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<p>Charting the CGIAR's Future - Reshaping the CGIAR's Organization</p>
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Vision and Strategy for the CGIAR

Attached is TAC's report entitled, *A Food Secure World for All: Toward a New Vision and Strategy for the CGIAR*. An earlier draft of this document was presented at MTM2000. At that time, TAC also presented a companion paper on priority research and research-related themes. At the request of the Group, both these papers have now been integrated.

The attached report will be discussed under Agenda Item 2: Vision and Strategy for the CGIAR. It will be introduced by the TAC Chair and will be followed by a discussion in plenary. Members will be able to ask questions and raise concerns.

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH
TECHNICAL ADVISORY COMMITTEE

**A FOOD SECURE WORLD FOR ALL:
Toward a New Vision and Strategy
for the CGIAR**

TAC SECRETARIAT
FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS

October 2000

11 October 2000

Dear Mr. Johnson,

I am pleased to transmit herewith TAC's document entitled, "A Food Secure World for All: Toward a New Vision and Strategy for the CGIAR", for discussion at ICW'00.

You will recall that at MTM'00, TAC presented two papers on the future of the CGIAR: one on vision and strategy and a second companion paper on priority research and research-related themes. The Group requested that the two papers be integrated into one. The Group adopted the seven planks of TAC's proposed new vision statement, and broadly endorsed the definition of the heartland. TAC was asked to complete this vision and strategy paper taking into account comments on the two papers from the CGIAR.

The attached document is TAC's final draft on the future vision and strategy of the CGIAR. It was finalized at TAC 79 at IITA in Ibadan following discussion of an earlier draft at a special TAC meeting at the end of August at ISNAR in The Hague. In this document, TAC proposes that the CGIAR adopt as its strategic framework a new vision, goal and mission. The Committee also proposes a new two-pronged approach for moving the CGIAR toward this vision and goal based on the integration of seven planks into a cohesive operational strategy.

TAC has also formulated views on the implications of the new vision and strategy for a future structure and governance of the CGIAR. The Committee has submitted its views directly to the members of the Synthesis Group at the meeting convened by the Oversight Committee and TAC's paper is included in the outputs of that meeting.

In the preparation of this paper, TAC benefited from inputs from the CDC and CBC, Members of the Group, as well as from a wide range of stakeholders through an electronic consultation organized on TAC's behalf by RIMISP. I would like to express my sincere thanks to the Members of TAC for their commitment and efforts in preparing this document. Thanks are also due to the staff of the TAC Secretariat for their support to TAC throughout this exercise.

Mr. Ian Johnson
Chair, CGIAR
Vice President
Environmentally and Socially Sustainable Development
The World Bank
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Washington, DC 20433 USA

On behalf of TAC, I would like to thank you and the Members of the Group for assigning this important task to us. The new vision and strategy will no doubt make us more effective in our battle to reduce poverty and to eliminate hunger in developing countries.

I look forward to a stimulating discussion at ICW

Kind regards,

Yours sincerely,

Emil Q. Javier

Emil Q. Javier
TAC Chair

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FOREWORD

At ICW99, the CGIAR requested TAC to lead an exercise to help address the future of the CGIAR (horizon 2005-2010) and to define: where it should be; what it should be doing and producing; and how it should be doing it and with whom. In so doing, TAC was asked to involve the Centres and seek the views of CGIAR Members and stakeholders. It was expected that the Committee would draw on previous work and move quickly to ensure completion of the task for consideration and adoption at MTM2000.

At MTM2000 in Dresden, TAC presented a draft paper on the future vision and strategy of the CGIAR, as well as a paper on the proposed future research agenda. The Group adopted the seven planks of TAC's proposed new vision statement, broadly endorsed the definition of the heartland and agreed on follow-up arrangements. TAC was requested to integrate both the papers it had presented at MTM and to prepare a final draft taking into account comments received from Members of the Group.

The attached document is the final version of TAC's paper on the future vision and strategy of the CGIAR.

A FOOD SECURE WORLD FOR ALL
Towards a New Vision and Strategy for the CGIAR

SUMMARY

Despite the efforts of national governments and the international development community, there are over one billion people still living in absolute poverty. The CGIAR proposes new ways to identify and tackle the problems of poverty that are amenable to agricultural research, while also continuing to contribute to sustainable productivity increases in global food supplies and improving the management of natural resources.

This document summarizes the rationale as to why the CGIAR is revising its vision and strategy and describes the motivation behind the proposed changes. These include the need for more effective approaches to reducing poverty and responding to changes in the external environment in which the CGIAR operates. It presents the future vision, goal, mission and strategy of the CGIAR and the seven planks on which the future strategy should be based.

Poverty and Population Trends: An estimated 1.2 billion people live in absolute poverty on less than US\$1 per day with another 1.6 billion subsisting on less than US\$2 per day (World Bank 1999). When more comprehensive measures of poverty are used, such as the UNDP Human Poverty Index¹, the estimated number of poor in the world is still well above one billion.

The world's population is expected to increase from 6.0 billion to 7.5 billion by 2020. Most of this increase will occur in the developing world where some 6.3 billion people will live. Rural poverty currently represents a high (62%) percentage of total poverty. With increasing urbanization, by 2020 an increasing proportion (52%) of poor people will be living in the cities of the developing world. At the same time, vital natural resources will be increasingly at risk from soil degradation, deforestation, water scarcity and contamination, biodiversity loss, and weather variability.

Major regions with a high incidence of poverty, notably extensive areas within South Asia and sub-Saharan Africa, where poverty is concentrated and growing, have benefited much less than others from technological advances in sustainable agricultural productivity over the past 30 years. The persistent and heterogeneous nature of poverty in these areas, the problematic and often degraded natural resources affecting production potential and the weakness of their

¹ A multi-dimensional measure of poverty which encompasses some key 'wellbeing' indicators such as life expectancy, literacy, and access to safe water and health services.

institutions, require a more concerted research and development effort by national governments, the international development community and the CGIAR.

Present Role of the CGIAR: The CGIAR's strengths lie in its strong mission and problem-solving orientation, its human capital, excellence in science and ability to sustain effort over the long term. Other strengths are its international and apolitical nature, its broad research agenda, the comprehensive *ex situ* collections of genetic resources and the location of its research institutions throughout the major agroecological zones.

New Scientific Opportunities: There are major new developments in the social, biological and physical sciences that will contribute to a better understanding of the causes of poverty, in identifying the researchable issues in different environments and in customizing solutions to particular situations. They will also enable the CGIAR to support new research to address the previous intractable problems that contribute to low productivity in marginal and hard environments.²

Future Strategy: The CGIAR will develop a two-pronged approach for the future in support of research and research-related activities to contribute both to the reduction of poverty and to improving food security. This will entail support for research on agriculture and natural resources to address the needs of the poor in the more favoured environments, to ensure food security and prevent future poverty, while at the same time tackling the more complex problems of poverty in the marginal and hard areas. This strategy entails more accurate targeting of people's needs, taking into account gender, and assessing how CGIAR-supported research can meet these needs.

In the above context, the CGIAR will adopt as its strategic framework the following new vision, goal and mission:

Vision: *A food secure world for all.*³

Goal: *To reduce poverty, hunger and malnutrition by sustainably increasing the productivity of resources in agriculture, forestry and fisheries.*

Mission: *To achieve sustainable food security and reduce poverty in developing countries through scientific research and research-related activities in the fields of agriculture, livestock, forestry, fisheries, policy and natural resources management.*

Recognizing that the CGIAR's comparative advantage lies in international agricultural research, the CGIAR's activities will seek to complement the efforts of other organizations working in

² Marginal = difficult agroecological environments

Hard = difficult policy and weak institutional environments

³ Food security refers to access at all times to sufficient nutritionally adequate and safe food (FAO 1996). The CGIAR defines poverty as a multi-dimensional concept that includes income below a poverty line and lack of satisfaction of basic needs such as water, health and education, as well as quantitatively and qualitatively inadequate nutritional standards.

rural development and related sectors, particularly those of health, education, nutrition, infrastructure, the environment, and social and economic policy.

The CGIAR's research priorities should be focused towards improving the livelihoods of the rural and urban poor. This will require not only ensuring continuing yield and productivity gains of staple food crops, livestock and fish, but also customizing agricultural technologies to optimize income and employment generation in the rural sector. It also requires that the CGIAR addresses new issues of food quality and safety and develop more integrated approaches to natural resources management (NRM).

The scientific, institutional and policy outputs generated by the CGIAR are, by themselves, insufficient to achieve the CGIAR's vision and goal. This means that the CGIAR should work more closely with other components of the development spectrum in determining its research priorities and in ensuring the dissemination of its research outputs. These outputs will be essential tools for promoting sustainable agricultural development, and hence in reducing food insecurity and poverty in a broad range of environments.

The future integrated strategy of the CGIAR will be based on the following seven planks:

Plank 1 - People and Poverty Focus: The CGIAR reaffirms its goal of sustainably reducing poverty, hunger and malnutrition of people in developing countries.

Plank 2 - Modern Science: Mobilize the new developments in social, biological and physical sciences so as to bring modern science to bear on the often difficult-to-address causes of poverty and food insecurity, related to production and institutions, that have proven intractable in the past.

Plank 3 - Geographic Priorities: In determining the relative geographic priorities, the CGIAR will give highest priority to developing a concerted approach to address the needs of people in sub-Saharan Africa and South Asia where poverty is concentrated and growing.

Plank 4 - Regional Approach to Research: Adopt a regional approach to research planning and implementation in order to address the heterogeneous nature of the causes of poverty and food insecurity in different regions and integrate regional priorities with global priorities in international agricultural research.

Plank 5 - New Partners in Science and Development: Give increased emphasis to seeking new types of partners and using new forms of partnership to improve the efficiency and effectiveness of problem identification, research, and dissemination of research outputs for poverty reduction and food security.

Plank 6 - Task Force Approach: The CGIAR will adopt a task force approach to addressing major, clearly identifiable problems where there is an opportunity for an impact to be made and/or where there are intractable problems that need a concerted approach by multiple actors and agencies within and beyond the CGIAR System.

Plank 7 - Catalytic Role: Strengthen the role of the CGIAR as a catalyst, integrator and disseminator of knowledge within the overall global agricultural research system.

The CGIAR should intensify its efforts to act as a catalyst, integrator, organizer and disseminator of knowledge and research efforts in support of NARS, in partnership with other sources of expertise. The CGIAR may also facilitate greater linkages between the NARS and the research institutions in industrial countries concerned with international agricultural research, so as to join its investments in research with those of others. This would also support the development of a global system for international agricultural research.

Future CGIAR Research Agenda

In the light of the future CGIAR strategy, and its seven key components, the research agenda supported by the CGIAR will evolve to address the new strategy, and its integrated focus on poverty reduction and food insecurity.

Criteria: The criteria used for making strategic choices amongst research themes are based on the principle of maximizing effectiveness and efficiency in implementing the System's mission and achieving its goals. The four criteria used to assess opportunities for strategic choices in shaping the CGIAR's future research agenda are: contribution to CGIAR goals; production of international public goods; probabilities of success and cost effectiveness; alternative sources of supply and comparative advantages.

Logframe: The CGIAR presently prioritizes its activities and allocates its resources in terms of the following logframe outputs:

1. Germplasm collection, characterization and conservation;
2. Germplasm improvement;
3. Sustainable production systems through integrated NRM;
4. Socioeconomic and policy research;
5. Enhancing institutions.

Germplasm conservation: The future priorities for the CGIAR System in relation to germplasm collection, conservation and characterization are in the areas of:

1. Technical and policy advice to governments on the role of multilateral systems of germplasm exchange for agriculturally important species;
2. Conservation and characterization of *ex situ* genetic resources collections of plants and micro-organisms;
3. Development of methodologies for *in situ* conservation and characterization of other agriculturally important species of crops, livestock, fish and trees;
4. Molecular characterization of the genomes of the agriculturally important species.

Germplasm Improvement

Crops: Twelve crops provide approximately 90% of the food in the developing world. There will be continuing need to work on improving the sustainable productivity of these major staple crops as they will remain the most affordable sources of calories and protein for poor consumers and a critical component of food security. In order to reduce poverty, other commodities that have high income potential for rural communities, including horticultural and tree crops will also receive attention.

Livestock: Livestock are becoming increasingly important in developing countries. As incomes rise, diets change to include more animal and fish protein, and urbanization increases. Livestock are also important as a source of wealth in rural communities. Livestock production in developing countries will need to double by 2020 to meet rising demand for meat, milk and eggs. This will require increased research efforts and additional investment in identifying and addressing the constraints to sustainable productivity of livestock-based systems and the development of more effective and affordable control measures for the major livestock diseases. Spillover with human health issues should also be explored.

Fisheries and Aquaculture: Aquaculture is the fastest growing agricultural industry in some developing countries. The most important concerns for the future include: sustaining aquatic environments to stabilize or augment production levels for human food; protecting aquatic biodiversity on which future productivity depends; and integrating the biophysical, socioeconomic and policy elements of aquatic resources management.

Forestry and Agroforestry: Forests and trees contribute to poverty reduction and prevention and to food security and environmental enhancement in a number of ways. Looking at potential from the point of view of poverty reduction will lead to some shifts in emphasis by the CGIAR, including more research related to forest-based employment, postharvest technologies, production to consumption systems based on the forest economy, and understanding the linkages between forests and agriculture.

Integrated Natural Resources Management

Conservation and enhancement of natural resources and protection of the environment are central and legitimate themes for CGIAR research today and in the future. Priorities can be determined on the basis of five principles:

1. The CGIAR should concentrate on NRM research that contributes to productivity enhancement and sustainability of natural resources for production of crop, livestock, forest and fish outputs that have impacts on poverty reduction and food security, giving appropriate consideration to the inter-generational equity of benefits.
2. The CGIAR Centres should use an integrated NRM *focus* in their planning to define problems in NRM that require research.
3. International integrated NRM research should be process oriented to ensure maximum contribution to producing international public goods.

4. The CGIAR should give much greater attention to research to resolve water issues.
5. NRM research should focus its efforts around common reference locations or benchmark sites, essential for integration of the many dimensions of integrated NRM.
6. Priorities for specific NRM research themes should be determined in the context of the sustainability issues affecting productivity increases, regional priorities and comparative advantages of the CGIAR.

Socioeconomic and Policy Research

The CGIAR's greater focus on poverty reduction will entail increasing the role of socioeconomic research to augment understanding of people and their agricultural and technological needs, and assess adoption and the impact of innovations. A highly selective socioeconomic and policy research agenda is needed to focus on the CGIAR Centres' new responsibilities in addressing both poverty reduction and sustainable food security.

Enhancing Institutions

The CGIAR's effectiveness and efficiency in enhancing the performance of research-related institutions in developing countries depends on whether the CGIAR is providing the right kinds of research and services for institution strengthening, maximizing its comparative advantage vis-à-vis alternative suppliers and ensuring that its activities are truly international public goods. The CGIAR has a continuing important role to play in capacity building but will also need to contribute to the sustainability of NARS.

Role of the CGIAR as a catalyst and integrator of knowledge

There are a series of global issues where the CGIAR should play a role as a facilitator, integrator and catalyst for mobilizing science to serve the needs of the poor. New modalities of information technologies, including establishing virtual entities, should be experimented with, in collaboration with others, to mobilize and make available the knowledge needed to solve the problems associated with poverty and food security. Integrating scientific discoveries into new knowledge and working with those who can develop this into knowledge-based solutions, customized to the needs of poor people in particular situations is the challenge the CGIAR faces.

CHAPTER ONE: CONTEXT

1.1 Introduction

This document summarizes the rationale as to why the CGIAR is revising its vision and strategy and describes the motivation behind the change. This includes the need for a more effective approach to reducing poverty and changes in the external environment in which the CGIAR operates. It presents the future vision, goal, mission and strategy of the CGIAR and the seven planks on which the future strategy should be based.

In developing the future strategy, the CGIAR identifies the researchable issues, which are among the major underlying causes of poverty and food insecurity. It also highlights the scientific opportunities provided by new developments in the biological, physical and social sciences, and information and communication technologies. In addition, it discusses how the CGIAR research agenda can evolve to address the future strategy and identifies some high-priority research targets that are international in character and need to be urgently addressed by the development of international public goods.

This document also discusses ways to improve the quality and relevance of the outputs of CGIAR-sponsored research and ways in which to measure its long-term outcomes and impact. It notes the need to develop new partnerships in both science and development to facilitate carrying out research and the wider dissemination of research outputs by working with potential users in NARS and other interested parties in governments, civil society and the private sector.

1.2 Food/Population/Natural Resources Nexus

Poverty and Population Trends: An estimated 1.2 billion people live in absolute poverty on less than US\$1 per day with another 1.6 billion subsisting on less than US\$2 per day (World Bank, 1999). Even when more comprehensive measures of poverty are used, such as the UNDP Human Poverty Index, the estimated number of poor in the world is still well above one billion (see Annex I).

Poverty is the result of people's lack of access to productive assets (human, natural, physical, financial and social capital) and their limited access to the rights, public goods and services essential to meet basic human needs for food, health, education and culture. There are also environmental causes of poverty, such as the lack of sufficient water for human consumption and agriculture.

Between now and 2020, the world's population will increase by nearly one-third from 6.0 billion to 7.5 billion. Nearly all of this increase will occur in the developing world where some 6.3 billion people will live, with the largest growth occurring in cities. At the same time, the natural resources upon which the world's population depend for sustenance will be increasingly at risk

from soil degradation, deforestation, biodiversity loss, water scarcity and contamination, and weather variability.

Rural poverty currently represents a high (62%) percentage of total poverty. However, with increasing urbanization, by 2020 a rising proportion (52%) of poor people will be living in the cities of the developing world. Thus poverty is both a rural and an urban phenomenon. Its causes are manifold and the relative importance of these varies within and amongst countries and regions. There is also a strong gender dimension to poverty. The agricultural and natural resources related causes of poverty can be addressed through international agricultural research.

Food Security Trends: In global terms, increases in world food production have more than kept pace with increases in the global population between 1960-2000. While the growth in world agriculture has decreased from 3% in the 1960s to 2% in the last decade, it is expected to continue to outpace world population growth, at least to 2020. Also, global food prices have declined generally. Over the 30-year period (1960-1990), world cereal production doubled, per capita food production increased 37%, calories supplied increased 35% and real food prices fell by almost 50% (McCalla, 1998). Most of these productivity gains have been due to yield increases and result from the benefits of agricultural research. However, these overall averages mask significant variations in agricultural performance across regions. The food-security situation in many developing countries is much more pessimistic and the situation in sub-Saharan Africa is particularly fragile (FAO, 2000a)

Despite the increasing overall availability of food, approximately 800 million people out of a total world population of 6 billion are food insecure (FAO, 1999). Two thirds of the undernourished live in Asia and nearly a quarter in sub-Saharan Africa. Of these 800 million people, 160 million are malnourished children. Without additional successful interventions in food and nutrition, there are still likely to be 135 million malnourished children in 2020. Of these, 77% will live in sub-Saharan Africa and South Asia.

Future Global Food Needs: About 73 million people will be added to the world's population every year between 2000 to 2020, most of whom will live in developing countries. Meeting the food needs of this growing and increasingly urbanized population requires increases in agricultural productivity, and matching these increases to dietary changes and rising incomes, especially the increasing demand for livestock and fish. World grain production will need to increase by 40%, roots and tubers by 58% and livestock production will need to double in order to meet projected world food demand in 2020 (Pinstrup-Andersen et al, 1999). These production increases will need to be achieved by sustainably increasing agricultural productivity per unit of land and per unit of water so as to conserve diminishing and degraded natural resources. Nearly all of these necessary production increases will need to take place in developing countries themselves, as opportunities for trade are very limited.

The Rome Declaration on World Food Security (FAO, 1996) recognized that the eradication of poverty is a critical step in improving access to food and hence improving food security. The target of the FAO World Food Summit is to halve the number of food-insecure people by 2015. The work of the CGIAR will contribute to achieving this target.

1.3 The Role of Research and of the CGIAR

Agricultural research that leads to improved technologies can benefit the poor in several ways (Hazell and Haddad, 2000):

- a) It can benefit poor farmers directly through an increase in their level of on-farm production. This may involve producing more food and nutrients for their own consumption, and increasing the output of marketed products to increase farm incomes.
- b) It can benefit small farmers and landless labourers through greater agricultural employment opportunities and higher wages within the adopting regions.
- c) It can increase migration opportunities for the poor to other agricultural regions.
- d) It can benefit a wide range of rural and urban poor through growth in the rural and urban non-farm economy.
- e) It can lead to lower food prices for all consumers, whether from rural or urban areas.
- f) It can lead to greater physical and economic access to crops high in nutrients that are crucial to the wellbeing of the poor and to poor women in particular;
- g) It can empower the poor by increasing their access to decision-making processes, increasing their capacity for collective action and reducing their vulnerability to shocks via asset accumulation.

Items (a) and (b) are often called direct benefits while items (c) to (g) can be termed indirect benefits. Items (f) and (g) have not received as much attention as items (a) to (e) either inside or outside the CGIAR.

In summary, agricultural research helps to produce the technology and knowledge necessary for sustainable agricultural development. This, in turn, is a necessary condition for economic growth in rural areas. Such growth is known to be an effective instrument for poverty reduction and hence for improved food security in countries where a majority of the poor live in rural areas. As well, an increase in food supply results in lower prices for poor urban and rural consumers who spend a proportionately higher share of their income on food. A recent IAEG/IFPRI study has documented available evidence on the positive impact of agricultural research on the poor (Kerr and Kolavalli, 1999).

A basic assumption of the CGIAR's current strategy is that increased productivity within agriculture (crops, livestock, fisheries and forestry) and more effective management of natural resources (especially biodiversity, forests, fish stocks, land and water) are central to alleviating present and future poverty and food insecurity, particularly in the poorest countries. Better technologies and improved policies and institutions all contribute to achieving increased productivity in agriculture. The quality and utility of these instruments rests ultimately on research of the kind emphasized by the CGIAR. The poverty-reduction effects of agricultural

research are enhanced by complementary interventions in education, health, social capital development, and infrastructure investment.

1.4 New Challenges and Scientific Opportunities

In recent years, there have been a number of rapid and profound developments in the various external environments within which the CGIAR works that have an influence on its future priorities and mode of operation. Amongst the most important global forces for change are:

- The increasing importance of intellectual property rights (IPR) and proprietary science, leading to a greater investment by the private sector in agricultural research.
- The increasing number of agencies involved in policy, development and science issues affecting developing countries.
- New developments in social, biological and physical sciences that offer new opportunities to address previously intractable problems of poverty and food security.
- The implications of international treaties such as the conventions on biological diversity and desertification and those of the World Trade Organization (WTO).
- The changing roles, priorities and composition of NARS.
- The impact of globalization on developing countries and their need to be competitive in markets.

Some of these global forces of particular importance to agricultural research are discussed in more detail below.

Proprietary Science, Intellectual Property Rights and the Role of the Private Sector: Private investment in agricultural research, especially the applications of modern biotechnology, has accelerated greatly over the past two decades, owing to expected returns to research investments via IPR. The future trend of IPR and investments in agricultural biotechnology will be influenced by public perceptions and acceptance or rejection of genetically modified organisms (GMO) and their products in different markets as well as by decisions taken at the national and intergovernmental level (e.g. the Convention on Biological Diversity and WTO/TRIPS).

In relation to the current use of IPR, the CGIAR Centres can operate freely in countries where patents are not held and with international public goods that do not fall under patent laws. The situation may change as a result of new national IPR regimes, rising local private-sector investment in developing countries and increases in the export of agricultural products based on proprietary science. The CGIAR Centres presently manage these trends by obtaining licences as necessary for components, seeking IPRs for their own discoveries and obtaining freedom to operate in segmented markets. Given the accelerating privatization of science, the CGIAR will need to collaborate more effectively with a much wider range of partners in an environment that is increasingly market-driven.

In assessing the global supply function for agricultural science in 2010, in developing countries the CGIAR must pay particularly close attention to the private-sector component within the

NARS, since their investment in agricultural research, including fisheries and aquaculture, is well above those of the CGIAR. Increased private-sector activity in some areas, e.g. in genetic improvement of certain crops, will begin to shift away from the CGIAR the comparative advantage in those areas of research. In addition, the private sector is increasingly acquiring control over the genetic information of the most important crops and livestock species through major investments in genomics. Commodity research on orphan crops (i.e. commodities important in the developing world that are unlikely to attract private R&D investment) and on traits that bring little monetary profit, as well as research on NRM where the results are unable to be appropriated, seem less likely to attract private investment.

Private-sector activity depends on incentives for commercial investment as they are affected by developments in science, policy, IPR, public perception and financial considerations. Developments in these areas may encourage the private sector to invest in research previously in the domain of the CGIAR or NARS. The CGIAR needs to explore new ways of collaborating with the local and multinational private sector as a deliberate component of its future strategy. A key element here would be partnerships that use private-sector resources, generate access to new knowledge and develop complementary research agenda.

The CGIAR should focus on important commodities for cash, food, feed and fibre in the developing world, on traits of specific importance to the poor and on NRM research to ensure sustainable productivity increases. The complementarities between the private and public sectors in many commodities are important for producing the final deliverable goods to those beneficiaries who are part of the CGIAR's mission.

International Agreements on Genetic Resources: The ongoing negotiations on the FAO International Undertaking (IU) on Genetic Resources and its relationship to the Convention on Biological Diversity could have far-reaching impacts on CGIAR activities on genetic resources. A favourable outcome may involve increased responsibility for the CGIAR in safeguarding biodiversity and benefit sharing with developing countries. A broad consensus seems to be emerging that would give plant genetic resources for food and agriculture special status within a multilateral system for germplasm exchange.

The future of the genetic resources collections held in trust by the CGIAR and operations in crop improvement may be seriously affected by claims for repatriation of collections or by impairment of the transfer, maintenance and use of germplasm if the negotiations on the IU fail to reach agreement. Apart from continuing to honour its current international obligations over its in-trust collections, the CGIAR has a vital corporate interest in strengthening its technical and policy support to the IU negotiations to ensure a favourable outcome for poor farmers in developing countries. There is opportunity for increased collaboration with FAO and national partners on this issue.

National Agricultural Research Systems: Despite important gains in the size and capacity of some national agricultural research institutes (NARIs) over the last twenty years, investments by the public sector in agricultural research in developing and industrial countries in the last decade have seen a major decline. Most national systems have been slow to adjust institutional structures to the increasing demands being placed on them in a context of diminishing resources.

Most NARIs have failed to develop the enabling environment for scientists needed to spur innovation on a sustainable basis. This has resulted in a decline in the quality of scientific output and a continuing gap between public research suppliers and technology users. Considerable efforts are being made in many countries to increase the responsiveness of NARS to their clients through various approaches. They include: restructuring public sector research institutes and constituting a more broadly based NARS with both public and private agencies, including NGOs and universities; greater involvement of stakeholders in setting the research priorities and financing the research agenda; involving a wider range of institutions, including universities, in the implementation of the research, often through the use of competitive grants; and increasing accountability of the research agencies to the stakeholders (Persley, 1998).

The implications of these trends for the CGIAR are considerable. In the future, the CGIAR and NARIs, and the more broadly based NARS, will require much more complex partnerships with different types of organizations, both public and private. NARS and regional networks will need to assume a stronger leadership role in both applied and strategic activities that generate international public goods. In turn, this will enhance the sustainability of NARS. Higher transactions costs will be involved for all concerned in order to clarify positions and negotiate strategies and priorities.

New Scientific Opportunities: There are major new developments in the social, biological and physical sciences that will contribute to increasing understanding of the causes of poverty, identifying the researchable issues in different environments and customizing solutions to particular situations. They will also enable the CGIAR to support new research to address the previous intractable problems that contribute to low productivity in marginal and hard environments⁴.

Social Sciences: There are important developments in sociology, social geography, anthropology and economics relevant to the future strategy and research priorities of the CGIAR. These include participatory approaches to research planning and priority setting, a better understanding of the decision-making process of individuals and groups in rural communities, bio-economic modeling and the new institutional economics.

Primarily, social science research in the CGIAR needs to focus more on: identifying the characteristics and needs of the ultimate client/beneficiaries, i.e poor farmers and urban food consumers; the institutional arrangements needed to foster social capital creation and activation; improved property rights and custodianship regimes and their management and distributional implications; the motivation behind poor farmers' cropping strategies; the factors of collective action in agricultural, forestry and fish production and marketing; and patterns of community or group-resource management.

The increased interest in social sciences is an important way of expanding knowledge-partnerships in the CGIAR. Research in sociology and anthropology should complement economic research in CGIAR and this socioeconomic research must be linked better, both upstream and downstream, to that in the biological and physical sciences. The CGIAR's social

⁴ Marginal = difficult agroecological environments
Hard = difficult policy and weak institutional environments

researchers also facilitate bringing into the System the new social research and knowledge on poverty worldwide that is needed by the CGIAR to determine its strategy, priorities and research agenda, and to assess its impact.

Modern Biology - Understanding Plant, Animal and Microbial Genes: The 1990s have seen dramatic advances in the understanding of how biological organisms function at the molecular level, as well as in the ability to analyse, understand and manipulate DNA molecules. The entire process has been accelerated by the Human Genome Project, which has invested substantial public and private resources into the development of new technologies for human gene research. The same technologies are directly applicable to all other organisms, including plants, animals and microbes of importance in agriculture and NRM.

Genomics and Bioinformatics: The study of genes involves the rapidly developing field of *genomics*, which refers to determining the DNA sequence and identifying the location and function of all the genes contained in the genome of an organism. The advent of large-scale sequencing of entire genomes of organisms is leading to the identification of all the genes found in many different organisms. This dramatically enhances the rate at which an understanding of the function of different genes is being achieved. This new knowledge will radically change the future of breeding for improved strains of crops, livestock, fish and tree species. Study of the function of different genes shows that similar gene(s) confer the same trait in different species. This will be especially useful in breeding for difficult traits such as drought tolerance. Once a gene has been identified in one species, its functional relative can be found in other species to aid breeding of any species (Meinke and Tanksley, 2000).

The present major technical limitation on the application of modern biology to improving agriculture is an insufficient understanding of exactly which genes control agriculturally important traits and how they bring this about. This is why the new developments in understanding gene function and linking this new information with breeding and genetic resources conservation programmes are so important to the CGIAR

The new scientific developments require diverse scientific expertise and access to biological resources, especially segregating populations for a particular trait. For many important food crops, national and international public-sector research, particularly that supported by the CGIAR, has a large investment in biological resources and a long history of understanding biological function and genotype x environment interactions through long-term international crop improvement programmes. These scientific and biological resources are increasingly important in gaining knowledge about the function of genes and in developing markers for assisting the breeding process. Mobilizing, managing and interpreting this vast body of information requires additional access to, and investment in, a combination of biological and information technologies (termed *bioinformatics*).

Advances in genomics should lead to a rapid increase in the identification of useful traits that will be available to enhance crops, livestock, fish and forests in the future. In animal health, knowledge of the genome of a parasite should assist in identifying essential proteins of the parasite against which an immune response can be targeted and hence may form the basis for effective animal vaccine development.

The new molecular techniques also offer more precise ways to characterize the crop genetic resources collections held by the CGIAR Centres and understand the biodiversity of the agriculturally important species and their wild relatives.

Biosafety: The new developments in biotechnology have also raised a series of issues in relation to the safe use of the new technologies, in terms of human health and the environment. This requires attention to risk assessment and management, and to the development of appropriate biosafety procedures and regulatory systems. CGIAR's research plays a role in assessing the environmental impact of new biotechnologies. The CGIAR Centres adhere strictly to international and national regulations in regard to their work on modern biotechnology, including the release of genetically modified organisms into the environment.

Physical Sciences - Understanding the Environment: There are also important new developments in the physical sciences that match the revolution in modern biology. For example, the development of geographical information systems (GIS) and the explosion of information and communications technologies (ICT) enable masses of location-specific data relating to land management to be assembled in a form that is useful for policy making and other interventions. Remote sensing and other space satellite outputs are providing detailed geographic information that facilitates land-use planning and NRM. The research fields of early warning and monitoring food and natural resource risks, which so closely relate to the causes of poverty, are strengthened through the application of these new physical sciences.

1.5 Towards a Future CGIAR Vision and Strategy

The CGIAR presently invests approximately US\$340 million per year on agricultural and natural resources research, and supports 16 international agricultural research Centres located throughout the world's major regions and agroecological zones. The CGIAR Centres and the NARS are the repository of a vast array of knowledge on the socioeconomic and food policy issues affecting agriculture and NRM as well as the biological resources of the world's major food crops, livestock, fish and tree species, and their associated pests and pathogens. These social, scientific, biological and financial resources are powerful assets. These now need to be developed with the global development and scientific communities in new and imaginative ways, if a quantum leap is to be made in sustainably improving food security and reducing poverty for millions of rural and urban people.

Over the past 30 years the CGIAR has made major contributions to improving food security and reducing poverty. The development of the high-yielding varieties of wheat and rice prevented famine in many parts of Asia in the 1960s and 70s. Globally, food production has kept ahead of population growth, and food prices have fallen over the past 30 years. Improved varieties of the major food crops having better nutritional value and with tolerance to pests, diseases and abiotic stresses continue to be developed by the CGIAR Centres. There are also substantial research efforts to improve livestock production and health, fisheries, forestry, NRM, biodiversity, genetic resources conservation, policies and natural research capacities.

Nevertheless, despite the efforts of national governments and the international development community, there are more than one billion people still living in absolute poverty. The CGIAR proposes new ways of identifying and tackling those problems of poverty that are amenable to research, while continuing to contribute to sustainable increases in global food supplies and improving the management of natural resources, in order to enhance food security.

CHAPTER 2 - THE CGIAR TODAY

2.1 Mission and Goals

The CGIAR System's current *mission* is to contribute to food security and poverty eradication in developing countries through research, partnership, capacity building and policy support to promote sustainable agricultural development based on the environmentally sound management of natural resources (ICW98). Its overarching *goal* is to reduce poverty and protect natural resources in order to achieve sustainable food security (ICW97). The CGIAR's intermediate goals are to increase the productivity of resources in agriculture, forestry and fisheries, and to improve the sustainable management of natural resources.

Over the past 30 years the CGIAR's impact on agricultural development has been achieved largely through yield-enhancing germplasm improvement for the major food crops, complemented by institution strengthening, policy support and NRM research. The impact has been mainly in the more favourable agroecosystems where intensification of agricultural inputs was feasible and the necessary policy framework, institutions and infrastructure were in place. In these relatively well-endowed areas, the CGIAR's contribution played an important role in reducing or stabilizing poverty and promoting food security by enabling agricultural production to stay ahead of population growth (Evenson, 2000; Anderson and Dalrymple, 1998).

The uneven geographic impact and distribution of the benefits of the CGIAR's work has meant that major regions with a high incidence of poverty, notably extensive areas within South Asia and Sub-Saharan Africa, have benefited much less than others from technological advances in sustainable agricultural productivity. The persistent and heterogeneous nature of poverty in these areas, their problematic and often degraded natural resources that affect production potential, and the weakness of their institutions, require a more concerted research and development effort by national governments, the international development community and the CGIAR.

2.2 Rationale/Comparative Advantage of the CGIAR

The original rationale for the establishment of the CGIAR lies in the special nature of international agricultural research and research-related activities. Because agroecological environments transcend national boundaries, international agricultural research can have significant spillover effects resulting in economies of scale that yield significant savings for research systems at national and regional levels. Demand for agricultural research and related activities conducted at the international level derives also from the uneven strength of NARS, a situation that may change over time as the national systems evolve. While the private sector has emerged as a large investor in agricultural research, incentives are not yet sufficient to induce private firms to allocate large resources to improving the crop, animal, fish and tree species and their associated traits that are important to the poor. Private investment is also unlikely to tackle NRM and environmental issues that are of a public goods nature. Emerging IPR regimes and lack of investment and infrastructure in developing countries contribute to reduced access by developing countries to privately developed technologies.

In the absence of more efficient alternative suppliers, the CGIAR works to correct market failure by conducting international agricultural research of benefit to poor farmers and consumers in developing countries. To maximize spillovers across national borders, the CGIAR focuses on strategic research and produces outputs of an international-public-goods nature. This focus, together with its ability to sustain scientific effort and physical presence over a long term, as well as the overall multidisciplinary orientation and scientific excellence of the CGIAR Centres, are comparative advantages of the CGIAR Centres vis-à-vis alternative research suppliers. The CGIAR Centres conduct multidisciplinary research centred on specific commodities, NRM themes and/or farming systems aimed at improving whole production systems in a sustainable manner. The CGIAR Centres collaborate closely with a wide range of partners, especially NARS, NGOs, advanced research institutes, universities and the private sector. To enhance its collaborative efforts the CGIAR actively participates in the Global Forum for Agricultural Research.

2.3 Organization

The CGIAR System's current research focus, mode of operation and global perspective are reflected in its organization, which is based on the concept of the international Centre as the basic organizational unit for conducting international research and research-related activities on a particular commodity, theme or ecoregion. Each Centre is expected to be a *centre of excellence*, politically neutral, with a problem-solving approach, a critical mass of scientific manpower and resources, a multidisciplinary research perspective, the capacity to catalyse and coordinate research on well-focused themes, and the ability to maintain the continuity of effort over the long-term that is needed for success. The international centre concept is complemented by other organizational approaches such as networks, research consortia, collaborative research programmes, Systemwide activities and the outposting of staff to NARS and ARIs.

2.4 CGIAR Research Thrusts

As indicated in section 1.2, the basic assumption of the CGIAR's strategy is that increased productivity and more effective management of natural resources are central to reducing present and future poverty and food insecurity. Better technologies and improved policies and institutions contribute to achieving increased productivity in agriculture. The quality and utility of these instruments can be improved by social and biophysical research of the kind supported by the CGIAR.

The CGIAR strategy includes the following major research thrusts:

Increasing Productivity: The CGIAR strives to make developing country agriculture more productive through genetic improvement of plants, livestock, fish and trees, and through better management practices.

Protecting the Environment: The CGIAR aims to conserve natural resources, especially soil and water, and to enhance the quality of our environment as part of its work on productivity

enhancement and poverty reduction. It is developing new research methods to identify long-term trends in major agriculture, forestry and aquatic environments, and to better manage natural resources in these environments.

Saving Biodiversity: The CGIAR holds in trust for the future large *ex situ* collections of plant genetic resources, containing over 600,000 accessions of more than 3000 crop, forage and pasture species. It is also actively contributing to research on biodiversity of animal, tree and fish species, and develops methods for *in situ* conservation.

Improving Policies: CGIAR policy research aims to improve policies that enhance food security, and encourage the adoption and dissemination of new technologies and the improved management and use of natural resources.

Strengthening National Research: The CGIAR works with developing countries in strengthening national research capacities.

2.5 Challenges of the CGIAR

The CGIAR's strengths lie in its strong mission and problem-solving orientation, its human capital, excellence in science and its ability to sustain a critical mass of effort over the long term. Other strengths are its international and apolitical nature, its broad research agenda, the comprehensive *ex situ* collections of genetic resources, and the location of its institutions throughout the major agroecological zones.

The less effective aspects of the CGIAR System are the relatively limited impact of new technologies in the marginal environments; the lack of critical mass in some areas of modern biological, physical and social sciences; some heterogeneity in the quality of science; insufficient regional commitment; dispersion of effort in certain undertakings; and the difficulties in developing common policies and a common voice on key issues in the international community, such as intellectual property.

The CGIAR also needs to respond more nimbly to the challenges of the evolving external environment, the broader natural resources and social agenda, and the need for new types of partnerships with the private sector, NGOs and development institutions.

CHAPTER 3 - FUTURE VISION, GOAL AND MISSION FOR THE CGIAR

The CGIAR will develop a two-pronged approach for the future in support of research and research-related activities to contribute both to the reduction of poverty and to improving food security. This will entail support for research on agriculture and natural resources to address the needs of the poor in the more favoured environments, to ensure food security and prevent future poverty, while at the same time tackling the more complex problems of poverty in the marginal and hard areas. This strategy entails more accurate targeting of people's needs, taking into account gender, and assessing how CGIAR-supported research can meet these needs. The CGIAR will focus on the rural and urban poor, including farmers, farm labourers, fishermen and poor urban consumers.

The CGIAR needs to derive its research priorities by looking at how the rural and urban poor earn their livings. This will require not only ensuring continuing yield and productivity gains in staple food crops, livestock and fish species, but also customizing agricultural technologies to optimize income and employment generation in the rural sector. It will also require the CGIAR to address new issues of food quality and safety, and develop more integrated approaches to NRM. These issues will be further elaborated in the development of the future research agenda of the CGIAR.

This strategy also requires more efficient and effective deployment of CGIAR resources to address the multiple dimensions of the poverty and sustainable food security challenges. The first step in the process will be to sharpen the poverty focus of the CGIAR's work with a view to addressing the problems of the very poor people where they live.

In the context of the above, the CGIAR will adopt as its strategic framework the following new vision, goal and mission:

Vision: *A food secure world for all.*⁵

Goal: *To reduce poverty, hunger and malnutrition by sustainably increasing the productivity of resources in agriculture, forestry and fisheries.*

Mission: *To achieve sustainable food security and reduce poverty in developing countries through scientific research and research-related activities in the fields of agriculture, livestock, forestry, fisheries, policy and natural resources management.*

⁵ Food security refers to access at all times to sufficient nutritionally adequate and safe food (FAO 1996). The CGIAR defines poverty as a multidimensional concept that includes income below a poverty line and lack of satisfaction of basic needs such as water, health and education, as well as quantitatively and qualitatively inadequate nutritional standards.

The above framework is comprised of a set of related goals:

- At the apex, a *food-secure world for all* is identified as the CGIAR's ultimate vision, making explicit its global scope and hence the rationale for conducting international public good research as well as the focus on benefiting the poor.
- To reduce *poverty, hunger and malnutrition*, the CGIAR will pursue the goal of fostering *the sustainable increases in the productivity of natural resources* which are needed to improve the livelihoods of the rural and urban poor.
- Finally, the CGIAR's vision and goal will be realized through *scientific research and research-related activities in the fields of agriculture, forestry, fisheries, policy and management of natural resources* drawing upon its unique role and strength as a knowledge-based organization.

The scientific, institutional and policy outputs associated with this framework are, by themselves, insufficient to achieve the CGIAR's vision and goal. It is their dissemination and uptake by farmers, national research systems, civil society, private sector, policy makers and governments in developing countries that will be required to achieve the vision of a food-secure world. This will require the CGIAR to work more closely with other components of the development spectrum in determining its research priorities and in ensuring the dissemination of its research outputs. These outputs will be essential tools for promoting sustainable agricultural development, and hence in reducing food insecurity and poverty in a broad range of environments.

Recognizing that the CGIAR's comparative advantage lies in international agricultural research, in its activities the CGIAR will seek to complement the efforts of other organizations working in rural development and related sectors, particularly those of health, education, nutrition, infrastructure, the environment, and social and economic policy.

CHAPTER 4 - FUTURE CGIAR STRATEGY

4.1 Introduction

The two-pronged approach for moving the CGIAR toward its agreed-upon vision and goals, as outlined in Chapter 3, involves the integration of seven planks into a cohesive operational strategy. The first and most fundamental plank is to **focus the CGIAR's agenda on the reduction of poverty, hunger and malnutrition**. This will involve a shift in research priority setting and planning that moves from determining priorities on the basis of commodities/crops to sustainable poverty reduction and prevention. Thus, priority setting, planning, and project and programme design need to look at research priorities, opportunities and objectives through a poverty 'lens' rather than a commodity 'lens'. This creates a fundamentally different strategic approach to research in the CGIAR. Successful implementation of this poverty-focused strategy depends on a second strategic plank, namely, use of the **best and most relevant science** available to address poverty related to agriculture and natural resources.

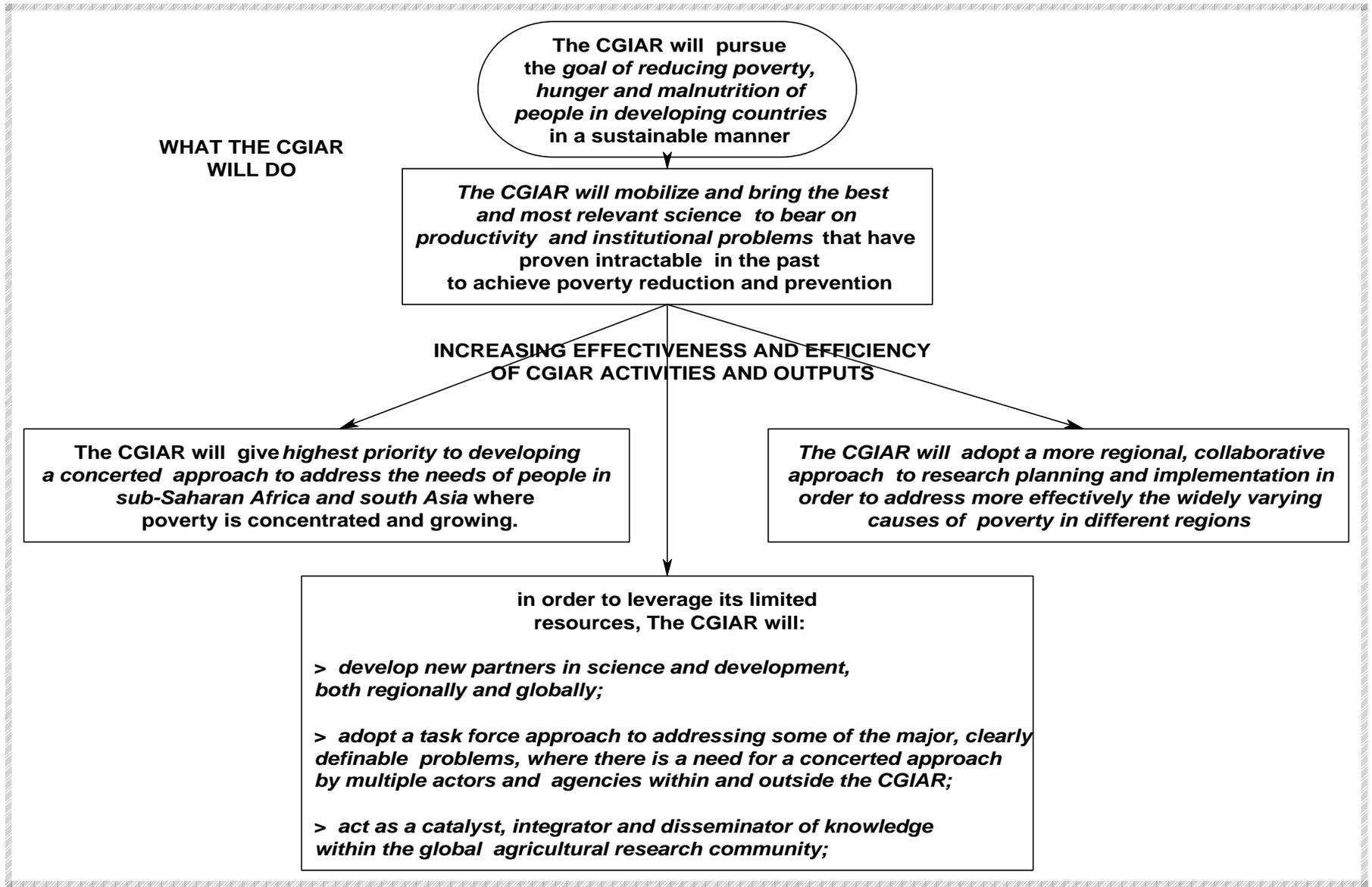
A focus on the objectives of increasing efficiency and effectiveness leads to five additional strategic planks. These are:

- The CGIAR will give highest priority to **developing a new concerted approach to addressing the research needs of South Asia and sub-Saharan Africa** where poverty is concentrated and growing, and where the CGIAR can have a major impact via technological breakthroughs and ensuring the sustainability of natural resources given the appropriate policy and institutional environment. This is aimed at increasing the efficiency with which the System spends its resources. The argument is that the CGIAR should be giving highest priority to areas where the greatest absolute numbers of poor live and where the severity of poverty is greatest, and where new technologies and policies will have maximum impact.
- In order to address more effectively the regional heterogeneity of the causes of poverty in the regions, the CGIAR, in close collaboration with its partners, will **adopt a stronger regional orientation in its research planning and implementation**.
- The CGIAR will **diversify and expand its partnerships** to ensure that its limited resources are effectively used to address the problems of the poor.
- For some specific global or cross-regional issues, the CGIAR **will use a task-force approach** to the organization and delivery of its products and services.
- The CGIAR will play **stronger facilitating and catalytic roles** within the overall global agricultural research system.

In sum, seven strategic planks have been identified that underlie the strategy outlined above to focus on poverty reduction and prevention, using the best and most relevant science in the most effective and efficient ways possible.

The overall strategy is disaggregated below to explain each of the seven planks underlying it (see Figure 4.1). Based on the planks, efficiency and effectiveness criteria can be derived to guide the analysis of the desirable programmatic changes needed to implement the CGIAR research agenda.

Figure 4.1. Planks in TAC's New Strategy for the CGIAR



4.2 Seven Strategic Planks

The future strategy to address the vision, goal and mission of the CGIAR contains seven key components. These strategic planks are:

1. *People and Poverty Focus*: Focus the CGIAR research agenda on people and the reduction of poverty, hunger and malnutrition in developing countries.
2. *Modern Science*: Mobilize new developments in social, biological and physical sciences to address the priority researchable issues.
3. *Geographic Priorities*: Give highest priority to developing a concerted approach to address the research needs of Sub-Saharan Africa and South Asia.
4. *Regional Approach to Priority Setting and Research Implementation*: Adopt a regional approach to research planning and implementation, and integrate this with global priority setting.
5. *New Partners in Science and Development*: Seek new partners for problem identification, research and dissemination of research outputs.
6. *Task Forces*: Use task forces to address priority problems in new and flexible ways.
7. *Catalytic Role*: Strengthen the role of the CGIAR as a catalyst and integrator of knowledge in support of NARS and the global agricultural research system.

The rationale and implications of the seven planks are discussed in the following sections. Planks 1-4 have programmatic and investment implications for the CGIAR and its research agenda. Planks 5-7 relate to the more efficient implementation of the CGIAR's research agenda. Achieving an impact on poverty with the greatest efficiency and effectiveness possible in a given national and regional context is likely to require the introduction by the CGIAR of a number of new institutional mechanisms and reorientation of others that have been used in the past. These are discussed further in Planks 5-7 below.

Plank 1 - People and Poverty Focus: The CGIAR reaffirms its goal of reducing poverty, hunger, and malnutrition of people in developing countries.

One of the most direct and pervasive causes of food insecurity is rural and urban poverty, and the related inability to produce and/or purchase food. Thus, the purpose of the CGIAR is to identify the researchable issues associated with the causes of poverty and food insecurity related to agriculture and natural resources, and the scientific developments that can be used to help bring people out of poverty and prevent them from slipping back into it.

Given the likely future resource availability in relation to the magnitude of the problems and opportunities that exist, a guiding principle in developing future priorities and strategy for the CGIAR is the need for the CGIAR to become more efficient and effective in achieving an impact on poverty.

Plank 2 - Modern Science: Mobilize the new developments in social, biological and physical sciences so as to bring modern science to bear on the often difficult-to-address causes of poverty and food insecurity, related to production and institutions, that have proven to be intractable in the past.

New developments in modern biology offer opportunities for improving the sustainable productivity of agriculturally important species of crops, livestock, fish and trees, and controlling their associated pests and pathogens. They also offer more precise ways to characterize and conserve agricultural biodiversity. Efficiency in breeding new varieties of crops, livestock and fish, and in addressing complex traits such as drought tolerance will also be greatly increased.

The management of natural resources (soil, water, rangelands, trees, fish, coastal environments) clearly has social and behavioural components, an understanding of which is indispensable in orienting biophysical research to these resources. Behavioural and sociocultural variables of resource management are no less important for resource sustainability than physical parameters. These variables require in-depth exploration through the use of social science research methods. The CGIAR will need to pursue more vigorously and consistently an integrated and high quality social and biophysical research approach to NRM.

A stronger capacity in modern social and economic sciences will amplify CGIAR research and policy effectiveness. The development of modern domains and new social and economics investigation methods holds promise for multiplying the effects and usability of the Centres' technological findings. Participatory approaches to research will also improve the understanding of human, social and institutional capital, and their dynamics that will strengthen understanding of community management of common property resources.

To realize the full potential of modern science, the CGIAR must integrate the biophysical, social and policy components of its research and bring them to bear on problems of the poor at regional and local levels. This entails three essential components: (1) maintaining high scientific quality and expertise in relevant disciplines, (2) using the most appropriate scientific methods, and (3) forging new partnerships and institutional arrangements that ensure accountability for contributing to poverty reduction and food security in priority regions. The need to engage the private sector and to address IPR issues in a more systematic way reinforces the rationale for an integrated approach.

Plank 3 - Geographic Priorities: In determining the relative geographic priorities, the CGIAR will give highest priority to developing a concerted approach to address the needs of people in sub-Saharan Africa and South Asia where poverty is concentrated and growing.

In order for the CGIAR to increase its impact in the most efficient and effective way possible, it should focus its activities on those regions with the highest incidence of poverty and absolute numbers of poor people, and where the CGIAR can have a major impact via technological breakthroughs and ensuring the sustainability of natural resources, given the appropriate policy and institutional environment. These areas include particularly South Asia and sub-Saharan

Africa. There are also substantial numbers of poor people in East Asia, especially China, and in parts of Latin America and West Asia/North Africa, who will also be the target of CGIAR research.

The role of the CGIAR in these various geographic regions will differ, depending on the extent of the problems of poverty and food security, the likelihood that they can be addressed through research and the strength of the NARS. In countries where there is a strong national research system the role of the CGIAR may be more that of a catalyst and link with international activities and knowledge than in the conduct of research programmes themselves.

Plank 4 - Regional Approach to Research: Adopt a regional approach to research planning and implementation in order to address the heterogeneous nature of the causes of poverty and food insecurity in different regions and integrate regional priorities with global priorities in international agricultural research.

The causes and appropriate means of reducing poverty and improving food security depend on the heterogeneous regional, social and institutional contexts within which poverty exists. Contributing through research to reducing poverty will depend on identifying researchable issues, and developing appropriate technologies and positive institutional and social environments in the regions where the poor live. Thus, the CGIAR should adopt a regional approach to research planning, priority setting and research implementation to complement its global approach to priority setting in order to increase the effectiveness with which it addresses the heterogeneous nature of poverty in different geographic regions. This will be particularly important where comprehensive development efforts are needed in order for agricultural innovations to have an impact on poverty.

The present priorities of the CGIAR have been determined more on the basis of commodity and activity than on reducing poverty and improving food security. Social science concepts and methodologies can assist in setting and pursuing the research priorities that will have most impact on poverty and food insecurity, and in customizing the resulting technologies to particular situations.

Plank 5 - New Partners in Science and Development: Give increased emphasis to seeking new types of partners and using new forms of partnership to improve the efficiency and effectiveness of problem identification, research, and dissemination of research outputs for poverty reduction and food security.

There are a range of agencies and organizations involved in poverty reduction and food security issues that go far beyond the groups traditionally involved in agricultural research. Further, within agricultural research, different actors are coming to the forefront, with increasingly important roles being played by the private sector, NGOs and advanced research institutes in developing countries with state-of-the-art equipment, facilities and highly qualified scientists. The CGIAR needs to work in different ways with a spectrum of new partners to help ensure effective and coordinated continuum from research priority setting and planning, to the research

itself and through to the application of results and their ultimate impact on the poor. FAO, UNDP and the World Bank as Cosponsors, of the CGIAR, could play an important role in strengthening the research/development interface for the CGIAR Centres with national governments, civil society and the private sector.

Plank 6 - Task Force Approach: The CGIAR will adopt a task force approach to address major, clearly identifiable problems where there is an opportunity for an impact to be made and/or where there are intractable problems that need a concerted approach by multiple actors and agencies within and outside the CGIAR System.

The complexity of the poverty and food-security challenges in the coming decades is such that research problems will become increasingly complicated in terms of their demands on science, and increasingly urgent in terms of the need for rapid response and effective impact on the poor and hungry of the world. No single institution will possess the range of instruments and flexibility needed to tackle such problems effectively.

The CGIAR has developed many different modes of operation in organizing its activities and its partnerships to achieve effective impact both at Centre level and Systemwide. In addition to those already effectively in use, the CGIAR should use task forces to address priority issues in new ways. A task-force approach would provide a means of bringing together a critical mass of diverse expertise and resources within and beyond the CGIAR System. This approach complements the international centre concept as an organizational model to facilitate inter-Centre collaboration and partnerships with other important entities. Such task forces need to be managed and to have clearly defined objectives, outputs, scientific and financial resources, timeframes and accountability mechanisms.

Plank 7 - Catalytic Role: Strengthen the role of the CGIAR as a catalyst, integrator and disseminator of knowledge within the overall global agricultural research system.

The CGIAR should intensify its efforts to act as a catalyst, integrator, organizer and disseminator of knowledge and research in support of the NARS. In partnership with other sources of expertise the CGIAR needs to increase its involvement in such functions.. The major focus should be on issues important to NARS and on the changing external international environment. These include issues related to genetic resources conservation and characterization, bioinformatics, IP, ICT and knowledge management. The CGIAR Centres may also facilitate greater linkages between the NARS and the research institutions in industrial countries concerned with international agricultural research, such as those in Europe, North America, Japan and Australia. In this way, the CGIAR's investment in research could be combined with those of others to support the development of a global system for international agricultural research.

CHAPTER 5: THE CGIAR FUTURE RESEARCH AGENDA

5.1 Introduction

In the light of the future CGIAR Vision and Strategy, and its seven key components, the research agenda supported by the CGIAR will evolve to address the new strategy and its focus on poverty reduction and food insecurity. The proposed research agenda includes both future priority areas requiring additional support and also areas where less effort is warranted due to changing priorities, or the availability of alternative providers amongst NARS, agricultural research institutes and/or the private sector.

The future research agenda will be influenced by the causes of poverty and the difficulty for the poor in making a livelihood. There are also major trends in agriculture, NRM and the environment. These include:

- a slowing down in yield increases for the major food crops, especially cereals;
- increasing environmental pollution caused by agricultural chemicals;
- diminishing availability of land for agriculture due to increasing urbanization;
- expansion of agriculture into marginal lands;
- scarcity of water for human consumption and agriculture;
- increasing problems with drought, floods, salinity, poor soils and desertification;
- a reduction in forested areas due to slash and burn agriculture, urbanization and rising demand for timber;
- threats to biodiversity;
- increasing demand for livestock products, due to changing dietary preferences of urban dwellers as incomes rise;
- increasing demand for fish, resulting in the rapid depletion of fish stocks.

5.2 Criteria for Choice of Research Themes

The criteria used for making strategic choices amongst research themes are consistent with those employed by the CGIAR in recent years in developing the priorities and strategies that currently guide the System. The criteria assume that, given limited resources, the CGIAR's priority setting should be based on the principles of effectiveness and efficiency in implementing the System's mission and achieving its goals. The four criteria used to assess opportunities for strategic choices in shaping the CGIAR's future research agenda are:

- contribution to the CGIAR's goals;

- production of international public goods;
- probabilities of success and cost effectiveness;
- alternative sources of supply and comparative advantages.

Contribution to the CGIAR's Goals: This criterion requires *ex ante* assessment of the potential impact of the products of international public goods research over the next 10-20 years on the CGIAR's goals of contributing to poverty reduction and sustainable food security. The broader the use and the greater the positive impact of using the international public goods, the greater the returns on the CGIAR's investments in the underlying research.

International Public Goods: The CGIAR focuses on the production of international public goods, i.e. goods which are non-exclusive in access and non-rival in use. The comparative advantage of the CGIAR derives partly from the fact that private firms operating through markets have limited interest in public goods since they do not have the capacity to capture much of the benefit through proprietary claims. Given that the private sector is unlikely to invest in such goods, socially desirable levels of investment in them can only be elicited from the public sector. National governments invest in public goods, but primarily in those whose benefits remain within national boundaries. The CGIAR investment in developing international public goods can complement investment by both the private sector and national governments.

Probabilities of Success and Cost Effectiveness: The differing probabilities of success within given time frames are of major importance in assessing the CGIAR's relative priorities. The probability of success will be affected by the pace of discovery in the science, likely progress in pursuing various research objectives, the quality of information available, the rates at which technologies may be adopted, and the utilization and value of products emerging from the research programmes.

Alternative Sources of Supply and Comparative Advantages: Efficiency considerations have major implications on whether an activity is within or outside the CGIAR's research agenda. To the extent that the outputs can and would be produced more cost-effectively by alternative sources of supply, efficiency considerations may well require that other providers produce them. This also requires a continuing assessment of trends in external environments likely to influence the CGIAR's comparative advantages and those of its partners.

Logframe Outputs, Evaluation and Monitoring of Science Quality

The CGIAR presently prioritizes its activities and allocates its resources in terms of the following logframe outputs:

- germplasm collection, characterization and conservation;
- germplasm improvement;
- sustainable production systems through integrated NRM;
- socioeconomic and policy research;
- enhancing institutions.

This generic partitioning of outputs is taken as the basis for analysis and the four broad criteria described above are applied to assess opportunities for improving effectiveness and efficiency of research in the CGIAR System. This needs to be combined with transparent and well-defined monitoring and evaluation of outputs and science quality, benchmarking of the CGIAR System's components, regular assessments of Centre programmes and management, and impact assessment.

5.3 CGIAR Research Agenda: Strategic Choices

5.3.1 Germplasm Collection, Conservation, Characterization and Distribution

The CGIAR Centres hold in trust some 600,000 accessions, the world's largest *ex situ* collection of genetic resources of crop, forage and agroforestry species. The *ex situ* collections themselves, and the value-adding work done by the CGIAR Centres through characterization, evaluation and enhancement, are some of the most important CGIAR-supported activities of an international public goods nature. Recent scientific developments also offer new opportunities for the characterization of the germplasm at the molecular level and the identification of potentially useful genes for use in germplasm improvement programmes.

The future priorities for the CGIAR System in relation to germplasm collection, conservation and characterization are in the areas of:

1. Technical and policy advice to governments on the role of multilateral systems of germplasm exchange for agriculturally important species.
2. Conservation and characterization of *ex situ* collections of plants and microorganisms.
3. Development of methodologies for *in situ* conservation and characterization of other agriculturally important species of crops, livestock, fish and trees.
4. Molecular characterization of the genomes of the agriculturally important species.

Multilateral Germplasm Exchange Systems: The stewardship of the international collections, including modalities for access and sharing the benefits arising from their use, is being renegotiated in the FAO Commission on Plant Genetic Resources within the context of a revised IU on Plant Genetic Resources for Food and Agriculture. Simultaneously, national legislation regulating access to genetic resources is being prepared by many national governments. A policy environment is needed that will permit continued unrestricted movement of germplasm of the agriculturally important species and their wild relatives, and an assurance that international agricultural research centres will be able to continue to generate and distribute germplasm-based international public goods.

The task of the CGIAR Centres, particularly IPGRI, is to facilitate negotiations on international undertakings by providing technical analysis and relevant information to national and regional country partners and in international public fora. The responsibility of member governments of the CGIAR is to adopt consistent negotiating positions in intergovernmental fora to facilitate the continued international exchange of germplasm for agricultural purposes and support the role of

the international agricultural research centres in an agreed multilateral system for germplasm exchange.

Conservation and Characterization of ex situ Collections of Plant and Microbial Genetic Resources: A review in 1998 of the *ex situ* plant genetic resources collections held by the CGIAR Centres estimated that it would require about US\$20 million to upgrade the present genebanks and characterize all accessions, and thereafter US\$7 million per year to maintain them. In addition, there are other international collections of agriculturally important micro-organisms that also need to be adequately characterized and conserved. Associated research to improve the efficiency of *in vitro* conservation, especially for vegetatively propagated species, is also of high priority.

In Situ Conservation: New methodologies for *in situ* conservation are also required. Such methodologies are especially important for tree species, farm animals and wildlife that cannot be conserved easily *ex situ*.

Characterizing biodiversity through genome mapping: Comparative genetics can enhance the utilization of genebank collections. The CGIAR Centres have an opportunity of becoming important players in this field by working in partnerships with others to take advantage of the latest technologies in genomics research to apply comparative genetics to the germplasm collections held in trust. Additional investment by the CGIAR and others in comparative genetics of agriculturally important crops will ensure that the results and benefits are available as international public goods.

Bioinformatics and the CGIAR Centres: The CGIAR should make a System-wide investment in bioinformatics to ensure access to major public bioinformatics databases and tools and to encourage the standardization required for effective comparative genetic studies.

The CGIAR Centres have gathered a huge resource of phenotypic data through their germplasm collections, and the crop improvement and international testing programmes conducted over the past 30 years. Research in molecular biology, genome sequencing, functional genomics and comparative genetics are producing large amounts of new genomic data. Bioinformatics is essential for the management, integration and analysis of phenotypic and genomic data if the promise of these aspects of molecular biology for genetic improvement is to be realized.

The CGIAR Centres have a unique role to play in the design and deployment of a bioinformatics system for use by the Centres and their collaborators. The CGIAR Centres need to work together with advanced research institutes and NARS partners to develop, deploy and extend an integrated bioinformatics system for the major food species. This will require new investments, new skills, and innovative organizational arrangements that cut across traditional commodity, discipline and Centre responsibilities. New, long-term international initiatives involving the public and private sectors are required to generate the appropriate knowledge databases containing the molecular characterization of agriculturally important species and their wild relatives amongst plant, livestock and microbial genetic resources.

Sustainable Finance: The *ex situ* collections and the biological information pertaining to them are a vast resource for genetic studies and the identification of useful traits. There is an urgent

need to ensure that the genetic resources collections of the agriculturally important species of crops, livestock and micro-organisms are financed in a more sustainable way than by the present annual budget allocations. Innovative financing mechanisms including the possibility of endowments and other multi-year funding mechanisms, would help to ensure that the genetic resources of the world's agriculturally important species are conserved, characterized and available in perpetuity. Similar financing mechanisms could also be used to stimulate the genomic mapping and gene identification in agriculturally important species in order to identify potentially useful genes and to make this knowledge available for use in improvement programmes.

5.3.2 Germplasm Improvement

Strategic Focus: The researchable issues relate to ensuring the continuing availability of sufficient nutritious food at affordable prices. This will require increasing the production of the world's major food commodities in crops, livestock and fish. This includes both improving yield potential and alleviating the biotic and abiotic stresses that constrain present production of the most important species. The associated and equally important sustainability issues include ensuring the conservation and sustainable use of the natural resource base for agriculture, i.e. land, soil, water and forests.

The future challenges posed by poverty and food insecurity necessitate strategic choices in terms of the researchable issues to be addressed, the commodities on which the System will work, the breeding methods and tools it will employ to improve those commodities, and the partnerships, alliances and collaborative arrangements it will forge to achieve its objectives most efficiently and effectively.

In terms of germplasm improvement, the key elements that will affect these strategic choices include the extent of the problems in particular commodities, advances in science, changes in the research capacity of NARS, involvement of the private sector, and issues of IPR and bio-safety. The opportunities made possible by these elements will shape the CGIAR's choice of target commodities, the specific traits selected as breeding objectives and its comparative advantage vis-à-vis alternative suppliers.

Crops: Twelve crops provide approximately 90% of the food in the developing world. They are: rice, wheat, maize, sorghum, barley, cassava, millets, oilseeds, banana/plantain, potato and sweet potato. There will be a continuing need to work on improving the productivity of these major staple crops as they will remain the most affordable sources of calories and protein for poor consumers. Improving the sustainable productivity of the major staple food crops is a critical component for achieving food security by 2020.

The problems to be addressed are: improving the yield potential, (for example, through new plant types in cereals), relieving the major biotic stresses (pests, diseases and weeds) and abiotic stresses affecting their production (drought, salinity and heat/cold tolerance), especially in the priority farming systems of Sub-Saharan Africa and South Asia. There is also a need to improve the nutritional content of some staple foods such as rice without imposing a yield penalty.

Improving postharvest quality and tolerance to postharvest pests is also a requirement for some commodities.

These are complex and multifaceted targets for crop-improvement programmes, especially those addressing traits of most importance to the poor. Priority traits for individual crops need to be developed on a case-by-case basis, taking account of the relative priority of the constraints in the target geographical areas and farming systems. Addressing these priorities then requires the use of modern plant breeding techniques and collaboration between national and international breeding programmes and advanced laboratories.

The new developments in genomics are showing that the genes controlling many traits are conserved across species. The use of new knowledge on genetic similarities across species will require much greater inter-Centre collaboration in crop improvement in the future and more international collaborative programmes on comparative genetics and functional genomics to identify useful alleles and genes controlling important traits for use in plant breeding programmes. Such collaboration could also make greater use of the location of the CGIAR Centres in the centre of origin of the agriculturally important commodities and their wild relatives.

The future comparative advantage of the CGIAR Centres lies in harnessing these new developments in genetics and modern plant breeding and applying them to the major food crops and the 'orphan' commodities of the developing world. Closer collaboration and increasing partition of international responsibilities with strong national plant breeding programmes are required to ensure that new genetic sources of tolerance to biotic and abiotic stresses, and other desirable traits, are introduced into the appropriate locally adapted varieties and evaluated in genotype x environment trials.

In regard to poverty reduction, other commodities are likely to emerge in different regions as having high income potential for rural communities. These include horticultural crops (e.g. vegetables, fruits, spices and ornamentals) tree crops (e.g. cocoa, coffee and coconut) and the so-called 'minor crops' (e.g. other millets or mung beans). Horticultural crops have significant potential for increasing rural incomes and non-farm employment through postharvest processing, which are key elements of the CGIAR's strategy for poverty reduction. Tree crops are important components of smallholder farming systems throughout the humid tropics of sub-Saharan Africa and South Asia. Indeed, minor crops can play an important role in ensuring the food security of poor farmers in certain sub-regions.

The opportunities and constraints affecting the production of horticulture and tree crops will need to be analysed in regions where they are identified as priorities and strategic international research opportunities requiring CGIAR support are identified. IPGRI's achievements and experience gained in support of international networks on banana and plantain, coconut and tropical fruit; that of AVRDC with vegetables; that of IITA, ICRAF and CIFOR with tree crops; and that of CABI with pest and disease control in cocoa and coffee should be drawn upon in determining the future role of the CGIAR in supporting additional research on these commodities.

Livestock production and health: Livestock are an important source of food, fuel and savings for large numbers of poor people in developing countries. They also provide traction and manure which are indispensable for many current cropping systems. The further integration of animals into cropping and forestry systems will improve sustainability, even out cash flows and reduce risks: all major benefits to poor producers. New, adapted grass and legume species have a proven role in the recuperation of degraded lands. A dramatic rise in demand for livestock products is predicted in developing countries as incomes rise and urbanization continues. A recent study estimates that livestock production in developing countries will need to double by 2020 to meet rising demands for meat, milk and eggs (Delgado *et al*, 1999). This offers new opportunities for income generation, both from domestic and international markets. Since animals are to be found on small farms throughout the developing world, this will have a favourable equity impact.

In order for producers to take full advantage of rising demands and achieve the necessary production increases, there will need to be an increased research effort and additional investment on the main constraints to livestock production in developing countries. New research is required on market-oriented production systems and on the problems associated with intensification. The role of ruminants (cattle, buffalo, sheep and goats) will continue to be important. Milk is an important source of nutrients and income for women and children. Non-ruminant (pigs, poultry) production is expanding rapidly and these species are key sources of income for poor farmers in Asia. These species are also important in intensive, privately financed production systems based on imported technology.

The risks associated with the consumption of food of animal origin are the subject of debate in temperate countries. There is broad consensus that increased intake of animal products will be nutritionally beneficial in the developing world, given the widespread existing deficiencies of calories, protein and micronutrients. The risks associated with animal production, such as the spread of disease, contamination from wastes, loss of biodiversity and other environmental damage, must be fully recognized and addressed as systems intensify and global trade increases.

The main constraints to livestock production in the developing world are the supply of nutrients (including water) of adequate quantity and quality, disease, genetics and management. Research in these areas must be complemented by research on production systems, with special reference to crop-livestock integration, and policy for sustainable livestock development. In the area of ruminant nutrition, the major problems relate to balancing diets based primarily on crop residues and forages, so as to ensure adequate nutritional levels throughout the year, particularly in the dry season. For non-ruminants, the replacement of cereals by locally available feeds is a critical area. The research needs of the small producer in this area are unlikely to be covered by the private sector.

Modern biotechnology offers new opportunities for the characterization of livestock germplasm. This work will be expanded to cover traits in traditional crops that are useful as animal feed. There is also a need for further genetic characterization of livestock breeds to facilitate identification and conservation of breeds under threat.

The main diseases affecting livestock in the developing world are largely absent from the industrial world, resulting in relatively limited research activity. The important diseases include

the epidemic viral diseases (foot and mouth, and rinderpest); the endemic diseases carried by ticks (theileriosis, cowdriosis, anaplasmosis, babesiosis); the tsetse-borne disease trypanosomosis; and bacterial diseases that cause pleuropneumonia. Sheep and goat productivity is significantly constrained by haemonchosis, a helminth infestation.

For some diseases, such as foot and mouth and rinderpest, effective control measures are available. For others, such as the tick and tsetse-borne diseases and bacterial pleuropneumonias, control measures are unavailable, ineffective, environmentally damaging or too expensive for smallholder producers. These diseases require additional international research investment to develop more effective control measures. New scientific developments in immunology, genetics and genomics of both the pathogens and their hosts offer opportunities for developing new vaccines, chemotherapeutics, diagnostics, and disease-resistance and epidemiological tools to address previously intractable problems. These may be achieved most efficiently through international collaboration to mobilize the best available scientific resources worldwide to address specific components of an overall strategy. Spillover with human health issues should also be explored in order to obtain new scientific and financial resources.

Fisheries and Aquaculture: Evidence and public awareness of the effects of overfishing and the limitations to harvests from marine and freshwater systems have increased in recent years. Aquaculture has also experienced an unprecedented boost, representing the fastest growing agricultural industry in some developing countries.

Issues of increasing prominence are: degradation of aquatic resource systems due to land-based activities; competition for water and coastal space; multifunctional uses of aquatic resource systems; management and governance of aquatic resource systems; linkages between the private and public sectors with respect to markets and the ownership of rights to germplasm; linkages between fisheries and aquaculture as a result of fishmeal availability and price; world fish supply and demand; and the role and contribution of women in fisheries.

The most important concerns for the future include: sustaining aquatic environments to stabilize or augment production levels for human food; protecting the aquatic biodiversity on which future productivity depends; and integrating the biophysical, socioeconomic and policy elements of aquatic resources management. These key areas must be addressed against a background of increasing global concern and dispute about rights over genetic resources, the effects of intermittent or long-term climate change, a widening gap between the rich and poor, increasing globalization and changing development paradigms.

In the light of this analysis, the CGIAR's research portfolio in the medium-term will need to encompass aquaculture and fisheries, and living aquatic resources management. Research thrusts will need to expand from ponds, coral reefs and coastal waters to freshwater systems, namely lakes, small bodies of water and floodplains. The geographic focus will continue to be on Asia, Africa and the developing small island states of the Indo-Pacific and Caribbean.

Fish genetics will also require increased links with advanced institutes with expertise on genetic marker technology for aquatic species and quantitative genetics. Priority traits include fast growth, resistance to diseases and to particular environmental conditions, and high survival rates.

Morphological characteristics may also be of regional importance. Carp and tilapia are the most important species for germplasm improvement but experiences with genetic markers can be applied across species.

An ecosystem approach is currently used to formulate integrated models for management and governance of whole resource systems. For the CGIAR, there is also a priority to pursue aquatic genetic research that addresses critical issues in aquatic biodiversity. The research outputs will be shared globally as international public goods in the form of new knowledge, databases and models, improved germplasm and aquaculture practices, and underpinning generic fisheries research.

Forestry and Agroforestry: On looking at the land-use continuum from natural forest through woodlands on to farms with a few trees providing various inputs for farmers, it can be seen that forests and trees contribute to poverty reduction and prevention, and to food security and environmental enhancement in a number of ways. Examples of the contribution of trees and forests to the CGIAR's goal and to implementing the TAC strategy include: (1) providing food directly from forests to supplement agricultural food outputs, e.g. through forests acting as living environments for animals providing bush meat, and fruits, nuts and other edible forest products; (2) providing fuelwood (and charcoal) which makes it possible (through cooking) to digest grains and other foods that uncooked would provide little nutrient value (e.g. millet in the Sahel); (3) providing income through the harvesting of wood and non-wood forest products, and sometimes through their processing, to generate income, e.g. furniture, housing, etc; (4) making marginal lands more productive for food production through application of agroforestry technologies (nitrogen fixation, green manure, fodder and shade for livestock, living fences, etc.); and (5) protecting the watersheds that contribute to downstream agriculture by regulating the water flow and quality that directly affect irrigation options.

Thus, research related to trees and forests has direct relevance to achieving the goals and implementing the strategy adopted by the CGIAR. Programmatically, most of the key research themes required for sustainable poverty reduction and prevention are being addressed within the System – various aspects of agroforestry, non-timber forest products, tree improvement and domestication, forest policy, watershed-management issues and needs. However, the increased stress on poverty reduction will probably lead in the future to some shifts in emphasis and more work related to forest-based employment, postharvest technologies, production to consumption systems based on the forest economy, and linkages between forests and agriculture, e.g., through such programmes as the Alternatives to Slash and Burn (ASB).

5.3.3 Sustainable Production Systems through Integrated Natural Resources Management

Poverty alleviation and sustainable food security for the rural and urban poor depend directly on the health of the environment and the sustainability of the natural resource base on which food, feed and fibre production depend. Such resources include, among others, forests and trees, soils, water and fauna. Thus, *conservation and enhancement of natural resources and protection of the environment are central and legitimate themes for CGIAR research today and into the future.*

While central to its core research agenda, there are limits to how much and what type of NRM research the CGIAR should support. Priorities can be determined based on the following five principles:

(1) *The CGIAR should concentrate on NRM research that contributes to productivity enhancement and sustainability of natural resources for production of crop, livestock, forest and fish outputs that have impacts on poverty reduction and food security, giving appropriate consideration to inter-generational equity of benefits.*

This principle should be a necessary condition for undertaking NRM research in the CGIAR System. It derives from the fact that priority should be given to research directly related to the mission and goals of the System. Effective management of the natural environment is an activity pursued by many organizations for many different and legitimate purposes, including global climate change, wildlife management, ecosystem health and recreational purposes. Given the competence and large numbers of alternative suppliers, the CGIAR should pursue only those activities that are targeting sustainable productivity improvements. In some cases, such as in fisheries or forestry, this may well translate into protection of the resource base as a key factor governing sustainable production.

NRM research designed for the necessary purposes of the CGIAR will often yield results that assist in achieving environmental objectives. Examples include: biological control undertaken primarily because of the rising costs of chemical control and resistance to chemicals which also benefits farmers' health and the environment; trees grown on farms for food, wood, and forage which also help to control erosion and, if native species, help to conserve biodiversity; and, reversing land degradation especially where rural livelihood strategies are seriously threatened as a result. Every effort should be made to create win-win situations and to minimize trade-offs between crop, livestock, forestry and fisheries production and environmental and natural resource protection.

(2) *The CGIAR Centres should use an **integrated NRM focus** in their planning to define problems in NRM that require research.*

In the 1997 TAC paper on CGIAR priorities and strategies for soil and water management research, an integrated NRM framework was proposed within which to identify research priorities and to provide a logical framework for linking the various NRM activities in the System. The framework should continue to evolve to provide a better defined and more operational focus for the CGIAR-supported activities in NRM. Improvements will arise from a shift from NRM research on-station to production ecology research in integrated production systems at benchmark sites (see also principle 4 below).

The integrated NRM framework incorporates a broad spectrum of disciplines and activities, including those related to forestry, fisheries and genetic resources. The 1997 TAC paper also identified a number of relevant specific research priorities in the context of the four integrated NRM linkages, i.e., productivity enhancing and resource conserving research linkages; spatial or landscape linkages; temporal linkages; and research and diffusion/adoption linkages.

In the case of linkages between research and the diffusion and adoption of technology, a key area is understanding why existing information and knowledge has not been used more effectively to improve NRM practices. This may require fostering a participatory approach to improving NRM. There is much research-generated information on NRM that is readily available but not being put

into use at present (e.g. soil conservation technologies and water management practices). This is a promising area of research and the CGIAR Centres are well positioned to undertake this assessment.

(3) International integrated NRM research should be process oriented to ensure maximum contribution to production of international public goods.

This principle applies to both biophysical and socioeconomic components, i.e. the nature of biogeochemical flows, relationships and changes across environments, and the sociopolitical processes by which positive changes can be made or negative ones avoided. Such process research (strategic or applied) involves consideration of changes over time, comparability of results across ecoregional production systems, and mechanisms for translating results through adaptive research done by NARS. Such considerations need to be introduced into the framework when looking at research priorities for the CGIAR System. This implies a shift towards process-level relationships understanding and modeling across environmental gradients, and away from site-specific component trials. Some examples might include:

- for water: modeling system flows (river-basin level) allocated across multiple users - with particular attention to on-site and off-site effects, developing recharge balance models for aquifers at risk of excessive drawdown;
- for forests: characterizing the complexity of forest systems and the range of stakeholders who interact with them, and developing strategies to influence the global policy agenda;
- for fisheries: identification of the types of farming systems and agroecologies into which integrated aquaculture-agriculture can be sustainably incorporated;
- for livestock: develop databases, models and methods for analysing livestock based systems to help identify priorities for research and development interventions;
- for soils: developing soil erosion models for various multifunctional land-use systems, or nutrient balance and flow models;
- for carbon stocks: documenting and modeling alternatives under multifunctional land use for above and below ground carbon stocks and relating changes in those stocks to global climate change impact;
- for pest and disease incidence: describing, defining and tracking key insect pests using GIS and developing models that relate incidence to agroclimatic conditions;
- for biodiversity: projecting alternative scenarios of functional biodiversity under different land management systems.

In addition to the development and application of such biophysical and economic models (listed above), CGIAR research in integrated NRM will also target a range of other international public goods including developing improved tools for research on land and water management, e.g., sustainability assessment, identification of resource management domains (typologies), and methods for impact assessment.

(4) The CGIAR should give greater attention to research to resolve water issues.

Irrigation currently uses more water than all other sectors and agriculture faces competing demands for water from the urban sector. Unless properly managed, lack of access to fresh water may well emerge as the key constraint to global food production. Resolving water conflicts could become the single most important resource-management issue in the future. There are inter-sectoral water management issues (competing use of water for agriculture, drinking, industrial

uses, environmental uses including fisheries) as well as issues within and between countries. The resolution of these competing demands for water may be assisted by well-focused research to improve the efficiency of water use in agriculture.

(5) Focusing NRM research around common reference locations or benchmark sites is essential in incorporating the many dimensions of integrated NRM.

This approach will provide a common environmental and problem set for multidisciplinary integration and interface with national programmers. The focal site (benchmark) work should be done within a GIS framework to facilitate extrapolation to the relevant recommendation or application domains.

(6) Priorities for specific NRM research themes should be determined by the CGIAR Centres in the context of the sustainability issues affecting productivity increases, regional priorities and comparative advantages of the CGIAR.

The CGIAR is well positioned to become the global focal point and provide visibility for international research to address NRM issues related to productivity enhancement. As a nucleus for global knowledge on sustainable land and water management, the CGIAR could lead and coordinate global efforts to improve the state of knowledge on land and water degradation and its impacts on agricultural, forestry and fisheries production. In addition, the CGIAR System can play a major role in surveying, analysing, integrating and disseminating information from a variety of sources dealing with scientific and indigenous knowledge on land and water management in relation to agricultural, forestry and fisheries production.

5.3.4 Socioeconomic and Policy Research

Socioeconomic Research: The CGIAR's enhanced mandate and strategic focus on poverty reduction will entail an increased role of socioeconomic research within the CGIAR Centres. Research of this nature is expected to build up the body of knowledge on understanding people, their agricultural and technology needs, assessing adoption and the impact of innovations. A highly selective and focused socioeconomic research agenda is needed that focuses on the CGIAR Centres' new responsibilities.

Additional socioeconomic research by the CGIAR, in collaboration with others, should focus on the sociocultural and agricultural dimensions of rural and urban poverty, such as:

- Improved socioeconomic understanding of individual, household and community behaviour, stressing in particular the heterogeneity of these agents and their differentiated demands for, and potential uses of, technological and institutional innovations.
- Clarifying the extent and location of poverty, its contexts, causes, vulnerabilities, risks of further impoverishment and resulting needs, for understanding the stratification of poverty within the specific target populations of the priority agroecosystems.
- Integrating poverty mapping with farming-systems mapping, spatially and with relation to markets, to increase the responsiveness of biophysical research to the locations of the poorest farmers and to the issues related to their cropping and farming systems. GIS technologies will assist with mapping the location and extent of poverty.

- Analysing policy-triggered adverse or constraining effects on productive rural populations, and researching improved policy options and solutions.
- Identifying the reasons for poverty and new strategies to escape poverty, capitalizing on the contributions that breakthroughs in agricultural technology can make when coordinated with other poverty-reducing instruments.
- Improved use of technological advances to develop products that can be used in the fight against the varied origins of poverty, i.e. capitalizing on new advances in biotechnology, production technology, precision farming, geographical information systems, and participatory breeding and extension techniques.
- Integrating biological models of plants and farming systems with socioeconomic models to obtain a better understanding of the roles and potentials of technology for food security, poverty reduction, and sustainable management of the environment.

Policy Research: The CGIAR will continue to play an important role in policy research. The System will need to revisit its role in the context of the activities of the many other national and multilateral organizations conducting policy studies. The future CGIAR policy research agenda is also shaped on the basis of its relevance to poverty reduction and sustainable food security, and with a focus on outputs that constitute international public goods. Policy distortions, institutional deficiencies and ill-defined public goods will continue to exist at local, national and international levels, acting as barriers to the diffusion and adoption of new technologies.

Policy research in the CGIAR Centres will capitalize on current advances in spatial analysis, new management science, institutional economics, general equilibrium modeling and political economy.

Policy research in the CGIAR System has been strong on policy analysis and impact, but has given less emphasis to analysis of policy-making processes. In the future, greater attention should be given to research on political economy processes and to the development of rules and principles for conflict resolution and regulation in agriculture, trade and NRM issues.

The evolving comparative advantage of the CGIAR Centres in policy work implies that in the future greater emphasis will be placed by the CGIAR on:

- legal and policy research on food, agriculture and resource use, e.g. access to germplasm with respect to IPR-related issues and regulation of environmental and human health risks associated with new technologies;
- providing information of use to global environmental conventions and fora on technical and policy research.
- construction of organizational models, using advanced communications and participatory approaches, for efficient and fair human relations, property rights and governance in order to foster rural development;
- the role of institutions in research and development, in particular for issues related to poverty, and the efficient and sustainable use of natural resources, e.g., in the decentralized and participatory management of irrigation water, forests and aquatic resources;

- policy research on inputs, products and markets;
- impact of, and responses to, globalization. Increasing importance is being given to research on domestic markets and international trade within the context of globalization. Understanding how both domestic and international policies can help in ensuring that globalization will benefit the poor is a priority for policy research.

5.3.5 Enhancing Institutions

The CGIAR's effectiveness and efficiency in ensuring that knowledge and expertise to enhance the performance of research and related institutions are accessible to relevant users hinges on whether:

- the CGIAR is providing the right kinds of research and services for institution strengthening;
- the CGIAR is maximizing its comparative advantage vis-à-vis alternative suppliers; and
- the CGIAR's activities are truly international public goods.

Crop Improvement Capacity: One of the results of the CGIAR's past efforts in training and institution strengthening is the greatly increased capacity in national crop improvement programmes in many countries. Some of the stronger national plant breeding programmes are able to take on international responsibilities for some aspects of crop improvement in certain commodities. This would enable the CGIAR Centres to make more strategic inputs into crop improvement, through research on difficult traits, using the new techniques of biotechnology and genomic studies.

This approach would require detailed planning, and a reallocation of responsibilities and resources amongst national programmes and international research Centres. In the first instance there may be merit in developing a pilot project with a selected commodity and a small number of national and international collaborators. Success in this approach would enable the NARS to become significant technology generators providing international public goods within a truly global research system with far broader commodity coverage than at present.

Biotechnology: An increasingly important area for capacity building is biotechnology. This involves enhancing scientific capacity in modern biology in developing countries and developing capacity and appropriate institutional arrangements in the related areas of science policy, bio-safety and intellectual property management. The CGIAR Centres also need to continually refine their own policies and practices in intellectual property management and bio-safety in the light of evolving experiences and changes in the external environment.

Small Countries and Spillover Effects: Many NARS in the smaller countries of Africa, Central America and the Pacific have limited research capacity. The role of regional research organizations is of key importance in these countries. Opportunities to exploit research spillovers from larger to smaller NARS, in terms of transfer of technologies, must be seized. Networking and the deployment of the new information and communication technologies can facilitate such South-South exchange.

Institution Strengthening Activities: The CGIAR's institution-strengthening activities involve: improving the capacity of NARS' scientific and management personnel; enhancing understanding of research management processes; and providing more efficient and effective tools for research policy formulation, planning and management, including priority setting and impact assessment. A special effort in capacity strengthening will be required in forestry and fisheries, given the limited national research capacities in these fields.

The kinds of institution strengthening in which the CGIAR engages may be classified into at least three categories of activities:

- the development and dissemination of generic, methodological tools for research policy, organization, management and impact assessment/evaluation;
- training, information and networking to enhance specific components of NARS;
- meeting the research policy, management and organizational needs of specific countries.

The first category of outputs above qualify as international public goods in which the CGIAR Centres have a comparative advantage over alternative suppliers in terms of efficiency and effectiveness.

The following areas of research also have high potential payoffs:

- Research on institutional development as it concerns agricultural research in developing countries, including the development of indicators for assessing institutional development requirements, evaluating which types of interventions have achieved the best results, and identifying political, cultural and institutional constraints.
- Research on the demands of the private sector and civil society, the public-private interface, the co-production of public goods by the public and private sectors, and the role and management issues in NGOs and other non-profit organizations.

The CGIAR will need to expand its activities in capacity building of NARS but it will also need to contribute to their sustainability. Therefore, it has a major role to play in encouraging national support for agricultural institutions and international support (bilateral, regional and international agencies) for national research systems.

5.4 Catalyst and Integrator of Global Knowledge

There are a series of global issues and concerns where the CGIAR should play a useful role as a facilitator, integrator and catalyst for mobilizing science to serve the needs of the poor. These include:

- raising public awareness of the importance of agricultural research for poverty reduction and ensuing food security;

- issues associated with biotechnology, such as access to genomic information, biosafety, intellectual property;
- conservation and characterization of genetic resources;
- the greater use of new information and communication technologies.

The CGIAR also needs to encourage the efforts of other institutions in the global system to tackle the problems of poverty. These include the research platforms in industrial countries, inter-governmental and regional organizations, the private sector, NGOs, universities in industrial and development countries, and efforts of the Global Forum for Agricultural Research.

Knowledge Management: New modalities of information technologies (e.g. virtual entities) should be experimented with, in collaboration with others, to mobilize and make available the necessary knowledge for the solution of problems associated with poverty and food security. New solutions to the problems of poverty will draw information from multiple disciplines and sources. Integrating scientific discoveries into new knowledge and delivering this to those who need it is the challenge facing the CGIAR.

5.5 Conclusions

The CGIAR has renewed opportunities to invest in, and mobilize, the necessary human, financial and biological resources to address the problems of poverty, food security and sustainability in effective and exciting ways. This will require the CGIAR to:

- invest more, and with a greater sense of urgency, in science to solve problems by integrating the advances in agroecology, genetics, biotechnology, physical sciences, NRM and the social sciences to deliver customized technologies to enhance the goals of poverty reduction and food security;
- build on traditional strengths in breeding, biology and genetic resources;
- analyse, interpret and make more accessible the wealth of existing biological, physical and social data;
- access new skills to achieve new goals;
- form new strategic alliances and partnerships in science and in development;
- create more innovative implementation arrangements that cut across traditional Centre and institutional boundaries.

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World Bank Poverty Website. URL: www.worldbank.org/poverty

ANNEX I

Measuring Poverty

A poverty focus requires that the CGIAR understand better who the poor are, where they live, why they are poor and how agricultural research can help them overcome their plight. The relative priority to be accorded to South Asia and Sub-Saharan Africa follows not just from the World Bank estimates of the numbers of people living on US\$1 per day (Table 1) but also from UNDP more broadly defined country-level assessments of the degree of development and estimates of poverty (Table 2). Both point to these regions as being the most in need.

Table 1: Population Living Below US\$1 Per Day in Developing and Transitional Economies, 1987-1998

Region	Number of Poor	
	1987	1998
	(Millions of People)	
Sub-Saharan Africa	217	291
South Asia	474	522
East and Southeast Asia	415	278
<i>East and Southeast Asia (excluding China)</i>	<i>(114)</i>	<i>(65)</i>
West Asia and North Africa ^{1/}	25	21
Eastern Europe and Central Asia	1	24
Latin America and the Caribbean	64	78
Total	1,196	1,214

Source: Adapted from World Bank Poverty Website

URL: www.worldbank.org/poverty

^{1/} The regional definition of Middle East and North Africa used by the World Bank does not correspond to the definition of West Asia and North Africa used by TAC. Specifically, Turkey and Afghanistan are not included by the World Bank, the former being included in Eastern Europe and Central Asia, the latter in South Asia.

TAC recognizes the limitations in using a single attribute – in this case income – to estimate the numbers of poor. Poverty has many facets so any index of human deprivation or human progress should incorporate a range of indicators to capture this complexity. Since 1990, the UNDP has used a composite index of three types of deprivation –life expectancy, literacy and purchasing power – to measure a country’s progress with respect to human development. The Human Development Index (HDI) is an average of three values (for each measure of deprivation), each of which is an index scaled from 0 to 1. The HDI itself is scaled from zero to one, where values closer to zero indicate the more extreme form of poverty or deprivation. Table 2 gives weighted mean averages of HDI values for major regions of the world for 1998.

While the HDI measures progress in a country as a whole, the Human Poverty Index (HPI) measures the extent of deprivation with respect to the proportion of the people in the country

who are left out of progress. This is defined in terms of three key deprivations in human life, specifically, life expectancy, literacy (knowledge) and economic provisioning (represented by access to safe water, health services and adequate nutrition for children).⁶ Weighted mean HPI values for regions in the developing world are also reported in Table 2. From these data and from regional population figures, the number of poor – as broadly defined here – can be estimated for each region of the world. HDI and HPI data are roughly consistent with the World Bank’s less –than US\$1per day poverty data, with the most extreme deprivation in overall development and poverty terms occurring in Sub-Saharan Africa (HDI = 0.384 and HPI = 0.406) and South Asia (HDI = 0.445 and HPI = 0.375). Clearly, however, the situation in East and Southeast Asia, with a HDI of 0.661, a HPI of 0.208 and a population of 1.8 billion, deserves some attention too. Maps 1 and 2 present a graphic illustration of the poverty situation in each region using HDI and HPI parameters.

Table 2: Human Development and Human Poverty Indices for Major Regions of the World

<i>Region</i>	Total Population (millions)	Weighted Average		Estimated Number of HPI-Poor (millions)
	(a)	Human Development Index (HDI) ¹	Human Poverty Index (HPI) ²	(a) x (c)
Sub-Saharan Africa	598	0.384	0.406	243
Western Sub-Saharan Africa	203	0.358	0.438	89
South Asia ³	1,275	0.445	0.375	478
East and Southeast Asia	1,815	0.661	0.208	378
East and Southeast Asia (excluding China)	571	0.648	0.253	144
West Asia and North Africa	372	0.690	0.263	97
Central Asia	72	0.654	n.a.	n.a.
Latin America and the Caribbean	494	0.801	0.145	72
Central America	128	0.800	0.136	17
Central America (excluding Mexico)	34	0.648	0.220	7
Transition Countries of Europe	342	0.768	n.a.	n.a.
Developed Countries	842	0.937	n.a.	n.a.

¹ HDI is a composite index of life expectancy, literacy rate, and per capita average incomes in purchasing power parity \$ (PPP\$) where values closer to 0 (scale 0 - 1) indicate a lower stage of development. The regional weighted average HDIs are calculated based on countries for which data are available, in most cases almost all countries in a region (see map 1).

² The HPI is a multidimensional measure of poverty that reflects the proportion of population unable to reach critical minimum levels of life expectancy, literacy and economic provisioning (access to safe water, access to health services, malnutrition of children under five years of age). Values closer to 1 (scale 0 to 1) indicate a higher proportion of population are deprived of basic necessities. (See UNDP 1999 for further elaboration). HPI values are based on 1997 data (UNDP 1999) except for Cambodia, Democratic Republic of Congo, Iraq and Madagascar which are based on 1995 data (UNDP 1998).

⁶ Thus a HPI value of 0.406 for Sub-Saharan Africa indicates that, on average, 40.6% of the population in that region suffer deprivation in terms of life expectancy, literacy and/or economic provisioning.

The regional weighted average HPIs are calculated based on countries for which data were available, in most cases almost all countries in the region (see map 4.2).

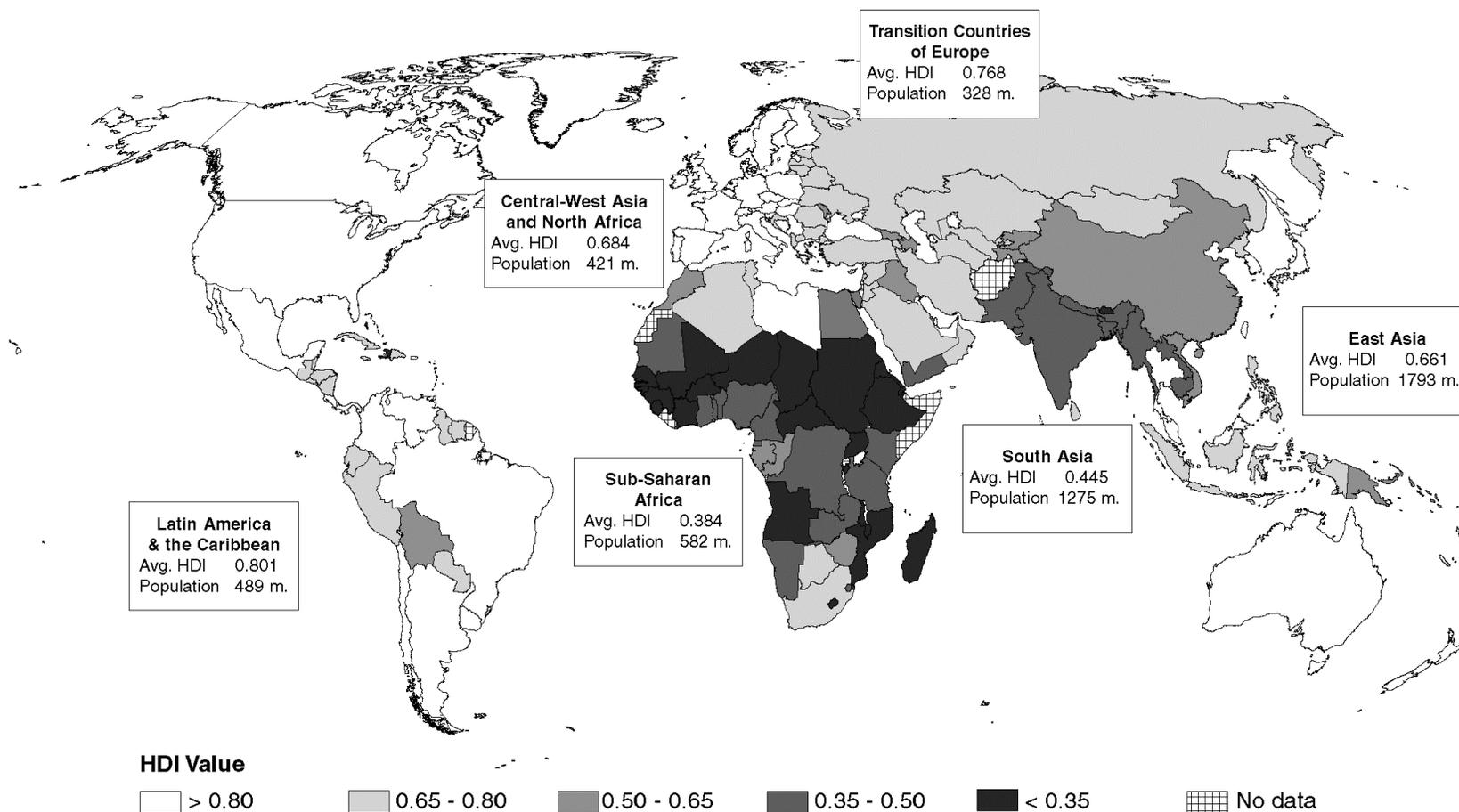
³ Regional value heavily influenced by India with a HDI of 0.451, a HPI of 0.359 and a population of 966 million.

Source: UNDP (1998; 1999) and FAO (2000b). TAC Secretariat calculations.

The HDI captures poverty aspects in a broad sense and the CGIAR can only address some key elements. Still, the HDI correlates with the more narrowly defined food and nutrition related poverty captured by an International Nutrition Index that combines WHO and FAO information, but there are large divergences between the two measures among countries (Wiesmann *et al.*, 2000). An appropriately weighted International Nutrition Index (NI) combines: (1) the percentage of undernourished in the population, (2) the prevalence of underweight children, and (3) the under-five-mortality rate, indicating the deadly combination of inadequate food intake and unhealthy living conditions, and serves as a comprehensive measure to analyse performance and trends in combating hunger and malnutrition in single countries and in regions. Looking at the NI at different points in time (1981, 1992 and 1997) highlights the stagnating and poor nutrition situation in South Asia and Sub-Saharan Africa and the improvements in Latin America and Southeast Asia (Wiesmann *et al.* 2000).

The CGIAR can further refine its regional priority setting by capitalizing on, and contributing to, relevant global databases such as the Committee on World Food Security's FIVIMS (Food Insecurity and Vulnerability Information and Mapping Systems) whose secretariat is provided by FAO. The participation of CGIAR Centres in the FIVIMS Inter-Agency Working Group should contribute to the System-level objective of locating regional, subregional and local concentrations of poor, food-insecure people not only in South Asia and Sub-Saharan Africa but also in the rest of the developing world. The CGIAR's cooperation in UNEP/GRID (United Nations Environment Programme/Global Resource Information Database) should also serve this purpose, as should future cooperation with other international agencies undertaking poverty mapping and assessments, such as the World Bank and UNDP.

Map 1 Human Development Indices for Developing Countries (UNDP, 1998)



Map 2 Human Poverty Indices for Developing Countries (UNDP, 1999)

