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May 21-25, 1990

The Hague, The Netherlands

**Report of the Committee on Sustainable Agriculture**

Agenda Item 13

Attached is the final report of the Sustainability Committee entitled, Sustainable Agricultural Production: Final Report of the CGIAR Committee. The report gives recommendations of the Committee regarding involvement of the CGIAR Centers in research on agricultural sustainability. It will be presented by Dr. L.D. Swindale, Chairman of the Committee for discussion as Agenda Item 13.

Attachment

Distribution

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CONSULTATIVE GROUP MEETING

May 21-25, 1990

The Hague, The Netherlands

# SUSTAINABLE AGRICULTURAL PRODUCTION:

# FINAL REPORT OF THE CGIAR COMMITTEE

(DOCUMENT NO MT/90/18)

Agenda Item 13

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## 1. INTRODUCTION

This report presents the findings of the CGIAR Committee on Sustainability of Agricultural Production Systems. It builds upon the 1988 TAC Report "Sustainable Agricultural Production: Implications for International Agricultural Research,"[1] and the 1989 Interim Report of this Committee, "Sustainability Research in the CGIAR: Its Status and Future."[2]

The report is based upon conclusions reached at a meeting of representatives from CGIAR and several non-CGIAR International Agricultural Research Centers (IARCs) held at the Center de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD) in Paris from November 28-30, 1989. The Summary Report of the Paris meeting provides an in-depth record of the deliberations of the Committee and is available to CGIAR members who wish to take up themes presented in this report in greater detail.

A subsequent survey of the program activities and long-term plans relating to agricultural sustainability in IARC research was completed by Committee representatives in January and February 1990. A summary of the materials provided and programs described by individual CGIAR Centers is presented as Appendix A of this Report.

## 2. KEY THEMES OF CGIAR SUSTAINABILITY RESEARCH

As the TAC Report stressed, agricultural sustainability is a dynamic challenge. It must be met by developing countries within the context of rapidly growing demands for food and fiber. In coming decades, developing country populations will continue to expand, urbanize and develop an appetite for a broader array of agricultural products.

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[1]Technical Advisory Committee, "Sustainable Agricultural Production: Implications for International Agricultural Research," (AGR/TAC:TAR/87/22 Rev. 2) presented at the Consultative Group Meeting in Berlin, Federal Republic of Germany, May 16-20, 1988.

[2]CGIAR Committee on Sustainability of Agricultural Production Systems, "Sustainability Research in the CGIAR: Its Status and Future," (MT/89/14) presented at the Consultative Group Meeting in Canberra, Australia, May 29-June 12, 1989.

In its previous Report the Committee set forth its views on the main sustainability issues with which the IARCs were concerned. These were: protecting the genetic base, dealing with soil degradation, addressing variations in climate, maintaining growth in productive agricultural systems and promoting growth in less productive systems, and managing pests and nutrients in ways that would reduce the use of agricultural chemicals. In its further considerations the Committee has reviewed and consolidated these major sustainability concerns.

## 2.1 Protecting the Genetic Base of Agriculture

As improved cultivars have spread over wider and wider areas, the maintenance of diversity in the genetic base for agriculture through protection of natural variability and collection of primitive land races has become increasingly important as a means of reducing the risks of catastrophic collapses in agricultural production systems.

Particularly for commodity based Centers, the sustainability of the genetic base for agriculture remains one of the fundamental tasks of the CGIAR. The Committee believes that on the whole the individual IARCs have clearly identified the most critical needs relating to this dimension of sustainability and are meeting them.

## 2.2 Preserving the Natural Resource Base

In recent years the CGIAR system and individual IARCs have increased their efforts to ensure that current production does not undermine the ability of the natural resource base of agriculture to meet the increased needs of future generations. Many successes have been achieved, but the urgency of the effort has grown as growth rates in yields for the major cereals of the Green Revolution have tapered off and as serious environmental degradation and natural resource destruction have been identified in many areas. Many of the specific steps being taken by IARCs to maintain productive potential in existing agricultural systems were detailed in the previous report of this Committee and in the TAC paper. Centers see the need to continue to increase their ability to anticipate threats to sustainability and to protect the natural resource base upon which food production for the next generation will depend.

Yet, the Committee believes that the challenge of introducing sustainable agricultural systems is more than an intergenerational balancing act. It is increasingly central to the mission of the whole CGIAR system. IARCs can and indeed must play a critical role in designing agricultural systems that do not force a trade-off between current and future production; systems that are more sustainable at the same time that they meet expanding production needs.

Both objectives cannot be accomplished in all agroecological settings at all times, but there are substantial opportunities

for new technologies and techniques developed in response to increasing concern about sustainability to raise production of food and fiber for current populations. There are numerous current examples where developing country farmers have taken up production-enhancing, land-conserving techniques. Where additional opportunities exist, particularly if they have the potential for widespread dissemination, they should be accorded high priority for CGIAR-sponsored research activities.

2.3 Research in Less Favorable Environments

The Committee's survey of all CGIAR and several non-affiliated Centers underscores that most IARCs are devoting higher priority and greater resources than previously to research that could help meet both production and sustainability objectives in agroecological settings that are characterized by stress conditions. A small but growing portion of IARC resources is dedicated to increasing food production and to maintaining or enhancing productive potential in marginal or fragile environments where the people are poor and highly productive varieties of crops or breeds of livestock are not well adapted to the adverse natural and socio-economic circumstances.

A review of the current Medium Term Plans of the major IARCs underscores the fact that international agricultural research priorities have broadened considerably in recent years. Most IARCs now can divide their research strategies into two categories:

- research to raise and sustain output in high production systems in favorable environments such as irrigated areas or fertile rainfed areas; and

- research to meet the needs of farmers in areas where production is constrained by unfavorable agroecological conditions.

The increased prominence of research relating to the latter category is especially pronounced among the CGIAR Centers that were formed to address research issues in marginal ecosystems (ICARDA and ICRISAT, for example), and among several non-affiliated centers that were established to deal with particular production factors (IBSRAM and ICRAF, for example).

ICARDA says its Medium Term Plan is devoted to alleviating "the problems experienced by farmers in an environment characterized by highly variable weather conditions and a fragile resource base." The urgent context is that "increasing population pressure and the resulting rising demand for food is placing stress on these fragile ecosystems," and threatening to undermine the very production systems that are the only means of support for the millions of rural poor in West Asia and North Africa.

The emergence of a "second thrust" of CGIAR research is also occurring among Centers that have been largely identified in the past with focusing singularly on raising yields of major cereals in irrigated and other favorable environments. For example, IRRI's Work Plan for 1990-1994 highlights the decision by IRRI researchers to increase the portion of their effort they allocate to "disadvantaged" environments. IRRI's strategy has evolved from one that focused for nearly two decades almost entirely on increasing aggregate rice production to one which balances regional production growth with concerns for the poor farmers who still depend on "marginal" rice ecosystems.

Most Centers state that they define the challenges of increasing agricultural productivity in fragile areas as differing from those in intensive agriculture areas. In particular, few expect that major breakthroughs in any one crop, farming method or input package will be sufficient to achieve sustained yield increases in such areas. Toward 2020: IRRI's Environment concludes that although the unfavorable upland ecosystem has potential for expanded rice production, maximizing farm incomes there depends on diversified farming systems with rice as a component.

As a consequence, an increasing portion of IARC research is devoted to identifying and developing genetic traits conducive to raising productivity within integrated cropping or livestock systems that are likely to be more sustainable in marginal environments. Commodity based programs within many Centers are engaged in considerable research efforts to produce plant material more suitable to special ecological circumstances and integrated farming systems than those deployed under more uniform ecological conditions and within monocropping systems. This research focuses in areas such as the efficiency of mixed and relay cropping systems, new cropping patterns or mixtures, crop/livestock interactions, a variety of agroforestry systems, and minimum tillage cropping.

Such research is also increasingly collaborative, with researchers from different commodity programs and from more than one IARC working to develop the most productive "package" of commodities and farming practices for a given agroecological area. For example, IRRI scientists are collaborating with CIMMYT scientists to select genotypes that perform well in rice-wheat rotations, and with CIAT scientists to identify acid tolerant cultivars of rice that can be incorporated with grass/legume pastures into savanna "ley-farming" systems.

## 2.4 Sustainable Agriculture and External Inputs

The Committee finds that concerns about sustainability overlap with concerns about reducing costs for poor farmers. IARCs have been induced to increase their efforts to develop a more complete understanding of how poor farmers can maximize the use of on-farm resources to sustain and increase agricultural production. This clearly has been a major emergent theme in IARC

research programs during the past decade. Increased focus can be seen on biological and ecological interactions, nutrient cycling techniques -- including the use of organic inputs -- and integrated pest management systems that poor farmers can use -- and often traditionally have used -- to generate factor inputs that they otherwise could not afford. Precisely because such input-lowering systems can actually reduce sustainability - for example, by aggravating soil mining - if not scientifically based, the Committee believes that even greater concentration by IARCs on research on on-farm production of inputs is necessary. It could yield substantial benefits in coming years to sustainable agricultural production both in developing and developed countries.

The Committee wishes to stress, however, that the concept of sustainable agriculture cannot be equated solely with alternative agricultural practices such as organic farming or low-input agriculture. Introduction of such techniques may be the primary means of increasing sustainability under certain ecological circumstances where there is already excessive build up of chemicals in soils and groundwater or in economic conditions where external inputs are rapidly increasing in cost. But in many developing countries and particularly in fragile and marginal environments, sustainability is itself threatened by the lack of external inputs to supplement on-farm practices for maintaining soil fertility and structure, or for protecting agricultural systems from pests and diseases.

What is clear is that there are many opportunities for integrated and well-managed farming systems to achieve lower use of synthetic pesticides, fertilizers and antibiotics per unit of production than is the case in many existing monocropping systems. This has both economical and ecological benefits because it can hold down production costs for poor farmers, increase the value of labor, and lessen the potential for the adverse environmental and public health effects that are associated with excessive use of chemicals.

Two caveats may need to be raised. Introduction of input-lowering techniques may increase the demand for and the skill levels required of labor. Where labor supply is constrained or skills are low such techniques may be slow to succeed. Secondly, Centers are seldom in a position to influence directly the exogenous factors that ultimately determine the success and sustainability of the technologies that they help to devise.

## 3. NEW INITIATIVES

The Committee believes that policies or projects relating to certain specific issues merit further attention from Center Directors, CGIAR Donors and TAC.

## 3.1 Long-Term Research and Trials

A number of Centers maintain or are in the process of initiating long-term projects of 10 or more years in duration that aim to assess the sustainability of existing and emerging agricultural production systems under both static and dynamic conditions. Many of these studies are described in the Summary of the Committee's Paris meeting or in the Appendix to this Report.

Not all sustainability issues require long-term studies. Many trends, good and bad, can be detected quickly. But the Committee believes that long-term research and trials are essential to building the knowledge base necessary to better understand and anticipate threats to existing, changing and emerging production systems. CGIAR Centers and CGIAR donors need to ensure adequate and continuous support for such trials and to outline parameters and conditions that should guide the research agenda. Because such research is costly in time and money, Centers and NARSs working in the same regions or within particular agroecological zones must work together. Coordination will also increase efficiency and produce more broadly useful results.

The Committee agreed that benefits would be derived from cooperating with existing ecological research centers and groups which are testing the application of ecological principles to agricultural systems.

## 3.2 Measurement of Sustainability

The Committee devoted a great deal of time to a discussion of how agricultural sustainability should be measured. A lengthy account of the Committee's deliberations on the topics of measurement is contained in the Summary of the Paris meeting and need not be repeated here. The main points of consensus among Committee members were that:

- Absolute and universal measurement of sustainability is difficult and probably lies outside IARC responsibilities. No single indicator is likely to incorporate many normative judgments that are difficult to quantify -- such as the reversibility of degradation, the critical threshold of decline, or the level of diversity necessary to protect the future genetic base of agriculture.

- Several quantifiable indicators taken over time can provide data along crucial dimensions that help to indicate the sustainability of most agricultural production systems. These include, especially, soil organic matter, soil acidity, crop yields or biomass yields per hectare, and net value added to production.

- Support should be given to developing and testing quantitative models to guide future sustainability research and to extend the utility of findings to new situations.

- The types of measurements that can be used to evaluate the success of technologies in maintaining or enhancing the environment are not adequate at the system or at national levels. Measurements are needed of the capacity of sustainable agriculture, within a regional or national economy, to increase the numbers of sustainable livelihoods.

The Committee recommends to TAC and the Center Directors that a specialized panel of experts should take up the question of the measurement of sustainability in greater detail.

### 3.3 Promoting Sustainability in National Programs

The Committee believes that successful introduction of sustainable agricultural production systems is heavily dependent upon the degree to which Governments and NARSs view this as a fundamental objective. One concrete outgrowth of the Paris meeting of this Committee was the formulation of plans for several regional workshops between IARCs and NARSs to discuss critical sustainability factors. The framework for these workshops would be the extended matrix which the Committee used at its February, 1989 Winrock meeting to delineate the broad array of physical, biological and socio-economic determinants that can support or undermine sustainability. The Workshops will seek to assist NARSs to identify their critical sustainability concerns and the gaps in their research and extension programs that need to be filled to overcome these concerns.

Two donors, IDRC and Switzerland, have offered assistance for such workshops. In Latin America, CIAT, CIMMYT, and CIP have accepted the responsibility to organize the Workshop with Swiss assistance. ICARDA, ICRISAT, and IRRI are coordinating the planning for the Asia Workshop. The African IARCs expressed interest in organizing two Workshops one, which ILRAD might convene, for eastern and the other, to be convened by IITA, for western NARSs. Each Workshop is expected to cost about US$100,000.

### 3.4 Identifying Emerging Threats to Sustainability

In its Interim Report, the Committee noted the need for IARCs to develop improved capabilities to anticipate the impact of rapidly changing demographic and economic circumstances that could undermine the sustainability of existing farming systems. Some of the research the Centers are now engaged in is aimed at this need. The Committee believes, however, that this challenge is likely to take on greater urgency in the coming decade as a result of population pressures, changing international

agricultural trade regimes, and changing levels of agricultural intensity. In addition, on-going natural resource degradation and the possibility of global or regional changes in climate in response to increased atmospheric levels of greenhouse gases, could disrupt or alter current natural conditions in many farming systems.

The Committee noted that interest in researching or addressing future threats to sustainability is still low within CGIAR Centers. This is likely to change as the decade progresses and as funding constraints ease.

## 4. SUSTAINABILITY AND THE CGIAR

Many of the issues crucial to the incorporation of a long-term commitment to research on sustainable agricultural systems by the IARCs are part of much broader questions concerning the future role and organization of the CGIAR system. In general, it does not appear fruitful or necessary to break out sustainability as a topic separate from these questions. Indeed, in many respects, the need to focus on long-term sustainability as a fundamental objective of CGIAR research should be a critical component in all of these discussions.

### 4.1 Institutionalizing Sustainability

The Committee does not believe that the sustainability dimension constitutes a gap to be filled with a special center devoted to the study of sustainable agricultural systems. Committee members and many of their colleagues expressed a strong sense that it would also be unfortunate to try to deal with the growing challenges of sustainability by creating special research units within the existing Centers. Sustainability needs to be a perspective; an evaluating criterion for research on technical components and their combinations.

However, IARCs are still in the process of defining new roles and new research objectives in response to the expanding concerns of the CGIAR for promoting sustainable agricultural systems. The extent to which achievement in making a system more sustainable can become as important as immediate success in raising short-term yields is still uncertain. Donors, while extremely concerned about the general objectives of sustainable agriculture, have not articulated a consensus on what they see as paramount in allocating scarce resources between the several competing claims on the Centers. Nor have they been able to provide additional resources for research on sustainable agriculture.

The Committee expects that this general state of flux will continue to characterize the debate about how important sustainability criteria are to become in CGIAR-sponsored research. In such circumstances, it is desirable that a focal point within the CGIAR network be designated to provide regular information to donors that are particularly interested in this

dimension. Such a role could be fulfilled by TAC or a Committee of the Center Directors General.

4.2 Forestry and Agroforestry

The Committee believes that the incorporation of forestry and agroforestry into the CGIAR system could expand the degree to which the system can respond to critical sustainability concerns. Several Centers (notably CIAT, ICRISAT, IITA, ILCA) are already engaged in significant efforts to incorporate trees into mixed farming systems in particular agroecological areas. CGIAR-sponsored work to build upon and complement such regional research -- such as breeding and improvement programs for multipurpose trees and research on tree/crop interactions -- would reinforce the fact that in many areas under CGIAR Center mandates, the prospects for sustainable agricultural production systems depend upon a mix of agriculture and forestry or agroforestry activities.

In refining current TAC recommendations to incorporate forestry and agroforestry by blending expanded regional research activities with a set of centralized research concerns, this Committee believes several points should be considered from a sustainability perspective.

- The research along forestry and agroforestry lines that has been undertaken in several centers has largely been demand driven and integrated into on-going research to respond to sustainability challenges in specific agroecological settings. Every effort should be made to identify priorities for further research through a process that encourages input from other CGIAR Centers as well.

- From a sustainability perspective, the most critical forestry related need within many IARCs is to increase the incorporation of trees and woody vegetation into farming systems. While the Bellagio process has identified a lengthy list of forestry research priorities, this Committee believes priority for CGIAR-sponsored forestry and agroforestry research should be accorded to research that complements on-going IARC research in agroecological areas where sustainability depends on the use of multipurpose trees in integrated farming systems.

- Increased support for three lines of forestry and agroforestry research would most enhance Center efforts to introduce sustainable agricultural production systems in fragile environments:

  - selection, breeding and genetic improvement of multipurpose tree species that help supply the demands of poor farmers for fuelwood, browse,

special foods (fruits, nuts), and building materials;

- research that further promotes the introduction of forestry to raise on-farm productivity by providing soil conservation, water retention and crop protection; and

- policy research to address the underlying causes of deforestation and to identify incentives for more effective farmer and community, participation in forest conservation.

4.3 Natural Resource Management

Almost all CGIAR Centers say that the sustainability of agricultural production systems within their mandate commodities, agroecosystems or regions hinges increasingly on greatly improved efforts to manage natural resources. Increasingly, Center researchers see the need to design and implement policies and programs that encourage soil and water conservation, long-term investments in improving common property resources, and the introduction of new techniques such as conservation tillage. Shifts in emphasis and priorities to increase physical and biological research on resource management have been made.

Most Centers have also increased the role of social scientists and of social science research to enable them to address the policy, human, and socio-economic constraints to implementing improved natural resource management practices. At the same time, Center researchers are aware that successful introduction of such programs in their mandate areas are dependent upon a large number of institutional factors and external factors over which they can exert little control. This does not decrease the imperative for CGIAR Centers to focus on ways to improve natural resource management practices in their mandate areas. It does point up the need for greater Center outreach and cooperation with organizations that are directly concerned with promoting improved natural resource management. It suggests a more active role for the CGIAR itself in utilizing Center-generated information to recommend national and international policies and practices that will promote sustainable agricultural development.

Regardless of the outcome of current discussions regarding the CGIAR relationship with non-affiliated Centers, links between CGIAR Centers and the major non-affiliated Centers should continue to be strengthened. Several of these Centers (IBSRAM, ICIPE, ICRAF, IIMI) focus on research, network exchange and policy analysis relating to natural resource management.

4.4 Degraded Lands

Building upon the discussion of gaps in its Interim Report, the Committee once again examined the question of whether CGIAR

Centers should address directly the growing problem of degraded lands in developing countries. Most Centers acknowledge that increasing amounts of once arable land in their mandate areas have been degraded and in many cases removed from production. Examples of research that IARCs might be suited to undertake in response include the breeding of stress tolerant varieties to compensate for changing physical circumstances, and the introduction of plant materials to halt or reverse land deterioration, such as leguminous vegetation to enhance soil fertility and coarse grasses and trees to slow soil erosion.

The Committee is deeply concerned about the high rates of land degradation and destruction that have accompanied the expansion and intensification of agriculture in many areas. But the Committee does not feel that rehabilitation of degraded lands should become a central priority of the CGIAR system at this time except perhaps for research on reforesting degraded forest lands. The Committee is aware of the considerable expertise and large investments already being applied to reclamation and rehabilitation in some countries, for example, of salinized lands. Clearly, where food production by poor farmers is directly threatened by widespread land degradation, Centers are likely to become involved in research that seeks to address the problem; there are already many examples discussed in the Committee's Interim Report.

The Committee believes that, by and large, definition of the CGIAR role in dealing with degraded lands is presently best handled at the individual Center level, with the caveat that Centers working across regions and specific agroecological areas will need to coordinate closely in any such projects.

## 5. FURTHER CONSIDERATIONS

### 5.1 Future Priorities

The IARCs have long had a sustainability perspective in their research. In recent years, in response to growing public concern and to the new CGIAR goals, Centers have shifted resources to put greater emphasis on sustainable agriculture and to make sustainability explicit in their own goal and mission statements. Work on several crop commodities has been terminated, and research on crop improvement for yield and on management of single crop systems has been much reduced. So, too, has training on crop production. The current Medium Term Plans of the CGIAR Centers propose to put even greater emphasis on components of sustainable agriculture and begin to tackle more complicated, multi-dimensional issues of sustainable agroeco-systems, long-term measurements of sustainability and technology/ institution/policy interactions. The activities relevant to sustainable agriculture in these Plans are summarized in Appendix A of this report. If the Plans are funded to their approved levels the CGIAR will be making a substantial contribution to sustainable agricultural development.

But it is likely that concerns about environmental problems and the sustainability of natural resources, food supplies and livelihoods will grow. The Committee is aware that Center research on degraded systems and lands may be judged to be inadequate, and that Center interest in new and future threats to sustainability is still rather low. In its Interim Report the Committee mentioned that its research did not adequately cover tropical hilly areas -- now partially corrected -- the combination of long- and short-term strategies to promote sustainable agriculture, research on institutions, and relevant population studies. More needs to be done on the measurement and prior assessment of sustainability. Long-term studies are necessary to learning how to ensure sustainable development. They are likely to be costly, particularly if they are to involve several Centers, NARSs and other agencies in cooperation and to cover several agroecological systems. Integrated pest management needs more emphasis.

These are future priorities. The extent to which they can be met will depend upon the extent to which further shifts can be made from current priorities and the extent to which growing public concerns about sustainability will be translated into additional support for the CGIAR.

## 5.2 The Limits to CGIAR Involvement

Many issues related to sustaining the productive potential of the resource base are specific to ecosystem and location. This emphasizes the need to strengthen cooperation: a) among IARCs working in similar agroecological settings around the world, and b) between IARCs and NARSs to ensure that research at the international level is relevant and adaptable to national and local settings. In addition, problems in sustaining agriculture in many settings often arise because of the interaction between technologies, the natural resource base, economic factors and government policies. Thus, many IARCs find it more and more difficult to focus narrowly on the scientific challenges associated with designing improved agricultural technologies and techniques without a clear picture of context. This has necessitated much greater attention to such tasks as: characterization of agroecological areas; understanding socio-economic settings; understanding farmer perceptions of sustainability; assessing institutional capabilities; and promoting efficient and sound economic policies.

All of these factors have added much complexity to the research programs of CGIAR Centers. It becomes more imperative than ever for the Centers and the CGIAR to agree upon the limits to Center involvement in sustainability issues. Center comparative advantage in contributing to sustainable agriculture development will lie in the adaptation of what the Centers already do well. This means:

- focusing genetic improvement efforts on developing genotypes that achieve greater efficiency in utilizing

the resources (moisture, soil quality, solar energy, etc.,) available within particular agroecological settings;

- promoting component research that maximizes the integration of biological processes to maintain and enhance soil fertility, and to protect production systems from pests, diseases and a variety of non-biological stresses; and using appropriate supplemental levels of external inputs to achieve maximum levels of sustainable agricultural production;

- designing technologies for agricultural systems that do not force trade-offs between current and future production systems that sustain or enhance the natural resource base;

- undertaking a range of appropriate socio-economic studies that will make more sustainable systems more acceptable; and

- assisting NARSs through cooperative research, training and information exchange to contribute to and create conditions for national sustainable agricultural development.

Additionally the Centers will contribute through long-term studies and measurements of sustainability in both favorable and marginal agroecosystems.

## 6. CONCLUDING REMARKS

The Committee's deliberations and survey underscore that a fundamental, even if gradual, evolution is underway in IARC research. This evolution is clearly apparent in the research programs of IARCs with mandates that concentrate in fragile environments (notably, CIAT, ICARDA, ICRISAT, IITA, ILCA). But it is also inducing significant changes in the research agendas of Centers (such as CIMMYT and IRRI) that have traditionally deployed the bulk of their resources toward production of high yielding varieties in favorable environments.

The focus of the CGIAR system as a whole has been steadily broadening from primary concentration on developing broadly adapted, high yield varieties in the direction of producing increasing numbers of varieties that are tolerant of biotic and abiotic stresses, are efficient in the use of nutrients, do not require large doses of chemical inputs and do not overtax available soil and water resources. Crop, livestock and policy-related institutes are increasing in cooperation. This evolution holds far-reaching implications for the future of the CGIAR.

CGIAR Centers are neither empowered nor particularly well adapted to provide the technical assistance, training, local

adaptation and appropriate policy and social settings to ensure that human farm management practices are sufficient to realize the potential of the input-lowering, output increasing technologies that many Center researchers are seeking to develop. The Committee believes that as the evolutionary trend in IARC research priorities continues, matters of cooperation and interface among IARCs and with numerous other international and national institutions involved in international agriculture (NARSs, NGOs, universities) will grow increasingly paramount in determining the success of the CGIAR system.

# APPENDIX A

## RECENT CGIAR CENTER ACTIVITIES RELATING TO AGRICULTURAL SUSTAINABILITY

## I. Major "Sustainability" Initiatives by CGIAR Centers

### A. Centro Internacional de Agricultura Tropical (CIAT)

CIAT's commodity programs are developing component technology for cultural practices which make possible more sustainable systems. This work will become more focused by specifically incorporating into the criteria for evaluation of cropping systems parameters linked to soil quality, nutrient cycling and pest management. (CIAT in the 1990s: A Strategic Plan, p.18.)

CIAT is now in the process of trying to define its role on the issue of sustainability at the broader farming systems or ecosystems level. These areas include the American tropical forests (i.e., the potential of acid-tolerance pastures for reclaiming degraded tropical areas), South American savannas (i.e., more intensive livestock and crop production through rice/pasture rotations where soils are improved by grass-legume associations) and the Andean hillsides (i.e., anti-erosion cropping systems and improved pastures to reduce overgrazing).

### B. Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)

CIMMYT's mission statement has no explicit commitment to sustainability as many of the others do. The report does comment on the new statement as showing a shift from emphasis on "increasing maize and wheat production to enhancing the productivity of resources committed to these crops ... we are focusing our attention on the input side of the production equation rather than the output side." (CIMMYT's Five Year Budget: 1990-1994, p.2.)

CIMMYT has found that the use of insect- and disease-resistant cultivars is an environmentally safe approach to crop protection and the most practicable one for poor farmers, since they can seldom afford chemical controls. (Ibid., p.27.)

The crop management program will increase information relating to the critical factors that affect the sustainability of maize production systems in developing countries. CIMMYT is also involved in breeding for improved nitrogen-use efficiency.

The wheat program is investing heavily in disease resistant breeding, research on drought and salinity tolerance. In

addition to its contributions to rice-wheat rotations in Asia it has commenced research on soybean-wheat combinations in South America.

CIMMYT's Economics Program will be more involved in applied on-farm research on issues such as methodologies for assessing new technologies and for analyzing sustainability issues and testing them with NARSs. CIMMYT expects to complete a series of studies that provide a measure of the rate of research progress in difficult environments. CIMMYT economists and biological scientists will be collaborating on crop management research on maize-based systems on steep, eroded hillsides in Central America, and on rice-wheat systems in Asia. (Ibid., p.41.)

C. Centro Internacional de la Pap (CIP)

CIP has undertaken an ambitious worldwide agroecological mapping, zoning and environmental characterization project. Production trends, agroclimatic conditions, topography constraints, and socio-economic factors have been documented for over 140 countries. This project was started with the belief that sustainability can best be understood if CIP has a firm scientific comprehension of the socio-physical environments where potatoes and sweet potatoes are produced. (Sustainability and CIP's Research, p.11.)

CIP's potato and sweet potato germplasm collections provide the building blocks for developing crops that can overcome problems related to decreasing quality and quantity of soil, limited irrigation water, the global warming trend, and increased hazards from misuse of agricultural chemicals. CIP's work on potato population development enhances sustainability of performance by maintaining wide genetic diversity while increasing the frequency of genes controlling adaptation, yield, resistances to biological stresses and tolerances to abiotic stresses. (Ibid., p.10.)

CIP's work on integrated pest management has shown how dependence on pesticides can be reduced by the integrated use of additional control factors such as locally available repellent weeds, pheromones, and genetically resistant potatoes. (Ibid., p.11.)

CIP has recently begun a new project on "Agricultural Chemical Use and Sustainability of Andean Potato Production."

D. International Board for Plant Genetic Resources (IBPGR)

IBPGR has started to measure crop diversity and more recently environmental diversity (Draft Summary Report from November '89 Sustainable Agriculture Meeting, p.11.)

E. International Center for Agricultural Research in the Dry Areas (ICARDA)

In addition to organizing research around three commodity programs -- cereals, food legumes and pasture, forage and livestock -- ICARDA has a farm resource management program which integrates the results of the commodity work and addresses the issues of wider concern including the socio-economic aspects of farming, agroecological characterization and the sustainability of the resource base. (Sustainable Agriculture for the Dry Lands: ICARDA's Strategy and Medium Term Plan, p.11.) ICARDA's second decade will devote greater resources to the threatened environments in the drier areas and the highlands because these two agroecologies are so extensive in the region that small increases in their productivity would have a substantial impact on total production. Further, these areas are exploited by the smaller and poorer farmers. (Ibid., p.23.)

Initially, the work will focus on the most vulnerable barley-livestock and highland mixed-farming systems. The range of the work will cover the testing of new varieties to define conditions vital for their environmental and economic success; agronomic studies to improve farming practices, studies on soil, water and nutrient management that would maintain yield and protect natural resources; and the determination of stable crop-livestock farming systems. (Ibid., p.27.)

ICARDA has launched a major effort to collect, conserve and characterize the land races and wild relatives of the major crops found in its mandate region (of West Asia and North Africa). Such plants, increasingly banished to remote areas by changes in land use, often harbor genes of great value in the development of new varieties tolerant or resistant to the many stresses of the WANA region's harsh environments. (Sustainable Agriculture ..., p.17.) ICARDA's germplasm enhancement program is based on the principle that germplasm for specific stresses is best identified when the material under selection is exposed to those stresses. This approach is not new but has seldom been applied to environments in which drought is a major problem. (Ibid., p.18.)

F. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

ICRISAT's Resource Management Program (RMP) seeks to develop sustainable farming systems for the semi-arid tropics that will reconcile efficiency with sustainability; conserve water and soil; improve soil structure and fertility; and control pests and diseases. This program will develop work on land management to minimize soil erosion and on the relation between erosion and productivity; on the fate of residues in soil and their contribution to structure and fertility, particularly in the sandy soils of West Africa; on the nitrogen status of soil in

rotations which include legumes; and on cropping systems including agroforestry in West Africa that provide farmers with fodder and fuel as well as food. ICRISAT is installing a geographical information system and cooperating in modeling the growth and production of 3 of the 5 crops of its mandate. (Summary Report, Sus. Ag. Research Mtg., p.11.)

RMP scientists will also be concerned with the nutritional and economic implications of fluctuations in weather from year to year which often determine the acceptability of new technology to farmers and which will form an essential basis for predicting the sustainability of agricultural systems if the global climate begins to change.

The Cereals and Legumes Programs are seeking ways of sustaining production by effective use of genetic resource collections and the search for varieties and hybrids that yield consistently well even when exposed to periodic drought, to attack by pests and diseases, and to competition from weeds. ICRISAT Sahelian Center gives special attention to breeding and selection for earliness in pearl millet and groundnut because early-maturing cultivars can escape drought in the declining rainfall patterns currently encountered in the Sahel. Work on pest and disease control in Asia will concentrate on developing resistance to minimize the need for chemicals and on an Asian pest monitoring program with NARSs, FAO, and mentor institutes.

ICRISAT's sorghum and millet improvement programs in southern Africa are specifically designed to increase the productivity of these two cereals so that they can bring greater yield stability to the dry areas by replacing less drought resistant maize.

## G. International Food Policy Research Institute (IFPRI)

IFPRI's current research impinges upon many aspects of sustainability. Poverty is at the basis of much environmental deterioration in developing countries, and IFPRI has specialized in poverty issue.

Environmental Policy for Agricultural Sustainability is a proposal by IFPRI to add a new environmental/sustainability research area. It calls for the addition of 5 new senior staff members who specialize in technology assessment, demography, institutions, health, and forestry. The report identifies and provides rationale for this new research agenda. IFPRI has chosen six critical environmental issues for in-depth analysis.

- The relationship between low-potential and high-potential agricultural areas and the variation in intensity of farming and output that may occur in each, the relevant institutional relationships, and the role of demographic factors.

- The trade-offs between low-input and high-input agricultures. What is the most effective deployment of physical and managerial inputs for each type of situation? Pest management is one particularly demanding subject in this category.

- The complex trade-offs and complementarities between crop and livestock agriculture, including the role of organic matter and its interactions with chemicals.

- Health is a major element of environmental concern in the developed countries, particularly health problems stemming from air and water pollution. In developing countries, much of the pollution of the land comes from poor sanitary facilities, which are the result of poverty. Health, nutritional status, and incomes are all interrelated. IFPRI has already done pioneering work on nutrition-income interactions; adding a health focus will provide powerful environmental insights.

- The loss of perennial cover, both grass and forest, is a critical issue in many developing countries, which has intense implications for poverty, agriculture, and the rural sector generally.

- Finally, there is the whole complex of issues relating to population growth and the interaction of population with institutional relationships.

H. International Institute for Tropical Agriculture (IITA)

IITA will be decentralizing its agroecological research by establishing small research substations or satellites in the key ecological zones of West and Central Africa. (IITA Medium-Term Plan, 1989-1993, p.9.) IITA plans to locate one research station in the humid forest zone, primarily for work on cassava and resource management, two others in the savanna for work on maize and cowpeas, and a fourth in an inland valley for rice research. (Ibid., p.11.)

As part of IITA's "Research and Crop Management" program, it has established multidisciplinary, crop-based systems working groups in order to link short-term crop-productivity and longer-term resource conservation research. (IITA Strategic Plan, 1989-2000, p.37) These groups will be conducting on-farm research to screen, test and evaluate new technologies, to adapt them to particular agroecological and socio-economic conditions, and to feed back information to the scientists. These groups will help to integrate IITA's three main program areas: resource management research, commodity improvement, and crop management research.

More details about IITA's resource management research are provided on pages 44-48 of the Strategic Plan. One of the areas IITA will be focusing on is developing alley farming techniques as a means to prevent degradation of the acid soils in humid zones. Alley farming has been shown to work on a sustainable basis on non-acid soils in the transition and moist savanna zones. There are other studies of rehabilitating degraded lands with approaches involving herbaceous and tree fallows with and without cropping combinations.

## I. International Livestock Centre for Africa (ILCA)

In its "Animal Feed Resources Thrust," ILCA is exploring the potential for alley cropping techniques to incorporate small ruminants in production systems and in the consequences of recycling nutrients through animals. The integration of legumes in mixed crop-livestock farming systems will help to overcome feed shortages and/or its low nutritive value. ILCA considers this legume technology one of the linchpins of its future research thrusts. (ILCA's Strategy and Long-Term Plan, p.28.) The particular studies in this area are discussed on pages 29-31, and include such things as research on assessing soils and germplasm screening of forages so that they match the prevailing soil-water-nutrient conditions; and the ability of forage legumes to improve soils and increase farm output.

The Livestock Policy and Resource Use Thrust is exploring the acute resource problems in semi-arid and arid areas. It focuses on cross-country comparisons of the critical policy issues affecting production and technology uptake, and on the sustainability of crop-livestock production in the rangelands and the semi-arid zone. (Ibid., p.39.) The specific areas for study are discussed on pages 40-41, and include such things as the effects of government policies on the stability and sustainability of mixed farming in marginal areas; the role of livestock in stabilizing and sustaining farming systems in the semi-arid zone; and the development of low-cost methods for assessing long-term productivity trends in the semi-arid and arid rangelands. ILCA is also implementing a program to collaborate with NARSs in the long-term monitoring of future livestock and vegetation trends in the productivity of Africa's rangelands. (Sustainable Production..., pp.39-40.)

Work in the drier areas will focus on developing draught animal technologies that improve resource conservation and use, thus contributing to ecologically sustainable production systems. (Ibid., p.24.)

## J. International Laboratory for Research on Animal Diseases (ILRAD)

By developing improved, inexpensive and safe methods of controlling East Coast fever and trypanosomiasis, assessing the

epidemiological, social, economic and environmental consequences of their application, and providing training in their use and application, ILRAD is directly contributing towards the goal of achieving agriculture sustainability. (Aldrian W. Mukhebi, "Sustainability Issues in ILRAD's Research Program," p.4.)

ILRAD began an Epidemiology and Socio-economics Unit in 1987 to study the factors that affect the implementation of improved livestock disease control, particularly through immunization, and to assess the likely impact of improved disease control in economic, social and environmental terms. (Ibid., p.8.) The studies will be concerned with such issues as the impact of disease control techniques on owners and non-owners of livestock, crop-livestock interactions, balances of power and access to resources in a community, local and distant livestock markets, and on resource degradation. (Page 15 of Program Plans and Funding Requirements: 1988-1992.) Agroecological zoning or geographical information systems will be developed to categorize livestock farming systems. The information generated by the unit will contribute towards the design of appropriate and sustainable livestock disease control programs tailored to the needs of varying livestock production systems and environments. (Ibid., p.10.)

Mukhebi's paper discusses concerns that the control or elimination of the tsetse fly and trypanosomiasis in Africa could precipitate environmental degradation through deforestation, overgrazing, soil erosion and ultimately desertification. In response, Mukhebi argues that disease control could open up new areas for development and reduce population pressures elsewhere. Also, combined with widespread practice of ecologically balanced farming systems, the reduction in disease risk would permit the rearing of improved and more productive animals that would lessen the need for keeping a large number of animals. (Ibid., p.18.)

## K. International Rice Research Institute (IRRI)

IRRI's new research budget reflects heightened commitment to addressing disadvantaged fragile environments where sustainability is a major concern to create greater balance among other ecosystems research. Upland rice production systems will receive a substantial share (12%) of IRRI's research budget; increased allocations are evident for rainfed lowland and deepwater and tidal wetland rice ecosystems. (See pages 23-27 of Implementing the Strategy:Work Plan for 1990-1994.) One example includes the effects of intercrops and rotation crops on soil organic matter, rice nutrient dynamics and soil acidity in upland rice cropping systems.

IRRI is also concerned with the long-term sustainability of the irrigated rice sector, due to high crop off-take and high input levels of inorganic chemicals combined with lower availability of quality irrigation water. Future research will

address concerns about the impact of high levels of pesticide use, waterlogging, and salinization of irrigated riceland on the long-term productivity of land, water, flora, fauna, and human health. The roles of disadvantaged groups, in particular those of rural women, and the impact of existing and emerging technologies on their productivity and welfare will be evaluated. (Ibid., p.21.)

Specific programmatic efforts to address sustainability include: 1) a hybridization program through biotechnology and tissue culture techniques to build greater resistance to biological stresses; 2) a germplasm collection, characterization and utilization program that will help to maintain genetic diversity in the field and improve and protect existing diversity; 3) greater attention to integrated pest management methods, which have shown greater stability and reduced the harmful impact of toxins in the environments; and 4) research on integrating agroforestry techniques with rice production in fragile areas such as upland and sloping lands.

IRRI is also researching the impact of climate change on rice production and the effect of flooded rice fields on methane and nitrous oxide emissions.

### L. International Service for National Agricultural Research (ISNAR)

ISNAR collaboration with NARSs has in some cases led the NARSs to allocate increased resources to their research programs in order to combine increased productivity goals with the maintenance of the natural resource base of the country. Kenya, for example, decided to change the mandate of one of its experiment stations to place much greater emphasis on soil and water management. In response to an ISNAR review, Morocco recently developed a new project with "interdisciplinary teams" to research in a systems context, and to determine the rationale for the existing production systems, and how they relate to the ecological potentials of different parts of the country.

ISNAR has a special program to strengthen the on-farm research capacities of NARSs as an integral part of their research effort and an important instrument for the designing of technologies most relevant to different agroecological regions, including the stress environments. ISNAR has recently issued four publications with case studies of on-farm research experiences with resource-poor farmers. The lessons from these studies are many, but include such concerns as problems with weak farmer participation and with compiling multidisciplinary teams to assess how new agrotechnologies are working in the field.

M. West Africa Rice Development Association (WARDA)

WARDA's research during the next five years places major emphasis on the further characterization and diagnosis of the region's diverse rice growing environments. Particular accent will be given to identifying the major problems which emerge as typical production systems evolve. WARDA sees environmental and management factors, not germplasm, as the primary set of constraints to sustainable improvements in production. (Medium Term Implementation Plan, p.14.)

The research agenda has several phases, and includes a "horizontal" classification of the principal rice growing environments and then "vertical" studies in key representative sites for long-term monitoring of the evolving impact of typical cropping and fertilization systems on the chemical and physical properties of soils and on-land productivity. (See Research Needs for Sustainable Rice Production in West Africa, pp.2-3.) Pages 5 and 6 summarize particular projects that address sustainability according to the mandate rice growing environments. They include studies of soil fertility improvement techniques; erosion control methods for upland ecosystems; improved water control methods for lowland ecosystems; sustainable water management systems for the saline soils of the irrigated lands in the Sahel; and locating and measuring environmental impact of clearing mangrove forests. WARDA will not be developing technologies for mangroves that might induce further clearing, but rather will focus research on intensifying and stabilizing production on areas already cleared.

WARDA will place emphasis on integrated nutrient management, and IPM techniques and on medium- and small-scale village irrigation schemes which involve greater farmer participation in water control, maintenance, and cropping decisions.

WARDA will also be researching the development of short-term indicators to help diagnose or predict future sustainability problems. This aims to help cut down on the long timeframe needed to screen emerging technologies for their impact on the environment and productivity.

## II. Long-Term Studies

IRRI published three long-term studies on declining yields under intensive irrigated cropping systems.

IRRI's International Network on Soil Fertility and Sustainable Rice Farming (INSURF) is involved in several long-term trials to include green manure and other organic manures to build up organic matter content in the soil.

Examples of CIAT's long-term studies include nutrient balance studies combining beans with banana/sorghum/maize in Africa (this project is in collaboration with Eastern and Central Africa Networks); erosion control in small cassava holdings on the hillsides of the Andes and Asia (in collaboration with Asian NARSs); the dynamics of nutrient cycling in grass and grass-legume pastures in acid soils of savannas and humid tropics of Latin America (in collaboration with the University of Hohenheim).

CIAT expects to find long-term measurement of sustainability difficult when it moves into working on an ecosystems level. In working on a sustainable system for the savannas, CIAT is using a multidisciplinary and multiorganizational approach.

ICARDA will be doing long-term rotation studies on station and on farmers' fields (in marginal dry areas) for evaluation of new technologies involving replacement of fallows by pasture, forage and food legumes.

IITA is involved in a major long-term study of sustainable alternatives to traditional fallow management systems in the forest-savanna transition zone.

ICRISAT's long-term studies include the role of nitrogen-fixing legumes in rotations, the effect of erosion of red soils on crop productivity, and the impact of organic amendments both on red and sandy soils. ICRISAT is considering a proposal for a network of stations in India and Africa to assess sustainability of production in trials which would involve comprehensive measurements of soil properties at regular intervals.

ILCA is involved in the study of long-term trends in the productivity of range resources in Africa. This study involves monitoring since 1984 of sites under its direct supervision and collaborating in a network with NARSs in identifying and introducing suitable long-term monitoring methods.

ILRAD's socio-economics unit has begun research on issues such as the sustainability of emerging farming systems and farmer responses in relation to potential widespread application of improved livestock disease control methods.

WARDA will be doing long-term studies after 1993 of "soil fertility under alternative fertility management regimes in rice systems...." and "changes in soil fertility due to continuous cultivation in various intercropping and rotation systems." (WARDA's Medium-Term Implementation Plan, pp.21-22.) WARDA will be evaluating the long-term effects of phosphorous in seasonally flooded areas. (See p.39.)

CIMMYT's long-term studies include "wheat yields and practices in Pakistan and Mexico, and rice-wheat rotations (with IRRI) in South Asia, maize productivity on sloping erodible lands in Central America."

ILRAD is continuing long-term studies in "understanding the biology of the organisms that cause livestock diseases, and developing immunological methods of disease control; it has also established a socio-economics unit recently that has begun medium-term and long-term studies on some of the socio-economic determinants of sustainability of livestock and crop-livestock production."

## III. Center-Center Collaboration

IFPRI-CIAT study on development alternatives for the Peruvian Amazon to analyze current patterns of agricultural production in relation to natural resources and existing infrastructure, to examine the environmental effects of agricultural activities, and to identify promising agricultural technologies and policies for raising productivity with a minimum of negative environmental effects.

IRRI-CIMMYT collaboration on rice-wheat farming systems; long-standing IRRI-IFDC on increasing fertilizer use efficiency and minimizing environmental pollution.

CIAT-CIMMYT collaboration proposed to study nutrient balance in bean-maize intercropping.

CIAT-IRRI collaboration to develop stable rice blast resistance.

IITA-CIAT collaboration on adapting cassava to the more arid zone of Africa.

ICRISAT will be collaborating with ILCA and ICRAF over the next decade on developing systems combining crops, trees, and animals to maintain ecological equilibrium.

WARDA collaboration with other Centers is listed on pages 56-59 of its Medium Term Implementation Plan.

CIMMYT-ICARDA cooperating on wheat breeding for dry areas.

ILRAD collaboration with ILCA and NARSs to evaluate the productivity of trypanotolerant breeds of cattle, sheep and goats exposed to different degrees of trypanosomiasis challenge in different ecological zones and under different management systems. Research is underway at sites in nine countries in West and Central Africa.

## IV. Center Collaboration with NARSs, NGOs, Academia

IRRI is collaborating with NARSs to research rainfed lowland, upland and deepwater rice sites across South Asia.

CIAT is working with the rice federation (FEDERARROZ) in Tolima-Colombia on IPM techniques for irrigated rice systems. CIAT is monitoring silvopastoral systems in the humid forests of Napo, Ecuador with CVC (a development parastatal), FUNDAEC (NGO), and the Fondo Ganadero (lending institution). CIAT is working on applying participatory research methods to develop sustainable agricultural innovations for small farm technologies on enhancing genetic diversity/soil conservation/IPM in Colombia in collaboration with the ICA, the coffee federation (FEDECAFE), and a group of NGOs led by FUDAEC and CLADES -- a Latin America-wide association of NGOs. CIAT is working with CATIE on monitoring nutrient and water balances in a bean-agroforestry system.

ICARDA's report on sustainable agriculture mentions that "As national capabilities are built up, ICARDA will shift its emphasis from training in varietal development and related topics to resource conservation and livestock management."

IITA's Strategic Plan mentions that they will be scaling down their large staff to service the NARSs. They see this as viable because the NARSs are now more capable than a decade ago.

ICRISAT works with India's Central Research Institute for Dryland Agriculture on crop rotations, agroforestry systems and the use of grasses for stabilizing soil on bunds and sloping land.

ILCA and ICRISAT collaborate on improving the stability and sustainability of crop-livestock production systems in semi-arid areas. They will collaborate with the Institute for Agricultural Research on Vertisol management in Ethiopia.

ILCA and ILRAD will be working jointly on trypanosomiasis and its effects on livestock performance at eight sites in Africa.

IRRI will be collaborating with agricultural universities in rice-wheat work in India.

ILRAD's socio-economics unit is collaborating with NARSs, universities and other research institutes in studying socio-economic determinants at farm, country and regional levels.

## APPENDIX B

Participants in the meeting of representatives from CGIAR and non-CGIAR Centers and Institutes held at the Center de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD), Paris, November 28-30, 1989.

| PARTICIPANTS | ORGANIZATION |
|---|---|
| L.D. Swindale (Chairman) | ICRISAT |
| K. Chowdhry | TAC |
| P. Cooper | ICARDA |
| S.K. De Datta | IRRI |
| S.A. El-Swaify | Univ. of Hawaii |
| M. Latham | IBSRAM |
| H.J. Leonard | The Conservation Foundation |
| M. Lipton | IFPRI |
| P.J. Matlon | WARDA |
| D.J. Merry | IIMI |
| J.L. Monteith | ICRISAT |
| A.W. Mukhebi | ILRAD |
| C. Pieri | CIRAD |
| R. Reid | IBPGR |
| S.G. Sandford | ILCA |
| M. Swift | IITA |
| F. Torres | CIAT |
| R. Van Den Beldt | ICRISAT Sahelian Center |
| B.C.G. Gunasekera (Secretary) | ICRISAT |
| K. Wright | CGSECT |

## APPENDIX C

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CGIAR | Consultative Group on International Agricultural Research |
| CIAT | Centro International de Agricultura Tropical |
| CIMMYT | Centro Internacional de Mejoramiento de Maiz y Trigo |
| CIP | Centro Internacional de la Papa |
| CIRAD | Center de Cooperation Internationale en Recherche Agronomique pour le Developpement |
| IARCs | International Agricultural Research Centers |
| IBPGR | International Board for Plant Genetic Resources |
| IBSRAM | International Board for Soil Research and Management |
| ICARDA | International Center for Agricultural Research in the Dry Areas |
| ICIPE | International Centre for Insect Physiology and Ecology |
| ICRAF | International Council for Research in Agroforestry |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IFDC | International Fertilizer Development Center |
| IFPRI | International Food Policy Research Institute |
| IIMI | International Irrigation Management Institute |
| IITA | International Institute of Tropical Agriculture |
| ILCA | International Livestock Center for Africa |
| ILRAD | International Laboratory for Research on Animal Diseases |
| IPM | Integrated Pest Management |
| IRRI | International Rice Research Institute |
| ISNAR | International Service for National Agricultural Research |

| | |
|---|---|
| NARSs | National Agricultural Research Systems |
| NGO | Nongovernmental Organization |
| TAC | Technical Advisory Committee to the CGIAR |
| WARDA | West Africa Rice Development Association |