

17 May, 2000

Dear Mr. Serageldin,

At the Consultative Council meeting at FAO on 10 April 2000 which discussed the draft paper prepared by TAC, *A Food Secure World for All: Toward a New Vision and Strategy*, the Committee was requested to prepare a supplementary note to indicate its implications with respect to the future research agenda of the CGIAR. I am therefore pleased to attach hereto this companion paper which provides the Committee's perspectives on the priorities for research and research related activities of the CGIAR in the next 10-20 years. This companion paper is for discussion at the next meeting of the Consultative Council on 20 May. The paper had as its basic point of departure a list of what to do more of and what to do less of developed by a Subcommittee of TAC jointly with representatives of the Centre Directors' Committee. It drew further on TAC's previous analyses and framework for research priorities. Since this companion paper was drafted in between TAC meetings, it did not receive the full debate that TAC documents normally are subjected to. However, TAC members' comments and contributions were solicited through e-mail.

Section 1 outlines the key elements of the CGIAR's vision and strategy. The analytical framework, employed by TAC in developing priorities, is presented in Section 2. Section 3 presents the strategic choices of the CGIAR research agenda in terms of the five CGIAR logframe outputs. This approach to elaborate TAC's thinking was adopted because the logframe currently structures the CGIAR research agenda and is a transparent way of identifying System goals, purposes, outputs and indicators. The conclusions in Section 4 are drawn from TAC's analysis of potential changes in the CGIAR's research agenda.

I would like to express my sincere thanks to the members of TAC and several Centre Directors, as well as to staff of the TAC and CGIAR Secretariats, who provided substantial inputs in the preparation of this companion paper despite the very short notice.

I look forward to another fruitful discussion with the Consultative Council.

Yours sincerely,

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A Food Secure World for All: Toward a New Vision and Strategy

Companion Paper on Priority Research and Related Activity Themes

1. Key Elements of the CGIAR's Vision and Strategy

A Food Secure World for All: Toward a New Vision and Strategy for the CGIAR, the paper prepared by TAC for discussion at MTM'00, recommended that the System adopt as its mission the achievement of sustainable food security and poverty reduction in developing countries through scientific research and research-related activities in the fields of agriculture, forestry, fisheries, policy, and environment. A strategy comprising six elements was advanced to realise this mission:

- sharply focusing System activities on the reduction of poverty, hunger, and malnutrition in developing countries;
- bringing modern science to bear on difficult productivity and institutional problems that have proven intractable in the past;
- giving highest priority to the research needs of South Asia and sub-Saharan Africa where poverty is concentrated and growing;
- adopting a regional approach to research planning in order to better address the heterogeneous nature of poverty;
- diversifying and closely integrating its partnerships; and
- adopting, under certain circumstances, a task force approach to the organisation and delivery of CGIAR products and services.

In addition, the CGIAR should continue to serve as a catalyst, organiser, coordinator and integrator of global efforts on key opportunities and constraints in agriculture, forestry and fisheries.

The Committee framed the strategy in terms of a perception that new possibilities in biophysical and social sciences offered opportunity for the CGIAR to address more effectively and efficiently the growing food security needs of the world's poor over the next two decades, while protecting the natural resource base upon which agriculture depends. TAC further perceived that the System's chances of success - particularly but not exclusively in less favoured environments that benefited much less from technological advances in agricultural productivity - would be enhanced by adopting a regional approach to priority setting as a complement to the System's current global approach. This would help to capture the heterogeneous nature of poverty and food insecurity and to diversify the technological, policy, and institutional instruments used by the CGIAR and its partners to address their

underlying causes with greater likelihood of having impact. Key to the success of this approach, in TAC's view, was the need, in an era of declining financial resources, to draw on the expertise of existing and new CGIAR partners via innovative institutional arrangements that maximise comparative advantage while minimising transactions costs. Finally, TAC saw the need to increase the System's flexibility to respond rapidly to urgent problems requiring multi-disciplinary approaches through time-bound task forces and other, more virtual structures.

2. Analytical Framework for Choices of Research Themes

The analytical framework for developing the strategic choices identified in Section 3 of this compendium is consistent with the one employed by TAC in recent years in developing priorities and strategies that currently guide the System. The framework assumes that, given limited resources, the CGIAR's criteria for priority setting should be based on the principles of effectiveness and efficiency in implementing the System's mission and achieving its goals.

The CGIAR currently prioritises its activities and allocates its resources in terms of the five Logframe Outputs: germplasm improvement, germplasm collection, sustainable production systems through integrated natural resources management, policy research, and enhancing institutions. TAC took this generic partitioning of outputs as the basis for its analysis and applied four broad criteria (see below) to assess opportunities for improving effectiveness. The Committee's qualitative¹ analysis yielded recommendations with implications for changes in emphasis, direction, or priority with respect to programmes carried out under the five Outputs. Some of these have implications for the relative priority, which might be accorded to the Outputs themselves (see Section 3).

The four broad criteria used by TAC to assess opportunities for strategic choices in shaping the CGIAR's research agenda are:

Contribution to CGIAR goals

This criterion gauges the likely extent of use of the products of international public goods research, i.e., by *ex ante* assessment of their potential impact on the goals of sustainable poverty reduction and food security in the context of enhancing the environment. Other things being equal, the broader the use and the greater the positive impact of using CGIAR products and services, the greater the gains from investment in the underlying activities. TAC uses 10-20 year projected estimates of future developing country requirements for products of direct interest to the CGIAR since programmes initiated today will be likely not to have major impacts at the farm level for at least that period of time.

International public goods

The International Public Goods (IPG) criterion derives from the special nature of international agricultural research, viz., that such research can have significant spillover effects beyond

¹ TAC's analysis of the research agenda was primarily qualitative in the sense of using informed judgement vis-a-vis systematic criteria to estimate contribution to CGIAR goals, international public goods character, availability of alternative suppliers, and probabilities of success.

agroecological or geographic boundaries, resulting in economies of scale that yield significant savings for research systems at national and regional levels.² To capitalise on such efficiencies, the CGIAR focuses on the production of international public goods - i.e., goods which are non-exclusive (would-be users could not be excluded via the market) and non-rivalrous in consumption (more for one does not mean less for another such as in the case of use of information). The comparative advantage of the CGIAR in these areas derives partly from the fact that private firms operating through markets have limited interest in such goods since they do not have the capacity to capture much of the benefit stream through proprietary claims. Given that the private sector would not be disposed to invest in such goods, socially desirable levels of investment in them can only be elicited from the public sector. "International" public goods are those that can be used in more than one country. Thus, individual countries have less interest in expending their resources to produce these outputs since the benefits do not accrue to them exclusively. It is important to note that there are strong complementarities between private and public goods. For this reason, current large-scale private investments in agricultural research need companion investments in public goods to benefit the clienteles selected by the CGIAR to fulfil its mission. Many of these public goods are of an international character. These factors give the CGIAR a clear comparative advantage in producing such IPGs.

Alternative sources of supply

Efficiency considerations have major implications for whether an activity is within or outside of the CGIAR's research agenda. To the extent that the System's outputs can and would be produced more cost-effectively by alternative sources of supply - e.g., by NARS, ARIs, Universities, NGOs or the private sector - efficiency considerations may well require that they be produced by these other providers.

Probabilities of success

Efficiency also compels the incorporation of uncertainties in reaching goals. These include, among others, uncertainties about the utilisation and value of products, the quality of information available, the rates at which technologies will be adopted, the pace of discovery in the various disciplines of science being utilised, and the likely progress in pursuing various research objectives. It is this last criterion, the differing probabilities of success within given time frames, that is of major importance to TAC in assessing the System's priorities.

In applying the above criteria to the strategic choices implied by TAC's recommended new mission and strategy, the Committee took into account trends in external environments likely to influence the System's comparative advantage and that of its partners. Specifically, TAC consulted with a broad range of outside experts in the fields deemed important to the CGIAR's vision and strategy for 2010.

² The CGIAR's most recent round of priority setting (1998-2000) did not include a priori regional or agroecological dimensions, these being derived from the incidence of poverty and of natural resource constraints as well as from criteria of efficiency. In the current vision and strategy exercise, TAC treated these dimensions in much the same way.

3. CGIAR Research Agenda: Strategic Choices

3.1. Germplasm improvement

Need for strategic choices

Over the years, the CGIAR has demonstrated its value as a global institution through its impact on poverty reduction and food security via improved agricultural science and technology. Most of this impact resulted from the adoption of high yielding modern varieties of the major commodities such as rice, wheat, maize, and cassava. The future challenges posed by poverty and food insecurity require selectivity and the need for strategic choices in terms of 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 advances in science, changes in the research capacity of NARS, involvement of the private sector, and issues of intellectual property rights. The opportunities made possible by these elements will shape the CGIAR's choice of target commodities, the specific traits it selects as its breeding objectives, and its comparative advantage vis-à-vis alternative suppliers.

Strategic focus on the needs of the poor

The CGIAR's commitment to reducing poverty and food insecurity in regions of highest incidence has implications that cut across the three production sectors on which it works.

Crops

There will be continuing need to work on the major staples - i.e., cereals, roots and tubers - as these will remain the most affordable sources of calories and even protein for poor consumers. The new plant types developed by the System's cereals breeding programmes promise yield breakthroughs that will significantly increase global production of these basic commodities in the medium-term. While the private sector is expected to continue investing heavily in cereals breeding, the economies of scale associated with research on these crops will continue to give the CGIAR comparative advantage particularly in breeding for traits of specific importance to the poor such as adaptation to abiotic constraints (drought, salinity, low temperature), durable pest and disease resistance, and nutritive and storage quality. As these crops are consumed by the poor in relatively large amounts, improvement of their nutritional value through breeding or transfer of genes for, e.g., higher iron or betacarotene content in rice without incurring yield penalties, will figure prominently in the CGIAR's future plant improvement agenda.

As the CGIAR complements its global priority setting process with a regional approach to research planning, commodities of regional importance having high income potential for rural producers such as horticultural crops (i.e., vegetables, fruits, ornamentals) will emerge as new possibilities for CGIAR research. However, the System will not have sufficient means to mount comprehensive improvement programmes for all of these potential commodities. They will have to be treated using a network strategy on the model of INIBAP for bananas and plantains. Such high value-added commodities have significant potential for increasing rural

incomes and non-farm employment (e.g., postharvest processing), all key elements of the CGIAR's strategy for poverty reduction.

Livestock

The "livestock revolution" projected in recent IFPRI/ILRI research pointing to a doubling of future demand for meat and milk in developing countries over the next twenty years provides compelling justification for continuing CGIAR involvement in global research for livestock improvement. The latter is likely to benefit in general from mammalian genomics work and from pathogen sequencing work in the case of disease resistance and epidemiology research and vaccine development, all such applications being of high priority for the poor beneficiaries. Research on quantitative trait loci (QTL) should be a priority for diversity assessment and conservation purposes. Transformation may in the future open avenues for solving specific low-input livestock system constraints.

Fish

Improvement of fish will require increased links with advanced institutes having 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 rate. Morphological characteristics may also be of regional importance. Carp and tilapia are the most important species undergoing germplasm improvement, but experiences with genetic markers can be applied across species.

Advances in science

Genetic improvement has usually been based on empirical selection aimed at increasing yield potential and high stability. In the future, an optimal combination of methodologies, including new molecular ones, will increase the continuing possibilities for impact. It is now technically possible to apply the new tools of biotechnology, such as genetic transformation and marker assisted selection (MAS), to a wide range of agriculturally important crop and animal species. Large-scale application of biotechnology in genetic improvement as well as biodiversity assessment and conservation is becoming a reality. The number of applications is likely to grow rapidly because of advances in genomics and biotechnology research in universities, life science corporations and other advanced laboratories, yielding new knowledge on the genetic base of important traits and intermediary research products. Also, the scientific breakthroughs for tackling the most challenging breeding problems, such as drought tolerance for crops, may be achievable. The challenge is twofold: maintain achieved gains for the globally important commodities by breeding for durable resistance while increasing yield potential and adding new desirable traits.

Most CGIAR Centres with crop and livestock research have established good quality, needs-driven biotechnology projects, which are generally well integrated to practical breeding. Application of biotechnology on a large scale for MAS and transformation is, however, only becoming part of routine breeding. These applications are most effectively incorporated into the breeding programmes by strengthening the facilities at each respective Centre. There will be need for investment in high throughput laboratory facilities at least in some Centres in the near future, and to establish the necessary bioinformatics capacity, for which there is a

Systemwide need. The Centres will need to weigh the probabilities of success against investment needs and consider contracting and outsourcing to advanced institutes and universities, particularly in the case of orphan crops. Inter-centre collaboration will also need strengthening. *Ex ante* economic analyses verifying potential efficiencies should guide the strategic choices.

Genetic transformation, allowing movement of genetic material from all life forms, will be of high priority in cases where the important traits are not available within the existing gene pools, and with vegetatively propagated crops which are difficult to breed. However, national regulations for field testing, biosafety and release will need to be in place to secure dissemination of the genetically engineered germplasm, before major investments in this technology are warranted.

Advances in functional genomics will increase the feasibility of success in breeding for complex traits in the long term. Rice breeding is beginning to benefit from rice genomics research, which due to gene synteny is likely to advance research on other cereals, as well. For the CGIAR Centres working with cereals, the strategic choices regarding their involvement in international functional genomics research is of immediate importance. The Centres, with their largely untapped germplasm collections, are well positioned to contribute to functional genomics work by providing unique phenotype data that can underpin developments in agricultural genomics. The Centres have also profound knowledge of the various stresses and other environmental conditions and they understand the phenotypes involved in stress tolerance. These strengths should give the Centres an important role in collaborative functional genomics programmes, which would guarantee access to the gene information being generated by others. Genomics research on other CGIAR commodities or related species, such as potato and tomato, is being undertaken mainly in advanced research institutes, with which the Centres need to develop strong long-term research linkages. Most Centres have limited capacity for genomics analysis in-house, and there is need to explore the opportunities for Systemwide co-ordination in genomics research.

Participatory methods

The need to reach the most resource-poor producers living in the most constrained environments, which so far have gained little from agricultural research, will require greater emphasis on participatory methods. The Centres' role should be primarily to develop models for participatory breeding and verify their usefulness. Analysis of the sustainability of participatory processes and the costs and opportunities at different stages of the breeding process are needed. The scaling up and extrapolation will rely on the acceptance, adoption and refinement of these methods by NARS and the incorporation of them in the national breeding programmes.

Increasing capacity of national programmes

Many national programmes have in recent decades substantially developed their own capacity to carry out variety breeding and have already taken over mainstream conventional breeding of the major commodities. Many have also built considerable capacity for biotechnology. The CGIAR Centres will need to move from covering the whole breeding chain to strategic research on difficult and complex breeding objectives and to pre-breeding and developing source populations with specific traits for a variety of needs to pass on to the national

breeding programmes. With complementary institutional support, there is potential for larger NARS to assume responsibility for part of the global commodity research agenda. The vision is one of NARS as significant technology generators providing international public goods within a truly global research system with far broader commodity coverage than at present.

However, many NARS in the smaller countries of Africa, Central America and the Pacific remain weak. Opportunities to exploit research spillovers from larger to smaller NARS in terms of finished varieties and populations must be seized. Networking and the deployment of the new information and communication technologies can facilitate such South-South exchange.

Increasing role of the private sector

The private sector's involvement in germplasm improvement is a growing global reality. More participation internationally and nationally is expected in the future as the private sector explores more commodities and traits, which provide promise of economic returns to their investment. The CGIAR must enter into partnerships where there are common interests while recognising that there will be orphan commodities and orphan traits. The complementarities between the private and public sectors investing in many commodities are important for producing the final deliverable goods to those beneficiaries that are relevant in the CGIAR's mission.

Policies and biosafety

As Centres move towards application of biotechnology in breeding and genetic engineering in particular, the need for covering areas of biosafety, capacity building and public awareness issues in biotechnology in their NARS collaboration becomes all important. Training should consequently take a form of capacity building and assisting national partners in the technology, management, regulatory aspects and biosafety related to biotechnology, while diminishing more conventional training for which there are other suppliers. There is urgent need to define Centre policies regarding intellectual property rights, both as they may restrict the Centres' freedom of doing research and disseminating research products and as they apply to the Centres own innovations. The Centres need to work together with their national partners and assist them to guarantee future access to germplasm and to the breeding and research products by the primary beneficiaries, the poor in the developing countries.

3.2. Germplasm collection/biodiversity

The CGIAR Centres hold large germplasm collections of crop, forage and agroforestry species in trust for the benefit of the international community. These collections are fundamental to world food security and central to the efforts of national programmes and the CGIAR Centres to reach their goals. The collections themselves, and the value adding work done at Centres through characterisation, evaluation and enhancement, can be considered as some of the most important CGIAR activities of an international public goods nature. The value of this work is likely to remain high even in the long term.

Currently the ownership and stewardship of these collections, including modalities for accessing them and sharing the benefits arising from their use, is being renegotiated within the context of a revised International Undertaking (IU) on Plant Genetic Resources for Food and

agriculture. Simultaneously, national legislation regulating access to genetic resources is being prepared by many countries in accordance with, and in response to, international conventions and agreements in areas such as biodiversity, intellectual property and trade. The outcome of these negotiations, and the implementation of national access legislation, may have far-reaching impacts on the ability of the Centres to continue to develop and to derive public benefits from the collections. A policy environment is needed that will permit continued unrestricted movement of germplasm and an assurance that the CGIAR System will be able to continue to generate and distribute germplasm-based international public goods. It is therefore essential that the Centres follow closely and help facilitate the negotiations by providing technical analysis and relevant information to their host and regional country partners and to the international public.

The IU negotiations also involve the question of benefit sharing. Under a multilateral system covering genetic resources for food and agriculture, the CGIAR Centres are likely to be expected to take on new tasks related to the development and implementation of mechanisms for sharing the benefits arising from the use of the global germplasm collections. Examination of possibilities for providing such benefits within the context of a multilateral system is thus of considerable importance and may facilitate the negotiations towards reaching an agreement. The future role of the Centres may involve them taking on new responsibilities while opening new possibilities for funding.

The CGIAR has over 600,000 accessions in its Centre genebanks. Their evaluation, characterisation, rejuvenation, storage and distribution is an expensive, labour-intensive recurring activity. Some of these efforts can be rationalised because of the presence of unrecognised duplication. New techniques in molecular characterisation will enable the Centres to assess the full range of variability within their collections and, at the same time, systematically get rid of duplicates.

The clean up, regeneration and quarantine of vegetatively propagated species is a particularly thorny problem for the CGIAR genebanks. Tissue, and cell culture, and cryopreservation methodology research will be in the research agenda for some time.

The greater bulk of the world's plant, animal and microbial biodiversity will have to be maintained in situ: the CGIAR Centres should lead the way in developing methods in characterising and tracking biodiversity and in research on maintaining and managing natural habitats to conserve biodiversity as much as possible.

The conservation of indigenous livestock populations and native breeds is a special challenge for ILRI together with its partners, in particular FAO and national programmes. This is not as yet considered sufficiently high priority presumably because of the associated costs, but the danger of losing these valuable livestock germplasms will be very pressing in the next decade.

Regarding efforts in functional genomics, where both the public and private sectors are very active, the CGIAR Centres have a common strength in their access to the unique range of genotypes contained in the vast germplasm collections and in their breeding material. The Centres are well placed, and need to maintain their ability, to use genomic information and technology to develop germplasm that is relevant to the unique environments that each Centre serves. Molecular tools make it possible to understand better what is present in the germplasm

collections at both a genetic and biochemical level. Added value can be derived from genetic resources by using them as a source of alleles for breeders and genes for biotechnology research. To achieve these benefits, Centres must be in a position to provide access to the genetic resources in the collections and to facilitate their use. In addition, it is important that the collections be truly representative of the full range of genetic variability within the gene pools of interest, and that the Centres have the capacity to manage the collections to agreed international standards.

3.3. Sustainable Production Systems through Effective Integrated Natural Resources Management (INRM)

Sustainable food security and poverty alleviation - whether for the rural or urban poor - depend directly on the health of the environment and the natural resource base on which all food production depends. Thus, *conservation and enhancement of resources and 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 natural resource management (NRM) research the CGIAR should be engaged in. Nevertheless, while the focus will narrow and sharpen, the overall emphasis on NRM research in the CGIAR system, relative to other undertakings, is expected to grow. Definition of the specific priorities and future NRM research agenda of the CGIAR in 2010 still awaits further dialogue and discussion (e.g., the CGIAR INRM Group's meeting in Penang in August). Nevertheless, TAC has identified five critical elements or principles on which, in its opinion, priorities can and should be determined.

- (a) **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 for intergenerational equity of benefits.** This should be a necessary condition for undertaking NRM research in the System. It derives from the obvious fact that priority should be given to research directly related to the mission and goals of the System. Only in exceptional cases should the CGIAR be involved in NRM research that does not meet this condition. Effective management of the natural environment is an activity pursued by many organisations for many different purposes, including recreation, global climate change, wildlife management and even ecosystem health for its own sake. TAC fully recognises the legitimacy, importance and value of these other objectives. However, given the competence and numbers of alternative suppliers, the CGIAR should pursue only those activities that are targeting sustainable productivity improvements.³ In any case, research designed for the necessary purposes of the CGIAR will often yield results that assist in achieving environmental objectives.⁴ Every effort should be made to create win-win situations or at least to minimise trade-offs between crop, livestock, forestry and fisheries products and those other environmental and natural resource values.

³ Note in some cases, e.g., in fisheries or forestry, this may well translate into protection of the resource base as a key factor governing sustainable production.

⁴ Examples include: biological control undertaken primarily because of the rising costs of chemical control with increasing resistance, but benefiting also farmer health and the environment; trees grown on farms for food, wood, and forage, but helping to control erosion and, if native species, helping also to conserve biodiversity; and, reversing land degradation especially where rural livelihood strategies are seriously threatened as a result.

(b) To the extent possible, centres should use an **integrated NRM (INRM) focus** in their research. In its 1997 paper on priorities and strategies for soil and water management in the CGIAR, TAC proposed and the Members accepted an INRM framework 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. Following the beginning premise - to define the problem focus clearly - will reduce much of the non-focused and non-integrated work. Indeed, it would reduce much of the traditional agronomy/soil science on-station research in favour of production ecology research. Most of such research would now be done in the context of integrated production systems at benchmark sites (see (d) below). At the same time the 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 specific research priorities (not listed here) in the context of the four INRM linkages, i.e., productivity enhancing and resource conserving research linkages; spatial or landscape linkages; temporal linkages; and research and diffusion/adoption linkages⁵. These are still relevant. International INRM research should be **process oriented to ensure maximum contribution to production of IPGs**. This applies to both biophysical and socioeconomic components, i.e., the nature of biogeochemical flows, relationships and changes across environments as well as socio-political 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 modelling across environmental gradients, and away from site-specific component trials. Some examples might include:

- for water: modelling 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: characterising 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 in 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 agricultural systems, or nutrient balance and flow models;

⁵ In the case of linkages between research and diffusion/adoption, the key area for research is understanding the reasons why existing information has not been used more effectively to improve natural resources management practices, for instance in the move from shifting to permanent cultivation; also, research on how to get more effective implementation of existing knowledge for improved INRM, i.e., research on cultural diffusion and adoption of research results already on the shelf, in the context of fostering a participatory approach to improving natural resources management. TAC is concerned that there is much research-generated NRM information that is readily available but unused in practice at present (e.g., knowledge regarding soil conservation technologies and water management practices). There is need for increased research to look at why there is a lack of application of known technologies and ideas. It is a promising, potential area of research and the CGIAR Centres are uniquely positioned to undertake this assessment.

- for carbon stocks: documenting and modelling 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 various biophysical and economic models (listed above), CGIAR research in INRM will also target a range of other IPGs 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.

- (d) Supporting the shift to the process-oriented approach, **a focus of effort around common reference locations, possibly "benchmark sites", or their equivalent is essential for integration of the many dimensions of INRM.** This provides a common environmental and problem set for multidisciplinary integration and interface with national programs. In fact, this was a main consideration in TAC's recommendations to initiate the Ecoregional Programs. The problem with them, as per the Eco-Regional Review Report (TAC, 1999), was that they did not focus enough, as suggested in the 1997 TAC priority and strategy document on INRM and in the current TAC vision document. The focal site (benchmark) work should always be done within a GIS framework to facilitate extrapolation to the relevant recommendation or application domains.
- (e) **Priorities for specific NRM research themes should be made by Centres** in the context of the needs of their other priority programs related to sustainable productivity enhancement, and in terms of **regional priorities** and their comparative advantages. This point has been discussed at length in the main vision and strategy paper. Nevertheless, specific examples of a global NRM agenda are cited below.

The CGIAR is well positioned to become the global focal point and provide visibility for international research to address natural resource management issues related to productivity enhancement. As a nucleus for global knowledge on sustainable land and water management, the CGIAR could lead/co-ordinate the effort to improve the state of information on land and water degradation and its impacts on agricultural, forestry and fisheries production. In addition, it can play a major role in surveying, analysing and disseminating information from the grey literature dealing with scientific and indigenous knowledge on land and water management in relation to agricultural, forestry and fisheries production.

3.4. Policy Research

The CGIAR will continue to play an important role in conducting socioeconomic and policy research. As in the past, the System will need to continuously revisit its role in the context of the activities of the many other national and multilateral organisations conducting such studies. The future CG 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 both the local/national and international levels, acting as barriers to the diffusion and adoption of new technologies.

Socioeconomic and policy research in the CGIAR will accompany the gene and information and communications revolutions. It will capitalise on current advances and push the frontiers of knowledge in bio-economic modelling, spatial analysis, new management science, institutional economics, socioeconomic understanding of household and collective behaviour, and political economy. Policy research in the CGIAR System has, in particular, been strong on policy analysis and impact, but has given relatively little emphasis to analysis of policy making processes. In the future, greater attention should be given to political economy processes and to the emergence of rules for conflict resolution and regulation.

The evolving comparative advantage of the CGIAR 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 consumer risks associated with new technologies.
- poverty mapping and monitoring; identification of the determinants of poverty and of new strategies to escape poverty, capitalising in particular on the contributions that breakthroughs in agricultural technology can make when co-ordinated with other poverty reduction instruments.
- 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.
- technical and policy research providing information of use to global environmental conventions and fora (e.g., on trade, biodiversity, desertification, climate change, fisheries, forests, water and the global monitoring of risks);
- improved use of technological advances for product development customised to the heterogeneity of poverty, capitalising for this on advances in biotechnology, production technology, precision farming, geographical information systems, and participatory breeding and extension techniques.
- integration of 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.
- construction of organisational models of efficient and fair human relations, property rights and governance fostering rural development applying advanced communications and participatory approaches;
- the role of institutions in research and development on particular issues related to poverty and efficient and sustainable use of natural resources, for example, in the decentralised and participatory management of irrigation water, forests and aquatic resources.

On the other hand, some topics will increasingly be addressed by other policy-oriented organisations and hence less emphasis will be given in the future to:

- input and product market policy research;
- trade liberalisation research;

- farming systems analysis.

More emphasis will also be given to studies with particular relevance to policy and institutional constraints in sub-Saharan Africa and South Asia to accompany the CGIAR's new vision and strategy. Similarly, emphasis will be given to models of regional development to experiment with alternative approaches to priority setting and institutional coordination at the regional level.

A large amount of policy research is currently conducted at Centres other than IFPRI to develop policy options for more efficient resource use with respect to their specific commodity, regional, agroecological zone and resource management mandates. While some of this ongoing work will evolve over time, there will be a continuing need to conduct research on policy options to enhance technology adoption and impact pathways, promote smallholder participation in input and output markets, and reduce negative environmental consequences of increased productivity.

3.5. Enhancing Institutions

The CGIAR's effectiveness and efficiency in ensuring that knowledge and expertise for enhancing the performance of research and related institutions are accessible to relevant users hinges on whether (a) the CGIAR is doing the right kinds of institution strengthening research and service work, and (b) it is maximising its comparative advantage vis-à-vis alternative suppliers; and (c) the System's activities are truly international public goods.

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. Research advisory services address the policy, organisation and management concerns of NARS, providing advice on national agricultural research policy, on the structure and organisation of national systems and their linkages, and on programme development, resource allocation and institute management.

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

- (a) the development and dissemination of generic, methodological tools for research policy, organisation, management, and impact assessment/evaluation;
- (b) training, information, and networking that enhance components of NARS (e.g., technology development) related to the specific mandates of the respective CGIAR Centres rather than to NARS as a whole;
- (c) the research policy, management, and organisation needs of specific countries.

Other things being equal, category (a) outputs would seem to qualify as international public goods that cannot be produced with as much efficiency or effectiveness as the CGIAR by alternative suppliers who lack a global mandate and a long-term research perspective. These outputs are a growing component of ISNAR's portfolio.

Outputs in category (b), traditionally provided by the most of the CGIAR Centres, are in some cases increasingly being produced by NARS themselves, often in collaboration with the Centres and sometimes with ARIs. Some laboratories and research groups of the larger NARS can increasingly assume the role of international Centres for specific research themes and problems. However, as the CGIAR moves increasingly in the direction of molecular genetics, there would appear to be a compelling rationale for continued IARC involvement in institution strengthening of this kind. The CGIAR would increasingly play a role of catalyst, organiser and coordinator.

The evolving capacity and sophistication of some NARS imply a progressive narrowing of the research space in areas traditionally occupied by the CGIAR. Opportunities for a progressive reduction of CGIAR activities in particular fields of research are provided in the earlier sections of this chapter.

Category (c) outputs provide advisory services that are country-specific and have limited potential for spillovers beyond national frontiers. It would, therefore, seem logical that they be prioritised in the context of the CGIAR's regional research agenda.

Apart from the choices implicit in the foregoing observations, TAC reiterates the stripe review's identification of institution strengthening research themes/directions having high potential payoff. These include:

1. The urgent need for more 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 the political, cultural and institutional constraints.
2. The need to broaden the CGIAR's mandate on research policy and management beyond traditional public sector R&D, to address the needs of the private sector and civil society, the public-private interface, the co-production of public goods by public and private sectors, and the role and management problems of NGOs and other non-profit organisations.
3. The need for closer collaboration among Centres in institution-strengthening activities. The emergence of regional groupings and of a global forum of NARS is a positive development that will help facilitate and channel the Centres' efforts in institution strengthening.

4. Concluding Comments

This paper has outlined, in broad terms, the future research agenda of the CGIAR in the context of TAC's proposed strategy and its six background elements. Thus, in the long-term, the CGIAR will need to play a continuing strong role in (a) the conservation, characterisation and distribution of germplasm; (b) germplasm enhancement and improvement for crops, fish, trees and animals of major international importance to poverty alleviation; (c) research on major global NRM themes, particularly related to productivity enhancement and with focus

on generating process oriented IPGs; (d) key policy research topics; (e) strengthening national and regional capacities in specialised areas; and (f) fostering its unique role as a catalyst and integrator of global knowledge and research efforts on key constraints to agriculture, forestry and fisheries. It is no coincidence, nor is it surprising that the six key priority areas that emerge for the future generally parallel those that exist today. These have emerged after many years of experience and many years of assessing the impacts, successes and failures of the CGIAR in the context of its goals and the changing outputs from the larger agricultural research community. What will differ in the future are the specific themes within the broad categories and the approaches to research that have emerged through the cumulative process we call science and technology development.

While new challenges and themes are being added to the CGIAR portfolio, TAC also has made suggestions on areas of activity where the CGIAR's role should be gradually reduced, either because they are increasingly done more efficiently by others, or because science has passed them by. In the area of germplasm improvement and production systems research, the CGIAR will de-emphasise its work on conventional plant breeding, traits increasingly being handled by the private sector, and on-station production agronomy. In the field of natural resources trials, less emphasis will be given to activities that have little relation to sustainable productivity improvements. In policy research, a number of themes are increasingly being researched and handled by local groups or by other international policy research entities. In capacity strengthening, they include areas of training increasingly handled well by NARS and others and individual country institutional services that have few IPG characteristics. These adjustments to the agenda will be reflected over time through regional priority setting and in the Centres' medium-term and strategic plans.

The CGIAR's role as a steward of international germplasm is expected to increase in the future because of the CGIAR's ability to provide considerable added value to the collections through its genomics research. The value adding function will remain the CGIAR's major role in germplasm conservation over the next two decades. The CGIAR as a publicly funded organisation also will remain committed to ensuring that free access to germplasm will continue to be guaranteed to all.

The increased involvement of the private sector in areas related to crop improvement for commercial agricultural production in developing countries provides the CGIAR System with a major new opportunity to get out of these areas and concentrate efforts on those traits that are of critical importance to the poor, but of little interest to the private sector because they cannot capture the benefits from such work. Given the greater interest of the private sector in crop improvement, this may well lead to a narrowing over time of the CGIAR research germplasm improvement agenda towards greater emphasis on traits of importance to the poor and towards a greater emphasis on integrated natural resources management and sustainability and productivity maintenance questions.

TAC's discussion on the research agenda has been very much in the context of themes of importance at the global level. TAC has refrained from giving advice on regional priorities, since these more appropriately will be developed in close consultation with Centre partners through the regional planning mechanisms that have been recommended by TAC. The task of reconciling regional priorities and action with the global priorities of the System will be a big challenge for TAC and the Group in the coming years. Increased emphasis on output focused

research and assessment of impacts of CGIAR investment will help to guide the System in the process of adjustments over time.

The above discussion provides indications that will allow the Group in its discussions to move closer to a definition of the "heartland" of the CGIAR research agenda. This heartland will clearly consist of those activities that make the largest contribution to the achievement of the CGIAR's mission of sustainable food security and poverty reduction through research that generates international public goods. TAC believes that the "heartland" of the CGIAR research agenda will and should change in an evolutionary, not revolutionary fashion. This should happen through an iterative process of doing, monitoring and evaluating results of research within the overall guiding framework as suggested by TAC and modified and adapted by the Group.

The information provided in this companion paper will be incorporated in TAC's final report to the Group, to be prepared at the time that TAC presents its assessment of necessary institutional realignment to most effectively ensure the implementation of the new vision and strategy, and the resulting "heartland" research agenda discussed in this paper.