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Reconciling Sustainability with Productivity Growth



**Opportunities For Collaboration Among U.S.
Universities, CGIAR Centers, and the NARS**



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Universities, CGIAR Centers, and the NARS**

A Summary Report

Of a Workshop Co-sponsored by
University of Florida and Cornell University

May 19-21, 1993
Gainesville, Florida



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"The question before us is to help the general public understand how to evaluate the tradeoff between this wonderful, mythical notion of the environment that nobody can define, and the immediate, dramatic need of the people to eat and survive that we all understand."

John Lombardi
President
University of Florida
May 19, 1993

PREFACE

Reconciling sustainability with productivity growth is an urgent task facing the international agricultural research community. On the one hand, the world's annual population growth of 100 million compels an increase in food production. On the other hand, this need for higher levels of food production causes an increased use of agricultural chemicals and other inputs, an intensified utilization of marginal lands, and greater demands on already limited infrastructures, leading, in many cases, to environmental stress and degradation. Demands and pleas to protect and wisely manage environmental resources compete with equally strong demands and pleas to produce more food.

The conflicts between sustainability and productivity objectives pose challenges which demand that the best scientific expertise focus on addressing these complex, multidimensional research needs. The resources of the international agricultural research community, especially for those Consultative Group on International Agricultural Research (CGIAR) Centers and the National Agricultural Research Services (NARS), have not, however, grown commensurately. Indeed, in many instances, their resources have decreased. To worsen the situation, U.S. involvement and assistance in international agricultural research in developing countries has declined.

Concern with the issues of how best to reconcile the needs of a hungry population without increasing environmental degradation and of how to strengthen U.S. involvement with the CGIAR Centers and NARS in addressing these needs led to the organization of a workshop held in Gainesville, Florida in May 1993. The workshop, "Reconciling Sustainability with Productivity Growth: Opportunities for Collaboration among CGIAR Centers, U.S. Universities, and the NARS", jointly organized by the University of Florida and Cornell University, was attended by 120 scientists from 14 of the 18 CGIAR Centers, 13 major U.S. universities, several NARS, the CGIAR's Secretariat and its Technical Advisory Committee (TAC), U.S.A.I.D, USDA, UNDP, and the Ford and Rockefeller Foundations.

By bringing together experienced scientists from throughout the world, the workshop not only intended to focus on the substance of the scientific research which needs to be undertaken but also to explore how the CGIAR Centers and U.S. universities may collaborate with the NARS in the developing world to help generate a second Green Revolution as called for by TAC. Generation of such a second Green Revolution will be, however, extremely complex and challenging. It will have to be based on less use of inputs to increase productivity while protecting natural resources. Workshop participants discussed a number of potential research areas and possible arrangements for collaboration among the CGIAR Centers, U.S. universities, and NARS.

This report originates from the work of a committee which summarized the discussions from their respective groups. Thanks are due particularly to Norman Uphoff for his major contribution in chairing the committee and to the following members: Chris Andrew, Ronnie Coffman, Hunt Davis, Peter Hildebrand, Jim Jones, Clive Lightfoot, Alison Power, Tom

Reardon, Robert Rhoades, and Margaret Smith. The discussions in the workshop were so rich with ideas and insights, however, that this kind of a summary report cannot give credit to all who contributed to thinking through the resolution of these urgent problems. Yet ideas and insights derived from the discussions of particular individuals and panel presentations of the workshop must be mentioned. Hubert Zandstra established the intellectual foundation for the workshop participants in a most effective manner. Particular thanks are also due to the other Directors General of the CGIAR Centers who took time to participate despite their hectic schedules and to the CGIAR Secretariat for their support. My own addendum to this report benefitted especially from discussions with Michael Collinson, Rattan Lal, Nyle Brady, E.T. York, Walter Coward, and Dana Dalrymple. Steve Kearl, Paul Psychas and Marjatta Eilitta edited this report. A list of participants is provided in Appendix II.

The workshop was co-sponsored by the University of Florida and Cornell University. I am especially grateful for the insightful and animated contributions of the Cornell faculty, most notably Ronnie Coffman, Norman Uphoff, and Larry Zuidema, throughout the planning stages of the meeting. The commitment of the faculty and administration of the University of Florida to organize an outstanding workshop greatly improved its content. I particularly want to thank John Lombardi, President of the University of Florida and James Davidson, Vice President for Agriculture and Natural Resources, for their unstinting support of the Office of International Studies and Programs. Sandra Russo's efficient organization set the path for the success of the workshop, while Hunt Davis devoted substantial time to the successful conduct of the project.

The workshop was partially supported by a grant from U.S.A.I.D. which we gratefully acknowledge.

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I. OVERVIEW

Background and Workshop Objectives

Since the Second World War, great increases in food production have stemmed from agricultural research. Rapid progress in scientific understanding of soils and crops, along with focussed efforts to increase productivity through breeding and crop management, have helped to prevent widespread malnutrition and famine in the developing world. High-yielding varieties of rice and wheat have contributed an additional 50 million tons of food per year, an extraordinary success hailed as a "Green Revolution." Increasing food security has also laid the foundation for socioeconomic development in many countries.

These breakthrough technologies and systems developed in the 1960s and 1970s resulted from intense collaborative efforts among scientists throughout the world. The major contributors were U.S. Land Grant universities, National Agricultural Research Services (NARS), and the newly established International Agricultural Research Centers (IARCs). Exciting developments at the International Centers, supported by basic and applied research in U.S. universities, enabled progress in improving yield potential and management techniques that could hardly have been imagined in the 1950s. In addition, U.S. universities aided these extraordinary accomplishments of the International Centers by training scientists and helping build the national and international research systems.

In 1971, the International Centers, together with a consortium of donors, formed the Consultative Group on International Agricultural Research (CGIAR). By the early 1980s, the CGIAR system comprised 13 research centers, located mainly in developing countries. The system operated with a heavy focus on the production of food commodities and a mandate to assist the NARS in enhancing nutrition and well-being, especially of low-income people.

In the wake of the Green Revolution, serious concerns have emerged over the ecological effects of the new agricultural technologies and the sustainability of these practices. It has become obvious that the productivity and viability of our natural resource base cannot be taken for granted. Concerns for conservation and sustainable management of natural resources have proven to be much more than a fad; hence they are unlikely to disappear from center stage.

Yet the need to increase agricultural production has not lost its urgency. Rapid population growth rates coupled with stagnating or even decreasing agricultural production in many developing countries still raise Malthusian concerns. Increased agricultural productivity is essential for reducing hunger and poverty among the billion poor people in the world who earn less than one U.S. dollar per day. Thus the challenge confronting agricultural research at the start of the 21st century is one of reconciling the developing world's need for increased agricultural production with the imperative of sustaining environmental resources.

Unfortunately, just as the CGIAR Centers and the NARS rise to confront this new, highly challenging research agenda, they find that the resources at their disposal are decreasing. Funding for the CGIAR Centers has stagnated since 1985, and it has actually decreased since 1991-92, when five new centers oriented to sustainable resource management were added to the system. Also, the NARS in many countries are operating in extremely difficult economic situations. Moreover, the U.S. university system—still the largest and most advanced in the world—has seen its once prominent role in international agricultural research diminish. The involvement of U.S. universities with the CGIAR system has decreased, both absolutely and relative to that of institutions in other donor countries. While the U.S. still contributes nearly one-fifth of the CGIAR system's resources, existing opportunities for engaging U.S. scientific resources in the work of the system remain limited.

The potential for fruitful collaboration among CGIAR Centers, NARS, and U.S. Land Grant universities clearly is great, and the time is ripe for new initiatives in collaborative research. Toward this end, concerned U.S. university scientists met with Directors General and senior scientists from CGIAR Centers, and with representatives of donor agencies and of NARS, for a three-day workshop at the University of Florida on May 19-21, 1993. This workshop was unique in the breadth and scope of the participants it brought together to address urgent issues confronting the CGIAR Centers and the NARS: the workshop's 120 participants came from 14 of the 18 CGIAR Centers, the CGIAR's Secretariat and its Technical Advisory Committee (TAC), 13 U.S. universities, and several NARS and donor organizations. Co-sponsored by the University of Florida and Cornell University, the workshop had the following objectives:

1. To define in broad terms the multidisciplinary research agenda that the CGIAR system, U.S. universities, and the NARS need to pursue on a vigorous basis to achieve rapid productivity gains, while at the same time addressing concerns about the sustainability of resources.
2. To identify the areas of that agenda in which U.S. universities have a comparative advantage in working collaboratively with the NARS and the CGIAR Centers.
3. To develop ideas for concrete, workable mechanisms and modalities, and to explore funding for collaborative arrangements among the CGIAR system, U.S. universities, and the NARS.
4. To set in motion a process that will lead to concrete outcomes which further the goals of research and collaboration elaborated at the workshop.

The workshop was intended to be the beginning of an active response to the challenge of achieving sustainable productivity growth that will preserve both people and the environment. The program of the workshop is presented in Appendix I; the list of participants in Appendix II.

The New Research Agenda: Reconciling Sustainability with Productivity Growth

Agricultural research draws on contributions from a multitude of scientific disciplines—biological, economic, physical, and social—and is truly international. It involves a complex network of institutions, including national agricultural research systems (NARS), universities in developing and developed countries, non-governmental organizations (NGOs), private sector organizations, and International Agricultural Research Centers (whether CGIAR Centers or other independent institutions). Institutions of all types are currently reorienting their research priorities to accommodate concerns about sustainable management of natural resources.

The CGIAR system, for example, formally committed itself in 1987 to increasing sustainable food production. It has since moved to expand its research capacity for promoting sustainable systems. In 1990-1993, the CGIAR added five new centers to the existing thirteen to deal with agroforestry, forestry, irrigation management, banana and plantain systems, and aquatic systems. In addition, a serious reorientation of priorities and programs has been implemented at the long-established CGIAR Centers.

The challenge of finding answers to the productivity/sustainability puzzle is enormous and complex. For a start, the concept of "sustainability" is difficult to define and even more difficult to measure given the present state of our knowledge. It is commonly observed that agricultural researchers are in need of more robust criteria with which to measure sustainability. However, this workshop highlighted the fact that, regardless of which of the many definitions is chosen, the biological, environmental, social, and institutional elements of sustainability will be fundamental concerns of the future research agenda.

Over the course of the first two days of the workshop, participants discussed the components of this research agenda. During the second day of the workshop, research needs were discussed in four concurrent morning groups that examined differing resource endowments and in a similar number of afternoon groups that focussed on various research program areas. Section II presents these discussions under five broad headings: (a) agroecological variations, (b) integrated resource management, (c) integrated pest management, (d) germplasm development and conservation, and (e) institutional and socioeconomic issues.

Opportunities for Collaboration

The workshop was also devoted to developing strategies for pursuing the new research agenda, with a focus on opportunities for collaboration among the NARS, the CGIAR Centers and U.S. universities. The potential for effective cooperation among these organizations is great because, as elaborated in Section III, each has complementary strengths. A second basic reason is that CGIAR system resources are limited to about \$300 million a year, and those for the NARS are also stretched very thin, while agricultural research in U.S. universities presents a reservoir of talent—annual scientist years of over 11,000 and federal expenditures of \$2.7 billion—some of which could be brought to bear on this work.

The CGIAR system has always valued working with universities and other agricultural institutions. By relying on universities and other research-oriented institutions to conduct some of the basic research and to devise new methodologies and conceptual approaches, CGIAR Centers can use their own scarce resources more efficiently. Additional benefits to the CGIAR Centers of a partnership with the U.S. scientific community include considerably increasing the productivity of the CGIAR system at a relatively small cost and sensitizing the American public to the value of international agricultural research. Unfortunately, CGIAR/university collaboration has not reached its potential. Especially significant have been the decline in U.S. bilateral assistance and the reduced support for U.S. universities.

In exploring means for successful and mutually rewarding collaboration, workshop participants found it instructive to look to the first Green Revolution for lessons. Why were U.S. universities able to make significant contributions to meeting the developing world's needs for food and fiber? First, they brought some of the best basic science to bear on technological change. Second, they helped to build local capacity through training. Third, they helped to redirect research programs in the developing countries to areas where there was the greatest potential for technological breakthroughs. Much can be learned from the processes involved in generating the first Green Revolution, including partnerships among scientists, politicians and administrators; partnerships among donor agencies; the centrality of training and institution building; development and implementation of a strategic research agenda; and, perhaps most importantly, the value of flexibility, learning-by-doing, and institutional innovations.

The Technical Advisory Committee (TAC) of the CGIAR has recently pointed to the need for a second Green Revolution. The second Green Revolution is essential so that productivity can be reconciled with sustainability concerns. While its realization is urgent, it will be harder to bring to fruition than the first Green Revolution. It must not only increase factor productivity but do so by using fewer resources and inputs and by protecting the natural resource base of various heterogeneous environments. A sustained, coordinated approach by U.S. universities, the CGIAR system, national programs, and donors is needed to improve the lot of hundreds of millions of small farmers and consumers. The vast system of U.S. Land Grant universities continues to have great potential for assisting the NARS and the CGIAR system in the realization of this complex task.

Section III of this report summarizes the workshop's efforts to develop a framework for collaboration. This section combines the committee report with ideas from various panel and other discussions. Strategies were developed first, by specifying the comparative strengths of the partners, and second, by discussing modalities and mechanisms in terms of organizational arrangements, information exchange, research, and training.

Role of the NARS

Participants emphasized that the extent to which future productivity growth will actually materialize will depend on the NARS playing a central role in technology generation and diffusion. In addition to research, strengthening training and extension in close collaboration with potential users is essential. U.S. universities could play a major role in these areas. The U.S. still educates a vast number of agricultural scientists from developing countries, yet only

a few, small-scale arrangements currently exist for financing student and faculty involvement in the CGIAR system. By strengthening these linkages, students educated on U.S. campuses would acquire the necessary training to be productive at home.

The CGIAR system recognizes that it needs to continue to help strengthen the NARS if it is to increase productivity in a sustainable manner. For these reasons, the workshop concluded that the inclusion of NARS in collaborative arrangements will be very important; in fact, it is essential that a tripartite partnership be formed among NARS, the CGIAR Centers, and U.S. universities.

Role of the Agricultural Research Institutions From Other Industrialized Countries

This workshop was specifically convened to explore how U.S. universities could have a closer and more productive working relationship with the CGIAR system and with the NARS. This is not to ignore or to depreciate the contribution which universities in other industrialized countries can make to international agricultural research generally, and to resolving the tensions between sustainability and productivity growth in particular. While this report deals with how to expand and improve collaboration among U.S. universities, the CGIAR system and NARS, nothing in it is intended to preclude any broader arrangement for international and national research programs to link with universities in North America, Europe, Australia, and Japan. In fact, it would be most beneficial to develop collaboration among the entire international research community, as proposed in Section IV, to make sure that the needs of the growing populations in the developing world will be met while maintaining the resource base in those regions.

II. THE NEW AGENDA FOR RESEARCH IN INTERNATIONAL AGRICULTURE

Agroecological Variation

The problems of reconciling agricultural production gains with environmental sustainability differ depending on the biophysical and socioeconomic conditions that prevail. Recognizing this, the CGIAR system has adopted an agroecological approach to research. Participants suggested that the implications of that approach for training and extension/outreach should be explored using an area-specific focus in research that brings disciplines and solutions together.

To highlight the importance of appreciating agroecological settings, the workshop divided up into four discussion groups to look at these problems under four archetypical environments (in considering their infrastructures, the participants recognized that there are significant differences among farmers with respect to access):

- where there is a favorable natural resource endowment and where farmers have access to considerable other resource advantages (good infrastructure, public services, markets, credit, irrigation);
- where the natural resource endowment is favorable—or potentially favorable—but farmers face infrastructure, service and other constraints;
- where the natural resource endowment is limited, but farmers have access to services and other productive benefits to take advantage of what natural resources exist; and
- where natural resources are constraining, and farmers operate with limited infrastructure and institutional support.

A major issue facing agricultural researchers and policy makers is the extent to which it is possible—and desirable—to intensify production on presently or potentially well-endowed areas (good soils and rainfall, with no topographic constraints) so as to reduce population and degradation pressure on less favorable natural resources. Such a strategy contains a possible risk of undermining even good natural resources, with very high human costs if these favored environmental regions "collapse," and with no guarantee that pressures on fragile environments would be relieved.

The sustainability of local populations and production systems can be threatened by cumulative, incremental changes, or by catastrophic events such as new pests, plagues, or an influx of refugees. For each major agroecological area, researchers will need to address both kinds of threats to long-term viability of agricultural systems.

Favorable environments

Where natural, human and infrastructural endowments are substantial, productivity is usually high relative to the potential of the genetic material. Increases in productivity require new technologies, including new genetic material, new plant and animal systems, and new management practices. On the sustainability side of these environments, high input farming systems may increase the threat of pollution to water and other surrounding resources. Intensive farming practices may also increase the risk of soil erosion and degradation, which will reduce productivity over time. For example, yields of rice-wheat rotation farming systems have levelled off and are even declining in some places. These declines threaten the food and economic security of large populations and involve land degradation issues at the field and watershed level. On a broader scale, trade, monetary, and energy policies could threaten the sustainability of high productivity farmers operating in a market economy.

Research concerns in these areas include:

- Avoiding resource degradation risks due to misuse or overuse of inputs (not necessarily due to high input use per se), lowering soil quality and productivity;
- Development of technologies that increase production while improving energy and resource-use efficiency; and
- Policies at national, international and regional levels that support the sustainability of farming systems (prices, credit supply, trade, energy, etc.).

Unfavorable environments

At the other extreme, one finds areas with unfavorable endowments of all sorts which pose the greatest challenge. Some areas will be best left unexploited, but the world will need to find ways to make sustainable use of most areas if it is to spread and make more bearable the pressures on natural resources. Research concerns include ways to prevent or retard resource degradation and productivity loss, and ways to recuperate and make more productive use of degraded areas. Some of the least favorable areas, for example, may prove to be productive and sustainable under forestry or agroforestry rather than annual crop management.

Socio-economic and policy concerns related to agroecological variation

In these discussions of "favored" and "unfavored" farmers, there was an emphasis on community-level decision-making processes and organization. Households do not utilize resources, natural or otherwise, in a socioeconomic vacuum. CGIAR Center researchers, like many university researchers, have focused on the household unit in the past. For dealing particularly with sustainability issues, the community becomes a more important unit of analysis as it is an important unit of action (or inaction), e.g., in the management of common property resources. Even at the household level, a principal recommendation was that more attention be paid to differentiation within populations with regard to gender, class, land tenure, ethnicity, and so forth, as they affect household and community. The stereotypes of "subsistence" or "commercial" farmers need to be revisited, as households commonly pursue

both strategies according to their opportunities and payoffs and also engage heavily in off-farm employment.

The policy environment is also a crucial factor affecting sustainable agricultural production, with quite differential effects across various agroecological settings. Marginalized populations are particularly vulnerable to discriminating policies on factors such as taxes, prices, credit, and land tenure. The impacts on local and regional resource management are greater if farmers, for example, are forced to pursue ecologically unwise practices to compensate for artificially low agricultural prices attributable to cheap food imports. The implications of various policies on resource use need to be studied, especially in the case of marginalized farmers.

Integrated Resource Management

Incorporating objectives for ecologically and socially sustainable development into agricultural research on natural resource-based rural livelihoods will require more systematic understanding of the "nested" contexts in which productive activities are undertaken: (a) field or pasture, (b) farm, (c) community, and (d) landscape (often delimitable in terms of a watershed). Within these settings, the productivity of soil, water and biological resources depends on their complementary relationships. Research questions which were identified as important for sustainable and increasingly productive rural livelihoods extend along this range of contexts. They include biological and socio-economic issues. Some questions of a more biological nature are, for example:

- Soil organic matter dynamics in relation to soil quality and sustainability;
- Technologies that can increase efficient use of phosphorus in legumes and nitrogen in rice;
- Techniques that maintain and enhance soil structure with respect to crusting, compaction, inundation, infiltration, and erosion;
- Means to rehabilitate the productivity of degraded lands and to enhance and maintain the fertility of prime agricultural lands, seeking to minimize risks of degradation from physical, chemical, or biological processes;
- Interaction between plant roots and soil for efficient use of water and nutrient reserves; and
- Techniques to increase efficiencies of irrigated agriculture through changes in water management and conservation at various levels (field, farm, community, and watershed).

A great deal can be learned from socioeconomic and system-wide studies on such topics as:

- Evaluation of indigenous, historical, and new methods for land improvement through levelling, terracing, drainage, ponding, soil mixing, and the like, and field, farm, and community-level water management;
- Interactions among components of farming systems (recognizing that most research has focused on commodities, plant or soil processes, households, or communities);
- Inventorying and evaluating farmers' indigenous knowledge where this contributes to sustainable and increasingly productive rural livelihoods;
- Factors affecting farmers' access to infrastructure, services, marketing, credit, extension, and so forth;
- Collection and assessment of information and decision-making rules needed by farmers and communities to make decisions for better and more integrated resource management;
- Incentive systems to strengthen and support community-level regulation of integrated resource management to ensure that communities make the "right choices" for sustainable livelihoods;
- Mechanisms for communities to "self-discover" means to improve sustainable production;
- The relationship between natural resource management and property regimes at the watershed/landscape level and the sustainability and productivity of rural livelihoods;
- Appropriate scientific methods and measures (quantitative and qualitative) for assessing sustainability at all levels;
- Interactions and critical decisions affecting sustainable natural resource management in the landscape; interactions between urban and rural, rich and poor social units, including households; and
- Well-planned and properly instrumented long-term field experimentation for representative soils and ecoregions, with standardized analytical techniques and designs to continue for 25-50 years.

Integrated Pest Management

Consideration of this subject focused on what constrains progress in pest management and the discussion was as much as possible site- and pest-neutral. The major constraints to significant improvement in integrated pest management (IPM) are: (a) institutional and disciplinary barriers; (b) a reliance thus far on control tactics rather than ecological strategies; (c) a lack of attention to rigorous problem assessment; and (d) inappropriate models linking research and extension.

To improve pest management effectively, researchers need to avoid crisis management and adopt a long-term perspective in research and extension approaches. They also need to move beyond crop/pest or livestock/pest interactions to examine agroecosystems as a whole. It is essential to investigate non-problems as well as problems, i.e., to develop an understanding of the conditions under which insects, pathogens, and non-crop plants are not pests in order to inform an understanding of the conditions under which they are pests.

The proposed strategy for collaborative research is:

1. Develop an analytical approach (systems analysis) that evaluates the agroecosystem in which pests and pest management are embedded by:
 - considering ecological, biophysical, political, economic, and social aspects of the production system;
 - evaluating how various scales (farm, community, regional, national) constrain pest management strategies;
 - using an iterative approach to IPM development that moves from an initial IPM system (which takes advantage of the global state of knowledge, as well as indigenous knowledge and technology), to outreach and field experimentation, to further research, to a refined IPM system, and back again in a sequence of outreach, research, and refinement; and
 - developing tools that include both conceptual modeling and simulation modeling.
2. Develop tools for a holistic assessment of the problems caused by pests and pest control technologies, including the assessment of:
 - the opportunity costs of different production or pest control technologies;
 - public health and socioeconomic impacts;
 - crop loss assessment;
 - the possibility of system breakdown; and
 - the potential for breaking a cycle of dependency on chemicals.

3. Develop strategies to reduce pesticide inputs to enhance sustainable productive agriculture, recognizing that reducing pesticide use is only the first step in a process that must move from increasing efficiency of use, to substitution, to system redesign.
4. Develop site-specific criteria for evaluating the effectiveness of various outreach/extension approaches.

It will be wise to make use of the comparative advantages of all three sets of institutions (universities, CGIAR Centers, and NARS), as outlined below in Section III.

Germplasm Development and Conservation

As part of an evolving program of research for sustainable productivity, exploiting existing and creating new genetic potentials in plants and animals will play a key role. Germplasm management covers a spectrum of activity from conservation of germplasm (including needs assessment, collection, maintenance, and evaluation) to sustainable utilization of germplasm (including evaluation of potentials, crop improvement, and variety/gene deployment). It encompasses the goals of stability, productivity, and biodiversity.

Among the necessary activities, some are location-specific, some are non-location-specific, and some are location-neutral. Making such a differentiation will help to clarify which institutions might have comparative advantages for undertaking certain germplasm-related activities. Some individual institutions have activities located both in the tropics and outside the tropics (e.g., universities), while other institutions which can serve useful roles are found both in and outside of the tropics (e.g., NARS and private companies).

There was consensus on eight research opportunities considered most critical for germplasm management for sustainability and productivity growth. This list reflects the participants' views of the needs of the CGIAR Centers, the NARS, and their clients rather than just the capabilities available in the research community.

- Identify varieties/genes for improving productivity and quality while maintaining stability of production in less favored environments;
- Derive techniques for assessing genetic variability, identifying gaps in the range of germplasm conserved, and appropriately maintaining conserved germplasm;
- Explain the physiological bases of genetic traits;
- Derive appropriate and functional approaches for *in situ* conservation;
- Develop methodologies for forecasting environmental alterations resulting from use of new varieties (changes in pest populations, soil resources, etc.);
- Improve the availability of healthy propagating material, including both seed and vegetative propagates;

- Appropriately reconcile needs for preservation of diversity (both cultural and biological) and needs for increased productivity and sustainable livelihoods; and
- Improve our understanding of indigenous knowledge, attitudes, and practices concerning germplasm resources.

It would be futile to attempt to establish priorities and specific actors for these research opportunities in general because these will vary from one research entity to another. Deciding who can best do what should be informed by a consideration of the relative strengths of universities and centers (as outlined in Section III), and of the location-specificity of the activities needed.

Institutional and Socioeconomic Issues

Being more complex and multidisciplinary than the other categories, this area of research does not have as well developed methodologies. Moreover, those methodologies that are available are often better developed for the farm/household unit than for the community, which are in turn often more adequate than those for studying larger regions (agroecological or administrative). The methodologies available for dealing with issues at the national and international levels can be even more problematic. The socioeconomic/institutional area, as it bears on sustainable agricultural productivity, ranges across all these levels of analysis and hierarchical systems, and cannot be ignored because this area has such decisive influences on the use and productivity of technologies and practices devised for natural resources, germplasm, and pest management.

At each level various economic, social and political factors along with policy issues affect the sustainability and productivity of resource use (natural, capital, human, and so forth). But it is the interplay of factors within and across levels which presents such a challenge to researchers and decision-makers.

While so many influences in this domain affect sustainable productivity, a comprehensive research program to understand the interaction of all factors is impractical because the cost would be too great and present theory is too limited. The need instead is to identify factors and outcomes that affect sustainable agricultural production at the levels of household, community, ecoregion, and nation.

1. A first focus is on household decisions in various domains (crop and livestock choices, farm vs. non-farm activities), treating the household as a mini-economy. It has multiple objectives (including social objectives and food security, status, and intra-generational perpetuation) so that a purely economic calculus does not suffice.
2. At the community level, mediating institutions are increasingly important as they influence resource management, group behaviors, and the collective response to various externalities such as voluntary and involuntary migration. Questions for research at the community level include:

- What are the determinants of natural resource use by farmers at the community level that can be affected by national policy to promote sustainability without diminishing incomes?
 - What community actions are needed to implement resource-conserving and enhancing technologies?
 - How can improved security of land tenure increase investment in practices and technologies that improve the sustainability of natural resources?
3. In the ecoregion context, questions for research might include:
- Which areas and production systems are best able to handle massive population influxes without significant resource degradation?
 - To what degree do agriculturalists rely on non-domesticated plants and animals in the region as essential elements in local economies?
 - Which of these non-domesticated species are early warning indicators of loss of environmental sustainability?
4. At the national/international levels, research is suggested to determine:
- What agricultural technology can have indirect but positive effects on land degradation and reducing population growth through poverty reduction?
 - What are the long-term consequences of multiple and often conflicting policies as they affect people managing production systems on fragile resources?
 - What are the impacts of international trade in agricultural commodities on the environment over time?

III. FRAMEWORK FOR COLLABORATION AMONG UNIVERSITIES, CGIAR CENTERS, AND THE NARS

Comparative Advantages of the Partners

The particular strengths of the individual scientists in the cooperating institutions are obviously the key to success in any collaborative arrangement. In addition, U.S. universities, CGIAR Centers, and the NARS each have unique institutional strengths, partly derived from their institutional context, including funding and mandates, and partly from their location. We should draw from these strengths not only in the design of research but also in determining administrative responsibilities for each collaborative arrangement.

Specifically, U.S. universities have strengths in the following areas:

- Establishing and maintaining a critical mass of researchers over a broad range of disciplines, many connections with other research groups, an intellectual climate conducive to the generation of new paradigms for research, and the complex infrastructure required in areas of rapidly evolving technology such as molecular genetics;
- Undertaking policy research and socio-economic research, as well as systems analysis and modelling;
- Conducting basic research;
- Carrying out research programs with a long time horizon; and
- Research and training involving many members of the next generation of researchers and agricultural leaders.

The CGIAR Centers have special strengths in a number of areas, including the following:

- Applied and strategic research;
- A global view and non-partisan status;
- Location and facilities in the tropics;
- Working relations with national institutions, including established networks and other links to the NARS;
- Emphasis on farm/food issues in research agendas;

- Capacity to identify problems and evaluate strategies in a wide range of ecological, cultural, and socioeconomic settings;
- Ability to tap indigenous knowledge and develop data collections based on these sources;
- Large and long-term databases;
- Access to a wide variety of germplasm, including wild and weedy relatives of many important crops; and
- Significant access to trained human resources for carrying out research around the world.

National research, training, and extension systems, including universities in developing countries, have the following unique contributions to make:

- Formulating strategies and problem definitions that best meet their own circumstances and needs;
- Attuning research objectives to the social and political realities and to the policy priorities of these countries;
- Ensuring that research results are translated into useful and accessible support for rural producers;
- Expanding the cadre of professionals and technicians taking responsibility and initiative for increasing productivity and sustainability; and
- Possessing the ultimate responsibility for improving the state of affairs in their own countries.

Modalities and Mechanisms for Collaboration

General strategic issues

There were several attempts in the workshop to outline the general characteristics of successful collaboration. These suggestions can help identify those collaborative arrangements among institutions which have the greatest potential for success and in which funds should therefore be invested to develop tripartite research proposals as soon as possible.

A workshop panelist outlined seven essential characteristics of collaborative work among the CGIAR Centers, U.S. universities and NARS, namely:

- A limited number of research priorities and collaborating institutions so that a concentrated mass of information can be obtained;

- Ability to attract the best scientists and science;
- Clear institutional commitment to (not just permission for) collaboration;
- Tripartite involvement of NARS, CGIAR Centers, and U.S. universities;
- Minimization of transaction costs;
- Orientation of donor thrust with program thrusts; and
- Matching external financial support.

Joint ventures in agricultural research are not new to the CGIAR Centers, universities, or NARS, and many variations have been tried and tested under different development strategies, each having its advantages and disadvantages. Collaborative arrangements to date have included a range of activities, from those requiring considerable overhead and effort (e.g., establishing research consortia) to "low input" collaborations (e.g., exchange of students). Some of the activities to date have been:

- Research consortia or networks;
- Collaborative germplasm testing efforts;
- Sabbatical research and study leaves;
- Exchange of visiting scientists;
- Joint training of graduate students (including student training at universities as well as student research at NARS and CGIAR Centers); and
- Posting CGIAR and NARS staff at universities (a recent and ongoing experiment in new modalities for collaboration).

Germplasm management was cited as a good source of examples for modalities and mechanisms for collaboration, because considerable cooperation already exists in this area. These experiences can serve as models for collaboration in other areas of research. Future arrangements for collaboration should take advantage of the lessons from past experience, using whatever arrangement is best-suited for a particular initiative.

One should note, however, that the international agricultural research community must also look for quite different solutions to the challenges of a broader, fundamentally different complementarity between environmental conservation and productivity growth. This means creating new operational mechanisms through institutional commitments that can capitalize on the comparative advantages of participating institutions. A number of different linkages might work better than relying on a few all-encompassing arrangements. The clamor for agricultural productivity growth that is environmentally benign must also be heard as well by the environmental community as by the proponents of agricultural research. Once-unlikely

partnerships involving environmentalists must be forged to target some selective experiments in order to place sustainable agriculture on the environmental agenda. This will require negotiations in the reconciliation of donor thrusts with the new agricultural research agenda, and vision.

It should be recognized that the solution to the problem of sustainability and productivity is only partly in the rural sector. The meeting concluded that the development community must come to grips with the full implications of population growth and poverty. Great numbers of marginalized people live in rural areas, but their employment and income needs will never be met in the agricultural sector. In addition, those in political institutions essentially responsible for the greater problems of poverty and population need to be working to resolve them and need to be informed of the importance of the role of agricultural productivity in helping to ameliorate these problems. Subsequent to the workshop the Clinton administration, represented by both the Secretary of State and the new U.S.A.I.D. Administrator, stressed that U.S.A.I.D. will place a strong emphasis on issues related to population. U.S. universities will therefore have the necessary governmental support to work on these issues.

Organizational arrangements and information exchange

Collaborations will need to be framed by agreements among institutions to ensure that continuity goes beyond the good will of individuals originally committed to the joint effort. In addition, the "transaction costs" of collaborations need to be minimized. In the past, U.S. universities expected and received high overhead costs, which also were a major incentive for international work. At present, fewer resources are available, with a consequent pressure for reducing overhead costs. Ensuring the support of university administrators must therefore be based on the benefits the U.S. agricultural research system derives from international work, such as access to plant materials and improved knowledge of plant and animal diseases.

For programs to function optimally, efficient systems of electronic communication will be essential. Many such systems are currently readily available, for example, E-mail and electronic bulletin boards. To facilitate collaborations, CGIAR Centers asked for improved dissemination of the research activities of interest to them. This is a project that the U.S. universities will need to work on with the CGIAR Secretariat. More advantage could be taken of the Scientific Liaison Officers whom U.S.A.I.D. appoints for each of the CGIAR Centers to inform U.S. university researchers about international activities. A computerized on-line inventory of activities in both CGIAR Centers and U.S. universities would be mutually beneficial and could be generated by a relatively simple questionnaire identifying researchers' topics and geographic regions of expertise. To be useful, these databases must, however, be updated on a routine basis and be accessible on a user-friendly basis.

Specific proposals to further collaborative work include the following:

- Develop multi-institutional consortia to mobilize funding for long-term research and to carry out such projects;

- Support existing networks of researchers and research institutions and foster new ones for information exchange on priority subjects; these should be "pluralistic," going beyond the CGIAR Centers and other developed country institutions to include NARS, NGOs, and national universities; and
- Conduct workshops on specific research topics, recognizing that there are already a great many meetings and that any additional workshops must be cost-effective in time and money and lead to useful results.

Research, training, and institution building through research collaborations

A recurrent concern was that collaborating institutions devise means for organizing, funding and maintaining long-term research and training. The subject of sustainability itself requires durable, sustainable approaches to knowledge generation and human resource development. Donor agencies should be provided convincing evidence that "sustainability" will not be achieved or known in three to five years. This need for a long-term perspective presents a serious challenge to the whole research and development community.

Problem-solving and theme-oriented research have been suggested as two differing approaches which might well serve collaboration on ecoregional research. While the first targets a specific problem, the second designs an agenda around a specific topical area, thus engaging university researchers and accumulating knowledge across different environments. In theme-oriented research, a number of cross-cutting themes should be developed to which researchers from various institutions can contribute; examples might be accessing and evaluating indigenous technical knowledge, or improving community capabilities to undertake natural resource management. Both research modes would accommodate pluralistic collaborations that could capitalize on the relative strengths of participating institutions. Either could also invite participation of regional stakeholders from the public and private sectors and/or involve concurrent research by multidisciplinary teams which transcends regions by addressing common concerns or like-environments. Either approach could involve scientists from different institutions and/or regions who are grappling with similar problems.

In either case—whether focusing on a specific problem or investigating a broader theme—the research should combine production and natural resource management objectives. This will require consensus on productivity and sustainability indicators, and on acceptable levels for both. Research should be systematically reviewed against these indicators. A number of the discussion groups emphasized the need for development of robust indicators of the sustainability of farming systems. These should be based particularly on the livelihoods of farm families and could include shifts in resource use and crop species or varieties, as well as changes in resource allocation which reflect resource degradation. It will often be easier to assess what is unsustainable than what will be sustainable.

Whatever the situation, the participation of NARS operating within the region could provide mutual benefits: their involvement would help to legitimize regional research activities, strengthen national institutions, and address policy concerns. Similarly, the participation of locally operating NGOs can be mutually beneficial, especially in problem-solving at the community level.

Besides addressing the new research agenda, such approaches also incorporate other concerns shared by CGIAR Centers, NARS, and Land Grant universities: they have the potential to catalyze investment in strengthening human capacity and to mobilize support of regional banking establishments. The long-term nature of natural resource conservation and the urgency of productivity growth in agriculture will require political will to be successful, making the participation of national and regional entities essential.

Specifically, proposals for furthering collaborative work in research and training include the following:

- Support long-term researchers working in an interdisciplinary way and interdisciplinary teams of students doing research on priority issues (biophysical and socioeconomic), preferably working with communities and resource users and involving University faculty, CGIAR scientists, NARS personnel, and other researchers;
- Involve researchers from national research institutions and universities in all these activities as much as possible to strengthen their capabilities for contributing to sustainability goals; this should include training and assisting national universities participate in broader national systems;
- Encourage U.S. universities to help with developing and testing diagnostic frameworks and methodologies, as well as methods for socioeconomic research at all levels;
- Encourage long-term longitudinal studies and methodologies for research at all levels;
- Publish and regularly update a directory of sites where area-based, long-term research is being conducted by the CGIAR Centers, including a list of major topics and disciplines involved in these sites, to promote coordination with universities in site selection for graduate dissertation field research;
- Initiate new courses in U.S. universities on issues identified with CGIAR Centers and NARS as important for reconciling sustainability and productivity growth issues. Material developed for these courses will be shared with universities in LDCs, and U.S. universities will work with CGIAR Centers in increasing the capacity of LDC university faculty to address these issues; and
- Institute peer review measures and procedures to ensure that the research done on sustainability and productivity issues is innovative and of the highest possible quality.

IV. MOVING THE AGENDA FORWARD

The final day of the workshop was devoted to developing mechanisms and strategies for furthering the research agendas set out by the participants. These were summarized by Uma Lele at the conclusion of the workshop. Having "raised a lot of expectations," she said, "we want to be sure that something will come out of this workshop. We want to capture the spirit of what we have discussed and remember that the second Green Revolution is essential so that productivity growth can be reconciled with sustainability concerns." The scenario of follow-up activities that could encompass the workshop's goals is as follows:

1. The University of Florida and Cornell University, along with other U.S. universities represented at the workshop, should form a planning committee. The membership should provide broad representation of the U.S. Land Grant university system, without becoming unwieldy. This workshop generated quite a large number of ideas on agendas and modalities for collaborative research, which the committee should evaluate with input from CGIAR Centers and the NARS. The committee should be charged with drawing up proposals for implementing workshop goals. A proposal for a small amount of seed money for the functioning of this committee should be generated immediately following the workshop. This phase should have a clear timeframe for the output of the committee and its various task forces and for developing a full proposal in order to mobilize the necessary funding for collaborative research.
2. The next steps should include the following considerations: First, NARS involvement should be increased. Second, the committee should stress the importance of collaborating with universities in industrialized countries at large rather than simply U.S. universities. The committee should work with European partners on this.
3. At least three different kinds of tasks would seem to face the committee: narrow down research priorities to no more than four that the NARS, U.S. universities, and CGIAR Centers can agree upon and carry out jointly on a long-term basis; recommend means to expand upon the more successful existing mechanisms for collaboration and devise new mechanisms; and develop training capacities and explore incentive systems needed for the U.S. universities to play a more active and productive role in international agricultural research.

A clear consensus had emerged by the end of the workshop that this event should be seen as the beginning of a process by which the participating institutions work to create a constituency for substantially larger amounts of funding for the research that is needed to reconcile sustainability concerns with productivity growth.

APPENDIX I.

PROGRAM FOR THE WORKSHOP

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Reconciling Sustainability with Productivity Growth

May 19 - 21, 1993

A workshop co-sponsored by the University of Florida and Cornell University
University Centre Hotel, Gainesville, Florida

**Wednesday
May 19**

Approaches and Challenges

12:30-2:00

Luncheon (by invitation)

Overview

Chair: James Davidson, University of Florida

The Role of Universities in Addressing Issues of Sustainability and Productivity Growth

Speaker: John Lombardi, University of Florida

Ballroom

Plenary Sessions

2:30

Approaches of International Agricultural Research Centers

Chair: David L. Call, Cornell University
Panelists: Gustavo Nores, CIAT
Jim Ryan, ICRISAT
Hubert Zandstra, CIP

3:30

Break

4:00

Approaches of U. S. Universities

Chair: Ronnie Coffman, Cornell University
Panelists: Louise Fortmann, University of California-Berkeley
Rattan Lal, Ohio State University
Susan McCouch, IRRI/Cornell University
David Pimentel, Cornell University
Jack Ewel, University of Florida

5:30

Challenges of Sustainability Research at the University and Center Levels

Speaker: Uma Lele, University of Florida

6:00

Workshop Objectives and Schedule

Presenter: Sandra Russo, University of Florida

6:15

Adjourn

7:30

Dinner at the home of President and Mrs. John Lombardi (by invitation)

**Thursday
May 20**

Research Issues and Opportunities

Ballroom

Workshop Sessions

8:30

Sustainability and Productivity Growth: Issues, Objectives and Knowledge Needs - Guidelines for Working Groups

Presenter: Hubert Zandstra, CIP

Meeting Rooms

Focus on Resource Endowments:

9:00

Favorable Natural Resources, Favored Farmers

Chair: Klaus Lampe, IRR1

Rapporteur: Jim Jones, University of Florida

**Concurrent
Sessions**

Fragile Natural Resources, Favored Farmers

Chair: Jim Lassoie, Cornell University

Rapporteur: Clive Lightfoot, ICLARM

Favorable Natural Resources, Unfavored Farmers

Chair: Nicolas Mateo, INIBAP

Rapporteur: Tom Reardon, Michigan State University

Fragile Natural Resources, Unfavored Farmers

Chair: Marianne Schmink, University of Florida

Rapporteur: Robert Rhoades, University of Georgia

Ballroom

Summary

11:30-12:00

Chair: Bo Bengtsson, CIFOR

12:15

Luncheon - Capriccio's

Focus on Research Program Areas:

2:00

Integrated Resource Management

Chair: Jacqueline Ashby, CIAT

Rapporteur: Peter Hildebrand, University of Florida

**Concurrent
Sessions**

Integrated Pest Management

Chair: Carl Barfield, University of Florida

Rapporteur: Alison Power, Cornell University

Germplasm Management

Chair: Eugene Terry, WARDA

Rapporteur: Margaret Smith, Cornell University

Institutional and Socioeconomic Issues

Chair: Larry Stifel, Cornell University

Rapporteur: Chris Andrew, University of Florida

5:00

Adjourn

7:00 - 8:00

Reception at the home of Provost and Mrs. Andrew Sorensen (by invitation)

**Friday
May 21**

**Opportunities for
University-Center Collaboration**

Ballroom

Plenary Sessions

8:30

Program Opportunities: Committee Report

Presenter: Norman Uphoff, Cornell University
Facilitator: Hunt Davis, University of Florida
Committee: Chris Andrew, University of Florida
Ronnie Coffman, Cornell University
Peter Hildebrand, University of Florida
Jim Jones, University of Florida
Clive Lightfoot, ICLARM
Alison Power, Cornell University
Tom Reardon, Michigan State University
Robert Rhoades, University of Georgia
Margaret Smith, Cornell University

9:30

Break

10:00

Modalities and Mechanisms

Chair: Michael Collinson, CGIAR Secretariat
Panelists: Larry Connor, University of Florida
David R. Lee, Cornell University
Ruben Puentes, Rockefeller Foundation
Filemon Torres, CIAT
Indra Vasil, University of Florida

11:00

Discussion: Issues and Implications

Chair: Jeffrey Sayer, CIFOR
Respondents: Norman Uphoff, Cornell University
Michael Collinson, CGIAR Secretariat

12:00

Luncheon - Top of the Centre

1:30

Donor Perspectives

Chair: E. T. York, University of Florida
Panelists: Nyle Brady, UNDP
Walter Coward, Ford Foundation
Pat Peterson, USAID

2:30

Moving the Agenda Forward

Speaker: Uma Lele, University of Florida

3:00

Adjourn

APPENDIX II.

LIST OF PARTICIPANTS

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Alexander von der Osten

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Ron Knapp
Gustavo Nores
Filemon Torres
Raul Vera

CIFOR

Bo Bengtsson
Jeffrey Sayer

CIMMYT

Larry Harrington

CIP

Hubert Zandstra

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ICLARM

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ICRISAT

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IITA

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ILCA

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Robert Blake
Louise Buck
David Call
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Jim Lassoie
David Lee
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Jim Davidson
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Hunt Davis
Richard Dierks
Mary Duryea
Jack Ewel
Christy Gladwin
Abe Goldman
Dorota Haman
Peter Hartmann

John Haydu
Gene Hemp
Clif Hiebsch
Peter Hildebrand
David Hubbell
Jim Jones
Mary Lamberts
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Martin Meltzer
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P.K. Nair
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