planning assumption will be tempered, on the one hand, by centre plans incorporating, for TAC's and the Group's consideration, a description of their MTP at a level 10% higher than assumed by the indicative resource envelope; and, on the other hand, by the mechanism which will reconcile annually reasonable differences between assumed funding and actual supply on the basis of the priority framework.

14.3.4. Character of Recommendations on Resource Allocations

Any recommendation on resource allocation to centres, derived from Systemwide priority considerations, would have to be considered tentative, until the Group has had an opportunity to review the implications of TAC's proposals, and the centres have tested their feasibility through the preparation of MTP proposals.

Consequently, TAC's recommendations on centres' resource allocation should be considered indicative. Their purpose is to provide a consistent basis for preparing centre MTPs for presentation to TAC and the Group. TAC will make firm recommendations on resource allocations, for approval at ICW'93, on the basis of centres' MTP proposals.

14.4. Priority Setting and Factors Relevant to Resource Allocation

14.4.1. TAC's Focus on the Core Programme

In its priority setting exercise, TAC focused on the core activities and programmes as they represent the essence of the CGIAR as a collective System; in contrast, the complementary activities and programmes, by their very nature, are prone to specific understandings and arrangements between individual donors and centres. In the priority exercise, TAC contemplates a time horizon of about 20 years (i.e. the year 2010), while it considers the medium-term frame - i.e. the next five years, up to 1998 - as an intermediary, operational stage by which directional changes towards achieving the medium/long-term priorities should begin to be implemented.

14.4.2. Priority Setting Methodology

In assessing priorities of CGIAR core programmes and activities, TAC has been using a number of elements which, in their final description, are directly relevant to the resource allocation. As described in Chapter 12, TAC analyzed CGIAR priorities in a multidimensional fashion. Sequentially - and eventually in an integrated way - it analyzed and set priorities among the five major categories of CGIAR activities (Table 12.1), indicating, for each region, the relative magnitude of the change in direction for each category of activity. On the basis of an analytical assessment of the regionally defined agroecological zones, TAC analyzed and proposed priorities among the four geographical regions as commonly used in the CGIAR context (Table 12.2). Finally, TAC examined and assigned relative importance to commodities and production sectors dealt with by the CGIAR (Tables 12.3 and 12.4).

For the medium/long-term priority statements to become effective for implementation and thus achievement, they needed to be translated into operational terms. This required that they be expressed in terms of intermediate targets for 1998, whereby a relative allocation was to be assigned to each of the priority parameters indicating the desired rate of progress towards achieving the ultimate goal, i.e. the recommended relative allocations by 2010. For setting that intermediary stage, TAC put side by side its recommendations on medium/long-term priorities, both in relative quantitative terms and the descriptive rationale underlying them, and the current relative distribution of resources between the priority parameters.

14.4.3. 1991 Distribution of CGIAR Core Resources

Table 14.1 indicates the 1991 relative allocation of core resources among the priority parameters.

Table 14.1. CGIAR Estimated 1991 Core Resources Distribution (in %) 1/

I. By Region:

SS Africa	43%
WANA	13%
Asia	29%
LAC	15%

II. By Category of Activity:

1. Conservation/Management Natural Resources	<u>13%</u>
1.1 Ecosystem Conservation	7%
1.2 Germplasm Coll./Conserv.	6%
2. Germplasm Enhancement/ Breeding	<u>21%</u>
2.1 Crops	20%
2.2 Livestock	0%
2.3 Trees	1%
2.4 Fish	0%
3. Production Systems Development/ Management	<u>33%</u>
3.1 Cropping Systems	18%
3.2 Livestock systems	13%
3.3 Tree Systems	2%
3.4 Aquatic systems	0%
4. Socio-econ./Public Policy/ Public Management Research	<u>9%</u>
5. Institution Building	<u>24%</u>
5.1 Training/Conf.	9%
5.2 Doc./Pub./Dis. Info.	8%
5.3 Org./Mngmnt. Counsel.	2%
5.4 Networks	5%

III. By Category of Activity and Region

1. Conservation/Management Natural Resources	<u>13%</u>
SS Africa	35%
WANA	19%
Asia	33%
LAC	13%
2. Germplasm Enhancement/ Breeding	<u>21%</u>
SS Africa	39%
WANA	14%
Asia	29%
LAC	19%
3. Production Systems Development/ Management	<u>33%</u>
SS Africa	49%
WANA	11%
Asia	23%
LAC	17%
4. Socio-econ./Public Policy/ Public Management Research	<u>9%</u>
SS Africa	46%
WANA	5%
Asia	41%
LAC	8%
5. Institution Building	<u>24%</u>
SS Africa	43%
WANA	9%
Asia	34%
LAC	13%

1/ Percentages may not add to 100 due to computer rounding.

By category of activity, about 13% of core resources were devoted to natural resources conservation and management (category 1), distributed evenly among its two components. Through research on crops and the other production sectors, 54% of the core resources were used for germplasm enhancement and breeding (category 2) - representing 22% of total core resources - and for production systems development and management (category 3), which used 33% of all core resources. About 9% of core resources went to socioeconomic, public policy and public management research (category 4), and 24% to institution building (category 5); of the total of category 5, about 8% was used for organization and management counselling, and about one third of the remainder for institution building oriented networks.

In terms of regional distribution, 43% of core resource were allocated to activities in Sub-saharan Africa, 29% to activities in Asia, and 13% and 15% respectively to activities in West Asia-North Africa and Latin America and Caribbean.

14.4.4. Results from Priority Setting

Tables 14.2A through C combine for each of the priority parameters (categories of activity, and commodities and production sectors, and regions) TAC's assessments on relative priorities for 2010 and the current (1991) relative distribution of core resources.

TAC's formulation of an intermediate, relative distribution for each of the priority parameters required a complex and iterative process. Iterations were necessary to assure a satisfactory degree of compatibility between the different priority parameters - which so far had been dealt with as independent variables - and to ensure the feasibility of the change in direction and the magnitude thereof from the centres' and the Group's point of view.

14.4.4.1. Categories of activity

As Table 14.2A indicates, TAC's recommendations with regard to the 1998 distribution of core resources among the five categories of activity is consistent with its statements in Chapter 12.

Natural Resources Conservation and Management (category 1) is projected to increase significantly in both absolute and relative terms by 1998, rising from 13% of total in 1991 to 18% by 1998. All regions are expected to benefit from the increased efforts, but mostly LAC (from a low base) and least WANA.

Germplasm Enhancement and Breeding (category 2) is projected to increase marginally in absolute terms and in relative terms, from 21% in 1991 to 22% of total in 1998. The projected increase will mainly benefit Asia.

Production Systems Development and Management (category 3) is projected to decrease in absolute terms and in relative terms, with its share of total declining from 33% in 1991 to 29% in 1998. All four regions will experience a decrease in efforts in this category of activity but the decrease will be relatively more pronounced in the Asia region.

Table 14.2.A: TAC's Decision Rules -- Relative Allocation by Category of Activity
(In Percentages)

Category	Subactivity	Table 12.1, Chapter 12, p. 222						1991 Relative Distribution of Core Resources					1998 Proposed Relative Distribution of Core Resources					Comments
		1991 Base	2010 Recomm.	Regional Emphasis				All Centers	Regional Distribution				All Centers	Regional Distribution				
				SSA	WANA	Asia	LAC		SSA	WANA	Asia	LAC		SSA	WANA	Asia	LAC	
1. Conservation and Management of Natural Resources, including Germplasm Conservation (Biodiversity)	1.1. Ecosystem Conservation and Management	13%	17-19%	+	+	-	+	13%	35%	19%	33%	13%	18%	33%	15%	32%	20%	In all regions and agro-ecological zones, there was a perceived need for expanded effort in research on natural resources conservation and management, in both components of this category. This need emerged even more strongly when modifiers such as yield gap, soil degradation risk, and deforestation are included. TAC therefore recommends a substantial increase in CGIAR efforts in this category, from 13% to 17-19%. However, the analysis suggests that, relative to the new level, more attention should be paid to resource management in SSA, WANA and LAC, and less in Asia. [Chapter 12, Section 12.3.1., page 223.]
	1.2. Germplasm Collection, Conservation, Characterization and Evaluation							7%	43%	19%	33%	5%	10%	39%	12%	31%	18%	
2. Germplasm Enhancement and Breeding		21%	21-23%	-	-	+	0	21%	39%	14%	29%	19%	22%	37%	13%	32%	18%	Germplasm enhancement and breeding have been the central thrust of the CGIAR since its inception. Increased emphasis is warranted in Asia, where substantial efforts are now required to lift the yield ceiling, particularly of rice. In WANA and SSA, the emphasis on germplasm enhancement breeding could be somewhat reduced where a greater effort on resource management is required. Overall, the conclusion is that research on germplasm enhancement and breeding should thus continue at the marginally higher level system-wide level of 21-23% of total activities. [Chapter 12, Section 12.3.1., page 223.]
	2.1. Crops							20%	37%	14%	29%	20%	20%	35%	14%	32%	19%	
	2.2. Livestock							0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	
	2.3. Trees							1%	82%	1%	6%	12%	2%	45%	3%	32%	20%	
	2.4. Fish							0%	10%	0%	90%	0%	0%	10%	0%	90%	0%	
3. Production Systems Development and Management		33%	28-30%	+	0	-	-	33%	49%	11%	23%	17%	29%	48%	11%	24%	18%	Overall, in the long term, there should be a reduced need for CGIAR research on the development and management of production systems, because of increasing national capacity to deal with this category of activity, which consists mostly of applied research. It is important to note, however, that the results obtained from applied research activities in this category feed into the planning of strategic resource management research. Continued emphasis is warranted in WANA, and more emphasis relative to the reduced level is needed in SSA, particularly to exploit the scope for growth. In Asia and LAC, the resources devoted to this activity could be reduced below the new system level. As NARS assume greater responsibility for research on the development of production systems, the modes of operation should evolve towards greater use of networks and consortia. Overall, TAC tentatively concludes that at the system level, efforts in this category could be reduced from 33% to 28-30% of total activities. [Chapter 12, Section 12.3.1., pages 223-224.]
	3.1. Cropping Systems							18%	30%	13%	38%	19%	14%	31%	14%	37%	16%	
	3.2. Livestock Systems							13%	73%	9%	1%	17%	11%	71%	10%	1%	18%	
	3.3. Tree Systems							2%	76%	1%	14%	9%	3%	52%	2%	28%	18%	
	3.4. Aquatic Systems							0%	9%	0%	91%	0%	1%	10%	0%	90%	0%	
4. Socio-economic, Public Policy, Public Management Research		9%	10-12%	-	-	+	+	9%	46%	5%	41%	8%	11%	34%	10%	40%	16%	Throughout the priority analysis, the need emerged for an expanded effort in socio-economic, public policy and public management research. In all regions and in most agro-ecological zones, there was a need for greater emphasis on policy research with respect to land use and sustainability issues, poverty alleviation and equity (particularly gender equity), irrigation management, and issues related to self-reliance. It is therefore proposed to increase CGIAR effort in this category of activity from 9% to 10-12% of total system activities. Even more emphasis relative to the new system level may be needed in Asia and LAC, because of the pressing problems of sustainability, deforestation and equity. [Chapter 12, Section 12.3.1., page 224.]
5. Institution Building		24%	19-21%	+	+	-	-	24%	43%	9%	34%	13%	20%	43%	9%	33%	15%	For the long term, TAC considered whether the resources allocated to institution building could be reduced. The study by Pardey and Roseboom (1991) has revealed the considerable increase in trained human resources in national programs. For many national systems, the major constraint is now a shortage of operational funds rather than of trained manpower. As already noted in Chapter 10, TAC's view is that the allocation of CG resources to institution building has reached a ceiling and that the CG should focus on its complementary role of strengthening NARS through technology development and partnership. In TAC's view, the overall proportion of CGIAR activities in the category of institution building should be reduced from 24% to 19-21%, but with less in training, information and networks, and more in organization and management counselling. [Chapter 12, Section 12.3.1., page 224.]
	5.1. Training & Conferences							9%	45%	7%	33%	16%	7%	44%	10%	31%	16%	
	5.2. Documentation, Publications, and Dissemination of Information							8%	44%	8%	33%	14%	6%	45%	8%	33%	14%	
	5.3. Organization and Management Counselling							2%	53%	8%	25%	14%	2%	52%	8%	25%	15%	
	5.4. Networks							5%	34%	15%	43%	7%	4%	35%	10%	40%	15%	

Socioeconomic, Public Policy and Public Management Research (category 4) is projected to increase to represent 11% of total by 1998, up from 9% in 1991. LAC and WANA are expected to be the principal beneficiaries at the expense of the remaining regions which in the past have benefited from a strong concentration of CGIAR efforts in this type of activity.

Institution Building (category 5) as a whole is projected to decrease in both absolute and relative terms, from 24% of total in 1991 to 20% in 1998. All four regions would be affected by the decrease but in varying degrees: SSA and LAC less than average, while Asia and WANA more or close to the average. The reduction is projected in three components of this category (training, information and documentation, and institution-building oriented networks), while organization and management counselling (category 5.3) is projected to increase significantly over 1991 levels, benefiting all four regions.

14.4.4.2. Production sectors and commodities

The combined outcome of the relative allocations to categories 2 and 3 is a result of recommendations made by TAC for the different commodities and production sectors.

TAC considered that there was no compelling rationale for changing the existing distribution between the four production sectors. On the other hand, TAC firmly believes that the System's expansion in forestry and fisheries should not be funded at the expense of agricultural crops and livestock.

As shown in Table 14.2B, assuming incremental core funding for forestry and fisheries doubles the relative allocations to these sectors by 1998 over the comparable 1991 level. Under that assumption, the 1998 proposed allocations for agricultural crops and livestock drop in relative terms to 66% and 23% respectively; these levels are however identical to the 1991 comparable levels of 70% and 24%, when the increment for forestry and fisheries is excluded.

It should be noted, however, that TAC's decision to reduce the relative share of the combined categories 2 and 3 resulted in reducing the global allocation available for commodities and production sectors; thus the maintenance of shares of each of the sectors actually represents a decline in absolute terms compared to 1991 levels.

Within the agricultural crops, while generally recommending a shift of efforts from production systems research (category 3) to germplasm enhancement and breeding (category 2) no major changes are proposed in the relative share of most crops compared with 1991. The cereals maintain their relative share, with a marginal shift from SSA towards Asia. The roots and tubers maintain their relative share as well as the regional distribution. The food legumes, as a group, decline as a relative share, and a shift occurs from Asia and LAC towards SSA and WANA; this results from reductions in emphasis in **phaseolus bean** and **pigeonpea** research, while **soybean** and **groundnut** research would receive greater attention.

Table 14.2.B: TAC's Decision Rules -- Relative Allocation to Commodities and Production Sectors

(in percentages)

Production Sector	Commodities	Chapter 12					1991 Relative Distribution of Core Resources (All Comm. & Sectors)					1998 Proposed Relative Distribution of Core Resources (All Comm. & Sectors)					Comments	
		Table 12.3		Table 12.4			All Centers	Regional Distribution				All Centers	Regional Distribution					
		VOP	Weighted Baseline	Modified Baseline (w = 0.5)	Modif. VOP Baseline (w = 0.5)	1991 Alloc. a/		SSA	WANA	Asia	LAC		SSA	WANA	Asia	LAC		
Agricultural Commodities	- Rice	17.7	15.6	13.2	19.2	18.4	15% b/	19%	3%	61%	16%	14% b/	19%	4%	61%	16%	TAC recognized the importance of rice as the staple food of a large number of people in developing countries and the substantial pay-off from CGIAR efforts on rice research in Asia and LAC. Since the situation in West Africa is more complex, TAC recommended a minimum effort in the region that has a reasonable chance of success. TAC recommends a continuation of current levels of CGIAR investment in rice research, but a shift in focus of rice research towards more strategic germplasm necessary to lift the yield ceiling of the crop, and to sustain current yield levels. [Chapter 12, Section 12.3.5.2., page 236.]	
	- Wheat & Barley	7.0	6.3	4.6	6.7	10.8	10%	1%	53%	36%	9%	9%	1%	53%	36%	9%	While a comparison of modified VOP with current CGIAR efforts would suggest an over-investment in wheat research, TAC recognizes the many distortions in marketing and trade of wheat. Noting the existence of research in developed countries, it reaffirmed the special role of CGIAR in catering for the needs of developing countries. TAC noted the higher cost associated with strategic research and the need to maintain efforts in maintenance breeding. TAC recommends a continuation of efforts in CGIAR investment in wheat research in the medium term, recognizing the potential for further gains to be made in increasing wheat productivity. In the long term, the priority of wheat is likely to decline given the importance of alternative sources of research supply. [Chapter 12, Section 12.5.3.2., page 239.] With regard to barley, TAC saw on balance no reason to alter ongoing CGIAR efforts and recommended that the level of investment should continue to focus on areas where poor farmers are heavily dependent on this crop. [Chapter 12, Section 12.3.5.2., page 240.]	
	- Maize	4.1	4.4	4.2	6.1	9.7	10%	52%	3%	15%	30%	9%	40%	3%	27%	30%	TAC recommends, in the short and medium term, maintaining current efforts in maize research, given the importance of maize in mixed cropping systems of resource poor farmers. Considering the rapid involvement of the private sector in the (hybrid) maize seed industry, in the long term a reduction in the priority of maize research is likely. [Chapter 12, Section 12.5.3.2., page 239.]	
	- Sorghum	0.6	1.1	1.5	2.2	3.2	4%	48%	0%	38%	15%	3%	48%	0%	38%	15%	With regard to sorghum, TAC saw on balance no reason to alter ongoing CGIAR efforts and recommended that the level of investment should continue to focus on areas where poor farmers are heavily dependent on this crop. [Chapter 12, Section 12.3.5.2., page 240.]	
	- Millet	0.7	1.0	1.5	2.1	2.2	3%	53%	0%	47%	0%	3%	53%	0%	47%	0%	Pearl millet is an important crop in SSA (Western Sahel), where half of the production is found. Millet is generally an important crop for the poor and is grown in farming systems in less endowed regions. In Asia, millet is mainly produced in India. Responding to TAC's 1986 suggestion, ICRISAT has transferred some of the millet responsibilities from its Asian HQ to West Africa and the SADC region. ICRISAT is now shifting its focus towards the drier areas of more limited potential, and towards more strategic issues. TAC endorses this view and recommends to maintain current CGIAR efforts on millet research. [Chapter 12, Section 12.3.5.2., page 239-240.]	
	Total Cereals		30.3	28.4	25.0	36.3	44.3	42%	27%	15%	41%	17%	39%	25%	15%	44%	17%	
Agricultural Commodities	- Cassava	2.0	2.9	4.5	6.6	5.4	5%	58%	0%	10%	32%	5%	58%	0%	10%	32%	TAC recognized the rapid rate of progress in cassava research, and the importance of cassava for low income consumers and producers. It also considered the negative income elasticity of cassava in most regions, and the need for the development of post harvest technology. On balance, TAC recommended a continuation of efforts in cassava research. [Chapter 12, Section 12.3.5.2., page 240.]	
	- Potato	2.6	2.7	2.1	3.1	4.3	4%	29%	10%	39%	22%	4%	29%	10%	39%	22%	The relative priority of potato is falling because it is predominantly grown in the subtropics and cold tropics. The production and consumption of potato is growing rapidly in developing countries, and good rates of progress have been obtained from CGIAR investments in potato research. Furthermore, potato is an important crop for low-income farmers. TAC recommends that, in the medium term, current efforts in potato research be maintained. [Chapter 12, Section 12.3.5.2., page 241.]	
	- Sweet Potato	2.9	2.3	1.4	2.0	1.1	1%	29%	10%	39%	22%	1%	29%	10%	39%	22%	TAC noted that over 80% of the global production of sweet potato is in China (which has a relatively strong NARS), that there has been steady decline in the importance of sweet potato as staple food, and a shift towards its utilization as livestock feed in Asia. However, TAC recognized that very little research on sweet potato is conducted outside CGIAR, that ongoing CGIAR efforts are of very recent origin, and that outside China sweet potato is a very important crop in a large number of small countries with very low income levels. For the medium term, TAC therefore recommends that CGIAR efforts be maintained. [Chapter 12, Section 12.3.5.2., page 240-241.]	
	- Yam	0.6	1.1	1.9	2.8	0.2	N/Ac/					N/Ac/						TAC noted that yam is produced mainly in West Africa, with Nigeria accounting for 70% of world production. In its 1986 priority review, TAC recommended the continuation, in the short term, of effort on yam pending a review in five years. IITA's third external review assessment was that the comparative advantage in crop management research related to yam lay with the Nigerian NARS. IITA should concentrate on germplasm conservation and focus its research on the critical constraints to germplasm improvement. TAC endorses this view, and suggest 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. [Chapter 12, Section 12.3.5.2., page 241.]
	Total Roots and Tubers		8.3	9.0	9.9	14.5	11.0	10%	43%	5%	25%	27%	9%	43%	5%	25%	27%	

Table 14.2.B: TAC's Decision Rules -- Relative Allocation to Commodities and Production Sectors
(in percentages)

Production Sector	Commodities	Chapter 12					1991 Relative Distribution of Core Resources (All Comm. & Sectors)					1998 Proposed Relative Distribution of Core Resources (All Comm. & Sectors)					Comments
		Table 12.3		Table 12.4			All Centers	Regional Distribution				All Centers	Regional Distribution				
		VOP	Weighted Baseline	Modified Baseline (w = 0.5)	Modif. VOP Baseline (w = 0.5)	1991 Alloc. %		SSA	WANA	Asia	LAC		SSA	WANA	Asia	LAC	
Agricultural Commodities (Cont'd)	- Phaseol. Bean	1.1	1.3	1.6	2.3	5.4	5%	32%	0%	0%	68%	4%	32%	0%	0%	68%	In view of the progress made by the Centers concerned on phaseolus bean in LAC and SSA, TAC proposes to reduce the research effort on this commodity. CIAT has successfully developed several improved varieties that are being widely adopted by farmers. The pay-off from CGIAR research has been substantial. TAC also recognizes that phaseolus beans are an important crop for poor farmers and of substantial significance in the diets of low income consumers. On the basis of congruence criteria, the CGIAR is over-investing in phaseolus beans. CIAT is already proposing a substantial reduction in the scale of its research on phaseolus beans. TAC endorses this trend, and recommends a modest reduction in the priority of this crop. [Chapter 12, Section 12.3.5.2., page 242.]
	- Faba Bean & Lentil	0.6	0.6	0.6	0.9	2.2	2%	0%	100%	0%	0%	2%	0%	100%	0%	0%	In 1986, TAC recommended the phasing out of research on faba beans and lentil. A CGIAR involvement was to be limited to the maintenance of genetic resource collections. The responsibility for faba bean research is being transferred to a NARS. While ICARDA's efforts in this regard have been successful, it will take more time than expected before its responsibilities can be fully discharged. ICARDA has also been requested to undertake an in-depth assessment of the potential pay-off of further research on the improvement of lentil, in the framework of ICARDA's upcoming medium-term plan. TAC notes that lentil is an important crop in farming systems of resource poor farmers in WANA, and that outside the CGIAR very little research is carried out on lentil. In the short to medium term, therefore, current efforts in lentil will continue, while reaffirming TAC's view that in the long term the role of the CGIAR in faba bean and lentil research should be primarily in maintaining genetic resource collections. [Chapter 12, Section 12.3.5.2., pages 241-242.]
	- Chickpea	0.5	0.5	0.4	0.6	2.2	2%	0%	45%	55%	0%	2%	0%	49%	51%	0%	The priority ranking of chickpea should be maintained. [Chapter 12, Section 12.3.6., page 246.]
	- Cowpea/Soybean	2.7	2.6	2.4	3.5	3.2	3%	100%	0%	0%	0%	4%	100%	0%	0%	0%	TAC recalled that cowpea was largely produced in Nigeria, but that the crop could be an important commodity for resource poor farmers throughout different agro-ecological zones and cropping systems of West Africa, where NARS are generally weak. TAC concluded that it would be appropriate to continue CGIAR support for this commodity in the short to medium term. TAC noted that soybean ranked above other legumes and the rapid progress of research on soybean conducted in Asia, particularly with regard to multipurpose varieties. TAC recognizes that soybean has substantial potential in developing countries and that the demand for livestock feed is growing rapidly. TAC recommends an increased resource allocation to this commodity in SSA, in view of the likelihood of rapid progress, particularly with respect to its potential as a nutritious food, cash crop, and protein-rich livestock feed. [Chapter 12, Section 12.3.5.2., pages 242-243.]
	- Groundnut	2.6	3.0	3.7	5.4	2.2	2%	42%	0%	58%	0%	2%	41%	0%	59%	0%	Among food legumes, the only commodity that appears underfunded is groundnut. TAC has noted the substantial pay-off from CGIAR investments in groundnut research in Asia. In SSA, progress has been slow. TAC recommends increasing current efforts in groundnut research modestly given the opportunities for further gains to be made through research on this commodity. [Chapter 12, Section 12.3.5.2., page 243.]
	- Pigeonpea	0.2	0.2	0.2	0.3	1.1	1%	15%	0%	85%	0%	1%	0%	0%	100%	0%	Pigeonpea is an important crop in one country only (India) which, in addition, has a strong NARS. The rapid progress achieved by ICRISAT in developing a hybrid pigeonpea variety adds further weight to the argument that responsibilities for pigeonpea research, particularly in India, can now gradually be transferred to the NARS. TAC recommends that CGIAR efforts in pigeonpea research be progressively reduced in the long term to limit its activities to maintaining genetic resource collections only, and be diminished significantly in the medium term. [Chapter 12., Section 12.3.5.2., page 242.]
	Total Food Legumes	7.7	8.2	8.9	13.0	16.3	16%	36%	18%	23%	23%	15%	42%	19%	20%	19%	
	Banana & Plantain	2.1	2.6	3.6	5.2	2.3	3% c/	34%	14%	33%	19%	3% c/	33%	14%	34%	18%	The CGIAR has recently expanded its activities in banana and plantain through the incorporation of INIBAP. TAC recommends maintaining current efforts in CGIAR research on these commodities. [Chapter 12, Section 12.3.5.2., page 244.]
	Agric. Commodities	48.4	48.2	47.4	69.0	73.9	70%	34%	14%	33%	19%	66%	33%	14%	34%	18%	

Table 14.2.B: TAC's Decision Rules -- Relative Allocation to Commodities and Production Sectors

(in percentages)

Production Sector	Commodities	Chapter 12					1991 Relative Distribution of Core Resources (All Comm. & Sectors)					1998 Proposed Relative Distribution of Core Resources (All Comm. & Sectors)					Comments
		Table 12.3		Table 12.4			All Centers	Regional Distribution				All Centers	Regional Distribution				
		VOP	Weighted Baseline	Modified Baseline (w = 0.5)	Modif. VOP Baseline (w = 0.5)	1991 Alloc. a/		SSA	WANA	Asia	LAC		SSA	WANA	Asia	LAC	
Livestock	Beef & Buffalo Meat	5.0	5.3	5.9	8.5	N/A	N/A				N/A					TAC noted that while congruence on livestock research appears close, in practice the modified VOP figure has to be treated with considerable caution. The figure includes the value of all cattle meat and milk, and small ruminants across all regions. The CGIAR does not conduct any livestock research in Asia however, nor does it conduct research on small ruminants in LAC or on large ruminants in WANA. When adjusting the modified VOP for these factors, the figure would be reduced from 25.8% to 16.5%, with a distribution of 40% to SSA, 9% to WANA, 27% to Asia and 24% to LAC. Actual resource allocation to livestock research amounts to more than 26% (of agriculture), distributed as 73% to SSA, 9% to WANA, 16% to LAC and only 1% to Asia. This would suggest that the CGIAR is substantially over-investing in livestock research, even when considering the important role of intermediate livestock products such as traction and manure. A disproportionate share of CGIAR resources for livestock research are allocated to SSA. In addition to the regional emphasis, major questions remain about the distribution of species emphasis and between animal production and health research. Furthermore, it is now increasingly clear that, in the future, much greater emphasis will have to be given to enhancing crop-livestock interactions. The major constraint to increasing livestock productivity is a shortage of feed, and this could, to a greater extent, effectively be addressed through more adequately focussed crop productivity research. TAC is also concerned about the generally slow rate of progress in obtaining impact from CGIAR investment in livestock research. TAC, therefore recommends a modest reduction in the priority the CGIAR currently allocates to livestock research. In the medium term, the allocation to livestock research in SSA could be reduced substantially. When the livestock study, currently being undertaken by Winrock International, and the external reviews of ILRAD and ILCA are completed, TAC will revisit livestock research priorities. [Chapter 12, Section 12.3.5.2, pages 244-245.]	
	Sheep & Goat Meat	1.7	1.9	2.3	3.3	N/A	N/A				N/A						
	Milk	8.9	9.5	9.7	14.0	N/A	N/A				N/A						
	Total Livestock	15.6	16.7	17.9	25.8	26.1	24%	73%	9%	1%	16%	23%	72%	10%	1%		17%
Trees		N/A	N/A	N/A	N/A	N/A	4%	77%	1%	12%	10%	9%	49%	2%	29%	19%	With respect to recommendations on forestry and fisheries, TAC reaffirms the outcome of the analysis made in Chapters 7 and 8. [Chapter 12, Section 12.3.6., page 246.]
Fish		N/A	N/A	N/A	N/A	N/A	1%	9%	0%	91%	0%	2%	10%	0%	90%	0%	
TOTAL						100%	45%	12%	25%	18%	100%	43%	12%	27%	18%		

a/ Excluding Forestry and Fisheries
 b/ Not including germplasm networks
 c/ Yam included in Bananas and Plantain

14.4.4.3. Regional distribution

TAC's allocation decisions on categories of activity (and their regional distribution) and on the commodities and production sectors resulted in a regional distribution for 1998 which - as indicated in Table 14.2C - is quite close to the regional targets set for 1998, i.e. 40% to SSA compared to 39%, 12% to WANA compared with 11%, 31% to Asia compared with 33%, and 17% to LAC i.e. the target set for 1998.

14.5. The Allocation Process

The **objective** of the medium-term resource allocation process is to ensure the implementation of the agreed core priorities of the CGIAR, expressed in several dimensions, in a coherent way by autonomous CGIAR Centres supported by donors acting individually. In order to ensure realism in the forward core planning by centres, and thus the relevance of the MTPs throughout the planning period, core operating resources need to be confined within the boundaries set by realistic estimates of core funding that will be made available to the System. Though, as indicated earlier, complementary programmes are being treated as financially unconstrained, they are expected to be broadly consistent with the general direction of the core priorities.

The **principles** upon which the resource allocation process has been constructed are:

(a) transparency, i.e. the rationale of the centre allocation recommendations can be related to the recommendations on System priorities as recommended by TAC and which will be discussed and reviewed by the Group;

(b) constraining, i.e., centres are asked to prepare MTP proposals which conform with the indicative core resource envelopes recommended by TAC; however, centres will have a reasonable margin of flexibility since they are also requested to present alternative proposals at 10% above and below the level of the core resource envelope. Centres in exceptional circumstances could present proposals in excess of this margin for consideration by TAC and the Group;

(c) interactive, i.e. starting from a centralized indicative planning allocation which will be discussed by the Group, centres will construct their MTP proposals, and will present them to both TAC and the Group; subsequently, TAC will need to reconcile the MTP proposals both in

substance - i.e. the convergence of the sum total of centres' medium-term programme proposals with the System priorities - and financially - i.e. the compatibility between the sum total of centres' proposed funding requirements and the core funding assumption used for the System as a whole.

The **format** of the centre resource allocation recommended by TAC is that of a centre specific, indicative envelope of core funding for 1998. The envelopes will serve as planning assumptions for centres to prepare their MTPs for review by TAC and by the Group.

14.6. The Resource Allocation Methodology

The decision to retain the evolutionary option rather than the construction of an "ideal" model, as described in Section 14.3.1 above, required the use 1991 data as a starting point for the resource allocation exercise. To that effect, centres' 1991 core programme and operating expense data were mapped in accordance with the activity structure and regional definitions used by TAC in the priority exercise. The initial mapping by the CGIAR Secretariat was reviewed and updated by the centres. The product of this exercise is shown in Table 14.3, which indicates for each centre the relative distribution of 1991 core operating resources among activities and regions. The consolidation of centre data at the System level is shown in Table 14.1.

The basic task is to chart the evolution from the actual situation in 1991 towards 2010 goals. The first step was to identify targets for 1998. TAC was assisted in its decision making by a financial spreadsheet. The spreadsheet used 1991 centre and System data as a starting point. These data were adjusted by applying weighting factors to 1991 data regarding activities, and proportional distributions to regions, commodities and production sectors. This was done in an iterative fashion, allowing TAC to consider the impact of the modifications it had introduced, alter modifications to obtain the desired outcome, and consider alternative scenarios and their impact. Thus TAC defined and refined, in an iterative way, the medium-term resource targets for each of its priority parameters. The spreadsheet provided the mechanical translation of the System-level priority choices to centre allocations. This facilitated TAC's consideration of individual centre resource envelopes, taking into account other factors such as need for minimum critical mass, stage of maturity and recent developments of centres' programmes, and relevant information on strategic plans as well as on programme and management reviews.

14.7. 1998 Core Supply Considerations

A key feature of the medium-term core resource allocation process is to ensure that the sum of the 1998 core funding requirements of all centres' MTPs remains within reasonable limits of expected core funding for that year. As indicated above (Section 14.3.3), a number of assumptions with regard to future core supply were considered. However, consistent with donor indications so far, the assumption that generally maintains the 1992 CGIAR core funding in real terms with the possible exception of new activities recently integrated in the CGIAR (i.e. fisheries and forestry) was chosen.

Therefore, the estimated 1998 core funding assumed by TAC in the resource allocation exercise amounts to US\$ 270 million in 1992 values - or US\$ 342 million in 1998 values, assuming a 4% annual rate of inflation. While this level assumes a mere maintenance of the value of 1992 core funding for most activities, it assumes for 1998 a near doubling of the funding of forestry activities provided in 1992. At ICW'91, 1992 core funding was estimated at US\$ 251 million, including about US\$ 14 million for forestry activities, but excluding US\$ 4 million of funding of fishery activities. This amount augmented by US\$ 5 million for fishery activities (up from US\$ 4 million in 1992) and an additional US\$ 14 million for forestry produces a US\$ 270 million estimate for 1998. The implication is that, with the exception of forestry and fisheries, the current core funding would need to be redeployed over a different portfolio of activities.

Table 14.3. Centers' Estimated 1991 Core Resources Distribution (in %) 1/

	Agriculture											Forestry/ Agroforestry		Fish- eries	Non-Commodity/Global				TOTAL
	Crops					Livestock						CIFOR	ICRAF	ICLARM	Genetic Resources		Policy/ Management		
	Global				Regional										IBPGR	IFPRI	IIMI	ISNAR	
	CIMMYT	CIP	INIBAP	IRRI	WARDA	ICRISAT	IITA	CIAT	ICARDA	ILCA	ILRAD								
Centers' Share of Core Resources	10%	6%	1%	11%	2%	11%	9%	11%	8%	8%	5%	1%	4%	2%	3%	3%	3%	3%	100%
Centers' Distribution of Resources:																			
I. By Region:																			
SS Africa	16%	29%	50%	5%	100%	40%	100%	17%	0%	100%	100%	27%	100%	10%	26%	42%	24%	52%	43%
WANA	16%	10%	0%	3%	0%	1%	0%	0%	100%	0%	0%	3%	0%	0%	15%	1%	3%	8%	13%
Asia	39%	39%	22%	86%	0%	56%	0%	6%	0%	0%	0%	36%	0%	0%	28%	55%	71%	25%	29%
LAC	30%	22%	28%	5%	0%	3%	0%	77%	0%	0%	0%	34%	0%	0%	31%	2%	3%	15%	15%
II. By Category of Activity:																			
1. Conservation/Management Natural Resources	4%	14%	0%	6%	0%	22%	18%	7%	25%	0%	0%	20%	22%	15%	78%	0%	35%	0%	13%
1.1 Ecosystem Conservation	0%	0%	0%	0%	0%	19%	18%	3%	16%	0%	0%	0%	10%	15%	0%	0%	35%	0%	7%
1.2 Germplasm Coll./Conserv.	4%	14%	0%	6%	0%	3%	0%	3%	9%	0%	0%	20%	12%	0%	78%	0%	0%	0%	6%
2. Germplasm Enhancement/ Breeding	53%	14%	74%	12%	27%	40%	32%	23%	20%	0%	7%	20%	12%	11%	0%	0%	0%	0%	21%
2.1 Crops	53%	14%	74%	12%	27%	40%	32%	23%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	20%
2.2 Livestock	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	0%
2.3 Trees	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	20%	12%	0%	0%	0%	0%	0%	1%
2.4 Fish	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%
3. Production Systems Dvlpmt/ Management	19%	28%	0%	40%	34%	17%	29%	50%	35%	74%	67%	60%	29%	29%	0%	0%	0%	0%	33%
3.1 Cropping Systems	19%	28%	0%	40%	34%	17%	29%	27%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%
3.2 Livestock systems	0%	0%	0%	0%	0%	0%	0%	23%	15%	74%	67%	0%	0%	0%	0%	0%	0%	0%	13%
3.3 Tree Systems	0%	0%	0%	0%	0%	0%	0%	0%	60%	0%	0%	60%	29%	0%	0%	0%	0%	0%	2%
3.4 Aquatic systems	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	29%	0%	0%	0%	0%	0%
4. Socio-econ./Public Policy/ Public Management Research	2%	8%	0%	6%	7%	3%	7%	4%	3%	5%	6%	0%	11%	22%	0%	72%	56%	12%	9%
5. Institution Building	21%	36%	26%	34%	32%	19%	14%	16%	17%	20%	20%	0%	25%	23%	22%	28%	9%	88%	24%
5.1 Training/Conf.	15%	7%	5%	13%	6%	7%	8%	9%	4%	7%	13%	0%	14%	7%	7%	0%	5%	21%	9%
5.2 Doc./Pub./Dis. Info.	6%	10%	21%	12%	12%	5%	6%	7%	6%	10%	7%	0%	11%	12%	15%	12%	5%	5%	8%
5.3 Org./Mngmt. Counsel.	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	62%	2%
5.4 Networks	0%	19%	0%	9%	14%	7%	0%	0%	7%	4%	0%	0%	0%	4%	0%	17%	0%	0%	5%
III. By Category of Activity and Region																			
1. Conservation/Management Natural Resources	4%	14%	0%	6%	0%	22%	18%	7%	25%	0%	0%	20%	22%	15%	78%	0%	35%	0%	13%
SS Africa	12%	29%	0%	2%	0%	41%	100%	11%	0%	0%	0%	31%	100%	10%	26%	0%	5%	0%	35%
WANA	22%	10%	0%	2%	0%	1%	0%	0%	100%	0%	0%	3%	0%	0%	15%	0%	0%	0%	13%
Asia	28%	39%	0%	94%	0%	58%	0%	9%	0%	0%	0%	22%	0%	90%	28%	0%	95%	0%	19%
LAC	36%	22%	0%	2%	0%	0%	0%	81%	0%	0%	0%	44%	0%	0%	31%	0%	0%	0%	33%
2. Germplasm Enhancement/ Breeding	53%	14%	74%	12%	27%	40%	32%	23%	20%	0%	7%	20%	12%	11%	0%	0%	0%	0%	21%
SS Africa	15%	29%	50%	8%	100%	41%	100%	25%	0%	0%	100%	31%	100%	10%	0%	0%	0%	0%	39%
WANA	19%	10%	0%	7%	0%	2%	0%	0%	100%	0%	0%	3%	0%	0%	0%	0%	0%	0%	14%
Asia	39%	39%	22%	73%	0%	51%	0%	5%	0%	0%	0%	22%	0%	90%	0%	0%	0%	0%	29%
LAC	27%	22%	28%	12%	0%	7%	0%	71%	0%	0%	0%	44%	0%	0%	0%	0%	0%	0%	19%
3. Production Systems Dvlpmt/ Management	19%	28%	0%	40%	34%	17%	29%	50%	35%	74%	67%	60%	29%	29%	0%	0%	0%	0%	33%
SS Africa	17%	29%	1%	1%	100%	34%	100%	13%	0%	100%	100%	24%	100%	10%	0%	0%	0%	0%	49%
WANA	12%	10%	0%	4%	0%	0%	0%	0%	100%	0%	0%	3%	0%	0%	0%	0%	0%	0%	11%
Asia	34%	39%	91%	4%	0%	66%	0%	5%	0%	0%	0%	45%	0%	90%	0%	0%	0%	23%	
LAC	37%	22%	4%	4%	0%	0%	0%	81%	0%	0%	0%	28%	0%	0%	0%	0%	0%	0%	17%
4. Socio-econ./Public Policy/ Public Management Research	2%	8%	0%	6%	7%	3%	7%	4%	3%	5%	6%	0%	11%	22%	0%	72%	56%	12%	9%
SS Africa	35%	29%	0%	0%	100%	36%	100%	9%	0%	100%	100%	0%	100%	10%	0%	42%	38%	42%	46%
WANA	7%	10%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	1%	5%	8%	5%
Asia	18%	39%	100%	0%	0%	64%	0%	9%	0%	0%	0%	0%	0%	90%	0%	55%	54%	32%	41%
LAC	40%	22%	0%	0%	0%	0%	0%	82%	0%	0%	0%	0%	0%	0%	0%	2%	3%	18%	8%
5. Institution Building	21%	36%	26%	34%	32%	19%	14%	16%	17%	20%	20%	0%	25%	23%	22%	28%	9%	88%	24%
SS Africa	15%	29%	50%	11%	100%	43%	100%	20%	0%	100%	100%	100%	100%	10%	26%	42%	6%	53%	43%
WANA	10%	10%	0%	2%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	15%	1%	5%	8%	8%
Asia	45%	39%	22%	81%	0%	57%	0%	10%	0%	0%	0%	0%	0%	90%	28%	55%	80%	25%	34%
LAC	30%	22%	28%	6%	0%	0%	0%	70%	0%	0%	0%	0%	0%	0%	31%	2%	9%	14%	13%

1/ Percentages may not add to 100 due to rounding.

This funding assumption may be considered too conservative. It should not be seen as an indication by TAC that the current level of resources is adequate to fully meet the challenges and tasks faced by the centres. It is a conservative approach at this stage of the planning process to ensure that the System has the opportunity to explore the operational implications of zero real growth. In order that this assumption is not counterproductive for centres by not providing them the opportunity to demonstrate their full potentials at higher levels of resource supply, the resource allocation process provides two mitigating mechanisms: one is that centres will be requested to explore in their MTPs what the impact would be on their programmes of higher than assumed core funding; the second being the mechanism of yearly adjustment of funding requirements which will distribute actual core supply to centres in function of their share of the total as determined by the medium term resource allocation process.

14.8. Recommendations of 1998 Resource Allocations

As implied by the previous discussion, TAC formulated recommendations with regard to the 1998 allocation of core operating resource at two levels: at the System level first and, subsequently, at the centre level.

14.8.1. System Resource Allocations

The relative distribution resulting from linking priorities to a global, hypothetical resource envelope as indicated in Tables 14.2A to C needed to be converted in absolute dollar core funding amounts. As explained in the previous section, the core funding for 1998 has been estimated at US\$ 270 million (in 1992 values); this amount assumes 1998 core funding at the 1992 level (US\$ 251 million), augmented by US\$ 4 million of ICLARM 1992 core funding, and by US\$ 15 million of incremental core funding in 1998 for forestry and fisheries.

14.8.1.1. Global outcome

Table 14.4 shows the translation of the relative resource distribution (Tables 14.2A to C) into 1998 core funding values of US\$ 270 million and the indicative allocation of that amount to the categories of activity, the commodities and production sectors, and the regions.

14.8.1.2. Regional portfolio of CGIAR investments

Table 14.4 provides also an insight into the composition of the regional research portfolios.

In SSA, 55% of the core resources would be allocated to germplasm enhancement and breeding (category 2) and production systems (category 3) research. This ratio is higher than the System average of 51%, and is related to the relatively lesser allocation in SSA to natural resources (category 1) research and to socioeconomic, public policy and public management research (category 4). The recommended level in category 5 (institution building) is near the System level target. Within the consolidated allocation to categories 2 and 3, research on agricultural crops represent 51% of total, which is well below the system average (66%) and reflects the high share allocated to

Table 14.4 1998 Proposed System Core Allocation by Category of Activity, by Region, by Production Sector and Commodity
(in constant 1992 \$ millions and percentages) 1/

Categories of Activity	1998 Proposed Allocation	Relative Distribution of Categories' Allocations by Region				
		SS Africa	WANA	Asia	LAC	Total
1. Conservation & Management of Natural Resources	48.6	15%	23%	19%	21%	18%
1.1 Ecosystem conserv./mngmnt.	27.0	10%	10%	10%	11%	10%
1.2 Germplasm coll./conserv./char./eval.	21.6	5%	13%	9%	10%	8%
2. Germplasm Enhancement & Breeding	60.0	20%	24%	23%	23%	22%
2.1 Crops	53.2	17%	24%	21%	21%	20%
2.2 Livestock	1.3	1%	0%	0%	0%	0%
2.3 Trees	4.7	2%	0%	2%	2%	2%
2.4 Fish	0.8	0%	0%	1%	0%	0%
3. Production Systems Development & Management	79.1	35%	28%	23%	30%	29%
3.1 Cropping Systems	38.5	11%	17%	17%	14%	14%
3.2 Livestock systems	30.5	20%	10%	0%	12%	11%
3.3 Tree systems	8.3	4%	1%	3%	3%	3%
3.4 Aquatic systems	1.8	0%	0%	2%	0%	1%
4. Socio-Economic, Public Policy, & Public Management Research	29.6	9%	9%	14%	10%	11%
5. Institution Building	52.7	21%	15%	21%	17%	20%
5.1 Training/Conferences	19.5	8%	6%	7%	6%	7%
5.2 Doc./Pub./Dis. Info.	16.9	7%	4%	7%	5%	6%
5.3 Org./Mngmnt. Counselling	6.2	3%	2%	2%	2%	2%
5.4 Networks	10.1	3%	3%	5%	3%	4%
System Total	270.0					
Regional Distribution:	US dollar millions	109.3	31.1	82.5	47.1	270.0
	Percentage	40%	12%	31%	17%	

Production Sector/Commodity (Aggregation of categories 2 and 3)	1998 Proposed Allocation 2/	Relative Distribution of Sectors and Commodities' Allocations by Region				
		SS Africa	WANA	Asia	LAC	Total
Cereals						
Rice	19.8	6%	5%	32%	13%	14%
Wheat/Barley	13.2	0%	43%	13%	5%	9%
Maize	13.2	9%	3%	9%	16%	9%
Sorghum	4.6	4%	0%	5%	3%	3%
Millet	3.8	3%	0%	5%	0%	3%
Cereals Subtotal:	54.5	22%	51%	63%	36%	39%
Roots & Tubers						
Cassava	6.5	6%	0%	2%	8%	5%
Potato	5.3	3%	3%	5%	5%	4%
Sweet Potato	1.3	1%	1%	1%	1%	1%
Roots & Tubers Subtotal:	13.2	10%	4%	9%	14%	9%
Food Legumes						
Phaseolus Bean	5.7	3%	0%	0%	15%	4%
Faba bean/Lentil	2.5	0%	16%	0%	0%	2%
Chickpea	2.6	0%	8%	4%	0%	2%
Cowpea/Soybeans	5.4	9%	0%	0%	0%	4%
Groundnut	3.3	2%	0%	5%	0%	2%
Pigeonpea	0.8	0%	0%	2%	0%	1%
Food Legumes Subtotal:	20.3	14%	24%	11%	15%	15%
Banana & Plantain						
Banana/Plantain/Yam	3.6	5%	0%	1%	2%	3%
TOTAL AGRICULTURAL CROPS	91.7	51%	79%	83%	68%	66%
LIVESTOCK	31.8	38%	19%	1%	22%	23%
FISH	2.6	0%	0%	6%	0%	2%
TREES	13.0	11%	2%	10%	10%	9%
TOTAL	139.2	100%	100%	100%	100%	100%

1/ Totals may not add due to rounding.

2/ Sum of Categories 2 and 3

livestock (38%) and forestry (11%) research in the region. Among the agricultural crops, cereals rank first (22% of total), followed by food legumes (14%), roots and tubers (10%) and banana, plantain and yam (5%).

In WANA, 52% of total resources would be allocated to categories 2 and 3 combined, slightly higher than the system average; category 1 (natural resources) would be allocated 23% of the resources, i.e. well above the System average (18%). In the two remaining categories, WANA's proposed allocations are below System averages. Within the global allocation to categories 2 and 3, agricultural crop research accounts for 79% of the resources (compared with 66% as System average), livestock for 19% (23% System average), and forestry for the remaining 2%. Among the agricultural crops, cereals account for 64% of total, 84% of which is allocated to wheat and barley; food legumes follow with 24%, two thirds of which is allocated to faba bean and lentil research; and roots and tubers represent a modest 5% of the regional total.

In Asia, only 46% of total resources would be allocated to categories 2 and 3, with all three other categories (and particularly category 5, Institution Building) receiving higher than System average allocations. Within the global allocation to categories 2 and 3, 83% of the resources would be allocated to agricultural crop research, i.e. well above the System average; this reflects the low share of livestock research (1%), while fisheries (6%) and forestry (10%) are still at modest levels but above the System averages. Among agricultural crops, cereals account for about 75%, half of which is devoted to rice; food legumes are a distant second with 11%, in part as a consequence of the proposed reduction in pigeonpea research not fully compensated for by the increase in groundnut research; and, roots and tubers represent 11% of total, i.e. at the System average.

In LAC, 53% of total resources would be allocated to categories 2 and 3 combined, slightly higher than the System average; category 1 (natural resources) is proposed at 21% of the resources, and is well above the System average (18%). While category 4 (Socioeconomic, public policy, public management research) is at the System average level of 14%, category 5 (institution building) represents a relatively modest 17%. Within the global allocation to categories 2 and 3, agricultural crop research accounts for 68% of the resources (compared with 66% as the System average), livestock for 22% (23% System average), and forestry for the remaining 10%. Among the agricultural crops, cereals account for 55% of total, 80% of which is allocated to maize and rice; food legumes follow with 22%, all of which relates to phaseolus bean research at a reduced level as recommended by TAC; and, roots and tubers represent 21% of the regional total.

14.8.2. Linking System Allocations to Centre Allocations

Once TAC had reached consensus on the System resource allocation, it considered the impact of its recommendations on centre allocations in terms of relative change from current core funding levels to reach the projected 1998 levels. These relative changes and their amplitude are shown in Table 14.5 by groups of centres and by category of activity. The table also illustrates how the directional changes proposed at the System level impact on centre allocations. This becomes particularly evident when the directional changes are analyzed by functional regrouping of centres as presented in Table 14.5. A plus or minus sign in the table indicates that the centre allocation is positively or negatively affected by the System relative allocation to the priority

Table 14.5: Directional Changes by 1998 in Centers' Resource Distribution Among Categories of Activity

Categories of Activity	Agriculture											Forestry/ Agroforestry	Fish- eries	Non-Commodity/Global				TOTAL			
	Crops						Livestock							Genetic Resources	Policy/ Management						
	Global			Regional			WARDA	ICRISAT	IITA	CIAT	ICARDA	ILCA	ILRAD		CIFOR	ICRAF	ICLARM	IBPGR	IFPRI	IIMI	ISNAR
	CIMMYT	CIP	INIBAP	IRRI																	
1. Conservation/Management of Natural Resources	+	+		+			++	++	++	+				+	+		++		++		++
1.1 Ecosystem Conservation							++	++	++	-					+			++			++
1.2 Germplasm coll./conserv.	+	++		++			+		+	++			+	++			++				++
2. Germplasm Enhancement/Breeding	++	+		++	+		--	+	-	+											+
2.1 Crops	++	++		++	+		-	+	--	++											+
2.2 Livestock																					+
2.3 Trees													++	++							++
2.4 Fish															++						++
3. Production Systems Dvlpmnt/Management	-	-		-	-		+	+	-	-	--	--									--
3.1 Cropping Systems	-	-		-	-		--	--	--	-											--
3.2 Livestock systems																					--
3.3 Tree Systems							+	+	+	+			++	++							++
3.4 Aquatic systems															++						++
4. Socio-econ./Public Policy/Public Management Research	+	++		+			+	-	++	++	-	-		+	+			++	++	+	-
5. Institution Building	--	-		--	-		--	-	-	-	--	--		+	+			-	-	+	--
5.1 Training/Conf.	--	-		--	-		-	-	--	+	--	--		+	+			-	-	-	--
5.2 Doc./Pub./Dis. Info.	-	-		--	-		-	-	--	-	--	--		+	+			-	-	-	++
5.3 Org./Mngmnt. Counsel.				--	-		--	-	--	-										++	--
5.4 Networks				--	-		--	-	--	-											--
Total	-	-		-	-		-	0	+	-	--	--	++	++	++		++	+	+	+	+

Signs: + indicates a positive impact, and ++ indicates a stronger positive impact on the Center's relative allocation
 - indicates a negative impact, and -- indicates a stronger negative impact on the Center's relative allocation

parameters; a double sign indicates a stronger impact, while a single sign indicates a more moderate impact. It should be noted that the signs are not directly comparable among categories of activity, and thus across centres, since the magnitude of the change of direction in the different categories varies widely. Given these factors the pluses and minuses can not be translated into monetary terms. Thus adding pluses and minuses within a centre or across centres has no real meaning.

The proposed increase in core resources for research on **natural resources conservation and management** (category 1) are allocated to all centres concerned. The Centres with a regional mandate and a natural resource management programme benefit more than the global commodity oriented centres, and mostly in their activities comprised in sub-category 1.1 (ecosystem conservation). In contrast, the proposed increase in category 1 in the commodity centres, while more modest in size, is fully allocated to sub-category 1.2 (germplasm collection and conservation), which is consistent with their commodity orientation.

The increase in resources proposed in category 4 (**socioeconomic, public policy and public management research**) is also allocated to all centres, except to those focusing on SSA. This is consistent with TAC's recommendation to shift the emphasis of this category from SSA towards LAC and, to a lesser extent, to Asia. The proposed reduction in **institution building** activities (category 5), will affect all centres except ISNAR which is allocated more as a consequence of TAC's recommendations to intensify efforts in organization and management counselling (sub-category 5.3).

The proposed increase in activities related to **germplasm enhancement and breeding** (category 2) is allocated mostly to the commodity oriented centres, while these centres see the relative allocation to category 3 (**production systems development and management**) decrease. This is consistent with TAC's recommendation to decrease the overall effort of commodity related production systems work and of emphasizing crop related germplasm work. In contrast, the regionally focused centres see their relative allocation to category 2 increase only modestly mainly as a consequence of TAC's recommendation to reduce efforts in food legumes. The same trends can be observed in the allocations to production systems work in the regionally focused centres; the significant reduction in sub-category 3.1 (cropping systems) is, however, in all cases somewhat compensated by an increase in sub-category 3.3 (Tree Systems), as a consequence of the assumed increment in forestry work.

The centres dealing with policy and management benefit from increases in the categories of activities relevant to them, and consistent with TAC's recommendations to strengthen natural resources conservation and management (category 1), public policy and public management research (included in category 4), and organization and management counselling (sub-category 5.3).

The African livestock centres will experience an overall reduction in resources, consistent with TAC's recommendations to decrease work on productions systems (category 3), including livestock systems (sub-category 3.2), and on institution building (category 5). As indicated above, these centres also see a decline in resources for socioeconomic work (included in category 4) as a consequence of TAC's recommendation to adjust this category in SSA.

The forestry and fisheries centres are allocated significant increases of resources in all categories of activity consistent with the assumption that incremental funding will be provided by the CGIAR for these activities.

Finally, the Genetic Resources Centre will see its overall resources increase significantly, as a consequence of the System increase in germplasm collection and conservation work (sub-category 1.2).

14.8.3. Centre Resource Allocations

The last step in TAC's resource allocation process consisted in translating the System resource allocations and the directional changes in centre allocations into centre specific absolute dollar amounts, which would represent the 1998 indicative resource allocations as a starting point for the preparation by centres of the 1994-98 MTPs.

TAC felt that in view of the indicative nature of the funding envelopes, it would need, at the final stage of the medium-term resource allocation process, some flexibility to reallocate resources - within the overall core funding envelope - among programmes and centres on the basis of centre proposals. Therefore, in developing the centre core resource envelopes, TAC has only allocated a total of US\$ 250 million out of the total of US\$ 270 million. The adjustment was made first by discounting all centres' initial resource envelopes by 5% (representing US\$ 15 million). This was supplemented by holding back US\$ 5 million of funding for African livestock centres - in view of the uncertainty surrounding the future evolution and direction of CGIAR livestock research as expressed in Chapter 12 (Section 12.3.5.2).

At the time of completion of the medium-term resource allocation process decisions can be made on allocating the resulting reserve of US\$ 20 million to centres to accommodate requests for core funding in excess of their resource envelopes for programmes and activities which TAC could not anticipate or for additional requirements resulting from external reviews or other studies. Such a reserve could also finance new and innovative programmes during the MTP implementation period, i.e. 1994-98.

Taking into account the set-side of US\$ 20 million, an indicative core funding envelope was established for each of the 18 centres. In order to provide flexibility in both System and centre level planning, centres are asked to present MTP proposals at three levels of core funding - i.e. at the level of their allocation (totalling US\$ 250 million) as well as in ranges 10% above and below that number. This should provide centres the opportunity to demonstrate their potentials at higher levels of funding, as well as show the impact of a lower funding on their programmes and activities.

These indicative planning targets and the corresponding brackets are shown in Table 14.6, which compares them with 1992 core funding as currently estimated.

Centres' individual, indicative resource envelopes are consistent with TAC's overall System recommendations as explained in the next section.

Table 14.6 Centers' Indicative 1998 Resource Envelopes and Planning Ranges

Centers	1992 Estimated Core Funding	Planning Ranges of 1998 Core Funding (in 1992 \$ millions)		
		Low	Base Resource Envelope	High
CIMMYT	25.6	21.7	24.1	26.5
CIP	15.2	12.9	14.3	15.7
INIBAP	2.2	1.9	2.1	2.3
IRRI	28.3	22.1	24.5	27.0
WARDA	6.2	5.2	5.8	6.4
ICRISAT	27.7	24.2	26.9	29.6
IITA	22.2	20.3	22.5	24.8
CIAT	26.5	24.8	27.5	30.3
ICARDA	18.9	15.8	17.6	19.4
ILCA	19.4	12.6	14.0	15.4
ILRAD	12.6	8.2	9.1	10.0
ICRAF	11.9	14.5	16.1	17.7
CIFOR	3.4	7.3	8.1	8.9
ICLARM	4.0	4.3	4.8	5.3
IBPGR	7.4	7.6	8.4	9.2
IFPRI	8.3	7.7	8.6	9.5
IIMI	7.3	6.8	7.6	8.4
ISNAR	6.6	6.1	6.8	7.5
Centers Total	<u>253.8</u>		<u>248.8</u>	
Add:				
External Reviews	1.2		1.2	
Reserve for future Allocation			20.0	
System Total	<u>255.0</u>		<u>270.0</u>	

14.8.4. Specific Factors Affecting Individual Centre Allocations

- CIMMYT:** CIMMYT's indicative 1998 core resource envelope amounts to US\$ 24.1 million, which compares with a current 1992 core funding assumption of US\$ 25.6 million. CIMMYT resources would increase modestly in natural resources conservation and management (category 1), more significantly in germplasm enhancement and breeding (category 2) because of the need to give greater attention to strategic issues in wheat research. The centre also benefits from the higher priority assigned to Asia and of the greater emphasis on socioeconomic work (included in category 4). Resources would, however, decrease, consistent with the Systemwide recommended trends, in production systems development and management (category 3) and institution building (category 5). The relative priority assigned to research on wheat and maize remains unchanged.
- CIP:** CIP's indicative 1998 resource envelope amounts to US\$ 14.3 million, which compares with a current 1992 core funding assumption of US\$ 15.2 million. CIP would benefit from a relatively modest increase in natural resources conservation and management (category 1), a more significant increase in germplasm enhancement and breeding (category 2) and in socioeconomic work (included in category 4). Its resources for production systems development and management (category 3) and in institution building (category 5) would decrease, consistent with TAC's System recommendations on these categories. The relative priority assigned to research on potato and sweet potato remains unchanged.
- INIBAP:** INIBAP's indicative 1998 resource envelope amounts to US\$ 2.1 million, which compares with a current 1992 core funding assumption of US\$ 2.2 million. INIBAP's core resources would be virtually maintained thus providing the institution, which joined the CGIAR recently, the necessary critical mass to bring its programme to fruition, which is consistent with TAC's recommendation to maintain the relative importance of banana and plantain at current levels.
- IRRI:** IRRI's indicative 1998 core resource envelope amounts to US\$ 25.8 million, which compares with a current 1992 core funding assumption of US\$ 28.3 million. IRRI's core resources would decrease significantly as a result of the Systemwide decreases in production systems development and management (category 3) and in institution building (category 5); with regard to the latter, IRRI is particularly affected by the reduction in sub-category 5.4 (networks). On the other hand, IRRI benefits from an increase in natural resources conservation and management (category 1) and from an even more significant increase in germplasm enhancement and breeding (category 2), both of which are not sufficient to offset the decreases in the previous categories of activity. IRRI also benefits from its overall focus on Asia, and on the need to give greater attention to strategic issues in rice research. The relative priority of rice research remains unchanged.

- WARDA:** WARDA's indicative 1998 resource envelope amounts to US\$ 5.8 million, which compares with a current 1992 core funding assumption of US\$ 6.2 million. WARDA's core resources would be virtually maintained at its current level. The application of TAC's System priority and allocation recommendations on WARDA would have implied a reduction in its core resources. However, such a reduction was considered to bring WARDA's current, modest research programme below the critical mass level.
- ICRISAT:** ICRISAT's indicative 1998 core resource envelope amounts to US\$ 26.9 million, which compares with a current 1992 core funding assumption of US\$ 27.7 million. Increases result from higher System allocations to natural resource conservation and management (category 1), in socioeconomic work (included in category 4) and in tree related work (sub-category 3.3). ICRISAT's resources are reduced by decreases in germplasm enhancement and breeding (category 2) and cropping systems (sub-category 3.1) as a consequence of TAC's recommendation to de-emphasize work on pigeonpea, though this is in part offset by the recommended increase in groundnut research. ICRISAT also benefits from its focus on the Asia region which has received a higher priority, and its overall emphasis on resource management issues in the semi-arid tropics. The relative priorities assigned to sorghum, millet and chickpea are unchanged. As other centres, ICRISAT's allocation for institution building (category 5) would decrease.
- IITA:** IITA's indicative 1998 core resource envelope amounts to US\$ 22.2 million, which compares with a current 1992 core funding assumption of US\$ 22.2 million. Increases result from System increases in natural resources conservation and management research (category 1), in germplasm enhancement and breeding (category 2), and in tree related work (sub-category 3.3); consistent with TAC's recommendation to strengthen soybean research, IITA's allocation for categories 2 and 3 increases in relative terms. IITA's allocation, however, experiences decrease in socioeconomic work (included in category 4) and in institution building (category 5), and because of its overall emphasis on SSA which has received a lower priority ranking.
- CIAT:** CIAT's indicative 1998 core resource envelope amounts to US\$ 27.5 million, which compares with a current 1992 core funding assumption of US\$ 26.5 million. CIAT benefits from the increases in natural resources conservation and management (category 1) and in socioeconomic work (included in category 4), with a special emphasis in both categories on LAC. CIAT also benefited from its overall focus on LAC, and the broadening of its agroecological zone coverage. Except for an increment in tree systems (sub-category 3.3), CIAT's envelope experiences a decline in the combined allocation to categories 2 (germplasm enhancement and breeding) and 3 (production systems) as a result of the overall recommended trend and more specifically as a consequence of TAC's recommendation to reduce the priority of research on phaseolus bean. Also, CIAT is impacted by a reduction in institution

building (category 5) as a consequence of TAC's global recommendation to that effect.

- ICARDA:** ICARDA's indicative 1998 core resource envelope is US\$ 17.6 million, which compares with a current 1992 core funding assumption of US\$ 18.9 million. ICARDA benefits from the system increases in natural resources conservation and Management research (category 1), in socioeconomic work (included in category 4) with a particular emphasis on WANA, in germplasm enhancement and breeding research (category 2) and in tree related work (sub-category 3.3). It experiences decreases in cropping systems (category 3.1) without altering the relative importance of ICARDA's specific crops, and in institution building (category 5), and through its overall focus on WANA which has received a lower priority ranking.
- ILCA:** ILCA's indicative 1998 core resource envelope amounts to US\$ 14 million, which compares with a current 1992 core funding assumption of US\$ 19.4 million. More than half of the reduction is accounted for by TAC's decision to set aside a reserve, pending the outcome of the Winrock livestock study, of the livestock centres external reviews, and TAC's review of these centres' MTP proposals. Discounting for this reduction, ILCA's resources would still decline as a result of TAC's Systemwide recommendations to reduce the priority assigned to SSA, and of efforts in Production System Development and Management (category 3), to adjust efforts in SSA in socioeconomic work (included in category 4), and to adjust Institution Building activities (category 5).
- ILRAD:** ILRAD's indicative 1998 core resource envelope amounts to US\$ 9.1 million, which compares with a current 1992 core funding assumption of US\$ 12.6 million. As in the case of ILCA, more than half of the reduction is accounted for by TAC's decision to set aside a reserve, pending the outcome of the Winrock livestock study, of the livestock centres external reviews, and TAC's review of these centres MTP proposals. Discounting for this reduction, ILRAD's resources would still decline as a result of TAC's Systemwide recommendations to reduce efforts in SSA, in particular in production system development and management (category 3), in socioeconomic work (included in category 4), and to adjust institution building activities (category 5). These reductions are, however, offset in part with an increase in resources for germplasm enhancement and breeding (category 2).
- CIFOR:** CIFOR's indicative 1998 core resource envelope amounts to US\$ 7.6 million, which compares with a current 1992 core funding assumption of US\$ 3.4 million. Virtually all of the increase is related to the assumption that the CGIAR will provide incremental core funding for forestry related activities. If this assumption materializes, CIFOR's activities in all categories would increase substantially. CIFOR also benefits of some increase as a result of TAC's System recommendation to increase resources for natural resource conservation and management (category 1).

- ICRAF:** ICRAF's indicative 1998 core resource envelope amounts to US\$ 15.6 million, which compares with a current 1992 core funding assumption of US\$ 11.9 million. As in the case of CIFOR, virtually all of the increase is related to the assumption that the CGIAR will provide incremental core funding for forestry related activities. If this assumption materializes, ICRAF's activities in all categories would increase substantially. ICRAF also benefits from some increases as a result of TAC's System recommendation to increase resources for natural resource conservation and management (category 1). As other centres, ICRAF would experience a relative decrease in resources for institution building (category 5), consistent with TAC's recommendation to adjust System efforts in this area.
- ICLARM:** Throughout TAC's priority and resource allocation exercise, it has been assumed that by 1998 ICLARM would be fully integrated in the CGIAR. On that basis, ICLARM's indicative 1998 core resource envelope amounts to US\$ 4.8 million, which compares with a current 1992 core funding assumption of US\$ 4 million. Virtually all of the increase is related to the assumption that the CGIAR will provide incremental core funding for fisheries related activities. If this assumption materializes, ICLARM's activities in all categories would increase significantly. In addition, ICLARM would benefit from some increases as a result of TAC's System recommendation to increase resources for germplasm collection and conservation (sub-category 1.2) and for socioeconomic work (included in category 4). As other centres, ICLARM would experience a relative decrease in resources for institution building (category 5), consistent with TAC's recommendation to adjust System efforts in this area.
- IBPGR:** IBPGR's indicative 1998 core resource envelope amounts to US\$ 8.4 million, which compares with a current 1992 core funding assumption of US\$ 7.4 million (excluding funding of one time costs in 1992). The increase results from TAC's recommended System increase in germplasm collection and conservation (sub-category 1.2), tempered somewhat by a relative decrease in the allocation for institution building (category 5).
- IFPRI:** IFPRI's indicative 1998 core resource envelope amounts to US\$ 8.6 million, which compares with a current 1992 core funding assumption of US\$ 8.3 million. The increase results from the significant increase in allocation to public policy research (included in category 4), in particular in view of the needs arising from the integration in the CGIAR of expanded areas of activity (natural resources management, forestry and fisheries) and from the greater emphasis given to Asia and LAC. IFPRI would, however, experience a relative decrease in resources for institution building (category 5), consistent with TAC's recommendation to adjust System efforts in this area.
- IIMI:** IIMI's indicative 1998 core resource envelope amounts to US\$ 7.6 million, which compares with a current 1992 core funding assumption of US\$ 7.3 million. The increase results from the significant increase in resources for natural resource conservation and management

(category 1) as well as for public management research (included in category 4). As other centres, IIMI would experience a relative decrease in resources for institution building (category 5), consistent with TAC's recommendation to adjust System efforts in this area. IIMI also benefits from its overall focus on Asia.

ISNAR: ISNAR's indicative 1998 core resource envelope amounts to US\$ 6.8 million, which compares with a current 1992 core funding assumption of US\$ 6.6 million. The increase results from the increase in resources for organization and management counselling (sub-category 5.3) as well as for socioeconomic, policy analysis and public management research (category 4).

14.8.5. Financial Factors Relevant to the Interpretation of the Centre Envelopes

In the process of preparing their MTP proposals, centres will add to these allocations the amount of revenue they expect to generate, and the resulting sum will provide the total core resources which the centre should assume to be available to cover all its 1998 core expenditures, i.e. operating expenses inclusive of depreciation charges, new capital requirements, and operating fund adjustments. Because of the application of the depreciation policy, and the expectation that most new capital requirements currently undertaken or envisaged will be largely completed by 1998, it is expected that core new capital requirements will be truly exceptional and will be especially scrutinized from a System's need perspective.

Also, since the centre resource allocations are expressed in constant 1992 values, they will need to be adjusted for inflation at an annual rate of 4% for each of the years 1993 through 1998.

Centres will also be requested to interpret the directional changes implied by their resource envelopes with care when it comes to implementing them during the MTP period, i.e. from 1994 through 1998. Experience has shown that the implementation of changes, particularly in resource allocations, in the CGIAR can only be implemented gradually. In addition, consistent with the basic assumption of constant supply, increases in one area will only be possible if decreases occur first in other areas. Therefore, centres whose resource envelopes imply an increasing trend should not assume that such increase will occur in full in the early years of the MTP period, but rather that the increase will be gradual, equally distributed over the intermediate years. Those centres whose resource envelopes imply a decreasing trend from 1992 towards 1998, are urged to assume that decreasing trends will occur in the early years of the MTP period.

14.9. Implementation and Execution of the Medium-Term Resource Allocation Process - The MTP Process

14.9.1. Planning Guidelines

The indicative resource envelopes are being communicated to all CGIAR Centres via this document, together with the process guidelines for the preparation of the MTPs.

At its mid-term meeting in May 1992, the Group will consider the proposed planning envelopes in the framework of this paper. Since the Group should not approve centre allocations before reviewing centres' final MTP proposals (ICW'93), at the mid-term meeting the Group is expected to evaluate, adjust as appropriate and endorse the overall CGIAR priorities and the general thrust of their translation into centre indicative allocations.

The System priorities, the indicative resource envelopes, as well as centres' strategic plans will serve as guidelines for the centres to prepare their medium-term plans. Centres have flexibility to cast their plans and priorities within them as they see fit.

14.9.2 Timetable

A number of centres have indicated their willingness to prepare 1994-98 MTPs in mid 1992, i.e. upon receipt of the guidelines, while the other centres are expected to initiate the process later in the year. Changes suggested by the Group, at the mid-term meeting in May 1992, to the resource allocation envelopes as planning bases will be communicated to the centres.

14.9.3. Interactive Review of the MTPs

In advance of their presentation to TAC and the CGIAR, centres are requested to send their MTP proposals to TAC (and TAC Secretariat) as well as to the CGIAR Secretariat. In the mean time, a working party composed of the TAC liaison scientist and staff members of the two Secretariats will visit each centre. The purpose of the visit is for the members to get acquainted with the centre MTP proposal, provide guidance to the centre as needed in developing its proposal, and facilitate the interaction between TAC and the centre. Interactions between TAC and the centres are scheduled to take place just prior to ICW'92 and in March 1993. Similarly, centres will present their proposals to the Group either at ICW'92 or at the 1993 mid-term meeting.

14.9.4. Consolidation and Approval of MTPs

At its June 1993 meeting, TAC will review all centres' MTP proposals in a consolidated way to evaluate their consistency with the overall System priorities and resource availability. TAC will then be in a position to formulate final recommendations for centres' resource envelopes, which will serve as a basis for the centres' preparation of the final MTP proposals for Group approval, individually and collectively, at ICW'93. Thus at ICW'93, the Group will be asked to approve a vector of budgets for all CGIAR Centres which will be valid through 1998.

14.9.5. Adjusting Planned Requirements with Actual Funding During Implementation

During the implementation of the MTPs, the relative share of each centre will serve as a bench mark for adjusting its level of funding whenever actual core funding is higher or lower than assumed at the time of the approval of the MTPs. This mechanism would be effective as long as the discrepancy between core requirements and supply is in a manageable range of say plus or minus 5%. Were the discrepancy to be much larger, the CGIAR would need to consider different approaches, which could include an interim review of all centres' MTPs.

14.10. Centres' 1993 Programmes and Budgets

14.10.1. A Transition Year

The launching of the second round of CGIAR MTPs in March-May 1992, combined with the deferment until mid and late 1993 of final recommendations and decisions on centres' resource envelopes and the MTP proposals, implies that 1993 is a transitional year for both the centres and the System as a whole.

All centres have thus been requested to prepare an annual programme and budget for 1993, which will be reviewed by TAC at its June 1992 meeting, and submitted to the Group for approval at ICW'92. The 1993 programmes and budgets are generally based on 1992 core funding, adjusted for inflation.

All centres will thus prepare the 1993 programme and budget proposals without explicit reference to their existing MTP, since existing MTPs covering 1993 or beyond are out of date as they do not relate to TAC's current priority and strategy setting analysis.

14.10.2. Matching Demand and Supply

In the event 1993 core funding will be different from the assumption made for the construction of 1993 budgets, the adjustment to centres' 1993 funding requirement should be made in the context of the new priorities and strategies, as follows:

(a) If 1993 core funding for the System exceeds the planning estimate, centres whose indicative 1998 resource envelope shows an increasing trend could be adjusted upwards in proportion to the relative increase of their 1998 indicative resource envelope up to 150% of the average increase in System funding compared with the planning estimate. The centres with a decreasing indicative 1998 resource envelope would be kept at the 1993 level recommended by TAC based on 1992 core funding.

(b) If 1993 core funding for the System falls short of the planning estimate, centres whose indicative 1998 resource envelope shows a decreasing trend could be adjusted downwards in proportion to the relative decrease of their 1998 indicative resource envelope up to 150% of the average decrease in System funding compared with the planning estimate. The centres with an increasing indicative 1998 resource envelope would be kept at the 1993 level based on the 1992 core funding.

14.11. Conclusion

The assignment of indicative 1998 core resource envelopes to each of the CGIAR Centres constitutes the first step in the medium-term resource allocation process. They will constitute the basis, together with the planning ranges indicated above, for centres to develop MTPs. In developing their proposals, centres will use TAC's present priority and strategy analysis as part of their reference. This should ensure a satisfactory degree of consistency between centre operational proposals and the System priorities and strategies. Following a series of interactions involving the centres, TAC and the Group, the medium term resource allocation process will come to a close when the Group will approve, at ICW'93, a vector of programmes and budgets for the period 1994-98.

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AGROECOLOGICAL ZONES FRAMEWORK AND DATABASE FOR THE REVIEW OF CGIAR PRIORITIES AND STRATEGIES

Introduction

The classification of regional agroecological zones (RAEZs) described in this Annex was devised for TAC's review of CGIAR priorities and strategies. In applying the classification to the four developing country regions, (sub-Saharan Africa, West Asia and North Africa, Asia and the Pacific, and Latin America and the Caribbean), the socioeconomic and land use database (available only in terms of political administrative units) had to be linked to the natural resource database of soil, climate and landform (available by FAO agroecological zones for each country). To achieve this linkage, agroecological zone boundaries were reconciled with political administrative boundaries, where possible.

Agroecological Zones (AEZs)

At the highest level of aggregation, nine agroecological zones were distinguished from the FAO agroecological zones (FAO-AEZ) land inventory. These are:

1. Warm arid and semi-arid tropics
2. Warm subhumid tropics
3. Warm humid tropics
4. Cool tropics
5. Warm arid and semi-arid subtropics with summer rainfall
6. Warm subhumid subtropics with summer rainfall
7. Warm/cool humid subtropics with summer rainfall
8. Cool subtropics with summer rainfall
9. Cool subtropics with winter rainfall

The FAO-AEZ classification is based on rainfed soil moisture availability in terms of reference length of growing period (LGP) derived using a water balance model, and temperature conditions during the LGP. The definitions of the LGP moisture and thermal zones in the FAO-AEZ classification, and of the above nine AEZs, are given in this Annex. The soils information in the FAO-AEZ land inventory is based on the FAO-UNESCO Soil Map of the World.

Distribution of RAEZs in the Four Regions

The application of the above AEZ classification to the four regions leads to a total of 23 RAEZs, four in Sub-Saharan Africa, three in West Asia-North Africa, seven in Asia and nine in Latin America and the Caribbean. RAEZs 1 and 2 in sub-Saharan Africa are each split into three parts: West Africa, East Africa and Southern Africa. The country classification by RAEZs is given in this Annex.

Database

The AEZ database developed for TAC's review of CGIAR priorities and strategies includes information on the following areas:

- Land resources and land potentials
- Land use and production
- Population (human, livestock)
- Demand, exports and value of production
- Income, poverty and malnutrition

DEFINITIONS

Tropics: All months with monthly mean temperature, corrected to sea level, above 18°C.

Subtropics: One or more months with monthly mean temperature, corrected to sea level, below 18°C.

Temperate: One or more months with monthly mean temperature, corrected to sea level, below 5°C.

Length of Growing Period (LGP): Period (in days) during the year when rainfed available soil moisture supply is greater than half potential evapotranspiration (PET). It includes the period required to evapotranspire up to 100 mm of available soil moisture stored in the soil profile. It excludes any time interval when daily mean temperature is less than 5°C.

Warm: Daily mean temperature during the growing period greater than 20°C.

Cool: Daily mean temperature during the growing period in the range 5-20°C (includes the moderately cool range 15-20°C).

Cold: Daily mean temperature less than 5°C.

Warm/Cool: Daily mean temperature during part of the growing period greater than 20°C, and during another part less than 20°C.

Arid: LGP less than 75 days.

Semi-arid: LGP in the range 75-180 days.

Subhumid: LGP in the range of 180-270 days.

Humid: LGP greater than 270 days.

- Warm Arid and Semi-arid Tropics:** Comprises the semi-arid (LGP = 75-180 days) moisture zone in the tropics. Arid (LGP = 0-75 days) moisture zone taken into account for the purposes of irrigation and rangeland assessments, and for reconciliation with political boundaries. Daily mean temperature during the growing period greater than 20°C.
- Warm Subhumid Tropics:** Comprises the subhumid (LGP = 180-270 days) moisture zone in the tropics. Daily mean temperature during the growing period greater than 20°C.
- Warm Humid Tropics:** Comprises the humid (LGP = 270-365 days) moisture zone in the tropics including the per-humid areas. Daily mean temperature during the growing period greater than 20°C.
- Cool Tropics:** Comprises the semi-arid (LGP = 75-180 days), subhumid (LGP = 180-270 days) and humid (LGP = 270-365 days) moisture zones in the tropics. Arid (LGP = 0-75 days) moisture zone taken into account for the purposes of irrigation and rangeland assessments, and for reconciliation with political boundaries. Daily mean temperature during the growing period in the range 5-20°C. Includes the moderately cool tropics major climate with daily mean temperature during the growing period in the range 15-20°C. Areas of cold tropics taken into account for reconciliation with political boundaries.
- Warm Arid and Semi-arid Subtropics with Summer Rainfall:** Comprises the semi-arid (LGP = 75-180 days) moisture zone in the subtropics. Arid (LGP = 0-75 days) moisture zone taken into account for the purposes of irrigation and rangeland assessments, and for reconciliation with political boundaries. Daily mean temperature during the growing period greater than 20°C. Includes the warm semi-arid temperate (summer rainfall) major climate in China.
- Warm Subhumid Subtropics with Summer Rainfall:** Comprises the subhumid (LGP = 180-270 days) moisture zone in the subtropics. Daily mean temperature during the growing period greater than 20°C. Includes the warm subhumid temperate (summer rainfall) major climate in China and Korea.
- Warm/Cool Humid Subtropics with Summer Rainfall:** Comprises the humid (LGP = 270-365 days) moisture zone in the subtropics. Daily mean temperature greater than 20°C during one part (warm) of the growing period, and less than 20°C during another part (cool) of the growing period. The cool part is moderately cool with daily mean temperature in the range 15-20°C. Includes the warm/moderately cool temperate (summer rainfall) major climate in China.

Cool Subtropics with Summer Rainfall: Comprises the semi-arid (LGP = 75-180 days), subhumid (LGP = 180-270 days) and humid (LGP = 270-365 days) moisture zones in the subtropics. Arid (LGP = 0-75 days) moisture zone taken into account for the purposes of irrigation and rangeland assessments, and for reconciliation with political boundaries. Daily mean temperature during the growing period in the range 5-20°C. Includes the moderately cool subtropics (summer rainfall) and transitional moderately cool subtropics (summer rainfall) major climates with daily mean temperature in the range 15-20°C. Areas of cold subtropics (summer rainfall) taken into account for reconciliation with political boundaries. Includes cool and cold temperate (summer rainfall) major climates in China, Mongolia and Korea.

Cool Subtropics with Winter Rainfall: Comprises the semi-arid (LGP = 75-180 days), subhumid (LGP = 180-270 days) and humid (LGP = 270-365 days) moisture zones in the subtropics. Arid (LGP = 0-75 days) moisture zone taken into account for the purposes of irrigation and rangeland assessments, and for reconciliation with political boundaries. Daily mean temperature during the growing period in the range 5-20°C. Areas of cold subtropics (winter rainfall) taken into account for reconciliation with political boundaries. Includes cool and cold temperate (winter rainfall) major climates in Turkey, Argentina and Chile.

COUNTRY CLASSIFICATION BY REGIONAL AGROECOLOGICAL ZONES (RAEZ)

1. Sub-Saharan Africa

RAEZ 1 Warm arid and semi-arid tropics (AEZ 1):

West Africa: Cape Verde, Chad, The Gambia, Mali, Mauritania, Niger, Senegal and parts of Benin, Burkina Faso, and Nigeria.

East Africa: Djibouti, Somalia, Sudan and parts of Ethiopia, Kenya, Tanzania and Uganda.

Southern Africa: Botswana, Namibia, Swaziland, and parts of Angola, Madagascar, Malawi, Mozambique, Zambia and Zimbabwe.

RAEZ 2 Warm subhumid tropics (AEZ 2):

West Africa: Guinea, Guinea Bissau, Togo, and parts of Benin, Burkina Faso and Nigeria.

East Africa: Parts of Ethiopia, Tanzania and Uganda.

Southern Africa: Comoros and parts of Angola, Madagascar, Malawi, Mozambique, Zambia and Zimbabwe.

RAEZ 3 *Warm humid tropics (AEZ 3):*

Cameroon, Central African Republic, Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Ghana, Liberia, Mauritius, Reunion, Sao Tomé, Sierra Leone, Zaire, and parts of Madagascar and Nigeria.

RAEZ 4 *Cool tropics (AEZ 4):*

Burundi, Lesotho, Rwanda, and parts of Angola, Ethiopia, Kenya, Madagascar and Tanzania.

2. West Asia North Africa

RAEZ 5 *Warm arid and semi-arid tropics (AEZ 1):*

Oman, United Arab Emirates, and parts of Republic of Yemen.

RAEZ 6 *Cool tropics (AEZ 4):*

Parts of Republic of Yemen.

RAEZ 7 *Cool subtropics with winter rainfall (AEZ 9):*

Afghanistan, Algeria, Bahrain, Cyprus, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Qatar, Saudi Arabia, Syria, Tunisia, Turkey and Western Sahara.

3. Asia and the Pacific

RAEZ 8 *Warm arid and semi-arid tropics (AEZ 1):*

Parts of India and Thailand.

RAEZ 9 *Warm subhumid tropics (AEZ 2):*

Myanmar, and parts of India, Sri Lanka and Thailand.

RAEZ 10 *Warm humid tropics (AEZ 3):*

Bangladesh, Brunei, Fiji, Indonesia, Kampuchea, Laos, Malaysia, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Tonga, Vanuatu, Vietnam, and parts of Sri Lanka and Thailand.

RAEZ 11 *Warm arid and semi-arid subtropics with summer rainfall (AEZ 5):*

Pakistan, and parts of China and India.

RAEZ 12 *Warm subhumid tropics with summer rainfall (AEZ 6):*

Parts of China, India, North Korea and South Korea.

RAEZ 13 *Warm/cool humid subtropics with summer rainfall (AEZ 7):*

Taiwan and parts of China.

RAEZ 14 *Cool subtropics with summer rainfall (AEZ 8):*

Bhutan, Mongolia, Nepal, and parts of China, India, North Korea and South Korea.

4. Latin America and the Caribbean

RAEZ 15 *Warm arid and semi-arid tropics (AEZ 1):*

Antigua, Netherlands, Antilles, Haiti and parts of Bolivia, Brazil, Cuba, Ecuador, Mexico and Venezuela.

RAEZ 16 *Warm subhumid tropics (AEZ 2):*

Bahamas, Dominican Republic, Guadeloupe, Martinique, St. Lucia, and parts of Bolivia, Brazil, Costa Rica, Cuba, Ecuador, El Salvador, Mexico, Paraguay and Venezuela.

RAEZ 17 *Warm humid tropics (AEZ 3):*

Barbados, Belize, French Guyana, Guyana, Jamaica, Nicaragua, Panama, Puerto Rico, Suriname, Trinidad and Tobago, Windward Isles, and parts of Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Peru and Venezuela.

RAEZ 18 *Cool tropics (AEZ 4):*

Parts of Bolivia, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, and Peru.

RAEZ 19 *Warm arid and semi-arid subtropics with summer rainfall (AEZ 5):*

Parts of Argentina and Mexico.

RAEZ 20 Warm subhumid subtropics with summer rainfall (AEZ 6):

Parts of Argentina.

RAEZ 21 Warm/cool humid subtropics with summer rainfall (AEZ 7):

Parts of Argentina, Brazil and Paraguay.

RAEZ 22 Cool subtropics with summer rainfall (AEZ 8):

Uruguay and parts of Argentina.

RAEZ 23 Cool subtropics with winter rainfall (AEZ 9):

Chile and parts of Argentina.

Average 1987-89 Value of Production and Shares for Commodities by AEZ by Region

		RICE		WHEAT		MAIZE		BARLEY	
		USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA									
total		1534.0	1.8%	254.1	0.8%	2034.3	10.3%	146.2	4.7%
AEZ	1	367.7	0.4%	79.3	0.3%	679.0	3.4%	3.7	0.1%
	2	454.4	0.5%	1.7	0.0%	601.3	3.0%	0.0	0.0%
	3	704.1	0.8%	1.0	0.0%	324.4	1.6%	0.0	0.0%
	4	7.3	0.0%	172.1	0.6%	429.5	2.2%	142.5	4.6%
WANA									
total		921.5	1.1%	5907.0	19.0%	786.7	4.0%	2055.0	65.9%
AEZ	1	0.0	0.0%	2.5	0.0%	1.5	0.0%	0.3	0.0%
	4	0.0	0.0%	17.8	0.1%	5.4	0.0%	5.9	0.2%
	9	921.5	1.1%	5886.7	18.9%	779.8	4.0%	2048.8	65.7%
ASIA									
total		79948.9	93.0%	21807.5	70.0%	11330.3	57.5%	717.3	23.0%
AEZ	1	9967.8	11.6%	0.0	0.0%	441.9	2.2%	0.0	0.0%
	2	7539.9	8.8%	23.0	0.1%	367.0	1.9%	0.0	0.0%
	3	19777.5	23.0%	151.7	0.5%	1340.0	6.8%	1.5	0.0%
	5	13103.6	15.2%	9030.0	29.0%	1540.3	7.8%	272.3	8.7%
	6	8709.6	10.1%	2694.3	8.7%	1032.6	5.2%	163.5	5.2%
	7	20316.7	23.6%	5002.2	16.1%	3278.7	16.6%	0.0	0.0%
	8	603.4	0.7%	4906.2	15.8%	3329.8	16.9%	280.8	9.0%
S/C AMERICA									
total		3594.2	4.2%	3178.8	10.2%	5569.4	28.2%	199.4	6.4%
AEZ	1	352.2	0.4%	107.6	0.3%	414.5	2.1%	0.0	0.0%
	2	811.0	0.9%	0.0	0.0%	1049.4	5.3%	0.0	0.0%
	3	1080.5	1.3%	0.0	0.0%	870.5	4.4%	1.0	0.0%
	4	195.5	0.2%	288.7	0.9%	718.6	3.6%	70.5	2.3%
	5	47.3	0.1%	359.2	1.2%	396.5	2.0%	34.2	1.1%
	6	12.3	0.0%	209.6	0.7%	125.2	0.6%	6.5	0.2%
	7	933.0	1.1%	958.6	3.1%	1349.0	6.8%	26.4	0.8%
	8	130.6	0.2%	973.5	3.1%	555.0	2.8%	50.9	1.6%
	9	31.8	0.0%	281.0	0.9%	90.6	0.5%	9.9	0.3%
OVERALL									
total		85998.6	100.0%	31147.3	100.0%	19720.7	100.0%	3117.9	100.0%
AEZ	1	10687.6	12.4%	189.4	0.6%	1536.8	7.8%	4.0	0.1%
	2	8805.3	10.2%	24.7	0.1%	2017.7	10.2%	0.0	0.0%
	3	21562.1	25.1%	152.8	0.5%	2534.9	12.9%	2.5	0.1%
	4	202.9	0.2%	478.6	1.5%	1153.5	5.8%	218.9	7.0%
	5	13150.9	15.3%	9389.2	30.1%	1936.9	9.8%	306.5	9.8%
	6	8721.9	10.1%	2903.9	9.3%	1157.8	5.9%	170.0	5.5%
	7	21249.7	24.7%	5960.8	19.1%	4627.8	23.5%	26.4	0.8%
	8	734.0	0.9%	5879.7	18.9%	3884.8	19.7%	331.7	10.6%
	9	953.3	1.1%	6167.7	19.8%	870.4	4.4%	2058.7	66.0%

SORGHUM			MILLET		CASSAVA		POTATO	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	1308.9	32.4%	1371.8	41.4%	4434.0	45.0%	424.2	3.1%
AEZ 1	733.3	18.2%	834.9	25.2%	948.6	9.6%	44.7	0.3%
2	397.0	9.8%	492.9	14.9%	1281.3	13.0%	99.6	0.7%
3	65.0	1.6%	42.1	1.3%	2129.7	21.6%	45.8	0.3%
4	113.5	2.8%	1.7	0.1%	74.1	0.8%	234.1	1.7%
WANA								
total	107.3	2.7%	27.7	0.8%	0.0	0.0%	2102.3	15.2%
AEZ 1	0.0	0.0%	11.2	0.3%	0.0	0.0%	2.8	0.0%
4	47.7	1.2%	4.1	0.1%	0.0	0.0%	21.3	0.2%
9	59.6	1.5%	12.3	0.4%	0.0	0.0%	2078.2	15.1%
ASIA								
total	1626.5	40.3%	1908.2	57.5%	3407.4	34.6%	8981.5	65.1%
AEZ 1	573.8	14.2%	662.5	20.0%	331.3	3.4%	0.3	0.0%
2	184.2	4.6%	210.1	6.3%	881.3	8.9%	35.6	0.3%
3	0.8	0.0%	9.4	0.3%	1976.3	20.1%	382.2	2.8%
5	590.3	14.6%	683.9	20.6%	50.1	0.5%	2812.2	20.4%
6	268.3	6.6%	320.3	9.7%	33.2	0.3%	1240.8	9.0%
7	10.0	0.2%	0.2	0.0%	135.7	1.4%	2142.9	15.5%
8	0.0	0.0%	25.4	0.8%	0.0	0.0%	2367.4	17.2%
S/C AMERICA								
total	995.3	24.6%	9.6	0.3%	2006.3	20.4%	2281.9	16.5%
AEZ 1	126.0	3.1%	0.0	0.0%	236.3	2.4%	98.1	0.7%
2	165.5	4.1%	0.0	0.0%	828.4	8.4%	27.2	0.2%
3	12.2	0.3%	0.0	0.0%	686.5	7.0%	9.0	0.1%
4	263.5	6.5%	0.0	0.0%	0.0	0.0%	1049.8	7.6%
5	201.7	5.0%	0.8	0.0%	2.6	0.0%	106.5	0.8%
6	37.5	0.9%	1.5	0.0%	5.1	0.1%	70.5	0.5%
7	12.1	0.3%	0.5	0.0%	246.8	2.5%	330.6	3.1%
8	172.2	4.3%	6.6	0.2%	0.0	0.0%	330.6	2.4%
9	4.1	0.1%	0.2	0.0%	0.5	0.0%	160.0	1.2%
OVERALL								
total	4038.0	100.0%	3317.2	100.0%	9847.7	100.0%	13790.0	100.0%
AEZ 1	1433.2	35.5%	1508.6	45.5%	1516.3	15.4%	145.8	1.1%
2	746.7	18.5%	703.0	21.2%	2991.1	30.4%	162.5	1.2%
3	78.1	1.9%	51.5	1.6%	4792.6	48.7%	437.1	3.2%
4	424.7	10.5%	5.8	0.2%	74.1	0.8%	1305.1	9.5%
5	792.0	19.6%	684.7	20.6%	52.7	0.5%	2918.7	21.2%
6	305.8	7.6%	321.9	9.7%	38.3	0.4%	1311.3	9.5%
7	22.1	0.5%	0.7	0.0%	382.5	3.9%	2572.8	18.7%
8	172.2	4.3%	32.1	1.0%	0.0	0.0%	2698.1	19.6%
9	63.7	1.6%	12.5	0.4%	0.5	0.0%	2238.2	16.2%

SWEET POTATO			YAM		BANANA & PLANTAIN		CHICK PEA	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	700.9	5.0%	2858.1	96.6%	3564.5	34.5%	59.8	2.7%
AEZ								
1	155.7	1.1%	37.4	1.3%	55.8	0.5%	10.5	0.5%
2	247.6	1.8%	1468.0	49.6%	1691.4	16.4%	14.9	0.7%
3	111.3	0.8%	1351.3	45.7%	1054.4	10.2%	0.0	0.0%
4	186.3	1.3%	1.4	0.0%	762.4	7.4%	34.3	1.5%
WANA								
total	8.7	0.1%	0.0	0.0%	78.0	0.8%	325.7	14.5%
AEZ								
1	0.0	0.0%	0.0	0.0%	7.0	0.1%	0.0	0.0%
4	0.0	0.0%	0.0	0.0%	4.8	0.0%	0.0	0.0%
9	8.7	0.1%	0.0	0.0%	66.2	0.6%	325.7	14.5%
ASIA								
total	13067.0	93.1%	24.5	0.8%	3013.1	29.2%	1800.6	80.3%
AEZ								
1	79.1	0.6%	0.0	0.0%	0.0	0.0%	777.3	34.7%
2	37.1	0.3%	0.0	0.0%	831.9	8.1%	267.5	11.9%
3	693.8	4.9%	24.5	0.8%	1574.4	15.2%	25.1	1.1%
5	2825.4	20.1%	0.0	0.0%	30.7	0.3%	548.8	24.5%
6	1974.2	14.1%	0.0	0.0%	333.2	3.2%	109.9	4.9%
7	7469.2	53.2%	0.0	0.0%	242.1	2.3%	26.1	1.2%
8	0.0	0.0%	0.0	0.0%	0.6	0.0%	45.8	2.0%
S/C AMERICA								
total	260.4	1.9%	76.5	2.6%	3678.9	35.6%	56.4	2.5%
AEZ								
1	67.6	0.5%	13.5	0.5%	531.0	5.1%	5.8	0.3%
2	45.9	0.3%	19.4	0.7%	790.1	7.6%	7.1	0.3%
3	22.7	0.2%	43.7	1.5%	1100.8	10.7%	9.4	0.4%
4	14.6	0.1%	0.0	0.0%	690.1	6.7%	16.1	0.7%
5	15.6	0.1%	0.0	0.0%	99.3	1.0%	13.9	0.6%
6	26.5	0.2%	0.0	0.0%	19.0	0.2%	0.2	0.0%
7	57.0	0.4%	0.0	0.0%	446.3	4.3%	0.1	0.0%
8	6.7	0.0%	0.0	0.0%	0.0	0.0%	0.8	0.0%
9	3.5	0.0%	0.0	0.0%	2.0	0.0%	3.0	0.1%
OVERALL								
total	14037.2	100.0%	2959.1	100.0%	10334.6	100.0%	2242.4	100.0%
AEZ								
1	302.4	2.2%	50.9	1.7%	593.9	5.7%	793.7	35.4%
2	330.8	2.4%	1487.4	50.3%	3313.5	32.1%	289.5	12.9%
3	827.9	5.9%	1419.5	48.0%	3729.7	36.1%	34.5	1.5%
4	200.9	1.4%	1.4	0.0%	1457.3	14.1%	50.4	2.2%
5	2841.0	20.2%	0.0	0.0%	129.9	1.3%	562.7	25.1%
6	2000.7	14.3%	0.0	0.0%	352.2	3.4%	110.1	4.9%
7	7526.3	53.6%	0.0	0.0%	688.4	6.7%	26.1	1.2%
8	6.7	0.0%	0.0	0.0%	0.6	0.0%	46.7	2.1%
9	12.3	0.1%	0.0	0.0%	68.2	0.7%	328.7	14.7%

	COW PEA		PIGEON PEA		BROAD BEAN		LENTIL	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	1052.9	95.5%	64.2	6.1%	180.8	8.9%	13.0	1.2%
AEZ 1	497.3	45.1%	17.1	16.0%	42.7	2.1%	1.5	0.1%
2	356.7	32.3%	47.0	4.5%	15.5	0.8%	1.3	0.1%
3	199.0	18.0%	0.0	0.0%	0.4	0.0%	0.0	0.0%
4	0.0	0.0%	0.0	0.0%	122.0	6.0%	10.2	1.0%
WANA								
total	4.0	0.4%	0.0	0.0%	457.9	22.5%	511.0	47.9%
AEZ 1	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
4	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
9	4.0	0.4%	0.0	0.0%	457.9	22.5%	511.0	47.9%
ASIA								
total	21.4	1.9%	974.4	92.4%	1300.2	64.0%	509.6	47.8%
AEZ 1	0.0	0.0%	498.2	47.2%	0.0	0.0%	173.3	16.2%
2	12.7	1.2%	160.4	15.2%	0.0	0.0%	50.3	4.7%
3	8.7	0.8%	1.4	0.1%	0.0	0.0%	75.7	7.1%
5	0.0	0.0%	241.1	23.1%	193.3	9.5%	107.6	10.1%
6	0.0	0.0%	66.7	6.3%	128.9	6.3%	27.9	2.6%
7	0.0	0.0%	0.0	0.0%	516.8	25.4%	19.4	1.8%
8	0.0	0.0%	4.6	0.4%	461.2	22.7%	55.4	5.2%
S/C AMERICA								
total	24.3	2.2%	16.1	1.5%	92.3	4.5%	32.8	3.1%
AEZ 1	23.6	2.1%	2.4	0.2%	6.0	0.3%	1.1	0.1%
2	0.0	0.0%	10.1	1.0%	18.6	0.9%	1.2	0.1%
3	0.6	0.1%	3.6	0.3%	10.8	0.5%	2.6	0.2%
4	0.0	0.0%	0.0	0.0%	28.5	1.4%	6.3	0.6%
5	0.0	0.0%	0.0	0.0%	7.5	0.4%	3.3	0.3%
6	0.0	0.0%	0.0	0.0%	0.9	0.0%	1.7	0.2%
7	0.0	0.0%	0.0	0.0%	15.4	0.8%	0.5	0.1%
8	0.0	0.0%	0.0	0.0%	4.4	0.2%	7.3	0.7%
9	0.0	0.0%	0.0	0.0%	0.1	0.0%	8.8	0.8%
OVERALL								
total	1102.6	100.0%	1054.7	100.0%	2031.1	100.0%	1066.4	100.0%
AEZ 1	520.9	47.2%	517.7	49.1%	48.8	2.4%	175.9	16.5%
2	369.4	33.5%	217.6	20.6%	34.1	1.7%	52.8	5.0%
3	208.3	18.9%	5.1	0.5%	11.3	0.6%	78.3	7.3%
4	0.0	0.0%	0.0	0.0%	150.5	7.4%	16.5	1.5%
5	0.0	0.0%	244.1	23.1%	200.8	9.9%	110.8	10.4%
6	0.0	0.0%	66.7	6.3%	129.8	6.4%	29.6	2.8%
7	0.0	0.0%	0.0	0.0%	532.2	26.2%	20.0	1.9%
8	0.0	0.0%	4.6	0.4%	465.6	22.9%	62.7	5.9%
9	4.0	0.4%	0.0	0.0%	458.0	22.5%	519.8	48.7%

	BEANS		SOYBEAN		GROUNDNUT		COCONUT	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	1313.0	13.4%	66.1	0.5%	2703.4	21.8%	267.2	4.9%
AEZ 1	209.4	2.1%	28.3	0.2%	1396.2	11.2%	77.5	1.4%
2	427.2	4.4%	26.3	0.2%	665.6	5.4%	69.0	1.3%
3	192.2	2.0%	9.5	0.1%	582.6	4.7%	120.7	2.2%
4	484.2	4.9%	2.1	0.0%	59.0	0.5%	0.0	0.0%
WANA								
total	429.0	3.4%	105.3	0.9%	106.0	0.9%	0.0	0.0%
AEZ 1	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
4	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
9	429.0	3.4%	105.3	0.9%	106.0	0.9%	0.0	0.0%
ASIA								
total	1108.0	51.5%	4060.2	33.3%	9129.7	73.5%	4773.3	87.9%
AEZ 1	318.2	14.8%	200.0	1.6%	2415.5	19.5%	652.6	12.0%
2	172.9	8.0%	136.5	1.1%	1082.1	8.7%	461.4	8.5%
3	141.9	6.6%	414.3	3.4%	668.1	5.4%	3649.6	67.2%
5	204.0	9.5%	789.6	6.5%	3234.8	26.0%	2.3	0.0%
6	71.6	3.3%	663.3	5.4%	1683.3	13.6%	1.5	0.0%
7	100.9	4.7%	1860.0	15.2%	50.7	0.4%	6.0	0.1%
8	98.6	4.6%	0.4	0.0%	0.0	0.0%	0.0	0.0%
S/C AMERICA								
total	2641.0	31.7%	7966.2	65.3%	480.0	3.9%	387.4	7.1%
AEZ 1	227.1	2.7%	419.6	3.4%	77.5	0.6%	52.6	1.0%
2	582.1	7.0%	1560.4	12.8%	122.7	1.0%	104.1	1.9%
3	469.1	5.6%	1153.8	9.5%	7.8	0.1%	128.0	2.4%
4	343.6	4.1%	7.3	0.1%	3.3	0.0%	0.0	0.0%
5	163.0	2.0%	234.6	1.9%	84.0	0.7%	61.7	1.1%
6	17.7	0.2%	324.7	2.7%	143.6	1.2%	0.0	0.0%
7	702.8	8.4%	2794.4	22.9%	24.9	0.2%	41.2	0.8%
8	79.0	0.9%	1435.6	11.8%	0.6	0.0%	0.0	0.0%
9	56.6	0.7%	35.7	0.3%	15.3	0.1%	0.0	0.0%
OVERALL								
total	5491.0	100.0%	12197.9	100.0%	12419.2	100.0%	5428.0	100.0%
AEZ 1	754.6	13.7%	647.8	5.3%	3889.3	31.3%	782.6	14.4%
2	1182.2	21.5%	1723.1	14.1%	1870.4	15.1%	634.5	11.7%
3	803.3	14.6%	1577.5	12.9%	1258.4	10.1%	3898.2	71.8%
4	827.8	15.1%	9.4	0.1%	62.3	0.5%	0.0	0.0%
5	367.0	6.7%	1024.1	8.4%	3318.8	26.7%	63.9	1.2%
6	89.3	1.6%	988.1	8.1%	1826.9	14.7%	1.5	0.0%
7	803.7	14.6%	4654.4	38.2%	75.5	0.6%	47.2	0.9%
8	177.5	3.2%	1436.0	11.8%	0.6	0.0%	0.0	0.0%
9	485.6	8.8%	141.0	1.2%	121.2	1.0%	0.0	0.0%

	TOMATO		ONION		CABBAGE		ORANGE	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	275.6	4.7%	103.9	2.8%	15.0	0.7%	277.5	1.6%
AEZ								
1	100.3	1.7%	52.8	1.4%	1.5	0.1%	54.5	0.3%
2	78.8	1.4%	19.5	0.5%	3.8	0.2%	43.4	0.3%
3	83.2	1.4%	18.7	0.5%	4.2	0.2%	144.3	0.8%
4	13.1	0.2%	12.8	0.3%	5.6	0.3%	35.0	0.2%
WANA								
total	2886.2	49.5%	859.7	23.4%	182.8	9.0%	2630.1	15.3%
AEZ								
1	14.1	0.2%	4.4	0.1%	2.1	0.1%	0.0	0.0%
4	27.5	0.5%	8.4	0.2%	12.2	0.6%	2.0	0.0%
9	2844.6	48.8%	846.9	23.1%	168.6	8.3%	2628.1	15.3%
ASIA								
total	1342.6	23.0%	2157.9	58.9%	1724.8	85.1%	3560.9	20.7%
AEZ								
1	80.6	1.4%	373.0	10.2%	37.6	1.9%	499.2	2.9%
2	34.1	0.6%	181.8	5.0%	27.4	1.4%	268.1	1.6%
3	100.6	1.7%	209.9	5.7%	160.1	7.9%	340.1	2.0%
5	185.8	3.2%	459.4	12.5%	163.2	8.1%	573.7	3.3%
6	123.1	2.1%	231.3	6.3%	391.7	19.3%	318.9	1.9%
7	454.1	7.8%	348.8	9.5%	463.8	22.9%	1155.3	6.7%
8	364.3	6.2%	353.8	9.6%	481.0	23.7%	405.6	2.4%
S/C AMERICA								
total	1328.2	22.8%	545.1	14.9%	104.4	5.2%	10708.3	62.3%
AEZ								
1	122.9	2.1%	23.8	0.6%	9.0	0.4%	381.6	2.2%
2	253.1	4.3%	70.0	1.9%	8.6	0.4%	3533.4	20.6%
3	204.7	3.5%	83.9	2.3%	25.5	1.3%	2547.7	14.8%
4	206.6	3.5%	117.2	3.2%	50.6	2.5%	300.2	1.7%
5	115.4	2.0%	7.4	0.2%	5.7	0.3%	259.0	1.5%
6	21.5	0.4%	14.7	0.4%	0.0	0.0%	58.4	0.3%
7	214.7	3.7%	96.8	2.6%	0.0	0.0%	3292.2	19.2%
8	106.6	1.8%	69.0	1.9%	0.3	0.0%	297.6	1.7%
9	82.8	1.4%	62.3	1.7%	4.8	0.2%	38.1	0.2%
OVERALL								
total	5832.7	100.0%	3666.6	100.0%	2027.1	100.0%	17176.8	100.0%
AEZ								
1	317.9	5.5%	454.0	12.4%	50.1	2.5%	935.2	5.4%
2	366.0	6.3%	271.4	7.4%	39.8	2.0%	3844.9	22.4%
3	388.5	6.7%	312.4	8.5%	189.7	9.4%	3032.2	17.7%
4	247.2	4.2%	138.3	3.8%	68.3	3.4%	337.3	2.0%
5	301.2	5.2%	466.7	12.7%	168.9	8.3%	832.7	4.8%
6	144.6	2.5%	246.0	6.7%	391.7	19.3%	377.4	2.2%
7	668.8	11.5%	445.6	12.2%	463.8	22.9%	4447.4	25.9%
8	470.9	8.1%	422.8	11.5%	481.4	23.7%	703.2	4.1%
9	2927.4	50.2%	909.3	24.8%	173.3	8.6%	2666.2	15.5%

LEMON & LIME			PINEAPPLE		GRAPE		APPLE	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	95.2	2.8%	286.0	11.1%	27.3	0.2%	4.5	0.1%
AEZ								
1	47.9	1.4%	39.1	1.5%	6.0	0.0%	0.0	0.0%
2	8.5	0.3%	30.7	1.2%	9.7	0.1%	2.3	0.0%
3	31.8	1.0%	157.2	6.1%	3.0	0.0%	0.0	0.0%
4	7.0	0.2%	59.0	2.3%	8.6	0.1%	2.3	0.0%
WANA								
total	978.8	29.3%	0.0	0.0%	6614.8	53.7%	1507.6	29.5%
AEZ								
1	27.0	0.8%	0.0	0.0%	0.1	0.0%	0.0	0.0%
4	3.9	0.1%	0.0	0.0%	106.8	0.9%	0.0	0.0%
9	948.0	28.4%	0.0	0.0%	6507.9	52.8%	1507.6	29.5%
ASIA								
total	688.2	20.6%	1638.5	63.7%	1116.3	9.1%	2585.9	50.6%
AEZ								
1	281.0	8.4%	136.0	5.3%	161.1	1.3%	0.0	0.0%
2	153.5	4.6%	370.6	14.4%	88.8	0.7%	0.0	0.0%
3	65.3	2.0%	915.4	35.6%	6.5	0.1%	0.0	0.0%
5	48.5	1.5%	3.0	0.1%	36.0	0.3%	83.1	1.6%
6	43.3	1.3%	42.0	1.6%	204.7	1.7%	921.8	18.1%
7	72.2	2.2%	171.5	6.7%	452.6	3.7%	1044.7	20.5%
8	24.4	0.7%	0.0	0.0%	166.6	1.4%	541.7	10.6%
S/C AMERICA								
total	1577.8	47.2%	648.8	25.2%	4567.8	37.1%	1008.2	19.7%
AEZ								
1	107.5	3.2%	23.8	0.9%	64.9	0.5%	0.0	0.0%
2	305.6	9.2%	168.8	6.6%	302.6	2.5%	0.0	0.0%
3	292.6	8.8%	218.4	8.5%	273.1	2.2%	0.0	0.0%
4	134.6	4.0%	97.2	3.8%	90.2	0.7%	235.1	4.6%
5	155.8	4.7%	25.0	1.0%	126.6	1.0%	0.0	0.0%
6	63.6	1.9%	0.8	0.0%	454.9	3.7%	64.5	1.3%
7	154.8	4.6%	114.7	4.5%	365.4	3.0%	178.3	3.5%
8	316.7	9.5%	0.0	0.0%	2081.3	16.9%	294.8	5.8%
9	46.5	1.4%	0.0	0.0%	808.8	6.6%	235.6	4.6%
OVERALL								
total	3339.9	100.0%	2573.3	100.0%	12326.2	100.0%	5106.3	100.0%
AEZ								
1	463.3	13.9%	198.9	7.7%	232.1	1.9%	0.0	0.0%
2	467.6	14.0%	570.1	22.2%	401.2	3.3%	2.3	0.0%
3	389.7	11.7%	1291.1	50.2%	282.6	2.3%	0.0	0.0%
4	145.5	4.4%	156.2	6.1%	205.5	1.7%	237.3	4.6%
5	204.4	6.1%	28.0	1.1%	162.6	1.3%	83.1	1.6%
6	106.9	3.2%	42.8	1.7%	659.6	5.4%	986.2	19.3%
7	227.0	6.8%	286.3	11.1%	818.0	6.6%	1223.0	24.0%
8	341.1	10.2%	0.0	0.0%	2247.9	18.2%	836.4	16.4%
9	994.4	29.8%	0.0	0.0%	7316.7	59.4%	1743.2	34.1%

SUGAR			COFFEE		TEA		COCOA	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	891.0	6.9%	2696.0	20.4%	504.3	12.3%	2215.4	57.6%
AEZ 1	469.0	3.6%	0.1	0.0%	0.4	0.0%	0.1	0.0%
2	138.2	1.1%	488.7	3.7%	112.1	2.7%	182.0	4.7%
3	282.9	2.2%	1079.1	8.2%	24.2	0.6%	2033.3	52.9%
4	0.9	0.0%	1128.1	8.5%	367.7	8.9%	0.1	0.0%
WANA								
total	844.6	6.5%	12.0	0.1%	357.3	8.7%	0.0	0.0%
AEZ 1	0.0	0.0%	2.2	0.0%	0.0	0.0%	0.0	0.0%
4	0.0	0.0%	9.4	0.1%	0.0	0.0%	0.0	0.0%
9	844.6	6.5%	0.3	0.0%	357.3	8.7%	0.0	0.0%
ASIA								
total	5198.8	40.1%	2246.9	17.0%	3150.2	76.6%	561.4	14.6%
AEZ 1	1063.1	8.2%	0.0	0.0%	0.0	0.0%	0.0	0.0%
2	680.0	5.2%	321.5	2.4%	1044.2	25.4%	12.7	0.3%
3	1155.3	8.9%	1744.7	13.2%	635.4	15.5%	548.7	14.3%
5	1154.9	8.9%	0.0	0.0%	0.0	0.0%	0.0	0.0%
6	312.3	2.4%	134.3	1.0%	493.0	12.0%	0.0	0.0%
7	827.6	6.4%	48.3	0.4%	505.9	12.3%	0.0	0.0%
8	6.7	0.1%	0.0	0.0%	471.4	11.5%	0.0	0.0%
S/C AMERICA								
total	6034.1	46.5%	8269.7	62.5%	100.2	2.4%	1069.2	27.8%
AEZ 1	1324.4	10.2%	0.0	0.0%	0.0	0.0%	0.0	0.0%
2	1716.1	13.2%	1816.1	13.7%	6.7	0.2%	518.9	13.5%
3	1497.7	11.5%	1920.7	14.5%	6.0	0.1%	541.5	14.1%
4	0.0	0.0%	2736.6	20.7%	9.3	0.2%	0.4	0.0%
5	393.5	3.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
6	120.9	0.9%	0.0	0.0%	12.1	0.3%	0.0	0.0%
7	865.6	6.7%	1794.6	13.6%	13.2	0.3%	0.0	0.0%
8	17.7	0.1%	0.0	0.0%	52.9	1.3%	0.0	0.0%
9	97.1	0.7%	0.0	0.0%	0.0	0.0%	0.0	0.0%
OVERALL								
total	12968.5	100.0%	13224.6	100.0%	4112.1	100.0%	3846.0	100.0%
AEZ 1	2856.5	22.0%	2.3	0.0%	0.4	0.0%	0.1	0.0%
2	2534.3	19.5%	2626.3	19.9%	1162.9	28.3%	713.6	18.6%
3	2935.9	22.6%	4744.5	35.9%	665.6	16.2%	3123.4	81.2%
4	0.9	0.0%	3874.1	29.3%	377.0	9.2%	0.4	0.0%
5	1548.4	11.9%	0.0	0.0%	0.0	0.0%	0.0	0.0%
6	433.3	3.3%	134.3	1.0%	505.2	12.3%	0.0	0.0%
7	1693.2	13.1%	1842.9	13.9%	519.1	12.6%	0.0	0.0%
8	24.4	0.2%	0.0	0.0%	524.3	12.7%	0.0	0.0%
9	941.7	7.3%	0.3	0.0%	357.3	8.7%	0.0	0.0%

TOBACCO			RUBBER		COTTON		JUTE	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	717.5	5.8%	310.0	6.1%	1208.3	8.9%	1.1	0.1%
AEZ 1	297.9	2.4%	0.0	0.0%	650.2	4.8%	1.0	0.1%
2	360.1	2.9%	0.0	0.0%	302.0	2.2%	0.0	0.0%
3	42.2	0.3%	310.0	6.1%	252.4	1.9%	0.0	0.0%
4	17.3	0.1%	0.0	0.0%	3.7	0.0%	0.0	0.0%
WANA								
total	755.7	6.1%	0.0	0.0%	1541.7	11.4%	1.6	0.2%
AEZ 1	8.0	0.1%	0.0	0.0%	6.2	0.0%	0.0	0.0%
4	14.3	0.1%	0.0	0.0%	2.5	0.0%	0.0	0.0%
9	733.4	5.9%	0.0	0.0%	1533.0	11.3%	1.6	0.2%
ASIA								
total	9120.6	73.4%	4737.2	92.8%	8833.7	65.1%	855.5	99.0%
AEZ 1	592.4	4.8%	0.0	0.0%	983.4	7.2%	0.2	0.0%
2	404.8	3.3%	791.0	15.5%	347.1	2.6%	281.2	32.5%
3	859.4	6.9%	3615.7	70.9%	31.6	0.2%	339.2	39.3%
5	1916.5	15.4%	0.0	0.0%	5313.6	39.1%	0.1	0.0%
6	1392.6	11.2%	128.9	2.5%	2161.6	15.9%	144.1	16.7%
7	3948.8	31.8%	202.3	4.0%	0.0	0.0%	84.3	9.8%
8	12.5	0.1%	0.0	0.0%	0.1	0.0%	6.3	0.7%
S/C AMERICA								
total	1840.5	14.8%	56.0	1.1%	1994.9	14.7%	5.8	0.7%
AEZ 1	178.2	1.4%	0.9	0.0%	232.6	1.7%	0.0	0.0%
2	477.8	3.8%	11.6	0.2%	776.9	5.7%	1.5	0.2%
3	411.4	3.3%	28.3	0.6%	419.2	3.1%	2.0	0.2%
4	0.0	0.0%	0.0	0.0%	2.1	0.0%	0.0	0.0%
5	109.8	0.9%	0.0	0.0%	196.0	1.4%	0.0	0.0%
6	97.1	0.8%	0.0	0.0%	148.5	1.1%	0.0	0.0%
7	527.5	4.2%	15.1	0.3%	203.0	1.5%	2.3	0.3%
8	3.5	0.0%	0.0	0.0%	0.1	0.0%	0.0	0.0%
9	34.9	0.3%	0.0	0.0%	15.8	0.1%	0.0	0.0%
OVERALL								
total	12434.4	100.0%	5103.2	100.0%	13578.5	100.0%	864.0	100.0%
AEZ 1	1076.4	8.7%	0.9	0.0%	1872.4	13.8%	1.2	0.1%
2	1242.8	10.0%	802.7	15.7%	1426.0	10.5%	282.7	32.7%
3	1313.0	10.6%	3954.0	77.5%	703.2	5.2%	341.2	39.5%
4	31.6	0.3%	0.0	0.0%	8.3	0.1%	0.0	0.0%
5	2026.3	16.3%	0.0	0.0%	5509.6	40.6%	0.1	0.0%
6	1489.7	12.0%	128.9	2.5%	2310.1	17.0%	144.1	16.7%
7	4476.3	36.0%	217.4	4.3%	203.1	1.5%	86.6	10.0%
8	16.0	0.1%	0.0	0.0%	0.1	0.0%	6.3	0.7%
9	768.2	6.2%	0.0	0.0%	1548.8	11.4%	1.6	0.2%

	HEMP		SISAL		PALM OIL		BEEF & BUFFALO MEAT	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	0.0	0.0%	40.4	24.5%	593.8	16.8%	3133.2	13.0%
AEZ 1	0.0	0.0%	27.4	16.7%	0.0	0.0%	1375.9	5.7%
2	0.0	0.0%	12.8	7.8%	233.1	6.6%	603.2	2.5%
3	0.0	0.0%	0.1	0.1%	357.0	10.1%	490.5	2.0%
4	0.0	0.0%	0.0	0.0%	0.0	0.0%	660.9	2.7%
WANA								
total	1.6	3.9%	0.7	0.4%	0.0	0.0%	2066.8	8.6%
AEZ 1	0.0	0.0%	0.0	0.0%	0.0	0.0%	12.9	0.1%
4	0.0	0.0%	0.0	0.0%	0.0	0.0%	19.0	0.1%
9	1.6	3.9%	0.7	0.4%	0.0	0.0%	2035.0	8.4%
ASIA								
total	36.8	93.1%	7.0	4.3%	2738.2	77.6%	5131.6	21.3%
AEZ 1	0.0	0.0%	0.0	0.0%	0.0	0.0%	410.2	1.7%
2	8.8	22.2%	0.0	0.0%	34.2	1.0%	461.6	1.9%
3	0.2	0.4%	0.0	0.0%	2629.1	74.5%	1342.9	5.6%
5	1.2	3.1%	4.0	2.4%	0.0	0.0%	1184.4	4.9%
6	10.9	27.5%	2.7	1.6%	15.0	0.4%	355.5	1.5%
7	15.8	39.9%	0.3	0.2%	59.9	1.7%	541.8	2.2%
8	0.0	0.0%	0.0	0.0%	0.0	0.0%	835.3	3.5%
S/C AMERICA								
total	1.2	2.9%	116.4	70.8%	196.2	5.6%	13809.1	57.2%
AEZ 1	0.0	0.0%	27.3	16.6%	0.7	0.0%	961.1	4.0%
2	0.0	0.0%	77.9	47.4%	25.0	0.7%	1888.4	7.8%
3	0.0	0.0%	0.1	0.1%	170.2	4.8%	1871.5	7.8%
4	0.0	0.0%	0.0	0.0%	0.0	0.0%	1927.2	8.0%
5	0.0	0.0%	11.5	7.0%	0.3	0.0%	1037.3	4.3%
6	0.0	0.0%	0.0	0.0%	0.0	0.0%	614.4	2.5%
7	0.0	0.0%	0.0	0.0%	0.0	0.0%	2018.5	8.4%
8	0.0	0.0%	0.0	0.0%	0.0	0.0%	3130.8	13.0%
9	1.2	2.9%	0.0	0.0%	0.0	0.0%	359.9	1.5%
OVERALL								
total	39.5	100.0%	164.5	100.0%	3528.2	100.0%	24140.7	100.0%
AEZ 1	0.0	0.0%	54.8	33.3%	0.7	0.0%	2760.0	11.4%
2	8.8	22.2%	90.8	55.2%	292.3	8.3%	2953.1	12.2%
3	0.2	0.4%	0.3	0.2%	3156.3	89.5%	3704.9	15.3%
4	0.0	0.0%	0.0	0.0%	0.0	0.0%	2607.1	10.8%
5	1.2	3.1%	15.5	9.4%	0.3	0.0%	2221.7	9.2%
6	10.9	27.5%	2.7	1.6%	15.0	0.4%	969.9	4.0%
7	15.8	39.9%	0.3	0.2%	59.9	1.7%	2560.3	10.6%
8	0.0	0.0%	0.0	0.0%	0.0	0.0%	3966.1	16.4%
9	2.7	6.9%	0.7	0.4%	0.0	0.0%	2394.9	9.9%

SHEEP & GOAT MEAT			PIGMEAT		POULTRY MEAT		MILK	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	1455.7	18.0%	287.5	1.2%	605.0	6.5%	3663.5	8.5%
AEZ 1	776.9	9.6%	68.1	0.3%	192.2	2.0%	2466.3	5.7%
2	213.0	2.6%	76.0	0.3%	140.3	1.5%	355.2	0.8%
3	173.0	2.1%	108.9	0.5%	180.5	1.9%	79.7	0.2%
4	286.5	3.5%	34.5	0.1%	92.0	1.0%	762.2	1.8%
WANA								
total	2411.6	29.8%	26.5	0.1%	1312.0	14.0%	4792.9	11.1%
AEZ 1	33.3	0.4%	0.0	0.0%	12.1	0.1%	97.0	0.2%
4	0.0	0.0%	0.0	0.0%	45.3	0.5%	16.2	0.0%
9	2378.4	29.4%	26.5	0.1%	1254.6	13.4%	4679.7	10.8%
ASIA								
total	3565.5	44.0%	20364.3	87.7%	4101.1	43.7%	22506.7	52.2%
AEZ 1	460.2	5.7%	193.2	0.8%	130.8	1.4%	7717.6	17.9%
2	147.4	1.8%	342.4	1.5%	450.1	4.8%	2468.3	5.7%
3	297.9	3.7%	1583.2	6.8%	1088.2	11.6%	555.0	1.3%
5	1167.5	14.4%	2626.5	11.3%	432.8	4.6%	8006.4	18.6%
6	201.7	2.5%	2148.3	9.3%	321.3	3.4%	1590.8	3.7%
7	544.8	6.7%	7826.4	33.7%	1032.0	11.0%	799.7	1.9%
8	745.9	9.2%	5644.2	24.3%	645.9	6.9%	1368.9	3.2%
S/C AMERICA								
total	669.5	8.3%	2530.3	10.9%	3360.2	35.8%	12193.7	28.3%
AEZ 1	47.8	0.6%	204.9	0.9%	283.9	3.0%	1053.5	2.4%
2	64.0	0.8%	382.1	1.6%	657.7	7.0%	2036.9	4.7%
3	70.0	0.9%	454.9	2.0%	699.4	7.5%	1984.3	4.6%
4	122.6	1.5%	690.6	3.0%	701.9	7.5%	1963.9	4.6%
5	41.6	0.5%	104.8	0.5%	78.5	0.8%	735.7	1.7%
6	25.0	0.3%	19.8	0.1%	33.4	0.4%	313.6	0.7%
7	61.1	0.8%	431.3	1.9%	579.2	6.2%	2046.1	4.7%
8	203.4	2.5%	146.1	0.6%	234.3	2.5%	1670.2	3.9%
9	34.0	0.4%	95.1	0.4%	91.9	1.0%	389.4	0.9%
OVERALL								
total	8102.3	100.0%	23208.7	100.0%	9378.2	100.0%	43156.9	100.0%
AEZ 1	1318.2	16.3%	466.2	2.0%	618.9	6.6%	11334.3	26.3%
2	424.3	5.2%	800.6	3.4%	1248.0	13.3%	4860.5	11.3%
3	540.9	6.7%	2147.2	9.3%	1968.1	21.0%	2619.1	6.1%
4	409.1	5.0%	725.2	3.1%	839.1	8.9%	2742.4	6.4%
5	1209.1	14.9%	2731.3	11.8%	511.4	5.5%	8742.1	20.3%
6	226.7	2.8%	2168.2	9.3%	354.8	3.8%	1904.5	4.4%
7	605.9	7.5%	8257.7	35.6%	1611.2	17.2%	2845.8	6.6%
8	949.3	11.7%	5790.3	24.9%	880.2	9.4%	3039.1	7.0%
9	2412.3	29.8%	122.0	0.5%	1346.5	14.4%	5069.2	11.7%

EGGS			SAWLOG & VENEER C		SAWLOG & VENEER NC		FUELWOOD & CHARCOAL	
	USD mil.	share	USD mil.	share	USD mil.	share	USD mil.	share
S/S AFRICA								
total	582.0	4.3%	131.5	1.8%	4798.8	9.1%	16974.1	27.8%
AEZ 1	198.3	1.5%	30.9	0.4%	36.7	0.1%	5517.4	9.0%
2	151.1	1.1%	60.5	0.8%	1389.5	2.6%	3392.8	5.6%
3	149.3	1.1%	0.6	0.0%	3248.0	6.1%	5405.0	8.9%
4	83.4	0.6%	39.5	0.5%	123.1	0.2%	2658.8	4.4%
WANA								
total	1565.5	11.6%	383.9	5.3%	366.2	0.7%	1075.7	1.8%
AEZ 1	69.9	0.5%	0.0	0.0%	0.0	0.0%	0.0	0.0%
4	256.2	1.9%	0.0	0.0%	0.0	0.0%	0.0	0.0%
9	1239.5	9.2%	383.9	5.3%	366.2	0.7%	1075.7	1.8%
ASIA								
total	8268.6	61.5%	3675.0	50.5%	37441.2	70.8%	31533.7	51.7%
AEZ 1	497.4	3.7%	0.0	0.0%	0.0	0.0%	5673.7	9.3%
2	286.0	2.1%	150.7	2.1%	4168.6	7.9%	3606.1	5.9%
3	871.9	6.5%	81.1	1.1%	24507.2	46.4%	10125.1	16.6%
5	1189.5	8.8%	21.1	0.3%	173.6	0.3%	4010.7	6.6%
6	984.0	7.3%	186.5	2.6%	765.9	1.4%	1573.0	2.6%
7	2497.0	18.6%	557.7	7.7%	1172.8	2.2%	3043.2	5.0%
8	1942.7	14.4%	2648.7	36.4%	6618.0	12.5%	3502.0	5.7%
S/C AMERICA								
total	3031.2	22.5%	3086.4	42.4%	10246.9	19.4%	11395.3	18.7%
AEZ 1	223.1	1.7%	9.7	0.1%	36.7	0.1%	815.8	1.3%
2	449.7	3.3%	590.9	8.1%	2339.8	4.4%	2155.7	3.5%
3	552.3	4.1%	1350.2	18.6%	4996.6	9.5%	2787.9	4.6%
4	939.1	7.0%	385.9	5.3%	954.8	1.8%	1998.6	3.3%
5	130.5	1.0%	0.0	0.0%	0.0	0.0%	91.5	0.2%
6	28.9	0.2%	0.4	0.0%	103.6	0.2%	20.8	0.0%
7	421.4	3.1%	266.8	3.7%	976.3	1.8%	2993.3	4.9%
8	206.1	1.5%	7.4	0.1%	385.7	0.7%	260.0	0.4%
9	80.1	0.6%	473.0	6.5%	451.9	0.9%	271.4	0.4%
OVERALL								
total	13447.4	100.0%	7276.8	100.0%	52853.0	100.0%	60978.8	100.0%
AEZ 1	988.8	7.4%	40.6	0.6%	73.4	0.1%	12006.9	19.7%
2	886.8	6.6%	802.0	11.0%	7897.9	14.9%	9154.6	15.0%
3	1573.5	11.7%	1431.9	19.7%	32751.8	62.0%	18318.0	30.0%
4	1278.7	9.5%	425.4	5.8%	1077.8	2.0%	4657.5	7.6%
5	1320.0	9.8%	21.1	0.3%	173.6	0.3%	4102.2	6.7%
6	1012.9	7.5%	186.9	2.6%	869.5	1.6%	1593.9	2.6%
7	2918.3	21.7%	824.5	11.3%	2149.1	4.1%	6036.5	9.9%
8	2148.8	16.0%	2656.1	36.5%	7003.7	13.3%	3762.0	6.2%
9	1319.6	9.8%	856.9	11.8%	818.0	1.5%	1347.1	2.2%

INLAND CAPTURE			MARINE CAPTURE	
	USD mil.	share	USD mil.	share
S/S AFRICA				
total	1208.0	14.3%	862.5	3.4%
AEZ 1	426.0	5.0%		
2	369.3	4.4%		
3	267.9	3.2%		
4	144.8	1.7%		
WANA				
total	243.3	2.9%	1205.2	4.8%
AEZ 1	0.0	0.0%		
4	0.0	0.0%		
9	243.3	2.9%		
ASIA				
total	6583.8	77.8%	13188.7	52.4%
AEZ 1	575.5	6.8%		
2	409.3	4.8%		
3	1702.5	20.1%		
5	796.9	9.4%		
6	481.7	5.7%		
7	1432.1	16.9%		
8	1185.9	14.0%		
S/C AMERICA				
total	426.4	5.0%	9923.2	39.4%
AEZ 1	34.5	0.4%		
2	69.3	0.8%		
3	79.1	0.9%		
4	145.4	1.7%		
5	19.2	0.2%		
6	0.9	0.0%		
7	70.3	0.8%		
8	6.3	0.1%		
9	1.4	0.0%		
OVERALL				
total	8461.6	100.0%	25179.6	100.0%
AEZ 1	1036.0	12.2%		
2	847.9	10.0%		
3	2049.5	24.2%		
4	290.1	3.4%		
5	816.1	9.6%		
6	482.6	5.7%		
7	1502.4	17.8%		
8	1192.2	14.1%		
9	244.7	2.9%		

<u>Commodity</u>	<u>Price</u>	<u>Market Source</u>	<u>Ref.</u>
Apple	378	Unit export value developing countries	B
Banana	150	Export quality farm-gate price, Ecuador	E
Barley	128	Unit export value developing countries	B
Beans(Phas.Vulg)	591	Washington, FOB dealer, common dry bean	A
Beans(Phas.Vulg)	277	Average farm-gate price, Snap	E
Beef/buffalo	1,458	Argentina, FOB, all beef	A
Cabbage	136	Average producer price	D
Cassava	32-110	VOP est.\$32 for dried,\$47 for processed, and \$110 for fresh cassava	E
Charcoal	182	Derived from FAO world prices	D
Chickpea	339	Average wholesale price, India	F
Cocoa	1,670	Unit export value developing countries	B
Coconut	143	Unit export value developing countries	B
Coffee	2,182	Unit export value developing countries	B
Cotton lint	1,244	Unit export value developing countries	B
Cowpea	591	Valued as common dry bean	A
Eggs	840	USA, farm-gate producer price	A
Fuelwood	41	Derived from FAO estimated world prices	D
Grapefruit	580	UK wholesale major markets	A
Grape	809	Unit export value developing countries	B
Groundnut	585	Unit export value developing countries	B
Inland capture	763	Calculated from production and value	D
Inland culture	1,474	Calculated from production and value	D
Lemon	774	France, wholesale	A
Lentil	489	UK, CIF Turkey	A
Maize	104	Unit export value developing countries	B
Marine capture	639	Calculated from production and value	D
Marine culture	1,561	Calculated from production and value	D
Milk	306	Average farm-gate price	E
Millet	132	Millet forecast price World Bank	D
Onion	235	Unit export value developing countries	B
Orange	512	France, FOR average price Morocco	A
Other Ind.R'wood	131	Derived from FAO world prices	D
Palm oil	365	Unit export value developing countries	B
Pigeon Pea	393	Average wholesale price, India	F
Pig meat	1,026	USA, wholesale, Omaka, Gilts	A
Pineapple	293	Unit export value developing countries	B
Plantain	144	Average farm-gate price, Colombia	E
Potato	180	Unit export value	B
Poultry	727	USA, farm-gate price, broiler	A
Rice	284	Milled Thai white, 5% broken, FOB Bangkok	A
Rubber	1,050	Malaysia, Kuala Lumpur FOB	A
Sawlogs (C)	97	Coniferous, USA, spruce/pine/fir	D
Sawlogs (NC)	296	Non-coniferous, Malaysia Meranti, standard	D
Sheep/goat meat	1,652	Unit export value developing countries	B
Sorghum	93	USA, Milo No.2, yellow, FOB Gulf	A
Soybeans	265	Rotterdam, CIF, US origin	A
Sugar	218	ISA Daily, raw FOB, Caribbean ports	A
Sweet potato	112	Unit export value	C
Tea	1,862	London auction, weighted avg., all origins	A
Tobacco	2,522	Unit export value developing countries	B
Tomato	195	Average production price 1984-86	D
Wheat	144	USA, Hard Winter No.2, FOB Gulf	A
Yam	105	Estimated price	D

References: A = FAO Production Yearbook 1989; B = FAO Trade Yearbook 1989;
C = CIP; D = ACIAR; E = CIAT; F = ICRISAT.

Land Use in Different Regions and Agro-ecological Zones

AGRICULTURAL LAND (000 ha)	Total	of which in AEZ								
		1	2	3	4	5	6	7	8	9
S/S AFRICA	815011.0	469352.8	143031.6	113351.3	89275.3	0.0	0.0	0.0	0.0	0.0
ASIA	967502.0	94378.5	46713.2	76712.1	0.0	162006.2	65919.9	207245.4	314526.6	0.0
S/C AMERICA	764627.0	47846.1	109588.0	107098.5	111229.1	41511.9	31426.3	141814.9	151847.1	22265.1
WANA	356148.0	9650.0	0.0	0.0	8445.0	0.0	0.0	0.0	0.0	338053.0
TOTAL	2903288	621227.3	299332.8	297161.9	208949.4	203518.1	97346.3	349060.4	466373.7	360318.1
AGRICULTURAL LAND share										
S/S AFRICA	28.1%	16.2%	4.9%	3.9%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%
ASIA	33.3%	3.3%	1.6%	2.6%	0.0%	5.6%	2.3%	7.1%	10.8%	0.0%
S/C AMERICA	26.3%	1.6%	3.8%	3.7%	3.8%	1.4%	1.1%	4.9%	5.2%	0.8%
WANA	12.3%	0.3%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	11.6%
TOTAL	100.0%	21.4%	10.3%	10.2%	7.2%	7.0%	3.4%	12.0%	16.1%	12.4%
FOREST + WOODLAND										
(000 ha)	Total	of which in AEZ								
		1	2	3	4	5	6	7	8	9
S/S AFRICA	667575	220441.8	121027.6	302260.0	23845.6	0.0	0.0	0.0	0.0	0.0
ASIA	489136	30590.9	59543.4	222018.3	0.0	20589.7	14400.2	18687.8	123305.7	0.0
S/C AMERICA	960946	85293.4	257874.1	385786.7	100269.3	22599.2	3541.2	51038.6	28924.5	25619.1
WANA	59325	2523.0	0.0	0.0	1600.0	0.0	0.0	0.0	0.0	55202.0
TOTAL	2176982	338849.1	438445.1	910065.0	125714.8	43189.0	17941.4	69726.4	152230.2	80821.1
FOREST + WOODLAND share										
S/S AFRICA	30.7%	10.1%	5.6%	13.9%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%
ASIA	22.5%	1.4%	2.7%	10.2%	0.0%	0.9%	0.7%	0.9%	5.7%	0.0%
S/C AMERICA	44.1%	3.9%	11.8%	17.7%	4.6%	1.0%	0.2%	2.3%	1.3%	1.2%
WANA	2.7%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	2.5%
TOTAL	100.0%	15.6%	20.1%	41.8%	5.8%	2.0%	0.8%	3.2%	7.0%	3.7%

Summary Land Table.

ARABLE LAND (000 ha)	Total	of which in AEZ								
		1	2	3	4	5	6	7	8	9
S/S AFRICA	161781	64036	43768	37253	16724	0	0	0	0	0
ASIA	462541	85925	40539	44979	0	106040	32516	78371	74171	0
S/C AMERICA	161369	10931	26124	21757	15377	8067	7065	33740	32175	6133
WANA	83025	235	0	0	1350	0	0	0	0	81440
TOTAL	868716	161127	110431	103989	33451	114107	39581	112111	106346	87573
ARABLE LAND share										
S/S AFRICA	18.6%	7.4%	5.0%	4.3%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%
ASIA	53.2%	9.9%	4.7%	5.2%	0.0%	12.2%	3.7%	9.0%	8.5%	0.0%
S/C AMERICA	18.6%	1.3%	3.0%	2.5%	1.8%	0.9%	0.8%	3.9%	3.7%	0.7%
WANA	9.6%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	9.4%
TOTAL	100.0%	18.5%	12.7%	12.0%	3.9%	13.1%	4.6%	12.9%	12.2%	10.1%
PERMANENT CROP LAND										
(000 ha)	Total	of which in AEZ								
		1	2	3	4	5	6	7	8	9
S/S AFRICA	14678	865.7	4842.7	6876.9	2092.7	0.0	0.0	0.0	0.0	0.0
ASIA	25562	2178.0	3375.0	15772.0	0.0	482.7	865.5	2038.6	850.2	0.0
S/C AMERICA	32576	1662.2	7818.1	5806.6	2059.9	455.4	1717.7	5281.4	7529.7	245.0
WANA	8283	50.0	0.0	0.0	95.0	0.0	0.0	0.0	0.0	8138.0
TOTAL	81099	4755.9	16035.7	28455.5	4247.7	938.1	2583.2	7319.9	8380.0	8383.0
PERMANENT CROP LAND share										
S/S AFRICA	18.1%	1.1%	6.0%	8.5%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%
ASIA	31.5%	2.7%	4.2%	19.4%	0.0%	0.6%	1.1%	2.5%	1.0%	0.0%
S/C AMERICA	40.2%	2.0%	9.6%	7.2%	2.5%	0.6%	2.1%	6.5%	9.3%	0.3%
WANA	10.2%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	10.0%
TOTAL	100.0%	5.9%	19.8%	35.1%	5.2%	1.2%	3.2%	9.0%	10.3%	10.3%
GRAZING LAND										
(000 ha)	Total	of which in AEZ								
		1	2	3	4	5	6	7	8	9
S/S AFRICA	638881	404451.1	94420.9	69221.4	70458.6	0.0	0.0	0.0	0.0	0.0
ASIA	479405	6275.4	2799.3	15961.1	0.0	55483.6	32538.4	126835.9	239505.4	0.0
S/C AMERICA	570693	35252.9	75645.9	79534.9	93792.2	32989.5	22643.6	102793.6	112142.3	15887.1
WANA	264840	9365.0	0.0	0.0	7000.0	0.0	0.0	0.0	0.0	248475.0
TOTAL	1953819	455344.4	172866.1	164717.3	171250.8	88473.0	55182.1	229629.5	351647.7	264362.1
GRAZING LAND share										
S/S AFRICA	32.7%	20.7%	4.8%	3.5%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%
ASIA	24.5%	0.3%	0.1%	0.8%	0.0%	2.8%	1.7%	6.5%	12.3%	0.0%
S/C AMERICA	29.2%	1.8%	3.9%	4.1%	4.8%	1.7%	1.2%	5.3%	5.7%	0.8%
WANA	13.6%	0.5%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	12.7%
TOTAL	100.0%	23.3%	8.8%	8.4%	8.8%	4.5%	2.8%	11.8%	18.0%	13.5%
CULTIVATED LAND										
(000 ha)	Total	of which in AEZ								
		1	2	3	4	5	6	7	8	9
S/S AFRICA	176459.0	64901.7	48610.7	44129.9	18816.7	0.0	0.0	0.0	0.0	0.0
ASIA	488103.0	88103.0	43914.0	60751.0	0.0	106522.7	33381.5	80409.6	75021.2	0.0
S/C AMERICA	193945.0	12593.2	33942.1	27563.6	17436.9	8522.4	8782.7	39021.4	39704.7	6378.0
WANA	91308.0	285.0	0.0	0.0	1445.0	0.0	0.0	0.0	0.0	89578.0
TOTAL	949815.0	165882.9	126466.7	132444.5	37698.7	115045.1	42164.2	119430.9	114726.0	95956.0
CULTIVATED LAND share										
S/S AFRICA	18.6%	6.8%	5.1%	4.6%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%
ASIA	51.4%	9.3%	4.6%	6.4%	0.0%	11.2%	3.5%	8.5%	7.9%	0.0%
S/C AMERICA	20.4%	1.3%	3.6%	2.9%	1.8%	0.9%	0.9%	4.1%	4.2%	0.7%
WANA	9.6%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	9.4%
TOTAL	100.0%	17.5%	13.3%	13.9%	4.0%	12.1%	4.4%	12.6%	12.1%	10.1%

Estimated Rates of Progress in Research on
Different Commodities by Region and Agro-ecological Zone

Rate of Progress.

	S/S AFRICA				WANA		
	1	2	3	4	1	4	9
rice (wetland)	3	4	4	-	-	-	-
rice (dryland)	-	4	3	-	-	-	-
wheat (CIMMYT/ICARDA)	2	-	-	4	2	5	4/3
maize (IITA/CIMMYT)	1/3	4/5	3/5	2/5	-	-	4
barley	-	-	-	(2)	-	(2)	3
sorghum	2	3	-	3	2	3	-
millet	3	3	-	-	-	-	-
cassava (IITA/CIAT)	3/1	3/1	4/1	-/1	-	-	-
potato	1	1	-	3	1	3	1
sweet potato (CIP/AVRDC)	1/2	1/3	1/2	3/2	1/2	1/2	1/2
yam	-	2	3	-	-	-	-
banana (INIBAP/IITA)	-	2/2	3/3	-	-	1	1
beans	2	2	(1)	2	-	-	(1)
broad bean	-	-	-	-	-	-	(2)
chickpea (desi/kabuli)	2	1	-	1	-	-	2/2
cowpea	4	3	2	-	-	-	-
pigeon pea	2	3	2	-	-	-	-
lentil	-	-	-	-	-	-	2
groundnut	2	3	-	-	2	-	1
soybean (IITA/AVRDC)	2/2	4/1	2/1	-/2	2	2	2
coconut	(2)	(2)	(2)	-	(2)	-	-
tomato	2	1	1	3	2	3	2
onion	2	1	-	3	2	3	2
cabbage	2	1	1	3	2	3	2
cotton	(1)	(1)	-	-	(1)	-	(1)
coffee (R+A)	-	(1)	(2)	(2)	-	(2)	-
tea	-	(1)	(1)	(2)	-	(2)	-
cocoa	-	(1)	(3)	-	-	-	-
sugar (cane + beet)	(1)	(1)	(1)	-	(1)	-	(1)
rubber	-	(1)	(2)	-	-	-	-
oil palm	-	(1)	(3)	-	-	-	-
beef & buffalo (ILRAD/ILCA)	2/1	3/3	3/3	4/3	2/1	2/3	3/3
sheep & goat (ILRAD/ILCA)	2/1	3/2	2/2	4/3	2/1	2/3	4/3
pig meat (IND)(ILRAD/ILCA)	3/1	3/3	3/3	4/3	-	-	-
poultry (IND)(ILRAD/ILCA)	3/2	3/2	3/2	3/2	1/1	1/2	3/3
milk (ILRAD/ILCA)	2/1	2/2	2/2	3/3	1/1	1/2	3/3
eggs (IND)(ILRAD/ILCA)	3/2	3/2	3/2	3/2	3/2	3/2	3/3

R - robusta A - arabica IND - industrial
 Values in parenthesis are TAC Secretariat's tentative estimates
 Ratings: 1=< 0.5% p.a., 2=0.5-<1% p.a., 3=1-<2% p.a., 4=2-<3% p.a., 5=>3% p.a.

ASIA	1	2	3	5	6	7	8
rice (wetland)	(1)	(1)	(1)	(1)	(1)	(1)	-
rice (dryland)	-	(3)	(2)	-	(3)	(2)	-
wheat	2	-	-	4	4	3	5
maize	3	5	5	3	5	4	4
barley	-	-	-	-	-	-	3
sorghum	2	3	-	2	3	-	3
millet	3	2	-	3	2	-	-
cassava	2	2	3	-	-	-	-
potato	1	1	-	2	1	-	2
sweet potato (CIP/AVRDC)	1/3	1/3	1/2	1/3	1/3	2/2	1/2
yam	-	-	-	-	-	-	-
banana	-	2	2	-	1	1	-
beans	2	2	1	2	2	2	(1)
broad bean	-	-	-	(1)	(1)	(1)	(2)
chickpea (desi/kabuli)	1	1	-	1	1	-	1/2
cowpea	-	-	-	-	-	-	-
pigeon pea	1	2	2	1	2	2	-
lentil	-	-	-	-	-	-	3
groundnut	1	1	-	1	1	-	-
soybean	2	2	1	2	2	2	2
coconut	(2)	(2)	(2)	(1)	(1)	(1)	-
tomato	3	2	2	3	2	2	3
onion	2	2	-	2	2	2	3
cabbage	2	1	1	2	2	2	3
cotton	(1)	(1)	-	(1)	(1)	-	-
coffee (R+A)	-	(1)	(2)	-	(1)	(2)	(2)
tea	-	(1)	(2)	-	(1)	(2)	(2)
cocoa	-	(1)	(3)	-	-	-	-
sugar (cane + beet)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
rubber	-	(1)	(2)	-	-	-	-
oil palm	-	(1)	(3)	-	-	-	-
beef & buffalo (ILRAD/ILCA)	2/1	3/2	3/2	2/1	3/2	3/2	4/3
sheep & goat (ILRAD/ILCA)	2/1	3/2	2/2	2/1	3/2	4/3	4/3
pig meat (IND)(ILRAD/ILCA)	3/2	3/3	3/3	3/1	3/3	3/3	3/3
poultry (IND)(ILRAD/ILCA)	3/2	3/2	3/2	3/2	3/2	3/2	3/2
milk (ILRAD/ILCA)	2/1	2/2	2/2	2/1	3/2	3/2	4/3
eggs (IND)(ILRAD/ILCA)	3/2	3/2	3/2	3/2	3/2	3/2	3/2

R - robusta A - arabica IND - industrial
 Values in parenthesis are TAC Secretariat's tentative estimates
 Ratings: 1=< 0.5% p.a., 2=0.5-<1% p.a., 3=1-<2% p.a., 4=2-<3% p.a., 5=>3% p.a.

S/C AMERICA	1	2	3	4	5	6	7	8	9
rice (wetland)	-	4	4	-	-	4	4	-	-
rice (dryland)	-	(3)	(2)	-	-	(3)	(2)	-	-
wheat	2	-	-	4	3	4	3	5	5
maize	3	5	5	5	3	5	4	5	4
barley	-	-	-	(2)	-	-	-	3	3
sorghum	2	3	-	3	2	3	-	3	2
millet	3	2	-	-	3	2	-	-	2
cassava	2	2	2	2	-	-	-	1	-
potato	1	1	-	3	1	1	-	3	-
sweet potato (CIP/AVRDC)	1/3	1/3	1/2	1/3	1/3	1/3	1/2	1/2	-/1
yam	-	-	-	-	-	-	-	-	-
banana	-	1	2	-	-	1	-	-	-
beans	3	2	1	2	2	2	2	1	1
broad bean	-	-	-	-	(1)	(1)	(1)	(2)	(2)
chickpea (desi/kabuli)	1	1	-	1	1	1	-	1/2	1/2
cowpea	-	-	-	-	-	-	-	-	-
pigeon pea	1	2	2	-	-	-	-	-	-
lentil	-	-	-	-	-	-	-	3	2
groundnut	1	1	-	-	1	1	-	-	1
soybean	2	2	1	2	2	2	2	2	2
cowpea	-	-	-	-	-	-	-	-	-
pigeon pea	1	2	2	-	-	-	-	-	-
lentil	-	-	-	-	-	-	-	3	2
groundnut	1	1	-	-	1	1	-	-	1
soybean	2	2	1	2	2	2	2	2	2
coconut	(2)	(2)	(2)	-	(1)	(1)	(1)	-	-
tomato	3	2	2	3	3	2	2	3	3
onion	2	2	-	3	2	2	2	3	2
cabbage	2	2	1	3	2	2	2	3	2
cotton	(1)	(1)	-	-	(1)	(1)	-	-	(1)
coffee (R+A)	-	(1)	(2)	(2)	-	(1)	(2)	(2)	-
tea	-	(1)	(1)	(2)	-	(1)	(2)	(2)	-
cocoa	-	(1)	(3)	-	-	-	-	-	-
sugar (cane + beet)	(1)	(1)	(1)	-	(1)	(1)	(1)	(1)	(1)
rubber	-	(1)	(2)	-	-	-	-	-	-
oil palm	-	(1)	(3)	-	-	-	-	-	-
beef & buffalo (ILRAD/ILCA)	2/1	3/2	3/2	4/3	2/1	3/2	3/2	4/3	3/2
sheep & goat (ILRAD/ILCA)	2/1	3/2	2/2	4/3	2/1	3/2	3/3	4/3	3/2
pig meat (IND)(ILRAD/ILCA)	3/2	3/3	3/3	3/2	3/2	3/3	3/3	3/3	3/2
poultry (IND)(ILRAD/ILCA)	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2
milk (ILRAD/ILCA)	2/1	2/2	2/2	3/2	2/1	3/3	3/2	4/3	3/2
eggs (IND)(ILRAD/ILCA)	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2

R - robusta A - arabica IND - industrial
 Values in parenthesis are TAC Secretariat's tentative estimates
 Ratings: 1=< 0.5% p.a., 2=0.5-<1% p.a., 3=1-<2% p.a., 4=2-<3% p.a., 5=>3% p.a.

TABLE 11.13: REGIONAL COMMODITY RESEARCH PRIORITY GROUPINGS : Maximisation of Regional Benefits Research Objective (at May 1991)

South Asia Regional Benefits		South East Asia Regional Benefits		China Regional Benefits		South Pacific Regional Benefits		
Priority Group	Commodity Ranking	Priority Group	Commodity Ranking	Priority Group	Commodity Ranking	Priority Group	Commodity Ranking	
	Rice	1	Rice	1	Rice	1	Tunas,bonitos et	1
	Millet	2	SawVen.logs (NC)	1	Sweet Potato	4	Fuelwood (NC)	1
	Fuelwood (C)	2	Fuelwood (NC)	1	Maize	4	SawVen.logs (NC)	1
1	Wheat	3	1 Palm Oil/Kernel	2	Potatoes	5	1 Sugar	3
	Pulses All	4	Rubber	3	Wheat	5	Banana/Plantain	4
	Potatoes	7	Sugar	9	Cotton	9	Coffee	7
	Cotton	8	Coconut	9	Soybean	19	Palm Oil/Kernel	10
	Sugar	8	Banana/Plantain	10	2 Pulses All	20	2 Cocoa	12
	SawVen.Logs (NC)	11	Cassava	12	Fuelwood (NC)	20	Demersal/other p	20
	Sorghum	11	Demersal/other p	15	SawVen.Logs (C)	26	Coconut	30
2	Groundnut	12	2 Prawns/shrimps	16	Sugar	26	3 Pulpwood	30
	Millet	17	Maize	16	3 Fuelwood (Con.)	29	SawVen.Logs (C)	30
	Sheep & Goat Mea	18	Coffee	18	Sheep & Goat Mea	39	Sweet Potato	30
	Banana/Plantain	21	Beef&Buffalo	25	Groundnut	40	Milk	59
	Maize	23	3 Tilapias	27	SawVen.Logs (NC)	41	4 Prawns/shrimps	59
3	Beef&Buffalo	27	Cocoa	28	4 Milk	46	Rice	59
	Prawns/shilaps	30	Oth.Ind.Rdwood	33	Oth.Ind.Rdwood	62	Tilapias	59
	Encom t	33	Tunas,bonitos et	57	Prawns/shrimps	67	Beef&Buffalo	0
	Demersal/other p	53	Mackerals & othe	61	Millet	81	Cassava	0
	Oranges & Tangar	55	4 Charcoal	63	Sorghum	89	Charcoal	0
	Herrings & other	64	Sheep & Goat Mea	65	5 Wool	97	Cotton	0
	Cassava	67	Herrings & other	67	Oranges & Tangar	129	Fuelwood (Con.)	0
4	Fuelwood (Con.)	67	Soybean	83	Beef&Buffalo	139	Groundnut	0
	SawVen.Logs (C)	67	Milk	95	Millet	163	6 Herrings & other	0
	Soybean	75	Pulpwood	141	Mackerals & othe	214	7 Lobsters	0
	(SawVen)	77	5 Sweet Potato	133	Demersal/other p	227	Mackerals & othe	0
	Oth.Ind.Rdwood	98	Pulses All	143	Cassava	275	Maize	0
5	Wool	136	SawVen.Logs (C)	143	Rubber	275	Millet	0
	Coffee	145	Cotton	154	Palm Oil/Kernel	289	Oranges & Tangar	0
	Tilapias	156	Groundnut	167	Pulpwood	413	Oth.Ind.Rdwood	0
	Rubber	183	Oranges & Tangar	222	6 Tunas,bonitos et	463	Pilprops	0
	Pilprops	301	Lobsters	286	Banana/Plantain	1286	Potatoes	0
	Pulpwood	324	Potatoes	500	Coffee	5785	Pulses All	0
	Sweet Potato	351	6 Sorghum	500	Herrings & other	5785	Rubber	0
6	Mackerals & othe	421	Wheat	667	Charcoal	0	Sheep & Goat Mea	0
	Tunas,bonitos et	842	Millet	2000	Cocoa	0	Sorghum	0
	Lobsters	2105	Fuelwood (Con.)	0	Coconut	0	Soybean	0
	Cocoa	4210	Pilprops	0	Lobsters	0	Wheat	0
	Palm Oil/Kernel	0	Wool	0	Tilapias	0	Wool	0

Source: ARIAR INFORMATION SYSTEM (May 1991).

ACIAR Commodity Research Priorities by Region (analysis based on objective to maximize regional benefits)

Africa Regional Benefits			W Asia/ N Africa Regional Benefits			Latin America Regional Benefits		
Priority Group	Commodity Ranking	Relative Benefits	Priority Group	Commodity Ranking	Relative Benefits	Priority Group	Commodity Ranking	Relative Benefits
	Fuelwood (NC)	1		Wheat	1		Soybean	1
	SawVen.Logs (NC)	6		Milk	2		Fuelwood (NC)	1
	Milk	8		Beef&Buffalo	3		Coffee	1
1	Cocoa	9		Sheep & Goat Mea	3		Milk	2
	Beef&Buffalo	9		Oranges & Tangar	3		Beef&Buffalo	2
	Charcoal	9		Cotton	4		Sugar	2
	Palm Oil/Kernel	9		Rice	5		SawVen.Logs (C)	2
	Cassava	10		SawVen.Logs (C)	5		Herrings & other	2
2	Sheep & Goat Mea	11		Pulses All	5	1	Oranges & Tangar	3
	Oth. Ind. Rdwood	17		Sugar	6		SawVen.Logs (NC)	3
	Banana/Plantain	22		Fuelwood (Con.)	7		Demersal/other p	3
	Rice	22		Herrings & other	7		Rice	4
3	Tilapias	22		Fuelwood (NC)	7		Maize	4
	Sugar	25		Potatoes	10		Cocoa	6
	Millet	26	2	Maize	11		Prawns/shrimps	6
	Maize	27		Wool	14		Pulpwood	6
	Pulpwood	50	3	SawVen.Logs (NC)	22		Wheat	7
	Fuelwood (Con.)	54		Oth. Ind. Rdwood	34		Cassava	9
4	Groundnut	54		Mackerals & othe	46		Fuelwood (Con.)	9
	Herrings & other	59		Demersal/other p	58		Banana/Plantain	9
	SawVen.Logs (C)	65	4	Pitprops	71		Sheep & Goat Mea	11
	Cotton	81		Charcoal	80		Charcoal	11
	Potatoes	81		Pulpwood	80		Cotton	14
5	Demersal/other p	129		Soybean	80	2	Pulses All	14
	Pulses All	129		Millet	92		Wool	17
	Sorghum	129	5	Banana/Plantain	107		Potatoes	22
	Wheat	161		Prawns/shrimps	214		Sorghum	25
	Coffee	215		Tunas, bonitos et	214	3	Oth. Ind. Rdwood	26
	Soybean	215		Groundnut	641		Rubber	36
	Wool	215		Cassava	0		Palm Oil/Kernel	51
	Coconut	323	6	Cocoa	0		Tilapias	53
6	Sweet Potato	323		Coconut	0		Lobsters	56
	Tunas, bonitos et	323		Coffee	0	4	Mackerals & othe	56
	Lobsters	645		Lobsters	0		Tunas, bonitos et	72
	Mackerals & othe	645		Palm Oil/Kernel	0		Coconut	253
	Oranges & Tangar	645		Rubber	0		Pitprops	506
	Pitprops	645		Sorghum	0	6	Sweet Potato	506
	Prawns/shrimps	645		Sweet Potato	0		Groundnut	1013
	Rubber	-645		Tilapias	0		Millet	0

Source: AICAR INFORMATION SYSTEM (May 1991).

LIST OF ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
AEZ	Agro-ecological zone
AVRDC	Asian Vegetable Research and Development Centre
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIP	Centro Internacional de la Papa
EPR	External Programme Review
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Production
GNP	Gross National Production
HCN	Hydrogen Cyanide
IBPGR	International Board for Plant Genetic Resources
ICARDA	International Centre for Agricultural Research in Dry Areas
ICLARM	International Centre for Living Aquatic Resource Management
ICRAF	International Council for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICSU	International Council of Scientific Unions
IFPRI	International Food Policy Research Institute
IIMI	International Irrigation Management Institute
ILCA	International Livestock Centre for Africa
ILRAD	International Laboratory for Research on Animal Diseases
INIBAP	International Network for the Improvement of Banana and Plantain
INTSOY	International Soybean Programme
IPCC	Inter Governmental Panel on Climate Change
IRHO	Institut de recherche pour les huiles et oleagineux
IRRI	International Rice Research Institute

ISNAR	International Service for National Agricultural Research
RAEZ	Regional agro-ecological zone
SADCC	Southern Africa Development Coordination Conference
TAC	Technical Advisory Committee to the CGIAR
WARDA	West Africa Rice Development Association

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH
TECHNICAL ADVISORY COMMITTEE

CGIAR MEDIUM-TERM RESOURCE ALLOCATION

1994-98

Analysis and Recommendations

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

September 1993

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

Alex F. McCalla
Chair

6 September 1993

Dear Mr. Rajagopalan

I am pleased to submit to you TAC's recommendations for allocation of CGIAR resources during 1994-98. This completes the process of linking CGIAR priorities and strategies with resource allocation. The recommendations provide TAC's views on the medium-term plan proposals submitted by the CGIAR centres to implement the priorities and strategies endorsed by the Group at MTM'92 in Istanbul, Turkey. As you are aware since MTM'92, the centres, TAC and the Group have been involved in an interactive process on these plans. The consideration of these recommendations by the Group will be the final step in this process, leading to resource allocation decisions at ICW'93 to guide the implementation of CGIAR Priorities and Strategies over the period 1994-98.

Consistent with the decision of the Group at ICW'91, the TAC recommendations are based on a projected 1998 funding support for core programmes of US\$ 270 million, in 1992 dollars. This level of funding support, maintains the 1992 pledges in real terms, except for a modest increase for forestry and fisheries. Obviously this does not represent the totality of the high payoff research opportunities at CGIAR centres. In this respect, the report identifies additional investment opportunities if a higher funding level were to become available. However, to inject realism in this planning, the report suggests an annual progression starting from the present 1993 funding levels to reach the proposed 1998 level. For 1994 therefore TAC recommends core funding support of US\$ 229 million in 1992 dollars or US\$ 248 million in current dollars.

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TAC has addressed the concerns expressed by some donors of the programme implications of funding below the recommended levels. TAC is convinced that lower funding levels if sustained over the 1994-98 period will require that discussions of alternatives for CGIAR programme and institutional restructuring presented in the context of 2010 (Chapter 11 of the CGIAR Expansion report considered at ICW'91) be advanced.

The resource allocation recommendations are therefore accompanied by a revision of Chapter 13 of the CGIAR Priorities and Strategies paper (MTM'92 dated 15 April 1992) which proposes a mechanism for looking at the structural options and alternative strategies available to the CGIAR. This revision has benefited from the extensive consultations that have taken place over the last twelve months regarding the ecoregional approach to research - a key principle in the proposed restructuring of the CGIAR.

You will also note that TAC has made two types of recommendations on funding in the CGIAR: centre specific funding, and programme funding for particular CGIAR Systemwide initiatives. With respect to programme funding, TAC has identified convening centres which will have an initiating and facilitating role, and which, in partnership with collaborating institutions, will develop proposals for joint programmes. TAC would be willing to receive these proposals if so requested by the Group. TAC recognizes the innovative but experimental nature of such programme funding and that many issues, for example with respect to accountability, have still to be resolved. However, TAC strongly believes that programme funding would provide an attractive and innovative mechanism to promote partnerships among centres, national programmes and other actors in the global agricultural research systems.

Mr. Chairman these reports represent the culmination of a concentrated and arduous process. They provide TAC's collective views and recommendations of priorities, strategies and resource allocation in the CGIAR. I would like to thank TAC members for their dedication and commitment throughout this exercise. I would like to publicly acknowledge the contributions of the staff of both the TAC and CGIAR Secretariats. Special recognition must be given to the enormous contributions that Guido Gryseels, TAC Secretariat, and Jean-Pierre Jacquemotte and Ravi Tadvalkar, CGIAR Secretariat, made to the analytical work throughout the process and to the writing of this report. I wish to stress the excellent cooperation and team spirit among members of the two Secretariats.

We look forward to the discussion at ICW'93. Hopefully our efforts will facilitate a constructive dialogue and useful conclusions.

Yours sincerely,

A.F. McCalla
TAC Chair

CGIAR Medium-Term Resource Allocation 1994-1998

Analysis and Recommendations

Summary

This report concludes TAC's review of CGIAR priorities and strategies for research on agriculture, forestry and fisheries, and the linking of these to resource allocation for the medium-term period 1994-98. It thus completes the report presented to, and endorsed by, the Group at MTM'92¹, in that it presents TAC's recommendations to the CGIAR for resource allocation for the System as a whole, for individual centres, and for Systemwide programmes. These recommendations are presented to the Group at ICW'93, as the basis for decision making in implementing CGIAR priorities and strategies in the medium term, and for approval of centre and programme funding requirements between 1994 and 1998.

The resource allocation process was undertaken in the framework of TAC developing its views on CGIAR priorities and strategies. In this process, TAC used a comprehensive analytical framework for setting priorities which facilitated the linking of resource allocation within the CGIAR to the priorities. Consistent with these priorities, TAC proposed, and the CGIAR endorsed, a tentative core resource envelope for 1998 for each centre. These indicative envelopes were subsequently used by the centres as planning guidelines in developing their Medium-Term Plan (MTP) proposals. Centre proposals were presented to TAC and the CGIAR, allowing both to raise issues to which the centres could respond. Progress in the resource allocation process was presented and discussed at a TAC/CGIAR Workshop in San Juan, Puerto Rico, in May 1993. Finally, at TAC 61, the Committee simultaneously considered all centres' MTP proposals and any additional information provided by the centres. It reconciled the MTP proposals with the System priorities and allocated resources accordingly by proceeding through a number of steps.

First, TAC evaluated the relevance of each centre's indicative resource envelope in close reference to the CGIAR priorities as views on both priorities and envelopes might have evolved since MTM'92 when they were agreed upon. In this step, the Committee took into account centres' MTP proposals and supplementary information, as well as recent internal and external developments in the CGIAR, and determined if a change in the level of resources tentatively assigned to each centre would be justified. This comprehensive review, comprising all centres, completed TAC's discussion of CGIAR priorities.

¹ TAC/CGIAR, 1992. Review of CGIAR Priorities and Strategies. Parts I and II. TAC Secretariat, FAO, Rome.

comprehensive review, comprising all centres, completed TAC's discussion of CGIAR priorities.

Second, TAC evaluated the MTP proposal of each centre in accordance with a set of five equally-weighted criteria: the strategic character of the centre's proposed research programme; the programme's potential for breakthroughs; centre's past performance and likelihood of sustained success; the centre's external environment, institutional health and quality of management; and, finally, the centre's collaboration with NARS, other IARCs and advanced institutions.

Third, TAC reconciled the outcome of these two evaluations, the first, largely priority- and demand-driven and the second, largely supply/institution-driven, in a step towards assigning core resources to individual centres and to a number of CGIAR Systemwide initiatives. In this step, TAC considered the implications of the proposed allocations for the implementation of the overall System priorities. This was done at two aggregate levels of assumed core resources in 1998, i.e., US\$ 270 million and US\$ 280 million expressed in 1992 dollars.

Also, aware of the limitations inherent to MTPs being developed at centre level, TAC considered a number of inter-centre and System issues which were not adequately addressed, and formulated a number of recommendations of funding of Systemwide initiatives within the overall funding assumptions for 1998.

In response to a request expressed at the TAC/CGIAR May 1993 Workshop, TAC also considered the scenario of a significant, sustained shortfall in core funding in 1998, e.g., at 10% below the base level of US\$ 270 million. Consistent with the views of participants in the Workshop, TAC concluded that the implications of such a scenario could not adequately be addressed by budgetary procedures only, such as across-the-board reductions: sustained under-funding would require structural adjustments of the CGIAR. Therefore, TAC concluded that the resource allocation process did not constitute the appropriate framework in which to explore and formulate System adjustments of a structural nature. Instead, the Committee decided to present to the Group a timed sequence of stripe reviews, of reviews of delivery mechanisms in the CGIAR and *ad hoc* reviews of possibilities of other structural adjustments. These reviews would be undertaken with a view to achieving the necessary savings, while assuring the maintenance of the System's integrity at a significantly lower level of core funding. The recommendations arising from these reviews could be implemented during the MTP period to the extent they will be accepted by the Group.

Recommendations of 1998 System Level Core Funding

TAC made two sets of recommendations on resource allocation across the System for the period, 1994-98. The first set was for allocations specific to all 18 CGIAR centres. The second set concerned a number of CGIAR Systemwide initiatives for which funding was recommended so that they could be undertaken on a collaborative basis, involving a number of CGIAR centres, national programmes and other relevant partners. Both sets of recommendations are summarized in Table S1.

Table S1: System Level Core Funding Recommendations (1998) (1992 US\$ million)		
	At US\$ 270 m.	At US\$280 m.
A. Centres		
Recommended Centres' Core Funding	257.8	262.1
Provision for External Reviews	1.2	1.2
Reserve for Fisheries	1.0	1.0
<i>Sub-total Centres</i>	<i>260.0</i>	<i>264.3</i>
B. CGIAR Systemwide Initiatives		
Ecoregional Programmes	4.0	6.0
Genetic Resources Programme	1.0	2.0
Livestock Programme	4.0	4.8
Water Management Programme	1.0	2.0
Fisheries Programme	0.0	1.0
<i>Sub-total Systemwide Initiatives</i>	<i>10.0</i>	<i>15.7¹</i>
Total Recommended Core Funding	US\$ 270.0	US\$ 280.0

¹ Totals may not add due to rounding.

Recommendations of 1998 Centre Core Funding

TAC's recommendations on 1998 centre core funding, at the aggregate System levels of US\$270 million and US\$280 million (expressed in 1992 dollars) are summarized in Table S2. The Table also lists the indicative envelope assigned to each centre in March 1992 and TAC's recommended 1994 core funding for each of the eighteen centres. Centre core funding levels for 1992 and 1993 are also presented for comparison purposes.

TAC's rationale and arguments for each of the recommended allocations are presented, centre by centre, in Chapter 4 of this report.

Recommendations for 1998 Core Funding of CGIAR Systemwide Programmes

In the review of centre MTP proposals, TAC identified a number of programmes that were put forward by more than one centre, mostly with cross reference to each other but not necessarily in an orderly or consistent way. In this respect, the Committee considered the need to promote collaboration not only among CGIAR centres, but also with national programmes and other relevant institutions.

Also, TAC noted that the medium-term resource allocation process was limited in its ability to deal adequately with concerns of System interest and transcending individual centre interests.

On that basis, the Committee identified eight ecoregional and four other Systemwide initiatives which it recommends for funding on a Systemwide programme basis within the 1994-98 medium-term period. TAC's recommended core funding for these programmes are also shown in Table S2. These resources would be intended to catalyse inter-centre collaboration in the planning and initiation of the specified global and ecoregional programmes. TAC selected the individual programmes listed in close reference to Chapter 13 of the Report on Priorities and Strategies, and to pertinent global and ecoregional research proposals contained in the centres' MTPs. TAC's rationale in selecting the eight ecoregional and four global programmes in question is outlined in Section 3.1.2.

Follow-Up

This report will be discussed at ICW'93 by the Group as the basis for decision-making on the implementation of the CGIAR priorities and strategies during the 1994-98 period, and on funding requirements during the same period of centres and Systemwide programmes. The latter would allow centres to finalize their medium-term plans and 1994 programmes of work and budget.

Table S 2: Recommended 1994 and 1998 Core Funding Requirements with Historical Comparisons
(in constant 1992 US\$ Millions)

A. CENTRES	1992		1993 Estimate (June 1993)		Base Envelope Assigned in March 1992	Recomm. 1994 Core Funding	Recommended 1998 Core Funding		
	Chap. 14 Estimate	Actual	in '92 \$	in '93 \$			At US\$ 270 m.	At US\$ 280 m.	
CIAT	26.5	26.9	24.4	25.4	27.5	25.0	27.5	28.3	
CIFOR	3.4	3.2	4.9	5.1	7.6	5.3	7.6	7.6	
CIMMYT	25.6	26.1	22.6	23.5	24.1	23.3	26.5	26.5	
CIP	15.2	15.3	14.3	15.0	14.3	14.3	14.3	14.3	
IPGRI									
	IBPGR	7.4	9.1	8.5	8.8	8.4	8.6	9.2	10.7
	INIBAP	2.2	1.8	1.7	1.8	2.1	1.7	1.8	1.8
	Sub-total	9.6	10.8	10.2	10.6	10.5	10.3	11.0	12.5
ICARDA	18.9	17.9	13.0	13.5	17.6	13.8	17.6	17.6	
ICLARM	4.0	4.5	4.2	4.4	4.8	4.4	4.8	4.8	
ICRAF	11.9	11.1	11.4	11.9	15.6	11.9	14.0	14.0	
ICRISAT	27.7	27.3	25.0	26.0	26.9	25.4	26.9	27.9	
IFPRI	8.3	8.3	7.8	8.1	8.6	8.1	9.5	9.5	
IIMI	7.3	6.4	6.0	6.2	7.6	6.3	7.6	7.6	
IITA	22.2	21.7	20.3	21.1	22.2	20.8	23.3	23.3	
Livestock Centre									
	ILCA	19.4	15.8	11.7	12.1	14.0	12.1	14.0	14.0
	ILRAD	12.6	12.6	9.7	10.1	9.1	9.9	11.1	11.1
	Sub-total	32.0	28.4	21.3	22.2	23.1	22.0	25.1	25.1
IRRI	28.3	28.6	24.6	25.6	25.8	25.5	29.4	29.4	
ISNAR	6.6	7.0	5.9	6.2	6.8	6.1	6.8	7.8	
WARDA	6.2	5.8	4.9	5.1	5.8	5.1	5.8	5.8	
TOTAL	253.8	249.2	220.8	229.8	248.8	227.7	257.8	262.1	
External Review Provision	1.2		0.9	0.9	1.2	1.2	1.2	1.2	
Allocatable Reserve					20.0				
Reserve for Fisheries							1.0	1.0	
CENTRES TOTAL	255.0	249.2	221.7	230.7	270.0	228.9	260.0	264.3	
B. CGIAR SYSTEMWIDE PROGRAMMES									
Ecoregional Programmes in:									
Sub-Saharan Africa:									
							0.50	0.70	
							0.50	0.65	
							0.25	0.75	
							1.25	2.10	
							0.40	0.53	
WANA									
							0.40	0.53	
							0.70	0.90	
							1.10	1.43	
							0.75	0.95	
LAC									
							0.50	1.00	
							4.00	6.00	
Sub-Total									
							1.00	2.00	
Genetic Resources Programme									
							4.00	4.75	
Livestock Programme									
							1.00	2.00	
Water Management Programme									
								1.00	
Fisheries Programme									
							10.00	15.75	
TOTAL CGIAR SYSTEMWIDE PROGRAMMES									
TOTAL SYSTEM									
	255.0	249.2	221.7	230.7	270.0	228.9	270.0	280.0	

