Consultative Group on International Agricultural Research – CGIAR

Agenda Item: 6
Document No.: MTM/95/10
Distribution: General
Date: April 12, 1995

Mid-Term Meeting 1995
Nairobi, Kenya
May 22–26, 1995

Renewal of the CGIAR: From Decisions to Actions

Report of the Task Force on Sustainable Agriculture

At ICW94, the CGIAR established two task forces to review the global context of CGIAR research in sustainable agriculture, and the ecoregional approach to research evolved by the CGIAR. The purpose of the Task Force on Sustainable Agriculture was to clarify concepts and priority themes and recommend what role the CGIAR centers should play in addressing issues relative to agricultural sustainability. The Report of the Task Force is attached.

The Task Force Chair, Rudy Rabbinge of the Netherlands, will introduce the report at MTM, when members will have an opportunity to comment on it, and to decide whether to endorse its conclusions and recommendations.

CGIAR Secretariat • Mailing Address: 1818 H Street, N.W., Washington, D.C. 20433, U.S.A. • Office Location: 701 18th Street, N.W.
Tel: (1-202) 473-8951 • Cable Address: INTBAFRAD • Fax: (1-202) 473-8110 • E-mail: CGIAR@cgnet.com or CGIAR@worldbank.org

Scientific Council for Government Policy
Wetenschappelijke Raad voor het Regeringsbeleid

Office: 2 Plein 1813
P.O. Box 20004
2500 EA The Hague
The Netherlands
Phone 070 - 3 564 600
Fax 070 - 3 564 685

Dr. Ismail Serageldin
Chairman
Consultative Group on International
Agricultural Research
1818 H Street, N.W.
Washington D.C. 20433
U.S.A.

Your letter	Reference	Date
	RR/lt	April 13, 1995
Subject		Direct phone
		.. 31 70 356 44 91

Dear Mr. Serageldin,

I am delighted to enclose herewith the report of the CGIAR Task Force on Sustainable Agriculture, which I had the pleasure of chairing. I hope you will find the report of value in furthering the dialogue at the Mid-Term Meeting in May on sustainability oriented research in the CGIAR.

The Task Force drew four key conclusions in the report, as outlined below. If endorsed by the Group, these conclusions would directly bear on the CGIAR's future research agenda.

First, there is no single remedy to problems of unsustainability. Solutions have to be designed for conditions in each eco-region. Many problem situations are being addressed, within and outside the CGIAR. However, a coordinated effort of research capacities at local, regional, national and international levels is required to effectively tackle these problems. To this venture the CGIAR centers should contribute their global, strategic perspective, and their experience and tradition of excellence in research.

Second, this will require a readjustment in the way CGIAR centers conduct research. It will necessitate a departure from the traditional working mode of the centers, that is away from a self-contained, campus style approach, toward one in which centers increasingly collaborate with others on a peer basis and operate "without walls", acting as sponsors and catalysts of research. The CGIAR has a unique comparative advantage to perform these functions, and the economies ultimately to be gained from focusing on such a collaborative approach will far outweigh the initial transaction costs of setting up consortia and other partnership arrangements.

Third, to achieve sustainable agricultural development, CGIAR centers must recognize the individual characteristics of varying ecoregions and tailor their research approaches to take such differences into account. In addition, areas not currently addressed, such as mixed smallholder farming systems, which are based on livestock, cash crops (particularly perennial

Scientific Council for Government Policy

tree crops), and vegetables for their economic sustainability, deserve attention.

Fourth, sufficient financial resources are required to meet the CGIAR's emphasis on sustainability oriented research to ensure its successful implementation. This may require a shift in the level of funding for individual center programs and activities.

The Task Force does not propose a revolution, but an acceleration of the CGIAR's evolution toward sustainability oriented research. We on the Task Force believe that ecological literacy at all levels, from policymakers to researchers to rural planners to farmers, is the best guarantee of ecological sustainability, social acceptance, and agricultural and economic productivity.

It was an honor to serve as Chairman of this important committee. I look forward to your comments on the report.

Sincerely,

Rudy Rabbinge

Rudy Rabbinge
Chairman
CGIAR Task Force on
Sustainable Agriculture

Enclosure

TASK FORCE REPORT ON SUSTAINABLE AGRICULTURE

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Task Force was asked to look at Sustainable Agriculture from four angles: as a concept relevant to CGIAR research; as issues to be addressed in international research; what others are doing and what CGIAR centers should do; and changes needed in their operating modes The terms-of-reference are reprinted on page 1 of the main report. The following summarizes the findings of the Task Force and gives its recommendations.

The Concept of Sustainable Agriculture

The prime goal of the CGIAR Mission is to provide food security to developing countries. This mission will not be achieved by changing agricultural production in ways that are not sustainable. The question of sustainability arises when resources used for production are placed under stress. This is now happening very widely, both in developing countries where increasing population pressure continues to strain production resources, and also in developed countries as a consequence of excessive fertilizer and pesticide application. An agricultural production system is not sustainable if it leads to declining productivity; if it degrades the resource base, particularly the soil and water resources; if it is not economically viable; and if it is not socially acceptable.

Sustainability Issues to Be Addressed in International Research

Some of the key problems which must be addressed by international agricultural research include:

- economic and policy measures to increase sustainable productivity, while preserving the resource base;
- the degradation of both marginal and high-productivity irrigated lands, each caused by different factors;
- the problems of sustained cultivation of steep and sloping lands;
- the problems of deforestation and loss of biodiversity;
- the threat posed by declining reserves and increasing competition for water resources.

To address these problems there is a need:

- for better information on the geographical distribution of declining productivity and natural resource degradation, on the gravity of these problems in different locations, and on methods for their alleviation;
- for integrated systems approaches to analyze sustainability issues and to design

solutions;

- for a stronger integrated program of soil, water and nutrient management research; and

- for an integrated pest, disease and weed management research program.

Sustainability Research of Others and the Role of the CGIAR

Research of most international and national agricultural research organizations includes aspects directly or indirectly related to sustainability. Many problems of land and water degradation are location-specific, and methods to minimize degradation have to be evaluated where the problems arise.

The Task Force noted the large number of initiatives which have been launched at national and regional levels, and globally by research groups and agencies in developing and developed countries. There are few research aspects that are not being currently addressed.

The role of the international centers in sustainability research arises because remedies for unsustainability will have to be derived primarily from strategic research. The international centers have a comparative advantage in the conduct of strategic research, and also in the conduct and management of research on a long-term basis, and in the development and management of international networks and consortia. Only by linking their strategic research capacity to the applied and adaptive research of the NARS and others will problems of location-specificity and the underlying causes of unsustainability receive adequate attention.

Changes in Center Operating Modes

It must also be recognized that the research agenda for sustainable agriculture represents an enormous task well beyond the financial and physical resources available to the CGIAR centers. The Task Force feels that the centers cannot and should not attempt to pursue these research goals with their own resources and within their own research establishment. These are new areas in which their prior experience in many instances is no greater than that of AROs and NARS. The Centers' strength lies in the role they can play as catalysts in bringing to bear a global strategic perspective; the experience of global and regional researchers; and a tradition of excellence in research organization and research output.

However, the present structure and funding arrangements for the CGIAR are not well adapted to research on sustainability issues. Present capacity in soil, water, and nutrient research, and in integrated pest management research is very limited compared with the magnitude and importance of the problem; research programs are fragmented and, with few exceptions, only weakly linked to the NARS, AROs and NGOs.

The present focus of sustainability research appears too narrow: Economic sustainability requires that attention be given to cash as well as food crops. These crops have generally not been included in the CGIAR research agenda, although vegetables, and annual and perennial (tree) cash crops are included in the farming systems of most farmers in

developing countries.

Identification of problems should start at the farm and local level. Much of the research of the CGIAR System has been scientist rather than demand driven. A new research agenda related to farmers' perceptions of sustainability as well as those of the scientist needs to be developed. It should be preceded by studies at the regional, national or supra-national level identifying constraints including socio-economic and biophysical ones.

Consequently, the Task Force feels, that there is a strong case for strengthening programs and increased funding to accelerate the implementation of CGIAR programs for sustainable agriculture research through collaboration with other agencies.

Recommendations

To enable the CGIAR System to include sustainability research as an important part of its activities the Task Force recommends:

(a) to advance and refine the eco-regional and system-wide initiatives as programs related to sustainability issues by adopting an interdisciplinary production-ecological approach which integrates productivity, environment and sustainability concerns, and to train staff to apply such systems-approaches in the programming and conduct of sustainability-related research;

(b) to consolidate the various on-going initiatives relating to soil, water and nutrient management conducted inside and outside the CGIAR into a coherent, integrated program to ensure a strategic foundation for sustainable agricultural development; such Soil, Water and Nutrient Management (SWNM) Research Program should build on the existing strengths of IIMI, IBSRAM, IFDC and TSBF, with linkages to other CGIAR centers, NARS, AROs and relevant UN organizations;

(c) to strengthen the system-wide program on integrated pest management and to include other AROs along with CGIAR Centers into an International Program and Consortium on Integrated Pest Management;

(d) to strengthen research, primarily but not exclusively conducted by IFPRI, on the socio-economic basis of sustainability, and re-examine how research on income generating crops such as vegetables and perennial tree crops can be effectively associated with the work of the CGIAR centers, so that economic sustainability of smallholder farms is enhanced;

(e) to strengthen other existing and proposed CGIAR activities related to sustainability, as described in the TAC "Review of Proposals for Systemwide and Ecoregional Initiatives" and the various proposals for a CGIAR response to UNCED's Agenda 21, including the development of a better information base to indicate where areas most at risk are located;

(f) to forge closer links with NARS, NGOs, AROs and others by establishing

consortia and strengthening present networking arrangements; CGIAR centers should pilot such initiatives as catalysts; circumstances should in each case determine whether formal convenership is best assumed by a CGIAR center, a non-CGIAR center, or several agencies jointly in a steering committee;

(g) to strengthen the capability of the CGIAR System in the management of broadly based research consortia;

(h) to strengthen research into the public policy aspects of resource management and planning (environmental, institutional and social aspects), as they affect the transfer to, and acceptance by, the farm population of research products from consortia and networks; and

(i) to earmark an increasing proportion of funding for sustainability related research and provide it in the form of incentives or seed money in order to encourage the formation and operation of consortia and networks.

The change to consortia-led sustainability research should be phased over a 3 to 5 year period.

INTRODUCTION

During the last 25 years the Consultative Group on International Agricultural Research has played a vital role in the improvement of agriculture in developing countries and made a major contribution to world food supply. The role of the CGIAR centers has evolved by stages to focus both on food production as well as conservation and sustainable management of soil, water and other natural resources.

At its mid-term meeting in New Delhi in May 1994, the CGIAR endorsed a response to the recommendations of UNCED focused on sustainable agriculture and eco-regionally oriented research. The ministerial meeting held in Lucerne in February 1995 affirmed this broadening of CGIAR goals.

At International Centers Week in October 1994, the CGIAR decided to establish two task forces to review the implications of the broadened mandate, as regards the substance and content of CGIAR research center programs, and the most effective way of organizing and managing natural resource related research in specific eco-regions. According to the Chairman's letter of invitation, one goal was to clarify and better understand the concepts and priority themes of sustainable agriculture and the concepts and mechanisms for an eco-regional approach to research. A second goal was to recommend the role the CGIAR research centers should play in addressing issues relative to agricultural sustainability, and in implementing an eco-regional approach to research.

The terms of reference of the Task Force on Sustainable Agriculture were:

(a) to further review and clarify sustainable agriculture as a concept of the CGIAR mission of providing food security in developing countries.

(b) to review the appropriateness of the issues and themes in sustainable agriculture which require further international research, taking into account factors such as population growth, poverty alleviation, available land and water resources, environmental and geographic conditions, policy concerns, conservation of nature, and management of natural resources.

(c) to comment on the agenda of research institutions active in sustainable agriculture and identify the role of the CGIAR within this portfolio of priorities in relation to other institutions.

(d) to review possible adjustments in the CGIAR structure and institutional arrangements and its interfaces with other research organizations.

The Task Force shared its report and recommendations with the Task Force on Eco-regional Research. It noted that, as both Task Forces cover related topics, some overlap in the deliberations of the task forces was inevitable.

CONCEPTS OF SUSTAINABLE AGRICULTURE

The concept that agricultural production must be sustainable has always been inherent

in good agricultural practice where farmers produce in an economic and socio-political environment conducive to long-term conservation and use, and do not want their source of survival and generation of income to disappear. The question of sustainability arises when the resources used for production are placed under stress. This is now happening widely in developing countries where increasing population pressure continues to strain production resources, and also in developed countries due to excessive irrigation, and fertilizer and pesticide application.

An agricultural production system is not sustainable if it leads to declining productivity; degrades the resource base, particularly the soil and water resources; is not economically viable nor socially acceptable. The CGIAR views research on "natural resource management" as a key to sustainability, such research being directed at understanding and preserving the resource base on which agriculture depends. Concern about the need for such research may be traced back to the CGIAR's beginnings, but from the mid 1980's onwards became a central theme of debate on the CGIAR's future role. A more detailed account of how its research focus changed over time is included in Annex I.

A benchmark in the political etymology of the word "sustainability" was established with its conspicuous use in "Our Common Future", the report of the World Commission on the Environment and Development in 1987. By then, the CGIAR had anchored sustainability as a formal goal in its mission statement. Sustainable agriculture was defined as the "successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources".

Sustainability in agricultural production was a central theme at the 1992 United Nations Conference on Environment and Development. In response to the UNCED "Agenda 21" document, particularly its chapter 14 devoted to agriculture, a CGIAR Working Group set up in 1993 recommended that the CGIAR agenda should be broadened to include soil and water related problems. That response included identification of eco-regions where CGIAR centers should increase activities (desert margins, areas of slash and burn, mountain areas, etc.) as well as key, crosscutting themes such as IPM. Details of the proposals made by the Working Group in 1993 and after are given in Annex II.

The CGIAR ministerial meeting of February 1995 urged the CGIAR to "concentrate ... on increasing productivity, protecting the environment, saving biodiversity, improving policies and contributing to strengthening agricultural research in developing countries"; and to "address more forcefully the international issues of water scarcity, soil and nutrient management, ...".

While the concept of sustainable agricultural production has gained currency and broad acceptance, the Task Force emphasizes three aspects that are not always recognized in the public debate.

(a) *Sustainable agriculture has to be interpreted according to socio-economic and environmental conditions.*

The agenda for sustainable agriculture development will vary from one eco-region to another and will be influenced by factors such as the level of socio-economic development,

share of population dependent on agriculture, and rates of change in productivity. For this purpose, production systems can be grouped into three general categories:

- High-resource cereal and root crop systems. These are located in the best soil and water resource areas, and produce the bulk of the world's food. Early CGIAR research focused squarely on these areas -- maintaining and increasing their long-term yield potential, developing methods to contain nutrients at high flow rates and reducing the need for high pesticide loading, an area still central to current CGIAR mandates;

- High productivity, vertically-integrated livestock, specialty crop and estate crop systems. These fall mostly within private sector influence and have had little CGIAR involvement. Their agenda for sustainability is somewhat different from that of intensive cereals.

- Highly diverse systems on fragile soils or in areas subject to moderate to severe growth-determining or growth-limiting factors (see Annex III). Such areas are coming under widespread and increasing population pressure, with issues of poverty, productivity, resource maintenance and social stability being dominant. The sustainability agenda in these areas is far more complex.

In terms of total degraded land area, depending on the classification used, as much as 95 percent of unsustainable agriculture today takes place on land falling into the last category while only 5 percent occurs on land that falls into the first two categories. This indicates the magnitude of the problem which - as explained in the next chapter -- is characterized by a spiral of unsustainability.

(b) *Research on sustainable agriculture should continue to focus on productivity and efficiency, within a framework of both short and long term environmental concerns that take into account inter- and intra-generational considerations.*

Research into improved productivity and efficiency must be based on insight and knowledge of basic processes (physical, chemical and physiological) that occur in living systems. More sharply focused up-front research is required to understand how agricultural systems can be manipulated for ecological, agricultural and economic aims, and how efficiency gains may differ according to the aim pursued.

(c) *Policies for future agricultural growth and food production must take into consideration poverty and equity concerns in all their ramifications.*

Their prior careful analysis must consider:

- social, economic and environmental trade-offs;
- effects on soil degradation and declining availability of water resources;
- long-term availability of essential chemical and other inputs;
- the dynamics of future changes in sources and cost of world energy supplies; and
- the possible impact of climate change on the agro-ecological potential of different regions.

The identification of appropriate policies for land tenure, market structure and infrastructure investment is most urgent in low resource areas where population pressures and poverty are increasing.

THE "SPIRAL OF UNSUSTAINABILITY"

With increasing world population, pressure on natural resources is mounting. Land degradation, including erosion, is proceeding rapidly. Surface water resources are increasingly preempted by urban use while supplies available to agriculture are diminishing, leading to loss in production, more poverty, and even heavier demands on remaining resources.

Visualizing this sequence as a downward spiral of diminishing resource availability, deteriorating environmental quality and disintegrating social and economic structures which, in turn, leads to even greater instability, emphasizes the cumulative impact of destructive factors. Figure 1 depicts this spiral, flags the factors driving it, and their interaction.

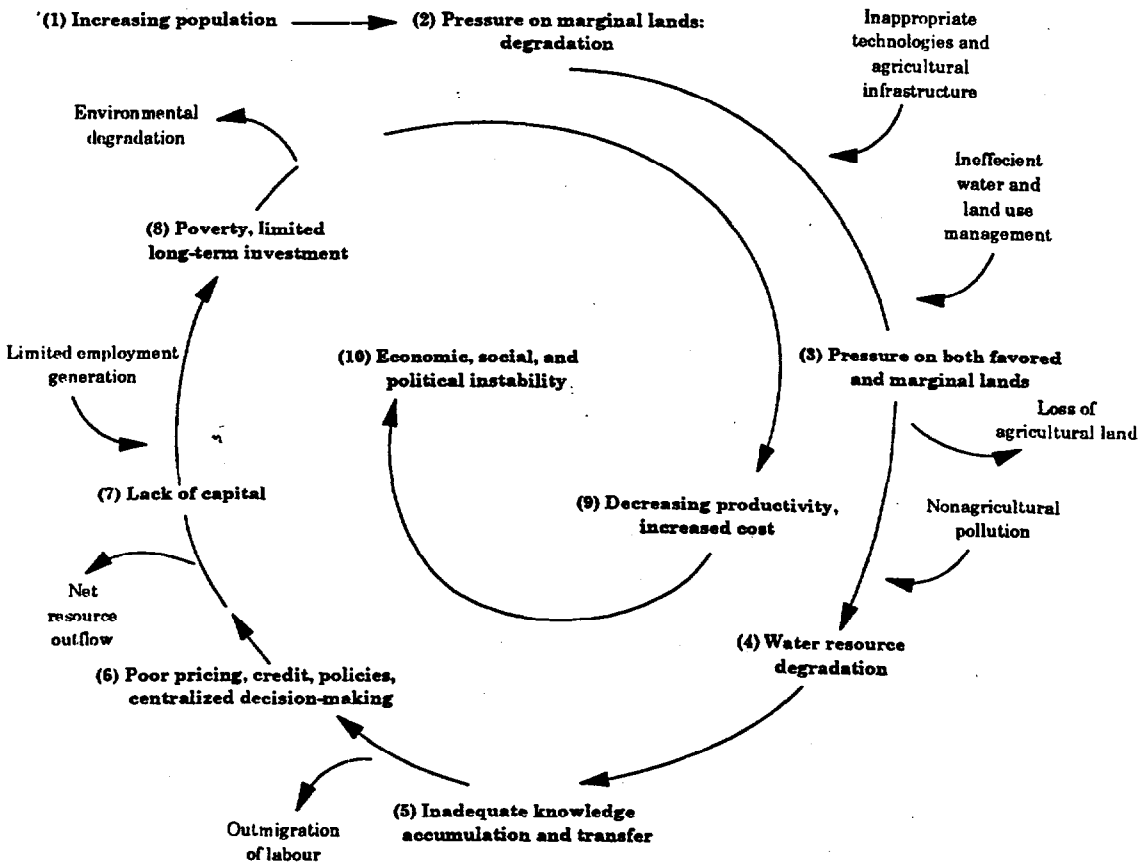

Figure 1 - The Spiral of Unsustainability

In the view of the Task Force, intervention at key points of this "Spiral of Unsustainability" can effectively break the forces driving the spiral and redirect momentum toward sustainability under conditions of more effective resource use, greater productivity and improved quality of life.

The Task Force also believes that in order to arrest these forces, certain principles must be followed when designing and programming research to reverse the unsustainability spiral. These principles are:

Principle One. Contributions of research organizations are valuable to the degree that they attack key problems in the spiral of unsustainability. Research can only succeed if other closely linked problems/processes are simultaneously addressed. For example, erosion control engineering must be linked to studies of cropping systems and economic incentives.

Principle Two. The systemic nature of the unsustainability spiral demands that scientists conducting the research be part of broad multi-disciplinary teams. A prerequisite for correcting symptoms of unsustainability (such as declining fertility of marginal lands, increased salinity of irrigated lands or decreasing biodiversity of forest ecosystems) must be a deeper, more sophisticated analysis involving all relevant sciences.

Principle Three. An appropriate research scale is at the watershed level. Although research at the plot, field, cropping system or regional level is legitimate and will provide necessary inputs into the research agenda, such inputs must be related to all factors driving the spiral of unsustainability and operating on a larger scale.

Principle Four. Some processes in the unsustainability spiral are beyond the direct influence of agricultural research scientists (e.g. urban sprawl, global commodity trade, national land policies). Nevertheless, there is a continual obligation to raise awareness among donors, policy makers and government officials that technical problems cannot be solved in isolation. Policy research has a special role to play in sensitizing national policy leaders to the options and likely benefits of policy reforms, closely associated with socio-economic and biophysical research on production systems.

Principle Five. Politically acceptable mechanisms must be devised for tapping into local traditional knowledge resident with both genders, and for imparting to local communities scientific knowledge that may involve the introduction of technologies, policy adjustments or institutional reforms developed elsewhere.

Principle Six. Research on sustainable agriculture must be conducted as efficiently as possible. Hence researchers should not work in isolation, but need to benefit from common work plans which reach across well selected global sites where long-term experiments are being conducted. This principle implies development of a global network of researchers, organizations and projects in which all understand how their efforts fit into a global plan to stop the downward slide and reverse the spiral of unsustainability.

Principle Seven. Research on sustainability issues necessarily involves a longer term perspective than conventional agricultural research. Hence, it must focus on specific points on the unsustainability spiral, with built-in provision for objective external review of progress and endorsement of future carefully targeted research plans.

Principle Eight. Any proposals for changes leading to sustainability, and reversing the spiral of unsustainability must have ownership at the local, national, regional and international level. International input into the research phase of the process must be structured so as to enhance and support such local and national identification.

RESEARCH FOR SUSTAINABLE AGRICULTURE

Any land-use system is unsustainable if it leads to irreversible biophysical changes in the ability of the land to produce equally well in a future cycle of similar land-use, or if the costs of preventing and reversing the degradative changes are not economically affordable and socially acceptable.

Complexity of the Task

Reversing the unsustainability spiral requires an integrated research strategy involving new methods and institutional arrangements significantly different form earlier production approaches. Natural resources are no longer perceived by the scientific or policy communities as merely the medium to produce more food through high yields of plants and animals, but rather in terms of local and global ecosystem functioning. In addition to production output, ecosystem maintenance, biodiversity, water recharge, clean air and bequeath value are important topics in the research effort.

Compared to crop management, natural resource management is more complicated technically and managerially for both farmers and scientists. Natural resource science involves relationships which are highly interactive. One land user can impact the health and production of many others. This complexity of natural resource systems raises the issue of linkages within sociopolitical hierarchies and scales of intervention. Sustainability raises new issues such as time and spatial dimensions, social hierarchies, and societal vs. individual benefits, and therefore requires new approaches to solving problems. Although lessons can be learnt from farming systems research, its goals and earlier approaches differ from those of natural resource management research (see Table 1).

Table 1: Comparison of Approaches to Traditional Cropping Systems, Farming Systems, and Natural Resources Management Research

Parameter	Traditional Cropping Systems Research	Farming Systems Research	Natural Resources Management Research
Temporal	Annual Cycle	1-3 year cycle	5-25 years
Spatial	Field-plot	Field-village	Watershed-region
Beneficiary	Farmer	Family	Multiple
Technology	Component	From production system	Natural resource system
Target	Self-sufficiency	Profits	Monetary/non-monetary inter-generational equity
Role of farmer	Recipient of technology	Provider of information	Participatory
Policy	Input/prices	Marketing	Multiple
Environment concern	Minimal, on-site	Marginal, on-site	Maximum, on- and off-site

(From IBSRAM Position Paper No. 1)

A "Production-Ecological" Approach

The Task Force recognizes the importance of several continuing activities of the CGIAR centers which make an important contribution to research on sustainable agriculture (Annex IV). Research on methods to increase productivity in relation to sustainability, and other CGIAR activities such as maintenance of genetic resources in relation to biodiversity, on agricultural and water policies and integrated pest management, have been identified as global priority themes.

While the Task Force agrees with these priorities and the on-going research programs, it has some concern that the need for new approaches to sustainability research may not have been given full attention. Creating sustainable agricultural and natural resource management systems from unsustainable ones can only be achieved by *finding solutions to whole-system deficiencies as well as to component problems.* It is futile to attack technical problems - as has been common in the past - without at the same time addressing the overall pattern of degradation caused by socio-economic pressures. Human behavior driven by poverty,

population dynamics, and inappropriate economic and land policies is the underlying cause of land and water degradation. The CGIAR agenda for research on sustainable agriculture must include social, economic, and policy issues as well as studies of biophysical processes.

Sustainability research must aim at all levels, including farmer's fields, cropping systems, farming systems, and regional and supra-regional levels. At higher levels, choices of land use become important as they imply trade-offs among socio-economic, environmental, and bio-technical benefits. Integration of natural resource management in land use studies requires systems approaches.

Such systems approach, or as the Task Force proposes to term it, a "production-ecological approach", from the outset will recognize and build into a research program environmental factors that bear on production. These factors can be grouped into three categories: growth and yield defining factors such as radiation, climate and crop properties; growth and yield limiting factors such as nutrient and water availability; and growth and yield reducing factors such as pests and diseases. Assessing interactions among these factors may lead to better insights and understanding of how agro-ecosystems function and how their continuity in time and space can be assured. In this approach (which is further elaborated in Annex III) productivity increase and sustainability are not conflicting, but complementary goals, with one being a condition for the other to materialize.

In this context, the Task Force noted also the discussion on food production and security in IFPRI's "Visions 2020" and a recent study by the Netherlands Scientific Council on Government Policies entitled "Living with Risks: An Enduring Phenomenon", and their projections for increases in demand for cereals, regional food security and the need for higher levels of rural employment. These studies also flag the need for more studies on how to guarantee food production and food security for a growing world population. The latter study shows how the right combination of land use options and production technologies can stimulate productivity while minimizing deleterious environmental side effects.

Research to address such issues requires input from biophysical and various socio-economic disciplines, and can only be achieved through consortia that utilize the proposed systems approaches. The CGIAR centers should participate in consortia which are problem oriented and can effectively combine research and implementation activities of NARS with strategic research of IARCs, while using the expertise of advanced research organizations. Particularly eco-regional consortia, but also global consortia such as the one on IPM and ICASA, should be strengthened. Such participatory approach to research will create synergies and lead to efficiency gains.

This will have consequences for the CGIAR research agenda which are discussed below.

Need for Better Information

As recommended in the CGIAR response to Agenda 21, information related to sustainability, and in particular to the identification of those factors active at or close to the bottom of the spiral of unsustainability, is critical for sustainability research. Considerable information is available outside the CGIAR System, and can be readily tapped. In this context

the Task Force welcomes the proposals for linking the UNEP's work on land and water resources, especially its GRID/Arendal project, to the activities of the CGIAR centers in their targeting of areas for sustainability research programs.

Information on remote sensing and GIS based analysis should be used to identify areas under greatest pressure and risk of increased population migration; key biodiversity resources that merit special protection; alternative cropping and animal husbandry systems; and relevant ongoing research outside the CGIAR System of key macroeconomic policies and political factors likely to constrain implementation. A thorough desk review of existing literature, past research efforts and proposals for solutions to reverse land degradation and improve human welfare should precede design of a research plan, and identification of special research tasks and initiatives.

Analyses should be carried out at the micro, meso and macro level, but with clear emphasis on the meso scale, taking into account the specific circumstances, conditions and potential of a particular eco-region. Studies of land use, food production, and nature conservation at various levels of integration, time and spatial scales are needed.

Given the considerable past research on the problems of marginal lands, it should be possible for these overviews to be conducted using the existing knowledge in agencies such as FAO, UNEP, the Development Banks, various specialized policy research institutes (such as WRI, IIED) and universities. Such overviews should lead to selection of CGIAR benchmark sites located in areas of greatest degradation or under imminent threat of further encroachment, and the formulation of hypotheses that are to be tested. These benchmark sites should be strategically located within targeted eco-regions.

Need for a Long-Term Perspective

Sustainability research requires time frames well beyond annual cropping cycles. In this context, three issues arise:

- the need to learn from the past;
- perceptions of impacts of current practices (good and bad) on the future; and
- inter-generational issues.

Degradation of natural resources occurs gradually; each generation only glimpses part of the process. Payoffs may not occur during the lifetime of the community or farm household which implements a practice but accrue to future generations. Conversely, people adapt to negative change which in turn accelerates further degradation, while disaster becomes discernible only to the later generation.

One problem which is still not given sufficient recognition is the effect of tenancy arrangements which provide no security of tenure and result in suboptimal use and management of natural resources. Tenants are often unwilling to incur short-term costs for the sake of benefits which will occur after the tenancy ends. Security is necessary for all land tenure systems from communal to freehold. Traditional land tenure systems often blend

elements of communal and freehold rights, and greater understanding of legal and administrative mechanisms governing these tenure systems is necessary if reforms are to secure land rights and lead to more sustainable use of natural resource by individuals, households and communities.

To assess the relative significance of facts related to sustainability, it is also essential to conduct a series of long-term agronomic experiments in different agro-ecological zones, some of them to be conducted on a catchment basis. Only in this way can organic-matter dynamics, water use and nutrient flow associated with changes in soil management be studied experimentally. However, catchment experiments are large and costly. The value of a few experiments supported by relatively simple long-term plot experiments and simulation modelling can provide a good basis for determining productivity increases and biophysical effects of land-use changes. These experiments can also provide important international reference sites for studies of organic-matter dynamics and the release and assimilation of greenhouse gases. Possibly, and most importantly, they can provide a reference point against which change can be assessed. The ICASA Consortium has taken a leadership role in this regard, and its progress should be followed closely.

Modelling can be a powerful tool in association with agricultural research, both to project probable consequences of alternative options, and to identify sensitive components in a system subjected to treatment. Models important for soil resource management include an estimate of the sustainable human carrying capacity of a target zone as a function of different levels of inputs. Econometric models, models predicting the long-term impacts of global climate change on the resource base and resource performance, and models evaluating irrigation practices all have valuable contributions to make - not only to understanding the complex processes involved, but also to research efficiency and cost-effectiveness. However, without an experimental base for validating their conclusions their value is limited and their results may be misleading.

Relating Location-Specific and Generic Problems

The problems of agricultural sustainability differ considerably in significance and extent in different parts of the globe. To assess their relative significance, it is necessary to have some means of categorizing them in relation to major land and land-use characteristics. There is, of course, much spatial variation. One of the great difficulties in agricultural development and in the application of research related to sustainable agriculture is its location-specificity. Land management methods show considerable variation from site to site. Management has to respond to climatic differences, soil differences, land differences, and the human factors related to land use.

The CGIAR Centers cannot deal with the extent of this variation, but the national agricultural research services have no choice but to endeavor to deal with it, in conjunction with farmers organizations, NGO's, and others. What the Task Force sees to be needed is a strengthening of the network approach to these problems, in which NARS, the CGIAR Centers, and others are linked in the common endeavor to reverse the spiral of unsustainability. We recognize the need to share indigenous knowledge between farmers, extension organizations, and researchers, and believe the way ahead is to build and strengthen consortia in which all those with relevant interest and expertise are included (Figure 2).

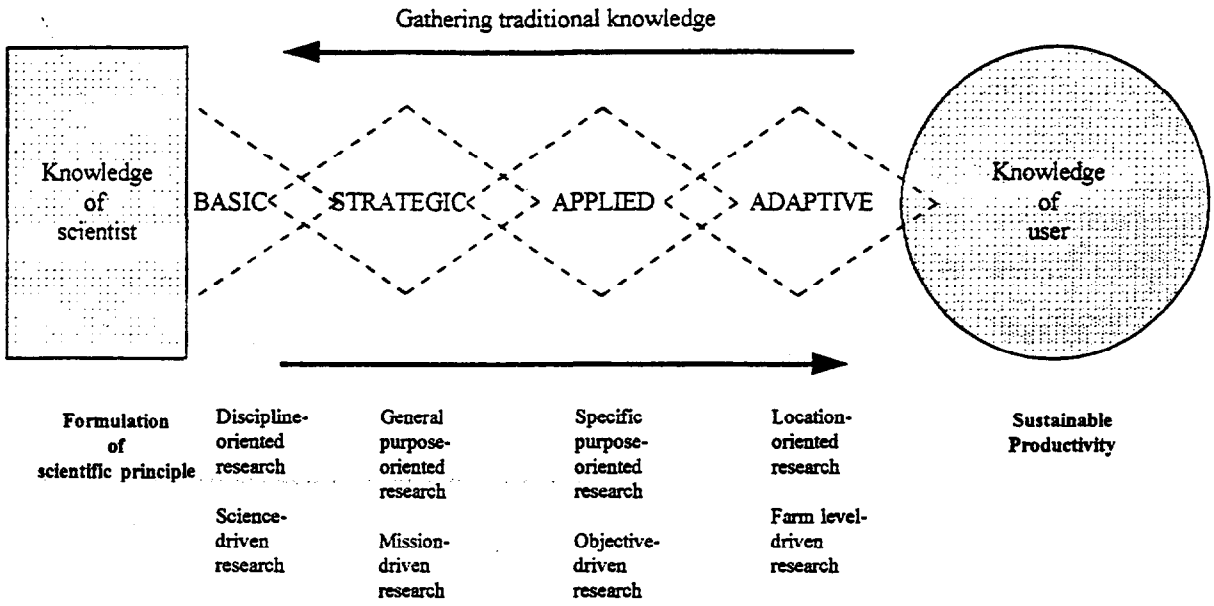

Figure 2 - An Iterative and Collaborative Process for Building and Exchanging Knowledge to Break the Spiral of Unsustainability

POSSIBLE GAPS IN THE CGIAR APPROACH TO SUSTAINABILITY RESEARCH

As part of its terms-of-reference, the Task Force reviewed the programs in the CGIAR research agenda relating to sustainable agriculture listed in Annex IV for possible gaps.

Several of these areas where land use practices are leading to unsustainable changes were earlier identified in three reports of CGIAR Working Groups and Task Forces in response to the recommendations of the UNCED Agenda 21, namely the desert margins, the lands deforested by slash-and-burn agriculture, mountain areas and other areas of steep and sloping lands, and irrigated lands where salinity and waterlogging have become a problem. The Task Force reviewed these initiatives (see Annex II) and agrees with the high priority recommended for them.

Taking into account on-going and proposed programs on sustainable agriculture of both private and public sector research institutions around the world, the Task Force concluded that most currently identified issues of sustainability are being addressed, at least to some extent, though the response to many of them remains inadequate. The CGIAR should not engage in research on issues already addressed by others, but rather follow closely their progress and use their findings in its own work. It may also have to adjust the ways in which it organizes its research, and collaborates with others. These aspects will be discussed in the next chapter.

The Task Force believes that the CGIAR should enhance its current work on sustainability in two areas, namely soil, water and nutrient management (SWNM), and integrated pest management (IPM). It should also strengthen research, now primarily but not exclusively conducted by IFPRI, on the socio-economic basis of sustainability, and re-examine

how research on income generating crops such as vegetables and perennial tree crops can be effectively associated with the work of the CGIAR centers so that economic sustainability of smallholder farms is enhanced.

(a) Soil, Water and Nutrient Management Research

The Task Force reviewed the recent recommendations for strengthening a factor based approach to soil, water and nutrient management related research. It strongly endorses the need for a well structured and focused approach to these tasks and regards these areas of research as of fundamental importance to not only traditional crop commodity research but as of particular relevance to the four marginal and degraded land topics that were identified as part of the CG's response to Agenda 21.

As one possible option for overcoming these problems the Task Force reviewed the potential SWNM strategic research agenda that emerges from IBSRAM's 1994 SWNM report and the Zschortau plan. These reports outline a comprehensive long-term strategic agenda that merits serious consideration by the CGIAR as the central theme of all of its SWNM related research. However, the absence of a convener or coordinating mechanism for the Zschortau initiative raises concerns about possible duplication and insufficient priority setting and focus. The Task Force sees a need to encourage interaction through seed money that should be placed in the hands of a coordinating mechanism.

(b) Integrated Pest Management

Insect and fungal related pest and disease problems, weeds and mammalian pests are a major cause of crop losses and reduced animal health. Insect borne diseases have serious implications for both human welfare and agricultural productivity. The insect resistance components of plant breeding programs will remain a major research priority for maintaining crop productivity and for underpinning IPM programs, but must not be the exclusive focus of this initiative. Plant diseases and weed control programs should be integrated in research activities from the start. Appropriate methodologies should be developed and implemented in close collaboration between researchers and end-users.

It is not clear whether existing research institutions adequately cover the problems of sustainability posed by diseases, pests and weeds, and the chemicals used to control them. The need for an International Crop Protection or Conservation Program and/or Consortium focused on sustainable agriculture, and integrating management and know-how, bears further review.

(c) Development Policy for At-Risk Agricultural Areas

The complex social, political and economic factors that interact in the spiral of unsustainability in the most at-risk eco-regions require an understanding which today is not available. Effective intervention in these increasingly troublesome downward spirals will require sophisticated policy advice and design that dwarfs the more straightforward production focus of policy for high resource areas. There is ample scope for scientific resource input into policy from the CGIAR, much of which should be coordinated by IFPRI, working with and through national institutions, and closely linked to production and resources development.

(d) Economically Viable Smallholder Units

The role that vegetables and high value horticultural crops can play, particularly in high density, low income areas, in stimulating intensive land use based on multiple cropping patterns and recycling of organic residues, is being increasingly recognized inside and outside the CGIAR. This type of agriculture helps to alleviate rural poverty and contributes effectively to economic sustainability of agriculture. The potential of vegetable and horticultural research to contribute to increased productivity, improved food security, rural income generation and sustainable land use is thus considerable.

The Task Force feels that the relevance of vegetable research to economic sustainability has not been given adequate attention in the earlier analyses carried out by TAC in the course of the debate about the possible entry of AVRDC into the CGIAR System. Further examination of how best to associate the work of AVRDC with that of the CGIAR Centers is needed.

(e) Perennial Tree Crops

Perennial tree crops have the potential not only to enhance rural incomes but also, and importantly, to provide one of the few well proven sustainable and ecologically acceptable agricultural cropping possibilities for the humid wet tropical forests. In many parts of Africa, Asia and Latin America, this agriculture is one of the few means available to help keep small farmer in their units and avoiding migration to the cities, thus reducing the threat of increased urban poverty.

Whilst the CGIAR itself may not need to engage directly in such research because of the wide range of private and public sector research institutions already working in this field, it needs to follow on-going research on long range marketing prospects for crops such as oil palm, rubber, cocoa, tea, coconut and coffee and the possibilities for their wider inclusion in the farming systems of smallholders. The case for CGIAR support to preservation and enhancement of coconut germplasm has already been made. The role of IPGRI in maintenance of germplasm of other perennial tree crops such as cocoa may need to be enhanced.

STRENGTHENING THE CGIAR'S ABILITY TO ADDRESS SUSTAINABILITY ISSUES

While there is limited need for adjusting the direction of CGIAR research in order to address sustainability issues, a major change is required in research approaches and the way such research is organized. From the preceding discussion it has become clear that sustainability research requires comprehensive and extensive explorative studies to provide its strategic foundation. It will also require an effective decision support infrastructure. It must integrate knowledge of basic biophysical processes, quantify the functioning of agro-ecosystems and their responses to various environments, and design options to manipulate agro-ecosystems.

These tasks cannot be discharged by the CGIAR centers without substantial support from, and in collaboration with, research organizations in developing and developed countries. The role of NARS in this cooperation will be critical and must be reinforced. Also the

arrangements for the implementation of the SWNM initiative need strengthening.

The Role of NARS in Sustainability Research

The Task Force strongly endorsed the many earlier TAC and other reports that have stressed the important linkages between NARS, IARC and advanced research groups. It is convinced that the partnership with NARS needs to be a two-way process, and that the IARCs involved in ecoregional research will need to maintain a continuous and long-term relationship with NARS. For ecoregional research the "center without walls" type of institution will be more suited than the traditional large campus crop commodity research infrastructure.

These partnerships will likely require intensive collaboration in the early years of investigating ecoregional problems. Because many NARS lack the range of multi-disciplinary expertise required to implement integrated research programs, the IARCs will frequently be dealing with a range of disciplines specific to NARS (agronomic, hydrology, soils, forests, livestock, etc). In some cases this collaboration would have to extend beyond these specific technical aspects and deal directly with the support for institutional building. This is probably the case of many NARS which need to adapt their programs, and their organization and structure to conduct effectively their corresponding national part of the sustainable agriculture research agenda. The implication of this is the need for effective mechanisms for establishing complex collaborative consortia.

Once these networks have been put in place, adequate staff training carried out and research tasks for the various partners in the program clearly defined, it can be anticipated that over time the IARCs' role will evolve. The early focus will be on developing methodologies on how most effectively to implement ecoregional research and development of technologies and policies that will contribute to sustainable agriculture. Increasingly, as the NARS assume responsibility for these programs and take up the adaptive research for testing solutions in various sites, the IARCs role will revert to that of providing a focal point for correlation and dissemination of research findings. That role is of vital importance but considerably different to the role most IARCs have played previously. Collaboration, initiation, quality control are the key words, based on good relationships. These relationships are already well covered in earlier TAC and other reports on this topic, and the Task Force indicates its endorsement of these findings.

The Task Force also sees the need to visualize the NARS as an array of several entities which can play significant complementary roles in sustainability research, including universities, private sector laboratories and farmer organizations.

Finally, the fact that part of sustainability research is location-specific makes the process of defining the research agenda a demand-driven one. Therefore, optimal arrangements to establish effective participatory and broadly representative steering committees for each ecoregional activity become an important strategic issue. Given that some of the key actions required to address policy and institutional reforms needed to ensure sustainable agriculture will be politically sensitive (land tenure, pricing and other policies) it appears necessary to ensure that high level government policy leaders should be involved from the outset in such steering committees together with representation of locally involved communities and farmer organizations. Regional research institutions and universities should

also be considered as participants and/or conveners.

The Case of the Soil, Water and Nutrient Management Program

In order to implement this program effectively, the Task Force emphasizes the need to assign within the System responsibility for long range integrated research relating to both soil and water conservation and management. It believes that a consortium headed by a convener with functional responsibility for the coordination is needed.

In reaching this conclusion, the Task Force was aware of the earlier recommendation by the CGIAR not to incorporate IBSRAM into the CGIAR System. Three factors have since changed which today justify a close association of IBSRAM with the System:

(a) the emergence of a well articulated SWNM long range strategic research agenda of relevance not only to the CGIAR's eco-regional research activities but also to its continuing research on increasing commodity crop productivity;

(b) the increasing focus of CGIAR eco-regional research on marginal and degraded lands all of which require a major and sustained SWNM research input. This research would benefit from a strong concentrated core of SWNM scientific expertise; the eco-regional centers could interact with it, and regional cross-cutting SWNM research results could be assessed by it on the basis of commonly developed research trials and impact indicators; and

(c) IIMI's Board has recently recommended that IIMI become more involved with long range global strategic water use issues which, in turn, will allow it to intervene at macro and meso regional levels and take into account the potential of various production technologies to reach high productivity and stability.

The Task Force shares the concerns expressed by IIMI's Board and TAC that the past research agenda of IIMI has been too narrowly focused on regional water micro-management issues in South Asia and endorses the views expressed by the Board that IIMI should develop a globally focused long range strategic research agenda that addresses issues such as global water availability, the future global potential of irrigated agriculture as well as technologies and policies for tackling water pollution and salinity.

Expertise Required for Sustainability Research

While it has not obtained a breakdown of the range of expertise available at each center, the Task Force's preliminary and admittedly superficial impression is that, because of the rapidity with which the transition to a broader focus on natural resource related research is taking place, there are substantial gaps in the capability of some centers to develop a comprehensive and truly multi-disciplinary range of scientific expertise.

The demands posed by many of the complex problems of sustainability require the purposeful merger of local knowledge, farmer preferences and excellence of science in widely diverse fields. Market demand for sustainable solutions as well as the need for minimal duplication of scientific effort is thus resulting in more collaborative approaches. Research

processes to generate sustainable solutions are increasingly guided by "steering committees" comprised of stakeholders. The complex array of science, of policy and of knowledge systems require a consortium approach, both among scientists and institutions. In all of this a balance is required between single factor, narrowly focused science, and multifaceted, integrative application to complex real-world problems. Landscape-level, eco-regional problem solving is but one example.

This Task Force sees the move toward consortium effort as inevitable. The international centers as well as their national partner institutions are constrained by the high transaction cost of these required approaches. It is evident that efficiencies are needed in the consortium "process". Scientists are not always highly skilled in management methods, nor can they afford the time to facilitate organizational processes. The international centers could well serve themselves and their partners by leading the way in improving the modalities of interaction for collaborative processes. They could sponsor training of skilled process facilitators who would manage networks of interaction with a combination of cultural sensitivity and efficiency, while at the same time improving the quality of interaction among scientists and other stakeholders. It is suggested that building process facilitation capacity be of high priority, to be implemented across the CGIAR System.

One key point emphasized by Task Force members is the importance of communicating to donors the diffuse nature of outputs from natural resource related research and the need for realistic expectations about the time frame required to have a meaningful impact.

Policy Issues and Socio-Economic Studies

Policy analysis and research is a prerequisite for developing a conducive environment for sustainable solutions to agricultural development. Policy formulation, however, has to be based on thorough analysis of social and economic circumstances of intended beneficiaries. Research on policy and socio-economics can be grouped into four main themes:

- resource management and planning;
- environment policy issues related to agriculture;
- institutional issues; and
- agricultural policy

Resource management and planning analysis must focus on economic and social issues related to conservation and management of land, water, forests, fisheries and wildlife. Environmental policy is important as it relates to agricultural development. Research and analysis on institutional issues is an area generally neglected. The role of national and international R&D organizations in the technical change process is not well understood. Such knowledge is needed to enhance capacity for institutional innovation. Similarly, knowledge is essential on farmer and community based institutions, given the need for a demand-driven process, and farmer empowerment necessary for solutions. In agricultural policy several issues impact on natural resource use and the environment. This should include the analysis of the effects of regional and international trade as well as marketing and rural infrastructure

on sustainability.

Governance and Leadership

The Task Force sees various modalities for governance and leadership of consortia that aim at sustainability research:

CGIAR center as convening institute: In this model, a CGIAR center takes responsibility for convening the consortium, managing the agreed research program, discharging administrative functions and putting in place appropriate evaluation procedures. The center organizes and chairs a steering committee that supervises research activities. That steering committee comprises specialists from various CGIAR Centers, NARS and advanced research organizations or universities. This model is currently applied in the ICRAF managed "Alternatives to Slash and Burn Project" (ASB). Among other things, the steering committee, in this case, is in charge of allocating funds. The model is based on a "center without walls" philosophy, with the result that probably less than 50% of consortium activities are within the convening institute. For soil, water and nutrient management this model could be emulated in the event that the mandate of IIMI is broadened as outlined elsewhere in this report, and merged with that of IBSRAM. The Task Force believes that for this case the ASB model ought to be modified to ensure that NARS have a sufficient role in the management of the Consortium.

Convener from outside the CGIAR System: This model would combine research, development and implementation activities in the hands of a consortium to be headed by a center or institute from outside the CGIAR System as convener, and may be particularly suitable in a field such as integrated pest, disease and weed management where no CGIAR center has an established track record. The recent initiative to set up a system-wide IPM group is the obvious example. In addition to CGIAR centers, such a consortium should involve FAO, AROs and NARS. The convener would coordinate planning and implementation in close interaction with participating institutes. The model may be successfully applied when an outward oriented and outward looking strategy is followed.

Eco-regional steering committee as convener: In some eco-regional research activities, a consortium could be led by a steering committee made up of NARS and/or specialized regional research institutes. A NARS would head a steering committee; a CGIAR center may be associated with it in a sponsoring role and be responsible for administrative and accounting matters, and possibly supply any lacking scientific expertise not available from NARS and AROs.

Financial Implications

Recognizing the merit of the various eco-regional and system-wide proposals submitted by the Centers and currently under consideration by TAC, the Task Force believes that System-wide Programs related to Soil, Water and Nutrient Management, including the development of several Consortia, should be funded as soon as satisfactory proposals are submitted. As an example, the initiatives related to management of steep and sloping lands

in the Andean region of Latin America, the eco-regional program for the East African Highlands submitted by ICRAF and the proposal for a Consortium on the Management of Steep and Sloping Lands in Southeast Asia submitted by IBSRAM (see Annex IV), should be considered as a System-wide Program and given high priority for funding. IRRI's eco-regional initiative on rainfed lowland rice production needs increased support.

Similarly, the system-wide program on Integrated Pest Management should be given high priority, once a proposal is submitted that makes clear how the proposed activities will be shared with the NARS and other AROs, and a management structure is established which ensures participation of non-CGIAR bodies in decision-making and funding arrangements for the operation of the program.

The need to develop research programs on economic sustainability should receive high priority, but may best be developed within existing proposals for eco-regional programs.

The Task Force considers current funding for sustainability programs as too low. To launch these initiatives successfully, substantially more than proposed by TAC is required. The Task Force has not been able to review funding requirements of the various programs currently under discussion. It therefore provides the following numbers only as an indication of the order of magnitude of required support, which should be provided through seed money and incentives such as matching offers.

The following numbers indicate the full funding requirements of individual participating CGIAR centers as well as the cost of common (collaborative) activities:

1996	SWNM Program	$20 m
	IPM Program	$20 m
	Other eco-regional and system-wide activities	$30 m
	Total 1996	$70 m
from 1997	Proportion of funds for directly sustainability related activities to gradually increase to around 30% of total CGIAR funding.	

The Task Force is aware that this will require a considerable shift in funding among centers and programs.

CONCLUSIONS AND RECOMMENDATIONS

During the 1950s and 60s the specter of global and regional food insufficiency was the single overriding concern. The International Centers then focused on increasing the genetic yield potential and extending production systems to the high soil and water resource areas where development investment had the highest and most immediate return. A parallel effort was undertaken by the international community to build NARS.

Today, thanks largely to that effort, global food security appears reasonable for the next decade, but the yield-enhancing technologies at the upper limits which will be needed into the following decades are not available and clearly need continued research. We have only bought time.

Of most immediate concern for at least the next decade is the spiral of unsustainability in major eco-regions. That spiral threatens the material resource base, the immediate well-being and survival of a large portion of earth's population, and the stability of many governments. It is no less serious than was the specter of hunger in the 1960s.

This task force recommends not only the maintenance of a viable long-term research thrust to raise production potential of the main food crops but also the redirecting of a significant portion of CGIAR resources to areas of major degradation.

With such appropriate strategic reallocation the goal would be to stabilize the most widespread at-risk areas within the next decade, and before the need arises for the next massive global effort to increase total production.

To enable the CGIAR System to include sustainability research as an important part of its activities the Task Force recommends:

(a) to advance and refine the eco-regional and system-wide initiatives as programs related to sustainability issues by adopting an interdisciplinary production-ecological approach which integrates productivity, environment and sustainability concerns, and to train staff to apply such systems-approaches in the programming and conduct of sustainability-related research;

(b) to consolidate the various on-going initiatives relating to soil, water and nutrient management conducted inside and outside the CGIAR into a coherent, integrated program to ensure a strategic foundation for sustainable agricultural development; such Soil, Water and Nutrient Management (SWNM) Research Program should build on the existing strengths of IIMI, IBSRAM, IFDC and TSBF, with linkages to other CGIAR centers, NARS, AROs and relevant UN organizations;

(c) to strengthen the system-wide program on integrated pest management and to include other AROs along with CGIAR Centers into an International Program and Consortium on Integrated Pest Management;

(d) to strengthen research, primarily but not exclusively conducted by IFPRI, on the socio-economic basis of sustainability, and re-examine how research on income generating crops such as vegetables and perennial tree crops can be effectively associated with the work of the CGIAR centers, so that economic sustainability of smallholder farms is enhanced;

(e) to strengthen other existing and proposed CGIAR activities related to sustainability, as described in the TAC "Review of Proposals for Systemwide and Ecoregional Initiatives" and the various proposals for a CGIAR response to

UNCED's Agenda 21, including the development of a better information base to indicate where areas most at risk are located;

(f) to forge closer links with NARS, NGOs, AROs and others by establishing consortia and strengthening present networking arrangements; CGIAR centers should pilot such initiatives as catalysts; circumstances should in each case determine whether formal convenership is best assumed by a CGIAR center, a non-CGIAR center, or several agencies jointly in a steering committee;

(g) to strengthen the capability of the CGIAR System in the management of broadly based research consortia;

(h) to strengthen research into the public policy aspects of resource management and planning (environmental, institutional and social aspects), as they affect the transfer to, and acceptance by, the farm population of research products from consortia and networks; and

(i) to earmark an increasing proportion of funding for sustainability related research and provide it in the form of incentives or seed money in order to encourage the formation and operation of consortia and networks.

The change to consortia-led sustainability research should be phased over a 3 to 5 year period.

ANNEX I

EVOLUTION OF CGIAR RESEARCH IN RESPONSE TO CHANGING DEMAND

During its short history, the Consultative Group on International Agricultural Research saw various periods of changing research focus:

Crop improvement through better use of genetic material

In this phase the need for better varieties was vital. IRRI and CYMMYT were created with a clear mandate: to develop improved varieties for the most important grain crops, wheat, rice and maize. That task was very successful and more and more national agricultural research systems became involved and took partly responsibility for fulfilling this task.

Development of technologies and agronomic innovations

Improvement of varieties was not sufficient. Appropriate agricultural measures were needed. Seed bed preparation, soil fertility and soil management, irrigation and crop protection were seen as important pillars in crop improvement and productivity rise. Those developments resulted in better agricultural methods enabling higher productivity and food production. It was the adequate response to the need for new.

Farming systems research, and research tailored to the farmers needs

This phase recognized that changes in agricultural systems required more knowledge of the way farming systems function. Socio-economic conditions and possibilities and better technologies dictate agricultural development. Technologies are instrumental in that process. The need for tailor-made technologies was felt clearly and required readjustment of research activities and a better division of responsibilities.

Awareness of environmental side effects and the need to contain them

Awareness of negative side effects of agriculture, especially in fragile environments grew in the seventies, calling for adaptation and changes in agricultural practices. Resource use management, soil conservation and erosion control research became necessary.

Integrating strategic, basic, applied or participatory research and tailoring it to eco-regions

More recently, the need to tailor approaches and technologies to specific circumstances was recognized. To achieve this research directions, systems approaches, and institutions had to be adjusted, and sustainable development and food security included in the mission of the CG.

Thus, in its twenty-year history, the CGIAR saw its agenda change from supply oriented research to more demand oriented research, from general to specific research, from

technology push to technology pull, and from concrete research products (varieties) to approaches, problem articulation and regional solutions. Its role as focal point in the tripartite collaboration with NARS and advanced research organization became increasingly important.

The pace of change accelerated when In the middle 1980s, the intensive agriculture championed by the CGIAR came under scrutiny from several quarters. The donor organizations that provide funds for the CGIAR made an issue of the environmental effects of green revolution technology. The CGIAR was not only prodded by its patrons to give environmental considerations more weight in its overall strategy, but additional pressure was applied by a coalition of environmental organizations. Earlier these groups achieved some success in persuading the World Bank and other international agencies to consider environmental consequences in the selection and design of development projects.

One response of the centers was to rely more heavily on farming systems research. As the name implies, this sort of research involves looking at farming as a system rather than focusing on a single crop. In particular, farming systems research recognizes that farmers make decisions based on social and economic factors and takes these factors into account. Farming systems teams included a significant proportion of social scientists. This contributed to increasing their numbers and strengthening their role in the centers.

In the latter half of the 1980's 'farming systems perspective' permeated the CGIAR. In practice, looking at farming as a system required the centers to make greater efforts to understand soil, water, weeds and climate. By all accounts, a majority of farming systems programs in the centers were reborn as resource management programs using a farming systems approach.

The dialectic between productivity and natural resources research, of course, did not proceed in a tidy and linear fashion, as this account might suggest. The dynamics varied from center to center and the partisans did not divide on absolutist lines. No one, for example, took the position that preserving the resource base was unimportant. Nevertheless, the shift in priorities in the 1980s has gone in the direction of resource research.

From the perspective of a long time participant in the CGIAR a change in outlook toward sustainability in recent years was most clearly apparent when the CGIAR decided to bring in centers that specialized in agro-forestry, forestry and irrigation, all of which have a strong natural resources management emphasis.

ANNEX II

THE CGIAR RESPONSE TO UNCED'S AGENDA 21

The following areas where land use practices are leading to unsustainable changes were identified in three reports of CGIAR Working Groups and Task Forces in response to the recommendations of the UNCED Agenda 21 (proposed convening center in parenthesis):

- for eco-regional and global research relating to restoration and/or maintenance of productivity of marginal and degraded lands:

  (1) Desert Margins (ICRISAT)

  (2) Tropical forested lands that are being deforested as a consequence of increasing slash and burn agriculture (ICRAF)

  (3) Mountain areas and upland water catchments (CIP)

  (4) Formerly fertile high potential irrigated lands that are becoming degraded as a consequence of increased water logging, salinity and other problems (IFPRI)

- for other natural resource management related problems of global significance:

  (5) Preservation of tropical forest ecosystems (CIFOR)

  (6) Preservation of Biodiversity with a special focus on in situ conservation of crops, livestock, fish and forest genetic resources (IPGRI)

  (7) Integrated pest management with a special focus on reducing dependence on chemical pesticides (IPM steering committee)

To obtain a comprehensive picture of the extent of the CGIAR's contribution to sustainable agriculture, the above seven topics need to be considered together with those elements of traditional CGIAR commodity crop research that have in the past and also in the future will continue to address problems of natural resource conservation and management and sustainable agriculture. That requires an adjustment of agricultural research. Examples of such research cited in the CGIAR report on the System's response to Agenda 21 presented at ICW93 included:

- The role that germplasm collection, evaluation and enhancement play in contributing both to sustainable agriculture as well as to conservation of biodiversity.

- The contribution of genetic improvement to disease, pest and weed resistance.

- The impact of CGIAR research aimed at increased use of nitrogen fixing plants and reduced dependence on artificial fertilizers.

- The effectiveness of integrated pest management research in reducing use of, and

dependence on, chemical pesticides.

- The potential of crop mulches to contain soil erosion.
- Improved water use efficiency.
- Integrated agricultural/aquatic resource management.
- The impact of socio-economic policy research on improved understanding of the underlying causes of environmental degradation and policy options for fostering sustainable land use.

The Working Group report includes an illustrative listing of the work of the past and ongoing work of many centers that have been carrying out research output and policy recommendations that have already contributed in a demonstrable way to breaking the spiral of unsustainability.

ANNEX III

THE CONCEPT OF PRODUCTION ECOLOGY

The expected increase in world population from 5.4 billion to 11 billion by the middle of the next century and continued economic growth will require a substantial increase in agricultural production. This, in turn, causes increasing demands on the natural resources of soil, air and water which are already being depleted and degraded in many parts of the world. Agriculture needs to meet a rising demand for marketable output, while satisfying ever tighter constraints with respect to the toxicological safety of their products and the impact of production techniques on man, nature, environment and landscape.

These issues require a comprehensive and integrated scientific analysis of socially relevant options for agricultural production activities at crop, farm, and regional levels. This analysis is to be focused on developing sustainable agricultural production systems in harmony with nature. The term "sustainable" is used here in the sense that utilization of natural resources, that is soil, water, and air does not lead to irreversible deterioration.

The concept of "production ecology " integrates knowledge of the basic processes in living production systems in such a way that sustainable land use and natural resource management responds to well defined socio-economic, ecological and agricultural objectives and constraints.

The term "production" refers to the interaction of energy and matter at different trophic levels. Part of this energy accumulation consists of products useful to man or animal. Animal production and the effects of animals on crops and agro-ecosystems is an integral part of this research.

This research requires the synthesis of knowledge from various disciplines on primary production into a coherent framework which is then used to develop, implement and evaluate location-specific options for profitable agricultural production systems associated with sustainable land use and natural resources management.

There is need to substantially increase our ability to control the biological interactions in our farm systems. Production ecology provides understanding of and ability to manage such factors as:

- pest-predator balance, for lowering losses and reducing the need for pesticides;
- the shift of genetic make-up of weeds which makes them resistant to common control methods;
- the use of crop diversity and residue management to enhance soil quality and efficiency of nutrient flow, and to achieve better synchrony of seasonal soil nutrient flux with crop demand. This leads to greater efficiency of resource use, less environmental loading, and enhanced production potential.

This research requires the synthesis of knowledge from various disciplines on primary production into a coherent framework which is then used to develop, implement and evaluate location-specific options for profitable agricultural production systems associated with sustainable land use and natural resources management.

Various scales of research in time and space can be distinguished, varying from the individual plant to global production systems. Figure 3 shows the spatio-temporal scales of primary production which can be distinguished in production ecology. Elements at a certain level are used to answer questions on a higher integration level. Studies of higher integration levels reveal missing elements at lower levels. Processes below the individual plant level are studied when information is needed to study higher integration levels. At the ecosystem level and higher integration levels, interactions between ecosystems and bio-physical and socio-economic variables are taken into consideration. Agricultural production systems are found at the ecosystem level or higher.

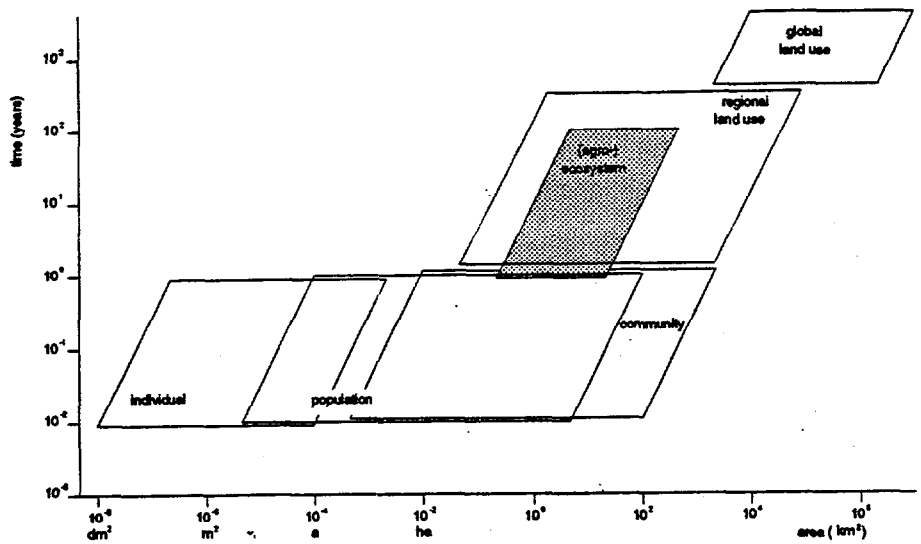

Figure 3 - Spatial and Temporal Scales in Agro-Ecosystems Development

Production ecology studies quantitative relations between environmental and genetic factors and growth, and the development of agro-ecosystems under various ecological and socio-economic conditions. In agricultural production growth-determining, growth-limiting and growth-reducing factors can be distinguished (see figure 2).

Growth determining factors: these determine the growth potential realized when crops grow with ample supply of water and nutrients. Growth determining factors include site-specific environmental variables determined by meteorological conditions which depend on location and season, and on species-specific characteristics of physiology, phenology and geometry of leaves and roots. Situations where potential growth rates are reached are rare; less than one percent of the world's agriculture takes place under such conditions.

Growth limiting factors: these comprise abiotic resources such as water and nutrients, which limit the growth rate of the crop to a value below the maximum when their supply is sub-optimal. The associated growth level is called "attainable". Management of growth limiting factors focuses on optimal fertilization practices which are observed in close association with natural or man-made water regimes in soils that can be influenced by management practices.

Growth reducing factors: these reduce attainable growth to actual growth. Reducing factors are both biotic (plant pests and diseases, weeds) as well as abiotic (pollution). Research focuses on biotic stress factors. Management of growth reducing factors aims at dealing with pests, diseases and weeds, emphasizing integrated pest management practices based on biological control mechanisms.

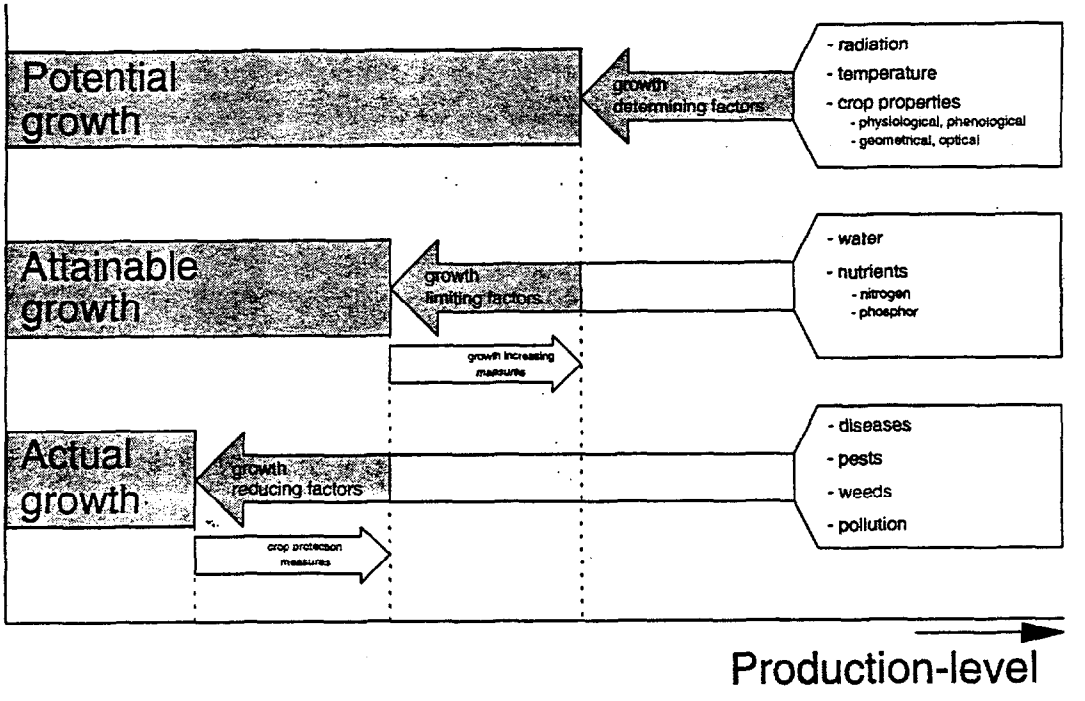

Figure 4- Factors Determining Growth

ANNEX IV

PRIORITY THEMES FOR SUSTAINABILITY RESEARCH

1 Seven new priority themes suggested by the task force on eco-regional and global research in response to UNCED's Agenda 21 (Report, May, 1994)

1.1 A Desert Margins initiative, convened by ICRISAT
1.2 Marginal and Degraded Lands from tropical deforestation; convened by ICRAF
1.3 Sustainable Agricultural Development for Mountain Areas; convened by CIP
1.4 Agricultural and water policies to sustain the resource base and productivity growth in fertile lands; convened by IFPRI
1.5 Global long term forestry research network; convened by CIFOR
1.6 Biodiversity with special focus on in situ conservation of crops, livestock, fish and forest resources; convened by IPGRI
1.7 Integrated Pest Management with a special focus on reducing reliance on pesticides.

2 The system-wide and eco-regional proposals reviewed by TAC, October 1994

2.1 **System-wide**

		Proposer
2.1.0.1	Genetic resources	IPGRI
2.1.0.2	Livestock	ILRI
2.1.0.3	Water management	IIMI
2.1.0.4	Property rights	IFPRI
2.1.0.5	Water policy	IFPRI*
2.1.0.6	Data base	ISNAR*
2.1.0.7	Forest ecosystem	CIFOR*

2.2 **Eco-regional**

2.2.1 *Africa*

2.2.1.1	Desert margins	ICRISAT
2.2.1.2	Humid tropics	IITA
2.2.1.3	Highlands	ICRAF*

2.2.2 *Asia*

2.2.2.1	Rice-wheat	ICRISAT
2.2.2.2	Humid-tropics	IRRI
2.2.3	*Latin America*	
2.2.3.1	Lowland-tropics	CIAT
2.2.4	*West Asia-North Africa*	
2.2.4.1	Northern margins	ICARDA*
2.2.5	*Global*	
2.2.5.1	Mountain agriculture	CIP/ICRAF
2.2.5.2	Alternatives to slash and burn	ICRAF

(*Recommended for funding at US$10,000 or less)

3 Recommendations for targets for research-theme consortia on soil, water, and nutrient management, recommended by CIAT/IBSRAM convened group of International Center staff, Rome, December 1994.

	Theme	Target Zone	Co-Conveners
3.1	Nutrient depletion/replenishment	Sub-Saharan Africa	IFDC, TSBF, KARI, IAR
3.2	Optimizing soil water use	Sub-Saharan Africa	ICRISAT IER
3.3	Managing acid soils	Latin America EMBRAPA	CIAT,
3.4	Controlling soil erosion	Southeast Asia	IBSRAM, PCARRD
3.5	Carbon sequestration	Southeast Asia	IRRI, China
3.6	Soil quality indicators	Southeast Asia	CIFOR

4 Recommendations for topics for Consortia on soil, water and nutrient management, agreed as components of the Zschortau Plan (September, 1994)

	Topic	Conveners
4.1	Biological management of soil productivity	TSBF, IFDC,

		KARI, IAR
4.2	Environmental management of acid soils EMBRAPA	CIAT,
4.3	Conservation and environmental management of sloping and steep lands	IBSRAM, PCARRD
4.4	Sustainable management of the desert margins of Sub-Saharan Africa	ICRISAT, Niger NARS
4.5	Alternatives to Slash-and-Burn; others	ICRAF,
4.6	Rice-wheat cropping systems others	ICRISAT,

Also considered as meriting support, but no proposals developed:

4.7	Amelioration of salinity and sodicity
4.8	Maintenance of Productivity on Mediterranean type ecosystems

REFERENCES

CGIAR. "Report by the Working Group on Possible Follow-Up Action for the CGIAR on UNCED Agenda 21". Circulated as CGIAR document MT/93/18 dated April 19, 1993

CGIAR Task Force Report. "CGIAR Response to UNCED's Agenda 21". October 1993 (circulated as CGIAR document ICW/93/10/Rev.1 dated October 10, 1993)

CGIAR Task Force Report. "Follow-Up to UNCED/Agenda 21 - Progress Report by the CGIAR Task Force". May 1994 (circulated as CGIAR document MT/94/06 dated May 11, 1994)

Deutsche Stiftung für internationale Entwicklung/IBSRAM. "Soil, Water and Nutrient Management - The Zschortau Plan. 1994 (circulated as CGIAR document ICW/94/21 dated October 19, 1994)

IBSRAM. "Soil, Water and Nutrient Management Research - A New Agenda". 1994 (circulated as CGIAR document MT/94/07 dated April 28, 1994)

IFPRI. "A 2020 Vision for Food, Agriculture, and The Environment - An International Initiative Sponsored by IFPRI". May 1994 (circulated as CGIAR document MT/94/26 dated May 22, 1994)

The Netherlands Scientific Council for Government Policy. "Duurzame risico's: een blijvend gegeven" (Living with Risks: an Enduring Phenomenon"). The Hague 1994

TAC (CGIAR Technical Advisory Committee). "Review of Proposals for Systemwide and Ecoregional Initiatives". September 1994 (circulated as CGIAR document AGR/TAC:IAR/94/11 dated September 8, 1994)

Rhoades, Robert E., and R.R. Harwood. "A Framework for Sustainable Agricultural Development: Synthesis of Workshop Discussions". In: Sustainable Agriculture in Asia. Asian Development Bank/Winrock International. 1992

United Nations Conference on Environment and Development. "Agenda 21". Rio de Janeiro, June 1992

World Commission on Environment and Development. "Our Common Future", Report by the Brundtland Commission. Oxford, U.K. 1987

ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Center for International Agricultural Research
ARO	Advanced research organization
AVRDC	Asian Vegetable Research and Development Center
ASB	Alternatives to slash and burn
BNF	Biological nitrogen fixation
CABI	CAB International
CGIAR .	Consultative Group on International Agricultural Research
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
CRSP	Collaborative research support project
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuniária
DANIDA	Danish International Development Agency
FAO	Food and Agriculture Organization of the United Nations
FSR	Farming systems research
GCTE	Global Change and Terrestrial Ecosystems
GIS	Geographical information systems
GLASOD	Global assessment of soil degradation
GRID	Global Resource Information Database
IAEA	International Atomic Energy Agency
IAR	Institute of Agricultural Research (Samaru/Nigeria)
IARCs	International agricultural research centers
IBSRAM	International Board for Soil Research and Management
ICARDA	International Center for Agricultural Research in the Dry Areas
ICASA	International Consortium for the Application of Systems Approaches in Agriculture
ICIMOD	International Center for Integrated Mountain Development
ICRAF	International Council for Research in Agro-forestry
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
ICSU	International Council of Scientific Unions
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IGBP	International Geosphere-Biosphere Program
IIED	International Institute for Environment and Development
IIMI	International Irrigation Management Institute
IITA	International Institute for Tropical Agriculture
ILCA	International Livestock Center for Africa
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
ISRIC	International Soil Reference and Information Center
ISSSICIP	International Society of Soil Science/Committee on International Programs
IUCN	World Conservation Union
KARI	Kenya Agricultural Research Institute

NARS	National agricultural research system
NARES	National agricultural research and extension system
NGO	Nongovernmental Organization
ORSTOM	Institut français de recherche scientifique pour le développement en coopération
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
SWNM	Soil, water, and nutrient management
TAC	Technical Advisory Committee to the CGIAR
TSBF	Tropical Soil Biology and Fertility Program
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
WHO	World Health Organization
WMO	World Meteorological Organization
WRI	World Resources Institute

TASK FORCE MEMBERS

NAME	ADDRESS	TELEPHONE	FAX
Rudy Rabbinge, Chair	Scientific Council for Government Policy 4 Plain 1813 P.O. Box 20004 2511 EA The Hague The Netherlands	31 70 3564491	31 70 3562695
	University of Wageningen The Netherlands	(O) 31 8370 83988 (H) 31 8370 11831	31 8370 84892
Armando Rabuffeti	Director Nacional Instituto Nacional de Investigacion Agropecuaria Andes 1365 P.12 1100 Montevideo, Uruguay	5982 920550 or 5982 923630	5982 923633
Mandivamba Rukuni	Dean of Faculty of Agriculture University of Zimbabwe P.O. Box MP167 Harare, Zimbabwe	(H) 2634 302175 (O) 2634 303211	2634 303544
Stein Bie	Director, Food and Agriculture Organization of the U.N. Research, Extension and Training Division (SDR-C864) Via delle Terme di Caracalla 00100 Rome, Italy	396 52253363	396 52255731
Dennis Greenland	Low Wood, The Street South Stoke Reading RG8 0JS United Kingom	441 491 873 259	441 491 873259
Richard R. Harwood	C.S. Mott Foundation Chair of Sustainable Agriculture Department of Crop and Soil Sciences 260 Plant and Soil Sciences Building Michigan State University East Lansing, MI 48824-1325	(517) 432 1611	(517) 353 3834
John Spears (until 4/16/95)	CGIAR Secretariat (Room J-4069) 1818 H Street, N.W. Washington, D.C. 20433	(202) 473-8912	(202) 473-8110
Wolfgang Siebeck (after 4/16/95)	CGIAR Secretariat (Room J-4062) 1818 H Street, N.W. Washiongton, D.C. 20433	(202) 473-8969	(202) 473-8110