

A summary of recently agreed CGIAR Priorities for Research

SC Secretariat March 1, 2008

This document, prepared as an input for the CGIAR Change Management Initiative (Working Group 1) summarizes the CGIAR document 'System Priorities for CGIAR Research 2005-2015 endorsed by the Executive Council of the CGIAR at its October 2005 meeting and subsequently approved by CGIAR Members at the Annual General Meeting of the CGIAR held in Marrakesh in December 2005

The overall goal of the research carried out by the CGIAR and its partners continues to be to improve the livelihood of low-income people in developing countries through reduced poverty, food insecurity and malnutrition; and to foster better institutions, policies, and sustainable management of natural resources of particular importance to agriculture and poor people. The goal is fully compatible with the Millennium Development Goals (MDGs) and the CGIAR aims to make the greatest possible contribution not only to their achievement but also to the achievement of similar goals beyond 2015.

The vision for the longer term is one in which the CGIAR is a provider of international public goods through agricultural research aimed at the alleviation of poverty. The CGIAR aims to progressively devolve some current research (particularly aspects of breeding for germplasm enhancement and site-specific natural resource management) to NARS with increasing capacity. Devolution and enhanced delivery to the poor in different localities will be effected through a range of partners. The CGIAR will move towards the solution of the complex system issues undermining moves out of poverty and the success of agriculture in developing countries, supported by genomics research and provision of science-based policy advice. It is clear that the staging of such a strategy will be different in regions where NARS have different strengths. Special attention will be paid to the building of partner capacity in sub-Saharan Africa.

Through an exhaustive Science Council-led process of participatory information gathering, analysis, synthesis, and debate, a set of 20 research priorities for the CGIAR, organized within five priority areas, has emerged. Three key criteria were employed to help identify the priorities: (i) the expected impact on poverty alleviation, food security and nutrition, and sustainable management of natural resources taking into account the expected probability of success and expected impact if successful; (ii) whether the research is of an international public goods nature; and (iii) whether there are alternative sources of supply of the research and whether the CGIAR has a comparative advantage in undertaking the research.

The following five System Priority areas for CGIAR research resulted from the priority-setting efforts (they are not ranked):

1. Sustaining biodiversity for current and future generations;
2. Producing more and better food at lower cost through genetic improvements;
3. Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products;
4. Poverty alleviation and sustainable management of water, land, and forest resources; and
5. Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger.

CGIAR research is prioritized to contribute directly or indirectly to seven of the eight MDGs ([Table 1](#)). International publicly-funded agricultural research, undertaken by the CGIAR and partners, is particularly effective in achieving *MDG 1, the reduction of poverty and hunger*, partly by helping smallholder farmers escape poverty, create wealth, and improve their competitiveness in the increasingly globalized market place and partly by creating employment among the rural poor and making food available to poor consumers at lower prices. Thus there are four principal ways in which the CGIAR research is prioritized to contribute to this MDG.

Table 1. Direct and indirect impacts of CGIAR priority research on the MDGs

Millennium Development Goals		System Priority Areas for CGIAR Research				
		1	2	3	4	5
1	Reduce extreme poverty and hunger	+	++	++	++	++
2	Ensure universal primary education		+	+		
3	Reduce gender disparity		++	++	++	++
4	Reduce child mortality	+	+	+	+	+
5	Improve maternal health	+	+	+	+	+
6	Combat HIV/AIDS, malaria and other diseases		++			++
7	Ensure environmental sustainability	++	++	+	++	++
8	Develop a global partnership for development	++	+		++	++

(++) denotes direct impact; (+) denotes indirect impact

First, past emphasis on research to help smallholders produce more staple food and fodder per unit of land, labor, and water in an environmentally sustainable manner will be maintained. This research will include genetic enhancement of selected staple food crops as well as improved agro-ecological production systems. Genetic enhancement will focus on traits of particular importance to the poor, to include resistance to selected biotic and abiotic stresses with emphasis on drought and salinity, and improvement in the nutritional content of staple foods. In addition to the benefits derived by the smallholder farmers, research on genetic enhancement and other productivity-enhancing research is expected to result in large benefits to the poor consumers in both rural and urban areas through reduced unit costs and prices. While the CGIAR will develop a genomics platform to facilitate genetic enhancement, it is envisaged that an increasing portion of maintenance research and agro-ecological research will be taken over by national agricultural research institutions.

Second, greater emphasis will be placed on research to enhance incomes of smallholders through the production of high-value commodities and products, with emphasis on fruit and vegetables, non-timber forest products, livestock, and fish. The very limited research currently undertaken by the CGIAR on fruit and vegetables will be expanded significantly along with increased research on processing of agricultural commodities and other aspects of the supply chain to help generate incomes for both smallholder farmers and rural labor. Expanded productivity and production of fruit, vegetables, non-timber forest products, livestock, and fish offer great opportunities for income gains for the rural poor partly because of the expected strong future demand for such products and partly because of the opportunities for adding value and employment in processing and other supply chain activities. Research will be undertaken to help enhance smallholders' incomes from livestock and fish in low- and high-productivity areas and to better manage intensification of livestock production. Improved nutrition and family income underpin the chances to enhance primary education.

Third, research on sustainable management of natural resources will be prioritized to achieve sustainability and poverty alleviation goals, thus contributing to both MDG 1 and MDG 7, ensuring environmental sustainability. The protection of biodiversity through the conservation of germplasm of key food staples, underutilized species, fish, and indigenous livestock will be prioritized, along with research on water, land and forest management, and related institutions and policy. Integrated land, water, and forest management research will be pursued at the landscape level along with research to facilitate agro-ecological intensification in both low- and high-potential areas. In

response to increasing water scarcity, research will be undertaken to improve water productivity at the farm, field and basin levels and to help ensure access to forest and tree resources by the poor. Research will be pursued to better understand and manage aquatic ecosystems for the benefit of the poor and the ecosystem. Research to help enhance potential positive—and cope with negative—effects of climate change will be prioritized.

Fourth, research on institutions, markets, and policy will be prioritized to assist governments, farmer associations, and others to facilitate effective production, market development, trade, and related changes needed to enhance the benefits to the rural and urban poor. Science and technology policy, as well as policy to support sustainable management of natural resources, will be important parts of this research. Research on institutions, governance, trade, and policies, which contributes to the achievement of *MDG 8, develop a global partnership for development*, is an integral part of the above research. Emphasis will be on research that facilitates poverty alleviation and agricultural development within the emerging global changes in trade and science.

All CGIAR research will include gender-specific analysis to identify technologies and policies that are likely to enhance gender equality and empower women, thus contributing to *MDG 3*. Reduced poverty, food insecurity, and malnutrition are linked to *reduced child mortality (MDG 4)* as well as *improved maternal health (MDG 5)*. Improved nutrition is particularly important for the fight against *HIV/AIDS (MDG 6)*. Furthermore, increased labor productivity, to help cope with the effects of HIV/AIDS will be pursued in both genetic enhancement and sustainable management of natural resources. Thus, while the research priorities are aimed first and foremost at improved livelihoods and sustainable management of natural resources, they are developed with these related MDGs in mind.

The System Priorities (Table 2) are structured around five major groups of strategic research activities aimed at producing common outcomes. In aggregate, the priorities provide a set of specific goals for a portfolio of research activities around which the CGIAR will organize its scientific and related capacities. The CGIAR also carries out research on particular cross-cutting topics or ecoregional issues through a number of implementation mechanisms; such as System-wide programs (SWP), Ecoregional Programs, Challenge Programs (CP), Task Forces and other modalities. It is anticipated that programs addressing important global or ecoregional research may be formed drawing on appropriate combinations of priority science and partnerships, to address particular issues for defined lengths of time (see final chapter and Figures 2-4). *Cross-cutting programs* will be developed from elements of the 20 research priorities, with any additional research that is needed being provided by partners.

Table 2. System Priorities for CGIAR Research 2005-2015

<p>Priority area 1: Sustaining biodiversity for current and future generations Priority 1A: Conservation and characterization of staple crops Priority 1B: Promoting conservation and characterization of under-utilized plant genetic resources to increase the income of the poor Priority 1C: Conservation of indigenous livestock Priority 1D: Conservation of aquatic animal genetic resources</p> <p>Priority area 2: Producing more and better food at lower cost through genetic improvements Priority 2A: Maintaining and enhancing yields and yield potential of food staples Priority 2B: Tolerance to selected abiotic stresses Priority 2C: Enhancing nutritional quality and safety Priority 2D: Genetic enhancement of selected high-value species</p> <p>Priority area 3: Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products Priority 3A: Increasing income from fruit and vegetables Priority 3B: Income increases from livestock Priority 3C: Enhancing income through increased productivity of fisheries and aquaculture Priority 3D: Sustainable income generation from forests and trees</p> <p>Priority area 4: Poverty alleviation and sustainable management of water, land, and forest resources Priority 4A: Integrated land, water and forest management at landscape level Priority 4B: Sustaining and managing aquatic ecosystems for food and livelihoods Priority 4C: Improving water productivity</p>

Priority 4D: Sustainable agro-ecological intensification in low- and high-potential areas

Priority area 5: Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger

Priority 5A: Science and technology policies and institutions

Priority 5B: Making international and domestic markets work for the poor

Priority 5C: Rural institutions and their governance

Priority 5D: Improving research and development options to reduce rural poverty and vulnerability

In addition, the CGIAR priorities listed above respond to regional and national needs for international public goods research. Collaboration with regional organizations will occur where there is a match between the needs for international collaboration, as expressed by the region, and the CGIAR priorities. Since CGIAR priorities have been set with input from the regions and given that the CGIAR has participated in deliberations on regional priorities, considerable complementarities exist between the two sets of priorities. However, since the CGIAR is global, and there are differing comparative advantages in tackling aspects of regional research, a complete match should not be expected.

The Science Council (SC), building on the consultative stage of the priority-setting process described above, has reviewed the total research portfolio of the CGIAR projected to 2015. Seeking to meet key needs and capitalize on new science, the intention is to focus the CGIAR research agenda on a smaller number of Priority areas for research. The Priorities have goals commensurate with the mission of the CGIAR, and encapsulate major areas of science within the CGIAR's comparative advantage in its assistance to developing country agriculture. Priorities are set so as to have measurable outcomes - specific links can, therefore, be made between priority setting and future monitoring and review functions.

The SC proposes that the Centers and the CGIAR members agree to allocate (following a transition period not to exceed three years) 80 percent of the total CGIAR budget to the five Priority areas described in the following sections of this document. It is recommended that donors provide funding for these priority areas in the future. It is suggested that the CGIAR spend up to 20% of its budget outside the System Priorities for Research. The SC further encourages Centers to utilize at least half of that 20% for exploratory, innovative research work to develop new science and potential new future priorities.

Capacity building is a key activity to meet the overall goals of the CGIAR. Reflecting the CGIAR's partnership approach to agricultural research, program-associated capacity building, as well as research on institutional strengthening is considered to fall within the 80% budget allocation. Only the more iterative types of course-related training unrelated to research are considered as falling within the additional 20% of budget allocated for other activities.

To adjust to these priorities (and to further refine them in the process) it is proposed that during the years 2006-2008 a program alignment be undertaken by Centers through Medium Term Plans and SC review of individual Center, CP and SWP MTPs. As soon as the priorities have been agreed upon, the SC suggests that discussions be undertaken to refine the implementation practice for the priority research. This document raises some of the strategic issues involved in the implementation of research priorities.

Center programs are expected to be time-bound and increasingly include exit strategies allowing for the products, and the program itself, to be taken over by NARS. The existence of strong NARS accelerates opportunities for transferring aspects of research to partners and raises the requirement that the CGIAR not duplicate existing capacities. However, the continued existence of weaker NARS in several regions means that *strategic choices about the speed and staging of research, capacity building, and ensuring regional spillovers* from CGIAR research must be made according to partner strengths.

There are opportunities to augment approaches and the rate of progress towards CGIAR goals through *the mobilization of new science*. For example, molecular biology-based research, including, where appropriate, genetic engineering and genomics, will play a major role in future agricultural research in many priority areas. However, the Science Council believes that the CGIAR should use the most appropriate research approach for a particular research endeavor, whether that relates to molecular biology, traditional plant breeding and related research, or agro-ecology.

It is expected that the proposed research will be carried out in *strong partnerships* with relevant agents. National and regional agricultural research systems, advanced research institutes and agencies, the private sector, and nongovernmental organizations all have a vital role to play in achieving our common goals. Strategic choices in dealing with the “other 96%” of the world’s agricultural research effort will be required, with the nature of the partnerships determined by the particular research. Elements of a successful strategy for collaboration with the private sector need to be integrated from Center to System level, through active research on *public-private partnerships*. The Science Council is interested in further strengthening the relevance of research through innovation systems and participatory research. Implementing the Priority research will also require that the CGIAR augment its *roles as catalyst, integrator, and disseminator of knowledge* in the overall global agricultural research system.

The aims of the implementation strategy will be to enhance the system’s efficiency in tackling major strategic objectives, to support system priorities through a move towards corporate donorship, to remain focused on international public goods research (rather than development) at Centers and to limit unproductive contract research.

The Need for System Priorities

The Science Council’s aim is to help develop a more cohesive and better-focused, high-quality research program to alleviate poverty, hunger and malnutrition. Despite many individual research successes in the past and the CGIAR’s important role in brokering and catalyzing international public goods research, there is an opportunity for the CGIAR System to have greater impact through a more consolidated research focus.

Secondly, there is a need to avoid dispersion of research. There has been a tendency to separate CGIAR research initiatives into a large number of projects (currently around 200) of different sizes, some of them rather small. At the same time that the CGIAR has undertaken a widening of its goals and its total budget has increased, there has been a relative decline in core funding, accompanied by selective funding of a large number of specific projects negotiated with donors. Many such projects address particular (local) development problems and do not focus on the core strength of the CGIAR, i.e. as a research supplier of appropriate international public goods, knowledge, technology and capacity building that can be used widely. Moreover, the Centers compete for these funds, often leading to overlaps in their portfolios.

Thirdly, there is the requirement to mobilize research capacity across the CGIAR System. Projects addressing difficult issues for sustainable poverty reduction (e.g., smallholder productivity gains in Africa) need sharply focused, long-term and multi-pronged approaches involving research on different commodities, themes, and disciplines. The CGIAR as a system has unique comparative advantage in mobilizing research across Centers and in organizing complex coordinated projects. The CGIAR should, however, exploit this advantage further.

Fourthly, there are opportunities to enhance coordination and cooperation. Centers have shown increased willingness and capacity to coordinate and cooperate (through the roles of CDC, CBC, System Office of the CGIAR, and development of a Future Harvest Alliance). Institutional mechanisms already exist to implement System-level projects through ad-hoc coalitions of Centers, SWPs, Task Force initiatives, and CPs, and the SC role in priority setting allows it to define, and to oversee the implementation of, ambitious Systemwide initiatives.

Well-defined System Priorities will help to develop more effective partnerships with NARS and advanced research centers, increase participation by stakeholders in priority setting, and assist donors in allocating their resources to the CGIAR projects with potentially large impacts. There are additional opportunities to mobilize contributions from other providers of research and extension activities to enhance the impact of the CGIAR’s science and approaches. Specially taking into consideration that the CGIAR, although very relevant, accounts for only a fraction of global research efforts undertaken by several international, regional and national organizations such as advanced research institutes, private companies, national research institutes, universities, and foundations.

Fifthly, setting system priorities provides the opportunity to enhance accountability. CGIAR System Priorities, broadly accepted by stakeholders, and internalized into Center MTPs, will help put in

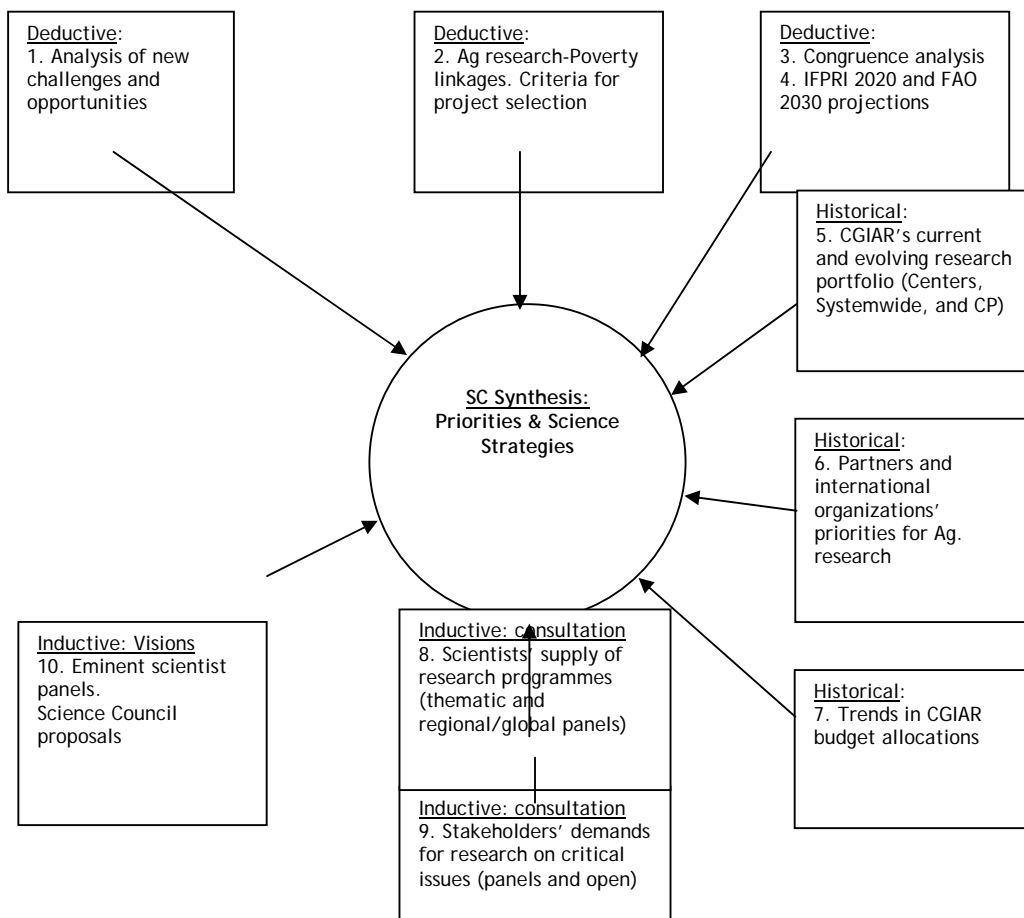
place a performance measurement system to translate logframes and milestones into objective indicators of performance.

A new process of CGIAR priority setting

The Centers and the CGIAR were created to apply science to the solution of problems related to poverty, agriculture, natural resources, food and nutrition. In the past, priorities for conducting this sort of research were set by decisions on relative priorities and resource allocation among commodities, facilitated by congruence analysis based on the value of production.¹

As requested by ExCo, the SC took the leadership in initiating a process of System-level priority setting. This consisted of a multi-pronged approach that had the distinguishing character of being both analytical and broadly consultative with stakeholders (including grassroots and non-governmental organizations), donors, and scientists both within the CGIAR System and in other research institutions (NARS and advanced research centers). The development of a preliminary set of System Priorities (and their associated sub-priorities) derived from a process of information gathering, analysis and consultations, and utilized three major approaches (Figure 1):

Figure 1. Science Council’s Approach to Identifying CGIAR Priorities and Strategies



- *Deductive approaches* including a broad analysis of new challenges and opportunities; the development of a set of criteria to achieve poverty reduction through agricultural research that can be used to screen future proposals; an updated congruence analysis to establish the future relative importance to be given in the overall budget to commodities (15 crops) and sectors (crops, livestock, forestry, and fish) by regions, and the use of global and regional projections of future supply and demand for commodities in agriculture.

¹ The former means of priority setting is now considered of limited value because of: (i) the complexity of goals, (ii) the value of production criterion does not work for non-market values (e.g. involved in prioritising germplasm conservation, or assistance to NARS), (iii) inability to encompass new issues and opportunities, and (iv) change in funding modalities.

- *Historical approaches* have included review of the current and evolving research portfolios for (a) Centers and the CGIAR, (b) the research portfolios for other selected research institutions and international organizations indicative of the “other 96%” contributing to agricultural research and development globally; and analysis of long-run trends in the CGIAR’s budget allocation across outputs, crops, sectors, undertakings, regions, and Centers.
- *Inductive approaches* have centered on a broadly consultative approach to identifying the demand for new research by stakeholders and of opportunities for the potential supply of research by expert scientists including members of the Science Council.²

Results from deductive approaches

Agriculture, and the CGIAR’s research and research-related activities on agriculture in developing countries, can contribute directly to meeting several of the MDGs (as outlined above). However, against these over-riding requirements, there is acknowledgement that the international context for agriculture is itself changing. The Science Council’s approach examined these changes in order to identify agricultural research needs appropriate for meeting the global challenges.

Approach 1 identified New Key Challenges and Opportunities in Agriculture. Within the last half a century the world has changed rapidly and so has the food security challenge. Urbanization and globalization are becoming pervasive, private sector involvement in agricultural research has been increasing rapidly around the world, and global concerns about the sustainable management of resources have been rising. The effects of population pressure and poor land and water use practices are noticeable in the (i) degradation of natural systems such as forests and fisheries, (ii) degradation of intensively cultivated lands, (iii) exploitation and erosion of marginal lands, (iv) water resource depletion, and (v) depletion of genetic diversity. At the farm and landscape levels, it is necessary to target research and development specifically towards technologies that enhance productivity while at the same time conserve resources. Improving opportunities for protecting and increasing incomes of the poor may be as important to their food security as providing them with new productivity-enhancing technologies. Since the Green Revolution, crop staples have been a key component of nutrition and food security. However, there are many other food and non-food commodities and resources, utilized in farming or taken from nature, which ensure nutrition, productivity, incomes, and better livelihoods of farmers, fishers, forest dwellers and pastoralists in developing countries. Trade liberalization and increased competition facing small farmers mean that the global food security challenge has over time become increasingly multi-dimensional. Climate change and instability are projected to become increasingly apparent through the next decades. Developing nations will require assistance to orient agriculture and agricultural practices into less vulnerable choices and pathways.

New Scientific Opportunities. Recent years have witnessed an unprecedented increase in the power and range of molecular biology to amplify and extend investigations across plant and animal species and to address the organisms, disease agents and abiotic stresses of most concern to developing country agriculture. A parallel explosion in computing and informatics has augmented data acquisition and storage, synthesis and transfer. Modelling, and the ability to combine data from different sources, not only can inform germplasm studies and the search for new genes and functions, but also promises to revolutionize understanding of processes affecting the management of natural resources. Thanks to the strategic accumulation of data, tools and modelling resources in the coming decade, one can expect the development of a more predictive approach to agriculture, the evolution of land and seascapes and the effects of climate, thus providing insights for the development of long-term agricultural and environmental policy.

Responding to the Globalization of Markets. Globalization will have impacts on growth and income distribution. Without targeted research to help develop new opportunities, the poor may be affected adversely by the liberalization of global markets. Reducing transactions costs associated with market access will be a key factor in enhancing the competitiveness of small farmers. National economies and users will face choices between responding to the *economic incentives offered by new markets* versus *multiple use* approaches optimized for other parameters such as social and environmental services.

² A more complete description of the approaches and analyses supporting the Consultative process, and the outcomes of this process, can be found in the “Report on CGIAR Priorities and Strategies for the Period 2005-2010: Outcomes of the Consultative Process” (Revised, August 2004, SC, Rome, Italy, 240p).

Potential and Challenges of the “New Agriculture”. There are opportunities for developing countries to take advantage of the new scenario for the future of agriculture. This will include balancing needs for the production of traditional staples, with diversification towards high-value products (including, for example, fruit, vegetables, fish, livestock products, horticulture, medicinal plants, etc). There will be greater focus on post-harvest improvements to increase cost efficiencies, or to increase the value added to products. Such market-oriented adjustments and increased competitiveness require greater consideration of product quality, and emphasis on production to market food chains, labelling (for product and human health, and environmental safety), and on managing and paying for environmental services. Organization of small farmers will be required to ensure their access to these supply chains and markets.

Regional Emphasis. Meeting the MDGs, and the vision of the CGIAR, will be most difficult in Africa. Sub-Saharan Africa is characterized by widespread poverty, the high relative dependence of populations upon agriculture or the extraction of natural resources, the low performance of agriculture at the aggregate level, poor infrastructure, and additional challenges from human disease, climatic instability and civil unrest which serve to increase the vulnerability of large numbers of people. There is the opportunity to join in consolidated partnership approaches for the enhancement of African agriculture laid out by regional priority setting and the New Partnership for Africa’s Development (NEPAD). Global research approaches can be expected to provide relevant outcomes and spillovers to areas with common concerns (including South Asia, WANA and some countries in Southeast Asia).

Approach 2 considered World Poverty Concerns. In the last 50 years, the world has changed fundamentally from one that was predominantly rural based to one where almost half the population is living in urban areas. Using agricultural research to reduce urban poverty through the resulting economic growth, employment creation, cheaper foods, and improved quality diets will consequently be increasingly important in the future for the CGIAR in meeting its poverty reduction objective.

The very poor tend to be associated with marginal production environments in rural areas. New technologies appropriate for these marginal and risky environments are still largely missing, and constitute an evident priority for the CGIAR. Identifying small farmer constraints to technology adoption and use continues to be a priority issue for consideration and planning.

Whilst the overall contribution of agriculture to GDP tends to decline with development, sustainable productivity improvement through agricultural research remains a key means to assist the poor and marginalized within wider development strategies. The indirect effects of agricultural productivity gains in poverty reduction must, therefore, remain a priority for the CGIAR, particularly in reaching the landless and urban poor.

Approaches 3 and 4 detailed World Food Concerns. Projections made by IFPRI suggest that many of the CGIAR’s major commodities remain critical for developing countries’ access to food. Rising food deficits in sub-Saharan Africa and WANA are important in rice, maize, soybeans, and low-value fish. Wheat deficits (in all regions except LAC) are largely associated with rising urban consumption, and alternative sources of supply exist in the international market. Deficits in ruminant meat in WANA, Southeast Asia, and East Asia are predicted to be important. The implication is that maintenance research on productivity of the identified staples, and new emphasis on non-traditional exports as sources of foreign exchange earnings would be appropriate. World market prices for wheat, maize and rice, adjusted for inflation, are the lowest they have been in the last century. Commodity prices for pulses have also dropped - to about half of what they were in 1989/90.

Towards 2030 (according to the FAO) the developing countries will become increasingly dependent upon cereal imports. The most serious imbalances for cereals will be experienced in wheat and coarse grains, in WANA, East Asia, and sub-Saharan Africa. Increased yields will be met primarily through increased intensification and technological efficiency in reducing yield gaps. New science has an important role to play in meeting these needs. Changes in the commodity composition of food are expected to occur in developing countries with a relative stabilization of per capita consumption of cereals, roots and tubers, and pulses (the latter somewhat in decline), and marked increases in vegetable oils, meat and milk and dairy products. There will need to be relatively large increases in the production of meat (beef and veal, mutton and lamb, pork and poultry) in developing countries. The trade imbalance in milk and dairy products (including demand for these in feeds) for developing countries will be 39 million tons annually by 2030. Fish consumption is likely to increase but there are

uncertainties about the final level of production that can be attained. More modest projections of demand at 150-160 million tons per annum will still mean that fish consumption may stagnate or even decline in sub-Saharan Africa and WANA.

These projections thus stress the dual challenge of meeting increasing demands for staple foods (that can only partially be met through trade) and for diversification to enhance the routes out of poverty through high-value crops, animal products, and fish.

Results from historical analyses

Approach 5 examined the Current and Evolving CGIAR Research Portfolio. The current research priorities of the CGIAR are represented *de facto* by the portfolio of projects being undertaken by the Centers. A review of the 196 projects presented in the Center MTPs for 2004-2006 provided general indications of what the CGIAR is doing today:

The Centers continue to conduct needed commodity improvement research (23 projects) in their mandated commodities. Improvement is carried out through genetic enhancement research (8) which encompasses breeding approaches and new genetic biotechnology approaches, and farming systems research (25) which is undertaken in a commodity-specific fashion, or more often in general improvement approaches to the key agro-ecosystems of developing countries where the commodities are grown or raised.

Whilst farming systems research encompasses aspects of resource management, there is a large body of Center research which concentrates on integrated natural resource management (INRM) (39) directed principally at water, soils, watersheds, fisheries, forestry, forages and pastures aimed at augmenting the sustainability of agricultural and natural production systems. Commodity, INRM and farming systems research are integrated in some ecoregional programs (6) run by Centers as research networks or as Systemwide programs.

The conservation and use of biodiversity (26) supporting agricultural productivity is carried out through Bioversity International's programs, the operation of gene banks by the plant commodity Centers, the Generation CP, the SWP on genetic resources and in conjunction with INRM research in natural ecosystems (forestry, fisheries) or agricultural systems.

There are smaller but emerging bodies of research on climate change (2), the links between agriculture and human health (1), and the Systemwide program on gender and diversity (1).

There is a large body of policy research (24) conducted by the CGIAR Centers. This is wide ranging across Centers addressing markets, trade and globalization (11); poverty research (3), and aspects of food safety and nutrition. There are sectoral or regional assessments (e.g. for livestock, or the semi-arid tropics), individual high priority issues (like genetic resources policy); and governance issues, particularly for common pool natural resources (such as forestry and fisheries).

To enhance performance, Centers have adopted participatory approaches (4) to assist design, dissemination and adoption of interventions; impact assessment procedures (8) aimed both at Center impacts and the effects of external factors on sectors or commodities; and the conversion of publication systems into true knowledge management systems (8) for Center efficiency and for the benefit of partners and stakeholders.

Similarly, there is a major component of the portfolio directed towards NARS capacity building (7), implicit in conducting research through partnership, but also as a specific goal in some regions, commodities and sectors, and subject to analysis through research on institutions and processes of development change.

This brief characterization of the current CGIAR research portfolio is of use in considering new or additional priorities and in determining the future evolution of the System's agenda. New priorities are also being developed by the Centers on the basis of the emerging issues. Amongst these, it is possible to note three major areas: (i) a heightened concern for knowledge management, (ii) a focus on systems of innovation amongst farming or resource management communities and NARS, and (iii) more explicit examination of the linkages between agriculture, health and trade.

Approach 6 considered the Priorities of Partners and International Organizations. The SC analysis considered the comparative advantage and priority portfolios of a number of other players:

(i) National Agricultural Research Systems (NARS) account for nearly 96% of agricultural R&D investments in the developing world, contributing a substantial share of the unprecedented rate of agricultural productivity growth seen over the past three decades. NARS are very diverse in size and capacity but they act and react with increasing numbers of partners and stakeholders. They are now being viewed within a wider innovation system (including farmers and foreign suppliers). (ii) *Apex NARS bodies* such as GFAR, The Global Forum for Agricultural Research, have recently developed authoritative regional priorities and programs which represent the demand side of priority setting. (iii) The Development Banks and other research providers have strategies which are aligned with the Millennium Development goals and/or have expertise that can be deployed in partnership to augment research progress. (iv) The private and civil society sectors: relationships amongst stakeholders in agriculture have changed dramatically; there has been a marked rise in the contribution of the private sector in some aspects of research; and of the civil society sector in defining relevance of research and partnerships, and for delivering research results. There are strong possibilities for augmenting public-private partnerships between the CGIAR and commercial companies, principally in biotechnical applications on behalf of the poor. Similar and complementary linkages can be formed with many of the "other 96 percent" of organizations that undertake and fund aspects of agricultural research in its widest sense.

Confronted by the same changing externalities as the CGIAR, the NARS too are facing new priorities. NARS are being challenged to strengthen their policy and regulatory frameworks for IPRs, biosafety, trade in genetically modified products, food safety, and strategies for accessing the new technologies. The strengthening of NARS to meet these emerging needs is central to the success of the CGIAR. There will be increased demands for knowledge management to enhance the workings of these communities of practice and research consortia, and there are major opportunities to capitalize on the new information and communication technologies in carrying out this collaborative mission. New priorities for agricultural research must be planned and delivered within these contexts in order to be relevant and to achieve objectives.

Approach 7 considered the Historical Budget Allocation. Historical analysis of the CGIAR resource allocation to commodities and sectors shows a steady reduction in allocations to cereal crop research. In 2002/2003, forestry (14%) and fisheries (5%) shares of the research budget had grown to anticipated levels and research on fish, forestry and livestock show increasing trends in resource allocations extrapolated to 2010.

In terms of CGIAR undertakings, productivity research has shown a steady decline (although it still remains the largest category, at 36% of expenditures in 2000), with increasing allocations to the Environment (18%), Policy (13%) and the Conservation of biodiversity (which received a 10% share of all resources in the year 2000). Provision of capacity-building assistance to NARS remained at around 22% of total expenditures.

Since the founding of the CGIAR, sub-Saharan Africa and Asia have received the main streams of resource flows. Most recently, there has been again an increase in funds allocated to sub-Saharan Africa, which received about 46% - or nearly half of all expenditures - for the period 2002-2003. Asia's levels of resource allocation have been 'stable' at around one-third of CGIAR funding, while the LAC region now receives 13% of funds, down four percentage points from the 17% level in the 1990s. There has also been a gradual decline in funding for the WANA region that is now at 9% of resources allocated, down four percentage points from a maximum level of funding of 13% achieved in the late 80s and early 90s.

Results from consultations

Approaches 8 and 9 followed a highly Consultative Approach for CGIAR Priority Setting. Firstly, a set of some 20 position papers were written by experts on the key issues in agricultural development and research and were shared with the other participants in the priority-setting exercise and the public at large.

Constraints were then further identified and elaborated through the discussions by a series of regional panels, as well as a global panel constituted virtually, each made up of some 20 experts with different disciplinary and organizational backgrounds. To broaden the consultation, and seek majority opinions, the list of activities was offered to stakeholders through an open electronic forum. More than 800 participated, including significant numbers of NGOs and NARS representatives.

On the “supply” side, thematic panels of scientists were asked to translate priorities into researchable activities. These panels proposed researchable themes (sub-activities) within each of the categories of activities identified by the earlier steps. Priorities were then established by regions. To do this, regional panels of scientists were asked to identify additional areas and to allocate given incremental resources to the researchable sub-activities identified by the thematic panels.

Final expert consultation. Draft research priorities (initially described across 10 priority areas) were developed by the SC synthesizing current research approaches, and new priorities and opportunities identified and developed over the two-year period. Outline descriptions of research prioritized under the ten areas were shared with the CGIAR and its stakeholders in October 2004, and the approach was widely discussed in several fora, including at the CGIAR’s Annual General Meeting in 2004. During January and February 2005, the Council organized discussion meetings on each of the ten priority areas, to examine and refine the rationale and possible research content for each area. Approximately thirty participants took part in each of the different meetings, including invited scientists, CGIAR Center researchers and SC and Secretariat members. Some of the draft priority areas were substantially revised and consolidated on the basis of the outcomes of those meetings. Finally, the Center Deputies for Research Committee provided comments on a subsequent draft of the outcomes of those meetings.

Criteria for identifying priorities for CGIAR research

The consultative process of priority setting has led to the identification of a number of potential topics for CGIAR research. Each responds to important issues in the new agricultural paradigm emerging with the globalization of agriculture. These need to be assessed through specific criteria. Potential impacts from new undertakings should be determined, and balanced against current undertakings of the System as a whole.

In identifying the priorities for research, the SC utilized the following three criteria:

- (i) expected impact of the research on the major CGIAR goals (poverty alleviation, food security and nutrition, and sustainable management of natural resources) taking into account the expected probability of success and expected impact if successful;
- (ii) production of international public goods; and
- (iii) alternative sources of supply and CGIAR comparative advantage in the conduct of the research

Particular emphasis was placed on identifying research which has a clear pathway (future food and livelihood situations) to *poverty alleviation*, and which impacts many, or many groups, of the world’s poor through any of the following ways:

- Increasing the production of staple foods in countries where food price effects are still important and/or that have a comparative advantage in growing these crops.
- Increasing agricultural productivity in many less-favored lands, especially heavily populated low-potential areas.
- Reducing risks in agriculture, in particular in high-value market-oriented production, and the vulnerability of rural households to shocks of both idiosyncratic and covariate nature.
- Helping smallholder farms across the board diversify into higher value products, including livestock products, especially in countries with rapidly growing markets for such products and/or access to suitable export markets.
- Increasing employment and income-earning opportunities for landless and near-landless workers in surplus labor regions.
- Developing more nutritious and safer foods to enhance the diets of poor people.
- Undertaking agricultural research in ways that are more empowering of the poor, in particular by helping them acquire the capacity to tailor technology to their specific livelihood strategies, with particular attention to women farmers and excluded groups.

Research to enhance *environmental sustainability* was considered to encompass (i) preventing the loss of agricultural and related biodiversity; (ii) productive and sustainable use of natural resources; and (iii) promoting the rehabilitation of natural resources and ecosystems underpinning the livelihood strategies of the poor.

The *expected impact* of priority areas was evaluated taking into account the *expectation of success* (more risks may be taken for higher expected gains) in meeting the specific goals through particular research pathways under a reasonable timeframe to achieve success. In addition, *cost effectiveness* of a particular research avenue was evaluated in relation to the costs of alternative approaches and the cost of research relative to the expected impact.

The CGIAR focuses on the production of *international public goods*, i.e. goods which are non-exclusive in access and non-rival in use, and which have application in more than one country (and preferably in more than one region). Working on global issues augments the opportunities for spillovers into several developing country regions. This constitutes part of the CGIAR's comparative advantage. CGIAR investment in developing international public goods can complement investment by both the private sector and national governments, which primarily develop more restricted benefits or local public goods.

The *comparative advantage* of the System to conduct the proposed research was evaluated on the basis of: (i) existing comparative advantage of the CGIAR relative to alternative suppliers i.e. ARIs, NARS and the private sector (given expected respective capacities in 5-10 years time), and, (ii) the possibilities for a high degree of leveraging through partnerships with key players in the near future.

Strategic considerations for the CGIAR in the implementation of research priorities

The System Priorities have been established within the framework of the Vision and Mission of the CGIAR.³ This includes seven planks or approaches to guide the development of CGIAR strategy. The current Priorities have been developed with a global focus and the following sections outline how these strategic considerations will contribute to the formulation and implementation of research.

Cross-cutting themes

The priorities are structured around five major groups of research activities aimed at producing common outcomes - such as the conservation of agricultural biodiversity, or improved income opportunities for the poor from the exploitation of higher-value commodities. Considered together, the CGIAR priorities provide a set of specific goals for a portfolio of research activities around which the CGIAR will organize its scientific and related capacities. However, the System will continue to carry out programmatic research on cross-cutting global, ecoregional or sectoral research topics through a combination of the 20 research priorities identified.

The principal cross-cutting theme is the focus on *poverty* which orients the majority of the research priorities. This is evinced from the level of research planning (e.g. dynamics of rural poverty, trait identification for genetic improvement) through the conduct of research, to the assessments of the effects of new agricultural technology, natural resource management practices and policy on the poor.

The CGIAR also carries out programs on particular topics or regions through a number of implementation mechanisms (SWP, Ecoregional Programs, CP, Task Forces and other modalities). Such programs draw on a number of the scientific and integrating capacities of the System according to the nature of the research challenge being addressed. It is anticipated that additional topical or regional research programs could be formed in the same way, bringing scientific expertise together from across the CGIAR matrix for particular issues or lengths of time.

As an example, a coordinated program on *nutrition and health* could be assembled directly drawing on CGIAR strengths in the characterization of genetic resources (Priority area 1), research to improve yield and biofortification of grains for (micro) nutrient content (Priority area 2), enhancement of livestock and aquaculture to augment protein supply (Priority area 3 and 4B), the improved management of water (Priority area 4), food safety in relation to storage (2C), and markets and trade (Priority area 5). This would be an approach to which the CGIAR could contribute according to its scientific comparative advantage in agriculture and sharing with partner expertise in the health sciences (Figure 2).

³ "A Food Secure World for All: Toward a New Vision and Strategy for the CGIAR" TAC Secretariat, FAO, October 2000. The seven planks include the focus on people and poverty; mobilization of modern science; geographic priorities and a regional approach to research; new partnerships in science and development, a task force approach, and playing a catalytic role in developing country agricultural research.

It is suggested that similar programs could be developed for research challenges of great global significance (such as *climate change*) or *research approaches for particular ecoregions* (Figures 3, and 4). In line with a more explicit cross-sectoral approach to natural resources management, *research on forest and tree resources* is not identified under a single priority. Nevertheless, a portfolio of research has been developed according to the CGIAR's comparative advantage, and these activities and cross-linkages are detailed in [Figure 5](#). The key consideration in such cross-cutting programs is that they draw on, and are limited to, the 20 priorities identified. Should research be called for by cross cutting programs outside the set of 20 priorities, it will be sought from partners.

Mobilization of new Science

A strict commodity focus has been avoided in setting priorities. Instead, research with a system focus is promoted. The main reasons are that a) much of the genomics and other upstream work that needs to be done is generic and can be most effectively and efficiently carried out across related species rather than on a commodity basis, and, b) much of the production by small farmers takes place within a multi-commodity system.

Similarly, the priorities are defined by specific goals and the likely scopes of research rather than by technologies. This stems from the Science Council's belief that the CGIAR should use the most appropriate research approach for a particular research endeavor. For example, molecular biology-based research including, where appropriate, genetic engineering and genomics, will play a major role in future agricultural research in many priority areas. In the planning and development of new research programs, researchers are urged to select the most appropriate approach whether that relates to molecular biology, traditional plant breeding and related research, or agro-ecology.

The changing context for agricultural research and adoption of the new priorities has strategic implications for the system. These include shifts in scientific expertise that may be needed in the system, some in different directions: (i) towards the acquisition of upstream genetic science and the establishment of platforms to relate to global efforts including the private sector, (ii) integrators of natural resources management research and policy development, (iii) policy and legal affairs - e.g. governing IPR and the use of genetic and other technologies at the system level and amongst NARS, (iv) increased capacity in effecting institutional change, (v) new social science capacities (or linkages) in poverty analysis, and market analysis and global trade, (vi) post-harvest management and linkages to production chain expertise, (vii) research management at the consortium level integrating system skills in ITC. The CGIAR Centers, and the system as a whole, have opportunities for consolidation and partnering strategies (e.g. in the case of functional genomics, and the development of other task forces).

Advocacy

It is clear that the results from CGIAR research may have little impact in adverse policy and institutional environments, so research is therefore proposed to better understand such environments. In addition, it is argued that the CGIAR should do more lobbying and the advocacy needed to bring about the appropriate supporting environment - including investments in rural infrastructure, delivery systems, and many other development aspects.

Regional priorities

In its analysis of the plausible futures for the rural and urban poor in developing countries, the SC has specifically considered regional differentiation in constraints, endowments and partnerships. The identification of strong national programs and other regional actors to tackle issues in collaborative partnerships form an important component of determining comparative advantage and in the placement of CGIAR research. Whilst the priorities identify important global research, it is fully anticipated that there will be different emphases in research approaches across regions constrained by different agro-ecologies, the distribution of poverty and development issues. For example, priority issues identified by the different regional organizations highlight tackling water scarcity in WANA, augmenting soil fertility in SSA, avoiding land and water degradation by intensive systems in the face of population growth in Asia, and dealing with the rise of new market realities for agricultural produce in LAC. The CGIAR portfolio is well placed to contribute to these priority research efforts and, through systemwide linkages, to provide the benefits of research through spillover to other regions. As above, CGIAR contributions will be limited to the 20 priorities.

Gender

It is intended that in the translation of strategic priorities into projects and programs, regional (biophysical and social) factors will be taken into account. In particular, the gendered nature of

agricultural production will influence research in areas with large numbers of women farmers (e.g. SSA) and approaches to defining pro-poor traits for improvement, market chain research, biodiversity conservation, and opportunities for land tenure, amongst others.

New Partnerships

It is expected that the research proposed in this document will be carried out in strong partnerships with relevant agents. Increasingly these will be national and regional agricultural research systems. However advanced research institutes and agencies, the private sector, and nongovernmental organizations have a vital role to play in achieving our common goals. Strategic choices in dealing with the “other 96%” of agricultural research will be required with the nature of the partnerships determined by the particular research.

Working with strong versus weak NARS. CGIAR Centers work with selected NARS in their regions, and share information globally with many more. All Center programs will be time-bound and increasingly include exit strategies where the products or the program itself will be taken over by NARS. However, it is difficult to prescribe a uniform interaction given variability in the NARS, and in the biophysical and human capacity of the states concerned. The heterogeneity of NARS in terms of capacity and rates of development by region increases the complexity of interactions for the CGIAR. The existence of strong NARS accelerates opportunities for transferring aspects of research to partners and raises the requirement that the CGIAR does not duplicate existing capacities. However, the continued existence of weaker NARS in several regions means that strategic choices (about the speed and staging of research, capacity building and ensuring regional spillovers from CGIAR research) must be made according to partner strengths. Involving NARS program partners of different strengths in research consortia can assist opportunities for south-south interactions and regional spillover.

Private sector. Among the major strategic opportunities to draw the private sector into assisting the global goals of the CGIAR will be the application of private sector biotechnologies in germplasm enhancement. This demands that the CGIAR is fully aware of private sector progress, able to access relevant technologies through partnerships, and apply them to the requirements of developing countries, particularly the poor. Elements of a successful strategy need to be integrated from Centre to system level, and through active PPP research utilizing proprietary technologies. Means to develop co-operative research on natural resource and environmental issues may be explored.

New linkages with ARIs. There are, increasingly, opportunities to source relevant research from non-CGIAR providers. In general, outsourcing of research or for example, capturing food safety, market chain knowledge and post-harvest expertise from others, is to be welcomed as part of the principle of developing new science partnerships.

The SC believes that an innovation systems approach should be pursued where appropriate instead of the traditional linear research through extension to farmer approach. As a minimum, there should be a strong two-way communication between farmers and researchers whether at the national or international level.

Finally, options for collaborative research on each of the priorities identified in this document should be pursued using three main criteria: low transactions cost, building on existing structures, and interaction among those researchers actually doing the research.

Catalyzing new solutions

Following from the above, it is clear that in the accomplishment of the Priority research the role of the CGIAR Centers will vary according to the subject and the expertise required. The CGIAR will expect to lead global research programs in some defined areas, working with existing and new partners. It will continue to convene consortium approaches to research on important challenges with other research providers (including NARS and research institutions in industrial countries concerned with international agricultural research). The implementation of the Priority research will also require that the CGIAR augment its role of catalyst, integrator and disseminator of knowledge within the overall global agricultural research system (Figure 6). Such approaches help in building common frameworks for all players (CGIAR, NARS and other partners) to conduct research in a cooperative and efficient manner. Finally, the CGIAR's SC has an important role to play in facilitating this overall process by helping CGIAR Centers and the System itself in mobilizing the global agricultural research system around the goals of the CGIAR.

PRIORITY 1: SUSTAINING BIODIVERSITY FOR CURRENT AND FUTURE GENERATIONS

Summary: The CGIAR should continue and extend its key role in the conservation of genetic resources for food and agriculture. The focus will continue to be on the genetic resources of crop plants, but there will increasingly be opportunities through under-utilized species with potential for income generation by the rural poor, including trees, livestock and aquatic genetic resources. However, the CGIAR should not act alone, but must become a well-defined component of a rational, coordinated, forward-looking global system with clearly described areas of responsibility.

The CGIAR's focus must move towards the use of collections rather than conservation for its own sake. Use, particularly in germplasm enhancement, should be encouraged, by making available highly characterized core cultivar subsets, more extensive accessions of well-described wild relatives and, for the first time, defined genetic stocks.

Rationale: Genetic and functional diversity of plants and animals are the building blocks of different agro-ecosystems and the basis of improved agricultural performance and production. Much of the diversity rests in under-studied wild relatives of major and minor crops, livestock and fish indigenous to the countries served by the CGIAR. In some areas of the world, the advent of monocropping, industrialization and habitat degradation threaten to marginalize or extinguish indigenous genetic diversity of plant and animal species useful for agriculture. There is a continuing need to collect, conserve and characterize this diversity in relation to sustaining and augmenting future agricultural production.

The CGIAR has made important contributions to the development of in trust collections of staple crops and forages to protect agricultural biodiversity and to provide for the future enhancement of production through breeding. However there are many plant and animal species which contribute to protecting smallholder farming and improving assets, for which there are not yet rational systems of conservation at the global level. In many cases, the conservation and characterization of new and underutilized plant species, as well as for indigenous animal and fish breeds, either does not exist or needs to be put on a modern, forward-looking basis. The CGIAR recognizes the role and contribution of the FAO in this area and seeks to provide its scientific and policy expertise to advancing the establishment of a global system of conservation in collaboration with the FAO and its partners.

It is particularly important in all aspects of the work undertaken by the Centers that due regard be given to the legal status of the materials under study and development. For many crop species, but by no means all, both cultivated varieties and wild relatives will be included within the multilateral system of the International Treaty on Plant Genetic Resources for Food and Agriculture. In the case of species of neglected or under-utilized crops, only a few will come under the multilateral system. Working in partnership with national institutions will be particularly important, as will due regard for access and benefit-sharing regimes.

The general goals for this area of work are as follows, and the likely research contributions to be made by the CGIAR system are identified as specific goals⁴.

- Conserve plant genetic resources of priority crops for food and agriculture and their wild relatives, and characterize them for intrinsic characters and characters of utility to the poor.
- To conserve and enhance the contribution of under-utilized plant genetic resources to the income, health and nutrition of the poor.
- Maintain and enhance livestock genetic diversity as the basis of further production improvements.
- Maintain genetic diversity as a basis for improvements in aquaculture.

PRIORITY 2: PRODUCING MORE AND BETTER FOOD AT LOWER COST THROUGH GENETIC IMPROVEMENTS

Summary: The key role of the CGIAR in providing food security through continued increased production of the major staples must be sustained, but with an increasing emphasis as a provider of novel genes for adaptation and yield enhancement. Specific attention should be paid to drought

⁴ The specific goals and the scope of the research effort in each case are being developed by the collaborative development of Framework Plans for each system priority.

tolerance and biofortification of relevance to the poor. Genetic enhancement activities, usually in collaborative arrangements, should also extend to some high value crops, livestock and fish.

Focus will be imparted by more closely tailoring the CGIAR program to NARS needs. In general, the CGIAR will move its efforts upstream to provide technologies, genes and enhanced breeder lines rather than finished varieties. The CGIAR should seek to combine forces with strong NARS to provide international public goods to serve partners with less capacity. Although the CGIAR is expected to be involved with more plant and animal species, all new initiatives will incorporate clear time-bound strategies to aid financial and resource planning.

Rationale: The CGIAR has traditionally had most success in meeting its goals for sustaining and improving the availability of food commodities for rural and urban populations through breeding and genetic enhancement methods. There are new and emerging opportunities to combine the analytical power of molecular science for trait capture with traditional approaches, and to speed the timeframe for research. Priority area 2 is an input to the accomplishment of the long-term goals shared by the CGIAR and the MDG of alleviation of poverty, hunger and unsustainable natural resource management.

The CGIAR is ideally placed to carry out international public goods research in this area, since it is able to make specific links between characterization, conservation and enhancement activities for important food, feed and fodder species e.g. through gene pools encompassing disease resistance, stability and environmental traits required to meet the MDGs. Phenotyping capacity is therefore key to the CGIAR's role in deploying existing genes (whether identified through characterization of in trust accessions, or genes characterized by other advanced research institutes) for the benefit of the poor. It also has a comparative advantage in forming alliances with other organizations to increase the effectiveness of germplasm enhancement programs. There are close and long-standing links to farming systems in different developing country regions, and the CGIAR's major impacts will be through the deployment of improved cultivars and the capture of benefits by poorer farmers and consumers.

To some extent, breeding and research in established crops is currently focused on defending yield gains (maintenance against evolving pest pressures and changing environments) rather than increasing the yield ceiling, as in the past. However, the projected requirements for yield increases in staples demand that research continues to improve the yield as well as maintain the current levels. The need for higher yield potentials is particularly important where land will be diverted to other higher value crops (see Priority area 4).

For both animal and plant improvement, a large effort should be made to alleviate some of the effects of stresses, particularly water shortage, and to improve efficiency of production per unit of input. The general approach encompasses different sorts of genetic improvement methods, and quantitative genetic approaches for sustained gains may be as important as quantum advances through genomics. This also applies to breed improvement in farmed fish and livestock, as well as to other higher value species and commodities.

It is recognized that accomplishment of some of the goals of this Priority will require more than just genetic science, including whole organism biology and physiology, eco-physiology and novel agronomies and, in particular, the development of effective seed distribution systems. Because of its broad nature and the different applicability to different goals, such additional research is not described in detail here. However, the ramifications are that (i) future genetic enhancement programs will be conducted with an array of partners - including emerging national systems and the various forms of the private sector (exemplified generically by the genetic technology providers in the North, as well as smaller but key players in seed distribution in the South), (ii) innovation and capacity building will be required at all levels of the germplasm enhancement pathway, (iii) the CGIAR's role will be limited necessarily to a smaller number of important projects, and (iv) sharing and devolution of tasks to NARS will be critical.

General goals

- To deliver sustainable productivity gains through genetic enhancement of staple crops to improve livelihoods and food security of the poor.
- To enhance the tolerance of crop species to selected abiotic stresses and so increase agricultural productivity and reduce risks in unfavorable agricultural environments.

- To enhance the content and availability of micronutrients and to reduce potentially toxic compounds in staple commodities for enhanced human nutrition.
- To enhance opportunities for the exploitation of high-value commodities by the poor.

PRIORITY 3: REDUCING RURAL POVERTY THROUGH AGRICULTURAL DIVERSIFICATION AND EMERGING OPPORTUNITIES FOR HIGH-VALUE COMMODITIES AND PRODUCTS

Summary: The research identified under this Priority addresses the opportunity to provide additional income for the poor through diversification and production of a range of agricultural products. Research on fruit and vegetables, livestock, fish and forest and tree products is designed to augment productivity, and income-generating opportunities for the poor, whilst managing the conditions of growth of individual sectors and the links to markets. This enhances earlier research approaches to fish and livestock and tree products, and expands the CGIAR's focus from staple commodities. The CGIAR will expect to link to international sources of expertise for commodities or approaches that have not been systematically addressed by the CGIAR previously. Approaches will link biological to socio-economic and market research in consideration of factors affecting the production to consumption chain. There are increased opportunities through the selection of some commodities (small livestock, backyard aquaculture, home gardens etc) and post-harvest value addition, to target income-generating opportunities for poor women and communities.

Rationale: Rural households typically pursue livelihood strategies that include not only farming systems (based on crops, livestock, forestry and agro-forestry, and fish), but also non-agricultural home-based micro-enterprises (processing, handicrafts), and off-farm activities (such as wage employment in agriculture, employment in non-agricultural activities, and migration). It is the mix of these income strategies that eventually provides them with pathways out of poverty. Rural development strategies that offer these pathways must consequently look at agricultural activities in the context of these multiple pathways and how they are inter-related. This often requires designing approaches to rural development from a territorial perspective, where the potential offered by agricultural research is a component, often the essential one, of a broader regional and local approach to poverty reduction (see Priority area 5). This implies that agricultural research needs to be coordinated with the other regional and local interventions that can provide pathways leading away from poverty. Where a blueprint approach to technological innovations has proved unsuccessful in some locations because the dimensions required to capitalize on the potential these new technologies offer for poverty reduction are missing, an integral territorial approach offers largely unexplored potential. This is particularly applicable to sub-Saharan Africa, where the full benefit from investments in agricultural research has rarely been accomplished. Given the heterogeneity of local conditions, these territorial approaches need to be based on extensive participation of local stakeholders, both public and private.

Smallholder farmers can increase their agricultural incomes through greater sales of high-value commodities such as livestock, dairy products, fish, fruit, vegetables, spices, and ornamentals. These products are typically perishable, of high quality-specific value, and increasingly sold through specialized markets. Labor opportunities are provided at various points (production, harvest, post-harvest and marketing) along the supply chain for new, higher value commodities. This part of world agriculture is growing rapidly, and is becoming increasingly capital-intensive and vertically integrated. The requirement is to identify critical areas for trade, marketing, capital market, and regulatory reforms that can facilitate the integration of small-scale and poor developing country farmers in rapidly growing global markets for high-value crop and animal products in a sustainable manner, and thus increase and diversify their incomes in the long term.

To participate in growing formal urban and export markets, producers need access to well-organized post-harvest chains that can handle the processing and marketing requirements. Agricultural processors and traders, on the other hand, face increasing pressures to certify the safety of production practices (such as to avoid pesticide residues in the final product), exact quality attributes, and timely deliveries. Informed policies and a conducive regulatory environment increase the incentives for agro-processors to use the produce of small-scale farmers as inputs, and improve their capacity to meet the product attributes required in a rapidly modernizing agricultural marketplace.

General goals

- Improve the income of smallholder producers and consumers through research relevant to major high-value fruits and vegetables.
- Augmenting the productivity and sustainability of livestock enterprises in developing countries.
- Increased livelihood benefits for poor people from increasing the supply of aquatic resources.
- To enhance livelihoods, and sustainably secure and harness the value and benefits of forest and tree resources.

PRIORITY 4: POVERTY ALLEVIATION AND SUSTAINABLE MANAGEMENT OF WATER, LAND AND FOREST RESOURCES

Summary: Sustaining natural capital and reducing risk are key components of an overall strategy for poverty alleviation. CGIAR research is prioritized to enhance the stability and sustainability of agricultural productivity through three means: firstly, improving knowledge of the interactive factors relating to resource and agricultural management and providing assistance to decision-making and trade offs amongst objectives at the landscape level. Secondly, it will identify within resource sectors (such as water, fisheries and forestry) better ways to sustain productive resources and to enhance the poor's share of benefits. Thirdly, there is a focus on combating land degradation in farming systems to underpin other CGIAR research on enhancing productivity, and to ensure the developing countries do not fall behind the challenging production targets for staples that remain to be met in the future. Emphasis will be placed on the nexus of agricultural and natural resource management research. Outputs will be new knowledge, decision support models and best practice examples for management, institutional development and policy advice. The research will be designed to have wide applicability and spillovers to a range of regions and across resource types. The approach will be characterized by partnership with a range of stakeholders in natural resources management so that externalities from all relevant sectors are considered in improved management of resources by and for the poor.

General goals

- Improved land use practices contribute to increased and sustained productivity, optimal conservation, reduced conflicts and equitable use of land, water and forest resources in multi-use landscapes.
- To safeguard and enhance the livelihoods of the poor through sustaining and augmenting the value of aquatic ecosystems and their resources.
- Increasing water productivity in irrigated and rainfed environments to enhance livelihood aspirations of rural and urban poor.
- To reverse land degradation and sustain increases in food supply in a range of agricultural systems using ecological principles to assure environmental integrity and food security for urban and rural poor through improved soil, land, and ecosystem management.

PRIORITY 5: IMPROVING POLICIES AND FACILITATING INSTITUTIONAL INNOVATION TO SUPPORT SUSTAINABLE REDUCTION OF POVERTY AND HUNGER

Summary: The CGIAR has identified *research* on policies and institutions that will augment its own capacity as well as that of its national partners to target and conduct agricultural research with increasing efficiency, and to create solutions and enabling environments for the alleviation of poverty. Research on science and technology policy will include a forecasting function and research on critical areas affecting access, generation and sharing of technologies for agricultural improvement and for sustaining biodiversity and natural resources. This will include work on intellectual property, incentives and the formation of partnerships. To support new approaches augmenting the contribution of higher value commodities to poverty alleviation, new research initiatives in international and domestic markets will be undertaken with particular focus on food and product safety. Research will be conducted on rural institutions to increase the ultimate impacts of CGIAR research and possibilities for the equitable sharing of outcomes. The focus will be on producer organizations and the evolving partnerships along the production to consumption chain focusing on innovation at all levels.

Rationale: It is understood that the research described in priority areas 1-4 will only be successful when the outputs are implemented by collaborating partners and stakeholders in such a way as to reach the poor. Building the capacity of people and institutions is considered as an integral function of that research and to constitute a major international public good provided by the work of the

CGIAR. The program-associated training and capacity building of the CGIAR is expected to continue. In addition, as described in Priority area 5, the CGIAR will also invest in research to a) enhance its research and the placement of system resources in a dynamic way, b) increase the capacity of smallholders to benefit from international and domestic markets, c) identify means of strengthening rural organizations, and d) identify agricultural research and development pathways to reduce rural poverty.

General goals

- To enhance the contribution of agricultural science and technology so as to reduce poverty and bring about development, through improved capability, to innovate as well as to offer new options and insights into ways of making more effective use of agricultural science and technology.
- To increase adaptive capacity of smallholders and poorer operators to exploit opportunities provided by international and domestic markets and to offset the negative impacts of global changes.
- Enhance the role that rural organizations and innovative institutional partnerships play in maximizing impact from agricultural research and in creating marketing platforms for smallholder producers.
- To enhance impact of agricultural research in promoting options for the reduction of rural poverty and vulnerability.