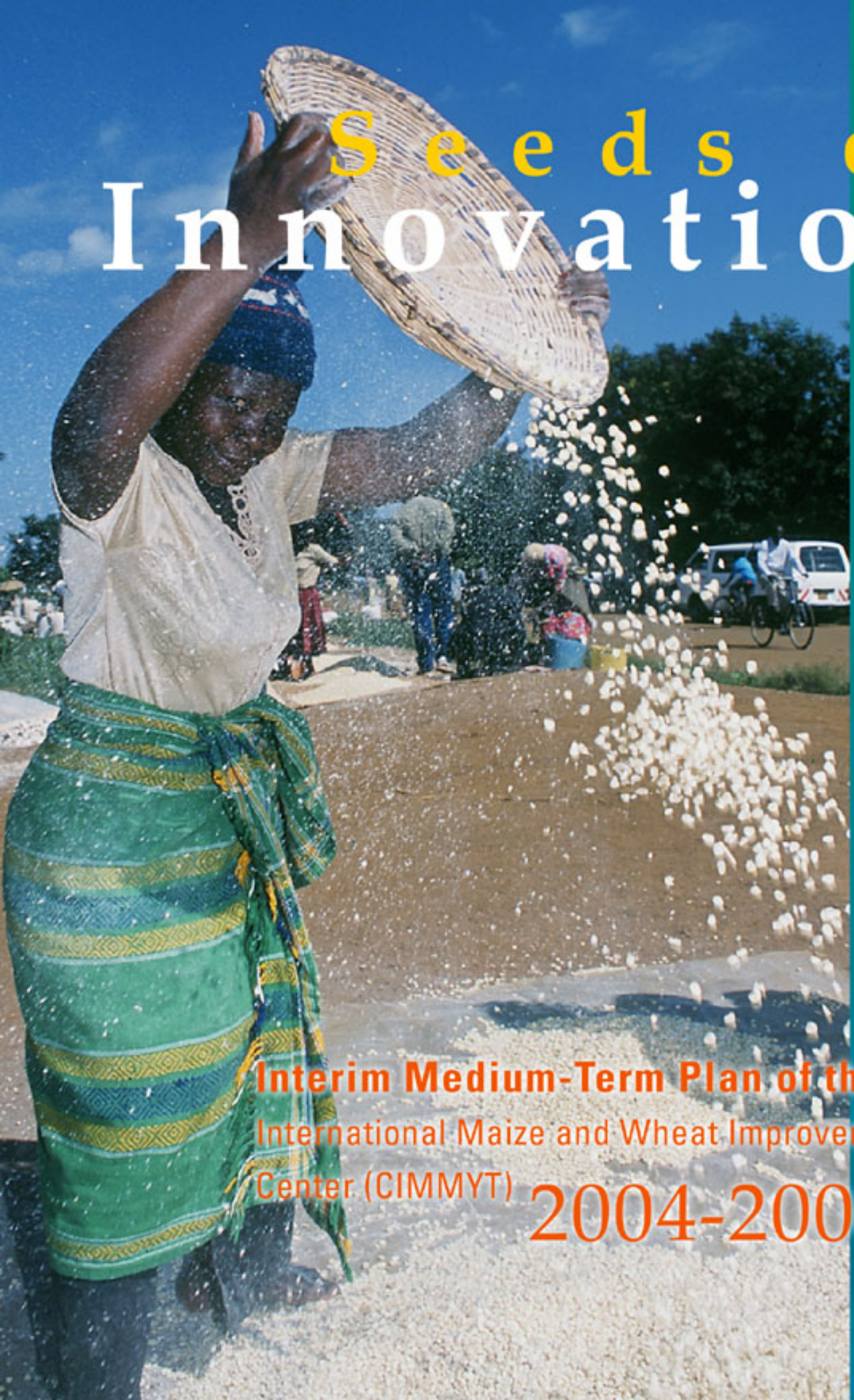

Seeds of Innovation

Interim Medium-Term Plan of the International Maize and Wheat Improvement Center (CIMMYT) 2004-2006+

S e e d s o f I n n o v a t i o n

Interim Medium-Term Plan of the International Maize and Wheat Improvement Center (CIMMYT)

2004-2006+

September 2003

CIMMYT® (www.cimmyt.org) is an internationally funded, nonprofit, scientific research, training, and development organization. CIMMYT serves as a catalyst and leader in a global innovation network that changes people's lives for the better. Drawing on effective science and partnerships, CIMMYT creates, shares, and uses knowledge and technology to improve the livelihoods of the world's poor who depend on maize and wheat. CIMMYT is one of 16 food and environmental organizations known as the Future Harvest Centers (www.futureharvest.org). Located around the world, the Future Harvest Centers conduct research in partnership with farmers, scientists, and policymakers to help alleviate poverty and increase food security while protecting natural resources. The Centers are supported by the Consultative Group on International Agricultural Research (CGIAR) (www.cgiar.org), whose members include nearly 60 countries, private foundations, and regional and international organizations. Financial support for CIMMYT's research agenda also comes from many other sources, including foundations, development banks, and public and private agencies.

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Abstract: This publication provides details on the general and technical objectives of CIMMYT's interim research agenda, along with details on financing, staffing, and contributions to the objectives of the Consultative Group on International Agricultural Research (CGIAR). The interim agenda is presented within the framework of seven new research projects. It reflects the changes in emphasis arising from CIMMYT's new strategic plan, which is under development.

AGROVOC descriptors: Planning; project management; research projects; research institutions; research support; budgets; finance; international organizations; trends; technical properties
Additional keywords: CIMMYT; CGIAR
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Contents

Acronyms

ADB	Asian Development Bank
ACIAR	Australian Centre for International Agricultural Research
APN	Asian Pacific Network for Global Change Research
ARC	Agricultural Research Council, South Africa
ARIs	Advanced research institutes
CAAS	Chinese Academy of Agricultural Sciences
CIDA	Canadian International Development Agency
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CONACYT	Consejo Nacional de Ciencia y Tecnología, Mexico
CODEPAP	Consejo de Desarrollo de la Cuenca del Papaloapan, Mexico
CORPOICA	Corporación Colombiana de Investigación Agropecuaria
CRCMPB	Collaborative Research Centre for Molecular Plant Breeding, Australia
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
CWANA	Central Asia, West Asia, and North Africa
DFID	Department for International Development, UK
DGIS	Directorate General for International Cooperation, Netherlands
DRIC	Délégation aux Relations Internationales et à la Coopération, France
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária, Brazil
FAO	Food and Agriculture Organization
FENALCE	Federación Nacional de Cultivadores de Cereales y Leguminosas, Colombia
GIS	Geographic information systems
GRDC	Grains Research and Development Corporation
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IAEA	International Atomic Energy Agency
IDB	Inter-American Development Bank
IDRC	International Development Research Centre, Canada
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IPGRI	International Plant Genetic Resources Institute
IP	Intellectual property
IWMI	International Water Management Institute
JIRCAS	Japan International Research Center for Agricultural Sciences
NARSs	National agricultural research systems
NGOs	Non-governmental organizations
OPEC	Organization of the Petroleum Exporting Countries
QPM	Quality protein maize
QTL	Quantitative trait loci
RWC	Rice-Wheat Consortium for the Indo-Gangetic Plains
SADC	Southern African Development Community
SADLF	Southern African Drought and Low Soil Fertility
SAGAR	Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, Mexico
SCOPE	Scientific Committee on Problems of the Environment
SPIA	Standing Panel on Impacts Assessment
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WANA	West Asia and North Africa

Part 1
Seeds of Innovation: CIMMYT's Proposed Research Plan and Budget, 2004-2006+

Preamble: Anticipating and Adapting to Change

CIMMYT has initiated major changes since submitting its last Medium-Term Plan to the CGIAR for consideration one year ago.

With the advent of a new Director General in July of 2002, CIMMYT's Board of Trustees recommended that CIMMYT conduct a full-scale strategic planning exercise to examine the continuing relevance of its mission, define how to position itself to meet the needs for agricultural knowledge and technology over the next 10-15 years, and determine the most appropriate organizational structure and operating modalities to deliver CIMMYT's products and services.

In late 2002 and early 2003, CIMMYT sought the counsel of more than 170 external stakeholders to orient its strategic planning. Stakeholders from six constituencies (national research systems, advanced research institutes, NGOs, farmers' groups, the private sector, and funding agencies) commented on the qualities and actions that would improve CIMMYT's effectiveness. Six internal task forces were convened to research broad trends in the global environment and specific trends in science, evaluate the status of CIMMYT's partnerships and networks, assess the Center's structure and management, review alternatives for financing the research agenda, and develop future scenarios for evaluating the robustness of CIMMYT's proposed strategy. These activities and two "CIMMYT summits" attended by staff and Board members helped forge a consensus about future needs and directions. This consensus was refined through continuing consultation as CIMMYT's new strategy was drafted in the latter part of 2003.

As of this writing, CIMMYT's new strategy awaits final consideration by its Board of Trustees. The strategy is the template for CIMMYT's metamorphosis: it outlines fundamental changes in CIMMYT's mission, structure, and way of doing business. The research agenda presented in this Medium-Term Plan reflects these proposed changes. It is important to emphasize that the Plan constitutes an *interim proposal* whose lineaments will be fully developed when CIMMYT's new strategy has been completed and accepted for implementation.

At the same time that CIMMYT has been critically reassessing its mission and strategy, the forces of change have been active within the CGIAR, and they have had important implications for CIMMYT. The CGIAR has created the Challenge Programs and other mechanisms to further Centers' impact through highly focused, efficient collaborations in

areas of strategic importance. Three Challenge Programs have started to operate, and each has a role for CIMMYT. As these programs become increasingly active, the implications for CIMMYT's research agenda and budget will be reflected in greater detail within its Medium-Term Plans.

The pages that follow provide the context for the detailed information presented in Parts 2 and 3 on financing and CIMMYT's project portfolio. They highlight recent research achievements that illustrate some of the new directions for CIMMYT's science and partnerships. Next, the likely outcomes of strategic planning at CIMMYT are described, along with CIMMYT's interim project portfolio. A brief review of participation and progress in the Challenge Programs, followed by a summary of financing and staffing issues, concludes Part 1.

Research Highlights

Connecting people to save African lives and livelihoods
For eight years, SoilFertNet (short for "Soil Fertility Management and Policy Network for Maize-based Farming Systems in Southern Africa," coordinated by CIMMYT) has developed and disseminated "best bet" soil fertility practices—more efficient use of mineral fertilizers as well as legume rotations, green manures, and other organic approaches—through partnerships with research and extension services, farmer groups, and NGOs in Malawi, Zimbabwe, Zambia, and Mozambique. The practices provide farmers with greater livelihood opportunities and expand biodiversity in cropping systems, rendering them more productive and resilient to stresses like drought and disease. Potential profitability and sustainability of best bet options have been demonstrated through financial and risk analyses. Network members also assess constraints to the adoption of new practices and, when necessary, promote policy changes to reduce those constraints.

National commodity task forces (e.g., on maize in Malawi and soybeans in Zimbabwe) have focused resources, partnerships, and the attention of government officials and policymakers on soil fertility and best bet technologies. In Malawi, for example, specific fertilizer recommendations were developed for hybrid maize. Practices for improving soil organic matter content were "officially released" by the Ministry of Agriculture and Irrigation. SoilFertNet members also provided technical input into a multi-donor "Starter Pack" scheme for farmers, which increased maize production and—in a year of acute hunger—saved lives.

In Chihota, Zimbabwe, almost 4,000 farmers have learned about new soil fertility practices, and more than 2,300 have used one or more of them. SoilFertNet members have also trained private sector dealers to offer smallholders appropriate inputs and advice. Current SoilFertNet membership surpasses 200, mostly from the region but also from the rest of Africa and the world.

Plant physiology: A catalyst in the application of biotechnology in genetic improvement

Biotechnology holds great promise for accelerating and enhancing the efficiency of genetic improvement. The principal limitation to a more widespread application is the enormous complexity of traits such as yield potential, which is related not just to the number of genes involved but also to the fact that genes are expressed differently in every environment, resulting in genotype by environment interaction (GxE). There is a significant gap (the genotype-phenotype gap) between the rate of gene identification and our knowledge of how those genes affect agronomic traits, their underlying physiological processes, and their interaction with the environment. Interdisciplinary research between plant physiology and genetics offers a powerful tool for bridging that gap by rigorously testing physiological hypotheses using appropriate genetic stocks. For example:

- *Genetic transformation.* At CIMMYT, genetically transformed wheat plants are being studied under drought to show the precise physiological effects of the gene *DREB 1A* in different moisture stress situations. Such information will enable breeders to more strategically deploy the gene to complement the effects of other traits, allowing stress-adaptive genes to be pyramided more effectively into modern cultivars.

- *Molecular mapping*. It is nearly impossible to relate genes directly to yield in a meaningful way because of the vast number of genes involved and their interaction with environment. Physiological approaches allow yield to be dissected into traits that are simpler than yield and can be studied more easily at the level of genes or quantitative trait loci (QTLs), and GxE. CIMMYT is developing molecular maps of drought-tolerance traits in maize (focusing on the anthesis-silking interval) and in wheat (focusing on canopy temperature depression), which show a strong association with performance.

- *Genomics*. Biotechnology tools such as functional genomics have the potential to unravel the complexities of gene expression and GxE, but they generate an enormous amount of information. Prior physiological understanding of growth processes and GxE allows gene expression to be studied in a specific tissue, at a particular growth stage, at a relevant time of day, and under a defined set environmental conditions, thereby greatly reducing the amount of information generated. At CIMMYT physiological studies are focused on elucidating the genetic basis of spike fertility in wheat and (as noted) on understanding aspects of drought tolerance in maize.

An effective research setting fosters a new kind of smallholder agriculture in South Asia

In South Asia, where more than 300 million people depend almost entirely upon rice-wheat cropping systems, the Rice-Wheat Consortium for the Indo-Gangetic Plains (RWC) has been instrumental in helping small-scale farmers use zero-tillage and other resource-conserving practices (green manure cover crops, mulch systems, and bed

planting). Even very poor farmers in Bihar, one of India's most impoverished and food-insecure states, are using the technology.

Zero-tillage for wheat planted after rice now covers a very substantial area in India and Pakistan (surpassing 500,000 hectares in 2002). Experimental data, currently being validated by farm-level studies, suggest that zero-tillage has tremendous potential in South Asia, for it saves fuel, raises yields, reduces herbicide use, and saves water. Yields are higher and costs are significantly lower. The next step is to use some of these conservation technologies in rice as well as wheat, to save even more water, reduce soil degradation, increase soil organic matter content, and reduce greenhouse gas emissions associated with global warming.

The RWC has achieved these results by partnering with national research systems of Bangladesh, India, Nepal, and Pakistan; farmer groups; private entrepreneurs; five CGIAR Centers (including CIMMYT); numerous advanced research institutes; and NGOs. CIMMYT played an important role by advocating research on conservation tillage throughout South Asia many years before the formation of the RWC, and subsequently by becoming a partner and the facilitating research center in the RWC.

Partnering with farmers to speed the adoption of new technologies in South Asia
Five years ago, partners within and outside South Asia (including members of the RWC, described previously) joined forces to develop and promote participatory adaptive research methods that would help raise productivity in South Asia's wheat systems. These systems are an economic mainstay across 35 million hectares in India, Bangladesh, Nepal, and Pakistan, but their productivity lags far behind their potential.

The partners—a collaborative network of farmer groups, extension agents, NGOs, private companies, advanced research institutes, CGIAR Centers, and other community and public-sector organizations—have used participatory methods to develop, identify, and promote wheat varieties adapted to local needs. They take a holistic approach to their work, looking at interactions between varieties, tillage practices, diseases, and the environment to identify and promote the most appropriate combinations of wheat varieties and resource-conserving practices for farmers' conditions. As a result, farmers are now sowing their chosen wheat varieties and applying new resource-conserving technologies.

Soil and root health research
Maize and wheat plants are anchored in soil all their lives, so soil and root health play a major role in determining their fate. A healthy soil for agriculture must have a balanced mix of physical, chemical, and biological properties. Intense agricultural production, particularly in marginal cropping systems based on monoculture, often disturbs the soil's ecological and structural balance. As a result, significant soil-borne pathogens can arise, including microscopic nematodes and root-rotting fungi, which, especially if combined with abiotic stresses such as drought and micronutrient deficiencies, can reduce yields by as much as 60%.

CIMMYT will devote considerable effort to addressing these “underground problems” in the years to come. The most economically and environmentally sound means of controlling subsoil pathogens is to develop cultivars that resist multiple root diseases. Presently conventional and molecular tools for pathogen identification and resistance breeding are used to develop such cultivars, but in the future, genetic engineering (based on a better understanding of gene function) may also play a major role.

Attention will also be given to studying the underlying effects of crop management on soil health and improving our understanding of which agronomic practices are most appropriate for maintaining healthy soils. We will also focus on assessing and maintaining soil health under zero-tillage to ensure that this resource-conserving practice remains viable over the long term.

Improved nutritional and industrial quality in maize and wheat for new and traditional foods

One of the realities of globalization is that farmers will increasingly need to meet the high standards set by industrial manufacturers and exporters if they are to earn income from their maize and wheat crops. CIMMYT has an important role to play in providing the value-added traits that will enable greater numbers of farmers to benefit from meeting those standards. Advances in biophysics, biochemistry, crystallography, and polymer science, as well as in statistical clustering and ordination analyses, are providing a better understanding of grain components that influence quality and how they interact during industrial processes used to manufacture specific products. More in-depth knowledge of protein and starch functionality for different products will pave the way for breeding “market-specific” cultivars. This knowledge will not only make it possible for producers to meet industrial standards, it will enable industry to offer locally important products made from maize and wheat (for example, the great range of flatbreads and noodles that are consumed in Asia), thereby preserving important aspects of local culture.

Such is the case in the Central Asian republics (Kazakhstan, Kyrgyzstan, Uzbekistan, and Tajikistan), which, since the breakup of the Soviet Union, have gone back to many of their old ways, including the type of bread they prefer: tandyr bread. Made of wheat, the most important staple in the region, tandyr bread is consumed at every meal and a principal source of nutrients. It usually takes the form of round or oval discs, 5-10 cm thick, baked on the inner walls of a concave clay oven, or *tandyr*. Tandyr bread making requires particular grain quality attributes that the winter bread wheat varieties cultivated in the region seem to lack.

Before embarking on a breeding program aimed at improving the quality of winter wheat varieties, it was necessary to investigate people’s criteria for good quality bread and determine the corresponding processing requirements. In September, 2002, a survey was conducted in the four Central Asian republics to collect information on the requirements for producing tandyr bread of acceptable quality. It was funded by GTZ (the German Agency for Technical Cooperation) and conducted by CIMMYT staff in collaboration with local researchers. The survey clearly indicated that the tandyr bread making quality of winter wheat varieties currently sown in the region is inferior. The main problems are

low gluten and protein content, and weak gluten type. To evaluate varieties for quality traits, laboratories have been identified in all countries except Tajikistan, and local researchers have undergone training at CIMMYT's wheat quality lab in Mexico. The CIMMYT lab is also assessing the quality traits of winter varieties and recommending the best ones for use as parents in quality improvement crosses. Systematic work including breeding and agronomy research and the establishment of a collaborative quality testing network in the region should substantially improve the tandyr bread making quality (and local commercial potential) of Central Asian winter wheats.

Multidisciplinary approach and partnership to take on drought

To make better progress in developing drought tolerant cereal varieties, there is a clear need to understand plants' responses to drought at the gene and physiological pathway levels. Ten years ago, CIMMYT initiated research on drought tolerance at the flowering stage of maize, a critical period in its development. Today, thanks to a team of dedicated CIMMYT scientists and to collaborations with Pioneer Hi-Bred International and Cornell University, a fuller understanding of plant drought response is emerging.

The three major components of drought tolerance—gene expression, metabolic pathways, and plant morphology—and their complex interrelationships need to be understood based on scientific data. Thanks to the input of plant physiologists at Cornell University, QTLs for key physiological pathways related to the drought response are being identified. As for gene expression, CIMMYT is collaborating with maize functional genomics experts at Pioneer Hybrid International on using microarrays to identify key genes with differential expression under water-limited conditions. Through these collaborations and "in-house" data, CIMMYT now has those three knowledge components available.

It is hoped that this knowledge will enable scientists to accelerate the development of drought resistant maize 1) by identifying the key genomic regions involved in drought tolerance and using the information in marker-assisted selection; 2) by identifying elite alleles at target genes that could serve as predicting factors for plant breeders; and 3) through genetic engineering to alter specific genes or pathways.

In wheat, the ABC is strongly involved in the development of drought tolerant varieties through molecular and comparative studies, and notably through genetic engineering. In 2000, JIRCAS supplied the ABC with a *DREB* gene from *Arabidopsis*, which has been shown to increase tolerance to drought in some plants. CIMMYT scientists successfully inserted the gene into wheat, but trials on wheat plants provided ambiguous results, possibly caused by experimental design problems. The design was refined in early 2003, and results from recent studies suggest that the *DREB* gene induces a drought tolerant phenotype that is probably more related to water use efficiency than to drought stress tolerance *per se*. This means that a plant will use all available water without incurring yield losses, before succumbing to extreme drought conditions. These results may also have promising implications for producing plants that use less water under irrigated conditions. *Dreb* plants will undergo further study under field conditions in late 2003.

Inside Mexico's traditional seed sharing networks

Under the auspices of the CGIAR's System-Wide Collective Action and Property Rights Initiative, CIMMYT is examining the structure and function of traditional farmers' networks and their role in the evolution and conservation of maize genetic diversity. The research is based in the Central Valleys of Oaxaca, Mexico, an area of significant maize diversity. Researchers initially hypothesized that farmers would have strong incentives for collective action to maintain access to many different maize landraces. Instead, they discovered that farmers' custom of routinely selecting and saving seed is central to understanding why no specialized networks or social institutions have developed to ensure access to seed. Saving seed is associated closely with being a good farmer. Seed (like tools and advice) appears to be another resource that farmers provide to each other through various social relations and networks.

Most seed transactions are motivated by farmers' interest in experimenting with a particular kind of seed. They rarely occur to recover lost seed. Transactions are bilateral, and the recipient carefully weighs the tradeoffs involved in obtaining seed from one source rather than another. Sometimes those relationships enable people to receive preferential treatment in the transaction. The priority is to obtain seed from someone who can be trusted to provide reliable information and seed with desirable characteristics. In comparison to the current, highly flexible, ad hoc approach, a permanent institution such as a seed club or community seed bank would be relatively costly. A community seed bank might also draw attention to someone's failure to save seed.

In this research, CIMMYT has employed interviews with farmers, focus groups, a study to trace seed transactions, and in-depth ethnographic case studies of 18 households in two villages. It is sometimes thought that this kind of research is too specific and localized to make a difference, but by making it possible to work with the people of Oaxaca to conserve the diversity of their traditional maize varieties, it can have an impact of global importance.

Adding impact to innovation in southern Africa

The Southern African Drought and Low Fertility (SADLF) Project is a collaboration between national agricultural research programs of the Southern Africa Development Community (SADC) region and CIMMYT. Involving more than 30 core participants, 80 institutions, and 1,000 farmers in approximately 150 farming communities, the project engages farmers, extension, community organizations, NGOs, and the private sector in developing stress tolerant maize varieties and delivering them to smallholders, especially those with poor access to seed systems.

This project has developed stress tolerant maize varieties and hybrids that use no more water or nitrogen than other maize varieties but yield better and more reliably under the conditions of resource-poor farmers, particularly those facing drought and infertile soils. With less fear of crop failure, farmers may be more inclined to invest in steps to improve soil fertility and conserve water. Because stress-tolerant varieties ensure improved food security on a smaller area, farmers can allocate more land and labor to legumes or cash crops, thereby improving incomes, soil quality, and possibly household nutrition.

To evaluate the varieties, the project adopted a participatory approach based on experiments called "mother-baby trials," grown by farming communities. Through the trials, information on farmers' opinions of trial cultivars and data on their performance flow back to researchers and seed companies, increasing the chances that seed companies will provide the kind of seed that farmers want. The trials have become a model for eastern and southern Africa and are also being used in Asia.

One result of the project's approach is that, for the first time, private seed companies—many of them struggling to survive in the volatile socioeconomic environment of southern Africa—have been provided with reliable information to develop and successfully market maize varieties for smallholders' difficult growing conditions and limited finances. Another result is that relief agencies providing seed to farmers who lost their seed stocks in the recent drought can supply varieties that will help them withstand future droughts. The goodwill created among a diverse set of partners is also making it possible to effect change at the regional level, by, for example, exploring a common regional policy for releasing new varieties to get them to farmers more quickly.

"Seeds of Innovation": The Elements of CIMMYT's Proposed New Strategy

The interim project portfolio presented in this Medium-Term Plan is the first step in implementing CIMMYT's proposed strategy. The driving force behind the strategy is CIMMYT's proposed mission:

> *CIMMYT serves as a catalyst and leader in a global innovation network that changes people's lives for the better. Drawing on strong science and effective partnerships, we create, share, and use knowledge and technology to improve the livelihoods of the world's poor who depend on maize and wheat.*

CIMMYT's strategy for accomplishing this mission rests on four sources, or "seeds," of innovation.

First, CIMMYT will focus on sustainable livelihoods for the world's resource-poor maize and wheat producers and consumers—putting the needs of people first.

Second, CIMMYT will draw on the best available science for its work, engage in advocacy to ensure that research truly leads to sustainable development, and promote and support scientific excellence in its partners.

Third, CIMMYT is committed to a broad set of partnerships and networks that will enable it to stay attuned and responsive to the needs of poor people and ensure the impact of all partners' efforts to promote sustainable development. Global research efficiency and impact in farmers' fields will be improved through collective priority setting and shared implementation. CIMMYT will outsource and devolve research wherever possible.

Fourth, to be effective as a catalyst in partnerships and innovation networks, CIMMYT will give careful attention to managing the full cycle of innovation and optimizing the sharing and use of knowledge across scientific, institutional, and national boundaries.

CIMMYT's commitment to these four aspects of innovation is reflected in new ways of doing business:

- A new organizational structure, in which projects replace commodity and disciplinary research programs
- Changing priorities across regions and crops
- More autonomy for research leadership across CIMMYT's locations, and stronger research teams on the ground
- Support to become a learning organization

Organizational structure

CIMMYT has operated under a matrix structure consisting of 21 research projects (described in our previous Medium-Term Plans) and 5 research programs.

To foster the integrated research perspective and partnerships that CIMMYT will require to fulfill its mission, its research programs will be replaced by the 7 interdisciplinary projects described in this Medium-Term Plan.

These projects encourage and reflect the synergies that CIMMYT values among colleagues, disciplines, and partners. They indicate clearly where CIMMYT focuses its efforts and impacts, and they highlight complementary efficiencies in the Center's work. The projects also provide a framework for CIMMYT to alter its research agenda in a transparent way as needs and objectives change over time. In purely practical terms, the projects are the medium through which CIMMYT's research is planned, led, and budgeted.

It is important to emphasize that groups sharing a common disciplinary or thematic focus will work *across these projects.* They will foster good communication among staff working on similar issues; offer counsel for identifying disciplinary expertise; provide another way to present CIMMYT or liaise with partners; ensure professional quality control; encourage synergies and collaborative learning across projects; and give a "voice" to minority disciplines. Membership in these cross-project groups or "communities of practice" may extend beyond CIMMYT's institutional boundaries to benefit from and encourage broader partnerships.

A new management group will comprise the project directors, Director of Corporate Services, Deputy Director General for Research, and Director General, who will draw on expertise from the various communities of practice and from staff appointed to liaise with the many countries and institutions with which CIMMYT works.

Changing priorities across crops and regions

Based on a detailed priority setting analysis, which considered such factors as national maize and wheat supply and demand, poverty indicators, and an assessment of

CIMMYT's comparative advantage, CIMMYT will also shift its allocations of unrestricted resources by region and crop in the years to come. The Center will continue to conduct a considerable share of research with global applications, but it will increase its emphasis on South Asia, maintain efforts in sub-Saharan Africa, North Africa, and Central and West Asia, and reduce the overall emphasis on Latin America, outside of a few areas of extreme poverty. In the near term, wheat research should receive slightly more emphasis than maize research; by 2020, if current trends continue, the opposite should be true. These targets will be reviewed periodically. They may be offset by the predominance of special project funding for a given region or crop, but they nevertheless provide an important empirical framework for seeking and allocating research resources.

A stronger research presence on the ground
In conjunction with adopting a new project structure, CIMMYT will reinforce its research presence, particularly in Asia and Africa, to address problems of poverty more directly where they are most extensive and severe. Research teams will act as catalysts for innovation and information sharing—locally, in the region, and throughout the world. Research leadership (i.e., the project directors) will not be concentrated in one headquarters location, and the various research locations will have considerable autonomy to direct their work.

Becoming a learning organization
To encourage the interdisciplinary teamwork and knowledge sharing (within and across CIMMYT boundaries) that will make this strategy work, CIMMYT will also place much greater emphasis to organizational/institutional learning, facilitated by investments in new technologies and infrastructure to improve research efficiency and communications.

In conclusion, CIMMYT's new strategy aims to contribute to, mobilize, and strengthen a global network for research and technology delivery. The ultimate goal is to fulfill the responsibility of research to the people it serves: to reduce their vulnerability to poverty and hunger, increase the probability of a stable transition to a better future, and help the next generation get ahead—*either in or out of agriculture.*

CIMMYT's New (Interim) Project Portfolio

CIMMYT's new structure is based on seven projects, each of which is described briefly here and in detail in Part 3.

Project 1. Maize and wheat genetic diversity for humanity
CIMMYT's pledge to conserve and facilitate the use of crop genetic diversity of maize and wheat for present and future generations is fundamental to its existence and mandated by its commitment to the Global Plan of Action for Plant Genetic Resources for Food and Agriculture as a means of implementing the Convention on Biological Diversity. Through this project, CIMMYT fulfills its pledge through: germplasm collection for *ex situ* conservation; characterization of genebank entries; pre-breeding; genomics; improved and more accessible information on stored genetic resources;

management of intellectual property associated with germplasm; economic assessment of the value of genetic resources; analysis of policies relating to genetic resources and genetic diversity; conservation of genetic resources for wild relatives of maize and wheat; and *in situ* conservation of maize and wheat genetic resources, including information on geneflow in these crops under farmers' management.

Project 2. Livelihoods and risk in rainfed, stress-prone, foodgrain systems
Agricultural systems in which food grains are grown under rainfed, stress-prone conditions have a broad geographical reach, extending from Turkey and Eastern Europe through Iran, Afghanistan, and northwestern Pakistan to the Central Asian republics and western China. Similar systems occur in central India, northern, eastern and southern Africa and South America. Across much of this area, livestock are as important (or more important) than grain production in sustaining farm family livelihoods. Crop production often is restricted largely to wheat (winter, facultative and spring types), barley, and pulses. The growing period is short and options for diversification quite limited. Water is scarce: some farmers harvest only one crop every two years. In these areas, food security depends heavily on "wheat security," as wheat alone often provides more than half of the daily calories consumed. Through this project, CIMMYT and its partners will foster the development of production and livelihood systems that improve local and regional food security; reduce the risks associated with recurrent drought; sensibly combine livestock and crop production activities; make the most of limited or variable water resources; help reduce land degradation; support the efficient use of scarce inputs; foster improved input and product markets and related institutions; and contribute to system diversification, for more stable production of a wider array of crops.

Project 3. Food security, markets, and livelihoods in Africa
The challenges to making sustained improvements in rural livelihoods throughout sub-Saharan Africa are well known. This is the only region in the world where per capita food production has declined in recent years. Child malnutrition has increased and widespread poverty persists. A combination of thin soils of low fertility, uncertain and variable rainfall, outbreaks of the parasitic weed *Striga*, and poorly developed markets and rural infrastructure have stalled efforts to improve the productivity and sustainability of agroecosystems. In some areas, political unrest, ill-advised policies, and/or a high incidence of HIV-AIDS have exacerbated these problems. This project focuses on improving the resilience and productivity of agricultural systems in the face of considerable biophysical and socioeconomic risk. It fosters the development of production and livelihood systems that avoid unacceptable levels of loss in bad (e.g., drought) seasons; are substantially more productive than existing systems in good seasons; improve labor productivity to compensate for the loss of family labor; sustainably exploit relatively favorable niches in the landscape; make the most efficient use of scarce and expensive inputs; take full advantage of locally available inputs such as leaf litter, cattle manure, crop residues, and green manure cover crops to maintain soil fertility and system productivity; and foster market development to reduce input prices and improve product prices at the farm level.

Project 4. Ensuring world food security through sustainable intensification in densely inhabited areas

Large numbers of the world's poor reside in densely populated rural areas where cropping systems are intensive and livelihood systems complex (examples include the rice-wheat and other cropping systems of the Indo-Gangetic Plains of South Asia, and cropping systems in China's Yellow River Basin). Production from these areas sustains local farming communities and neighboring cities. On a global level, improved food security and livelihoods for poor people depend heavily on "getting things right" in those areas where the poor are concentrated in enormous numbers.

This project will foster the development of farming systems that are more intensive and, at the same time, more resilient and sustainable than those presently being used; deliver a more diverse set of higher-value products; use fewer external inputs more efficiently; generate more employment for the landless; supply less expensive food for poor urban consumers, and do all of this while conserving and improving the soil and water resource base. Of special concern is the need to conserve water resources. Improved water productivity in crop production is needed to free up scarce water for competing uses. Beyond increasing maize and wheat yields, the project will seek improvements in system productivity and diversity, which at times may imply a decrease, not an increase, in resources devoted to cereal production. The project will also seek to improve nutrient and water use efficiency, for better harvests with fewer inputs.

Project 5. Improving livelihoods and conserving natural resources in tropical agroecosystems

The rural poor in tropical Latin America, including members of many indigenous groups, grow maize to avoid purchasing it at times of the year when it is expensive. Part of the maize may also used to feed small numbers of livestock. Livelihood strategies may include the production of cash crops (e.g., coffee), manufacture of handicrafts, seasonal off-farm work, or remittances from family members who have migrated. More recently, systems based on maize have come to dominate smallholder rainfed agriculture in tropical Southeast Asia and China, where demand for meat and dairy products is exploding and demand for feed maize is increasing in proportion. Mounting demand for tropical maize (whether grown for food in Guatemala or feed in Indonesia) is triggering an expansion of production in unsuitable areas, such as fragile hillsides and tropical forests, as relatively poor households seek to improve their livelihoods through maize production. This project will develop production systems that improve the livelihoods of poor farm households; exploit ecological principles to help control weeds, pests and diseases; foster soil and water conservation; and help meet increasing demand for food maize in Latin America and feed maize in Asia. In contributing to the development of such systems, CIMMYT is aware that work to improve the productivity of maize in tropical agroecosystems is only an entry point into the larger question of improving livelihoods and reducing poverty, and that close collaboration with numerous other partners will be needed.

Project 6. Policies and institutions that maximize research impact
If CIMMYT is to succeed in meeting its global mandate, research focused on location-specific problems must be complemented by strategic research focused on issues that transcend particular regions, ecosystems, or crops. This project will focus on five activities of strategic global importance to the impact of CIMMYT's work: monitoring global trends in the economic, political, and institutional environments in which CIMMYT operates; setting overall priorities based on a comprehensive assessment of potential research and development activities for CIMMYT worldwide; assessing the impact of CIMMYT's work at the global level and through targeted case studies to ensure that CIMMYT's overall portfolio of resources is used efficiently and effectively; designing policy interventions to improve the likelihood that products and services reach potential users quickly and effectively; and advocating for change in a consistent, coherent way.

Project 7. Sharing and managing knowledge
All of the projects described previously support a major long-term objective for CIMMYT: to become a catalyst and leader in a global innovation network that effectively mobilizes knowledge about maize and wheat in the service of sustainable development. This project supports that objective in three ways. First, it will develop comprehensive, web-based resources to provide the scientific information that supports effective research. This information includes external resources such as databases and scientific journals, as well as new tools that enable large amounts of data from CIMMYT and its partners to be managed in a way that is useful for further research. Second, it will create a virtual context in which knowledge, information, and other resources (e.g., seed) is shared by partners, stakeholders, and the general public (e.g., through a digital maize and wheat information center, communities of practice, and knowledge banks for specific uses, such as information on the advantages of particular varieties available locally, of new practices that are locally relevant, or of support programs). Third, it will establish a strong service to build human capital among research partners, rural communities, and our own staff, based on a more precise assessment of needs and a more effective use of information technology.

Participation and Progress in Challenge Programs

Few CGIAR Centers actively participate in all three approved Challenge Programs. CIMMYT is one. Apart from helping convene the Challenge Program on Unlocking Genetic Diversity in Crops for the Resource-Poor and serving as a partner in the Challenge Program on Biofortified Crops for Improved Human Nutrition, CIMMYT participates in the Challenge Program on Water and Food.

Challenge program on unlocking genetic diversity in crops for the resource-poor
The genomics revolution means that genetic resources available in the public sector, especially from the CGIAR Centers and their partner organizations in developing countries, can be used to enhance social welfare as never before. This Challenge Program, whose development has been led by CIMMYT, IRRI, and IPGRI, will assemble

partners from other CGIAR Centers, national research systems, advanced research institutes, and the private sector to create a unique public research platform for accessing and developing genetic resources to reduce poverty. It will enhance the use of genetic resources in public breeding programs—and ultimately improve livelihoods and increase food security in developing countries—through a concerted effort to generate, manage, and apply genomic information derived from comparative studies.

The Challenge Program has been approved by the CGIAR and a payment of US$1.5 million has been made to CIMMYT by the World Bank. The second tranche of World Bank funding for the Challenge program of $1.5 million has not been factored in yet, since it is contingent upon the submission of a work plan in early November of this year. The EC funds for the Genetic Resources Challenge Program will not be received until the latter part of 2003. The EC is planning to disburse 4.15 million Euro.

To launch this recently approved Challenge Program, more than 40 participants from 19 organizations, including all 15 Program consortium members, attended a technical planning workshop in Wageningen, The Netherlands, in late August. The participants approved a research agenda for the Program, along with a detailed workplan for the next 12 months, and determined the objectives to be achieved within the first five years. Members of the Program Steering Committee also met in Wageningen, where they discussed a number of issues relating to research, governance, and management, and endorsed a process for appointing the Program Director. A Director will be appointed by the end of September 2003. The Committee also resolved that by the end of 2003 the Program will issue clarifying statements on IP policy and genetic resource stewardship that are consistent with CGIAR guidelines. The Program will give immediate priority to building partnerships with national research programs and the private sector.

Challenge program on biofortified crops for improved human nutrition

This Challenge Program, convened by IFPRI and CIAT, will improve the health of poor people by breeding staple food crops that are rich in micronutrients, a process referred to as “biofortification.” The Program grew out of a pilot project in which several CGIAR Centers, including CIMMYT for maize and wheat, assessed the feasibility of breeding biofortified crops. Activities are undertaken by an international alliance of CGIAR Centers, national agricultural research and extension systems, departments of human nutrition and plant science at universities in developing and developed countries, advanced research institutes (ARIs) with expertise in micronutrients in plants and animals as well as in genomics, NGOs, farmers’ organizations in developing countries, and private organizations. The Program has hired a Director, secured its funding base, and is presently conducting a series of meetings to organize its work, including research on the various crops and on socioeconomic aspects of their development and adoption.

Challenge program on water and food
CIMMYT and its partners have enjoyed a great deal of success in improving farm-level water productivity through new maize and wheat system technology. The on-going "zero tillage revolution" in the Indo-Gangetic Plains is probably the best example. This success is due in part to resource-conserving technologies (zero tillage, soil mulch cover, permanent bed systems, laser leveling) as well as to revolutionary new maize and wheat varieties that are vastly more drought tolerant and water use efficient than alternatives. After contributing to the design of this Challenge Program through stakeholder meetings, CIMMYT worked with partners to submit concept notes for competitive grants. Six grants were approved for work in five river basins: the Indus-Ganges, Kharkheh, Limpopo, Nile, and Yellow River basins. These are among the few projects that will deal with food and water dimensions of the Challenge Program, as opposed to water issues alone.

A Note on Financing and Staffing

CIMMYT funding overview 2002-2003
The governments and agencies that provided the largest share of our funding in 2002 are shown in Figure 1 (CIMMYT's Top 10 donors). The contributions to CIMMYT's budget by CGIAR member countries, North and South, as well as foundations and advanced research institutes (public and private), are presented in Figure 2 (Investors in CIMMYT 2002). Expenditure by object is shown in Figure 3 (Expenses by Object of Expenditure).

Sources of income from grants are presented in Table 1 (page 20). Targeted funding continues to provide the bulk of CIMMYT's research resources—almost two-thirds (Figure 4). The trend to declining core unrestricted funding in relation to targeted contributions continues to provide challenges to management of the Center, as flexibility is reduced and our capacity to undertake a range of core activities within CIMMYT's mandate is reduced. Full costing of projects is more important than ever, as is the recovery of all direct and indirect costs to the Center. Indirect cost recovery is currently just under 13%.

Funding trends
Funding for 2002 was $35.806 million, of which 81% came from CGIAR investors and 19% from other sources**.** Expenditure was $43.933 million and the result for 2002 was ($4.946 million).

The result for 2002 has presented CIMMYT with a number of challenges with regard to financial management of the Center's resources. The larger than anticipated deficit for the year was a result of some unexpected funding decisions and a more prudent approach to the write-off of unfulfilled pledges, as recommended by CIMMYT's new external auditors. The deficit for 2002 comprised an operating loss of $1.441 million, including staff reduction costs of $1.193 million, in addition to a write-off of unfulfilled pledges from previous years amounting to $2.312 million. A revised depreciation schedule, in line with CGIAR accounting standards for a total of $5.269 million, changed the net

assets amount at the end of 2002 to $10.215 million. CIMMYT has responded to ensure stronger financial management in the Center. Particular attention has been paid to guard against exchange rate losses through the use of more conservative exchange rate forecasts; a more stringent review of unpaid funds to avoid multi-year accumulation of bad debts has been implemented; and, a more conservative approach to the budgeting of activities funded by core unrestricted and core restricted contributions has been adopted.

Estimated budget for 2003

Our budget estimate for 2003 is US$ 39.02 million. CIMMYT's financial situation has improved markedly since the last Board meeting in March of this year. Income is up by $0.830 million on the March Board estimates (excluding the Genetic Resources CP funds) and expenditure has been constrained.

Since mid year closing there have been a number of positive developments in regard to income. For example, we have recently signed an agreement with GRDC, Australia, that will result in AU$ 0.730 million being paid to CIMMYT in the fiscal year 2003-04. In addition, we have also received a written commitment of US$0.5 million from the Mexican authorities and there are strong indications that the contribution from Japan will be at least US$0.1 million higher than the previous forecast.

Prospects for 2003-2004

As a result of a more prudential approach to financial management, mentioned previously, and vigorous efforts to raise additional income, the Center expects to increase its working capital reserves by more than $1 million by the end of 2003. CIMMYT has embarked upon a concerted effort to raise working capital reserves to the level of 90 days by the end of 2007. CIMMYT's staff reductions over the past 16 months—both voluntary and involuntary—have provided the Center with a more flexible cost structure while, at the same time, ensuring that the core competencies of CIMMYT are maintained.

Starting in late 2003, CIMMYT will embark upon a new phase with the implementation of our new long-term strategy. We are confident that a new, well articulated strategy that is relevant to today's complex environment will help CIMMYT in its work on behalf of the resource poor farmers and consumers in developing countries.

CIMMYT is actively participating in the development and implementation of the new global challenge programs and we expect that participation in the work of the challenge programs will help to offset changes to the general support allocations by the World Bank and other donors. We also welcome the introduction of performance-based funding allocations. Together with our partners, we at CIMMYT will continue to pursue science that is based on excellence and relevance for developing countries.

Projected financial trends over the 2004-2006 planning period

Our interim research agenda represents a significant change from last year's Medium-Term Plan by allocating CIMMYT's research activities and resources across 7 rather than 21 projects.

With respect to financing CIMMYT's research agenda, we anticipate that the current trend for funding agencies to support short-term, highly specific projects will not change considerably over the planning period. We expect such projects to form the bulk of our research resources in the foreseeable future.

The funding landscape will also be transformed as the CGIAR Challenge Programs and other funding mechanisms come into play, and as various donors alter their CGIAR investment strategies. CIMMYT expects that participation in the CGIAR Challenge Programs will somewhat offset changes to the general support allocations of the World Bank and other donors. We also anticipate that the introduction of performance-based funding allocations will enable CIMMYT to continue to pursue science that is based on excellence and relevance for developing countries.

Center staffing

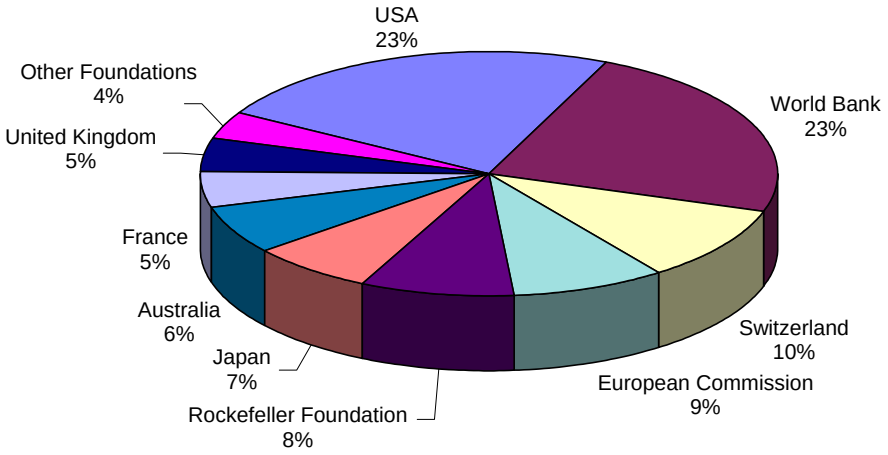
In late 2002 and 2003, CIMMYT reduced its staff numbers by 20 internationally recruited staff and 60 nationally recruited staff to cope with budget shortfalls. These reductions were taken into account in preparing the interim project portfolio.

Staffing trends are shown in Table 9. We anticipate some movement of staff in the coming years to bring our human resource allocations into line with priorities under the new strategic plan. The projections in the table should be considered extremely provisional, however, until CIMMYT's strategy is implemented.

Capital investment

Based on approval of CIMMYT's strategy and on funding prospects, over the planning period CIMMYT is committed to investing a greater share of its capital resources in information and communications infrastructure and in technology to improve the efficiency of its field operations.

Figure1. Top Donors to CIMMYT, 2002



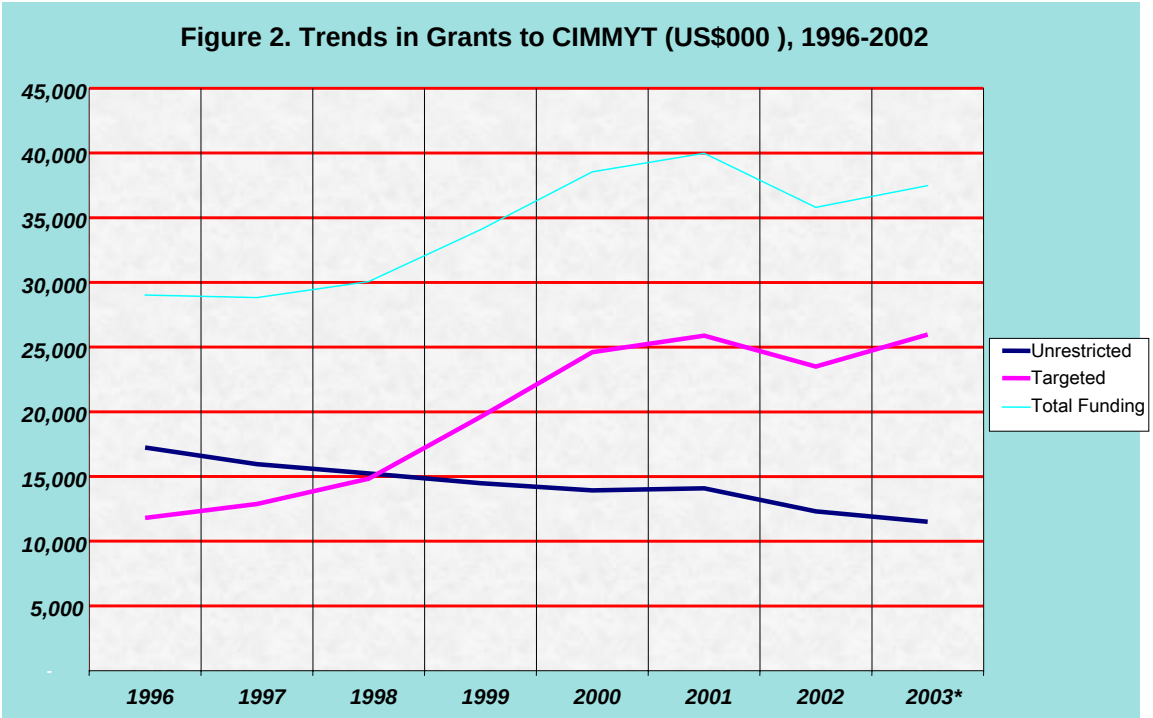


Figure 3. Expenses by 0bject of Expenditure, 2002

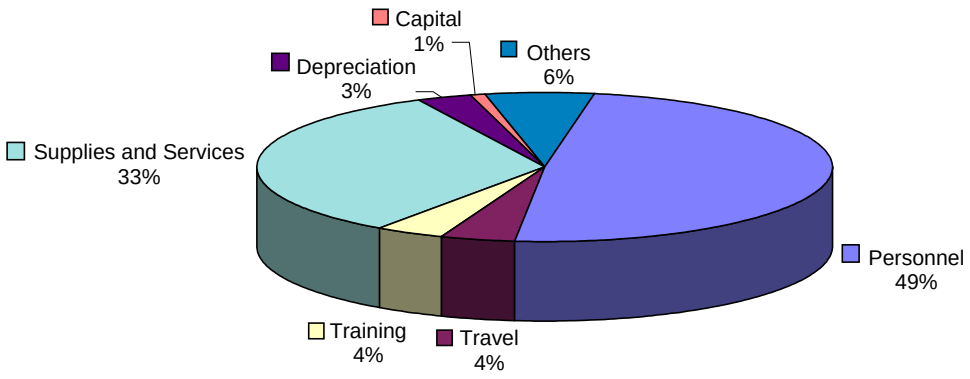


Figure 4. Investors in CIMMYT, 2002

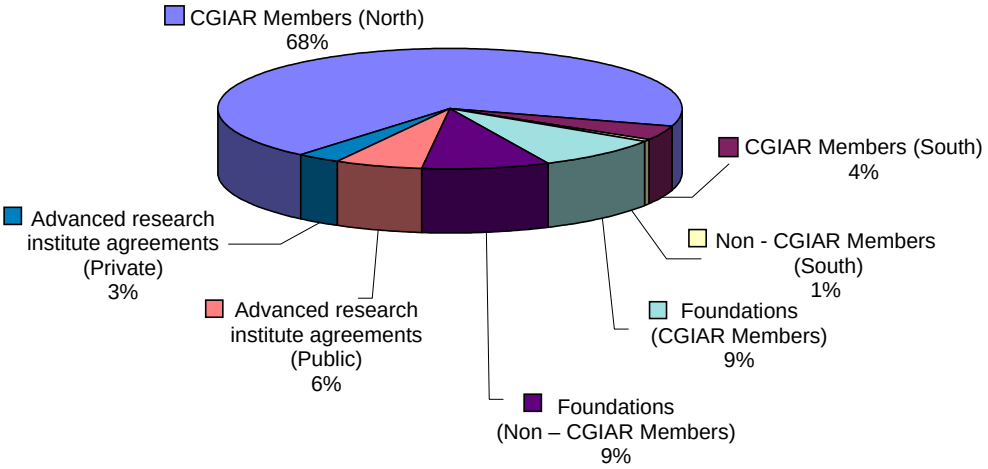


Table 1. CIMMYT sources of income from grants by country / entity (US $000s), 2002.

	Investor		Grant	%
1	ADB (Asian Development Bank)	829	829	2.32%
	Australia		1,773	4.95%
1	AusAID	303		
1	Australian Centre for International Agricultural Research	603		
6	CRC Molecular Plant Breeding	179		
6	Grains Research and Development Corporation	683		
5	Southern Cross University	5		
	Austria			
6	IAEA (International Atomic Energy Agency)	7	7	0.02%
	Azerbaijan			
3	Agency for Support to the Development of the Agricultural Private Sector	43	43	0.12%
	Belgium			
1	Ministry of Foreign Affairs, Foreign Trade and International Cooperation	423	423	1.18%
	Brazil			
2	EMBRAPA (Brazilian Agricultural Research Corporation)	40	40	0.11%
	Canada		970	2.71%
6	Agriculture and Agri-Food	38		
1	Canadian International Development Agency	924		
1	International Development Research Centre	8		
	CGIAR		190	0.53%
1	Centro Internacional de Agricultura Tropical	16		
1	CGIAR Finance Committee	5		
1	International Food Policy Research Institute	127		
1	International Livestock Research Institute	3		
1	International Plant Genetic Resources Institute	8		
1	Standing Panel on Impact Assessment	31		
	China		453	1.27%
6	CAAS (Chinese Academy of Agricultural Sciences)	300		
2	Department of International Cooperation , Ministry of Agriculture	130		
7	Lamsoo Milling Company	23		
	Colombia		191	0.53%
3	CORPOICA (Corporacion Colombiana de Investigacion Agropecuaria)	41		
3	FENALCE (Federación Nacional de Cultivadores de Cereales y Leguminosas)	11		
2	Ministry of Agriculture and Rural Development	139		
	Denmark			
1	Danish International Development Agency	822	822	2.30%
	European Commission			
1	Rural Development and Food Security	2,402	2,402	6.71%
	Ecuador			
3	Promsa	25	25	0.07%
1	FAO (Food and Agriculture Organization)	21	21	0.06%
4	Ford Foundation	6	6	0.02%
4	Foundation for Harvest Solutions	753	753	2.10%

	Investor		Grant	%
	France		1,290	3.60%
1	Ministere de l'Education Nationale, de la Recherche et de la Technologie-DRIC (Delegation aux Relations nternationales et a la Cooperation)	1,191		
7	Club Cinq (Wheat Breeding)	99		
	Germany		886	2.47%
5	Eiselen Foundation	68		
1	Federal Ministry of Economic Cooperation and Development	813		
6	University of Hohenheim	5		
	India		149	0.42%
1	Department of Agriculture , Research and Education	113		
7	Maharashtra Hybrid Seed Co. Ltd. (Wheat Germplasm)	36		
1	IDB (Inter-American Development Bank)	95	95	0.27%
1	IFAD (International Fund For Agricultural Development)	439	439	1.23%
	Iran , Islamic Republic of			
2	Ministry of Agriculture	283	283	0.79%
	Japan		1,948	5.44%
6	APN (Asian Pacific Network for Global Change Reseach)	39		
1	Economic Cooperation Bureau, Ministry of Foreign Affairs	1,428		
5	Nippon Foundation	472		
5	Sasakawa Global 2000	9		
	Korea , Republic of			
2	Rural Development Administration	154	154	0.43%
	Mexico		706	1.97%
5	CODEPAP (Consejo de Desarrollo de la Cuenca de Papaloapan)	4		
2	SAGAR (Secretaria de Agricultura,Ganaderia, Desarrollo Rural, Pesca y Alimentacion)	324		
5	Fundacion Guanajuato Produce A.C.	30		
5	Fundacion Hidalgo	42		
5	Fundacion Sonora	169		
7	ICAMEX (Maize and Wheat Improvement)	98		
7	Grupo Industrial Bimbo (Industrial Quality in Wheat)	39		
6	Miscellaneous Research Grants	128	128	0.36%
	Netherlands		274	0.77%
6	DGIS (Directorate General for International Cooperation)	11		
1	Ministry of Foreign Affairs	263		
	New Zealand			
1	Ministry of Foreign Affairs and Trade	117	117	0.33%
	Norway			
1	Royal Norwegian Ministry of Foreign Affairs	286	286	0.80%
1	OPEC Fund for International Development	50	50	0.14%
7	Other	538	538	1.50%
5	Other Foundations	992	992	2.77%
	Peru			
2	National Institute of Natural Resources	60	60	0.17%
	Phillippines			
2	Bureau of Agriculture Research, Department of Agriculture	12	12	0.03%
	Portugal			

	Investor		Grant	%
1	Institute for International Scientific and Technological Cooperation	169	169	0.47%
4	Rockefeller Foundation	2,350	2,350	6.56%
6	SCOPE (Scientific Committee on Problems of the Enviroment)	73	73	0.20%
	South Africa , Republic of		91	0.25%
6	Agricultural Research Council	40		
2	National Department of Agriculture	51		
	Spain		293	0.82%
7	Agrovegetal, S.A.	81		
2	Ministerio de Agricultura, Pesca y Alimentacion	212		
	Sweden			
1	Swedish International Development Agency	277	277	0.77%
	Switzerland		2,837	7.92%
1	Swiss Agency for Development and Cooperation	1,452		
5	Syngenta Foundation for Sustainable Agriculture	1,385		
	Thailand			
2	Department of Agriculture	9	9	0.03%
	United Kingdom			
1	Department for International Development	1,254	1,254	3.50%
	UNDP (United Nations Development Programme)			
1	Africa Bureau	209	209	0.58%
	Uruguay			
3	National Institute of Agricultural Research	114	114	0.32%
	USA		6,466	18.06%
6	Cornell University	7		
6	Kansas State University	15		
7	Monsanto Company (Hybrid Wheat)	162		
6	Oklahoma State University	91		
7	Pioneer Hi-Bred International	27		
6	Stanford University	158		
1	United States Agency for International Development	5,559		
6	United States Department of Agriculture	357		
6	Washington State University	90		
1	World Bank	4,309	4,309	12.03%
	Total Grants *	35,806	35,806	100.00%

1) CGIAR Members (North).
2) CGIAR Members (South).
3) Non - CGIAR Members (South).
4) Foundations (CGIAR Members)
5) Foundations (Non - CGIAR Members)
6) Advanced research institute agreements (Public)
7) Advanced research institute agreements (Private)

* Does not include Center Income of $0.736M.

Part 2

Financial Tables

Table 1a. CIMMYT -- Research Agenda Requirements, by Output, 2002 (Actual)

(expenditure in $ million)

Center Projects	Germplasm Improvement	Germplasm Collection	Sustainable Production	Policy	Enhancing NARS	PROJECT TOTALS
001. Maize and wheat genetic resources: use for humanity	0.617	1.475	0.000	0.295	0.295	**2.682**
002. Improved maize for the world's poor	0.859	0.391	0.474	0.000	0.414	**2.137**
003. Improved wheat for the world's poor	1.439	0.608	0.735	0.000	0.416	**3.198**
004. Maize for sustainable production in stressed environments	0.374	0.213	0.541	0.000	0.136	**1.264**
005. Wheat for sustainable production in marginal environments	0.646	0.336	1.355	0.000	0.202	**2.540**
006. Wheat resistant to diseases and pests	0.411	0.446	1.178	0.000	0.207	**2.241**
007. Impacts of maize and wheat research	0.000	0.000	0.000	0.597	0.218	**0.815**
008. Building human capital	0.000	0.000	0.000	0.000	3.968	**3.968**
009. Conservation tillage and agricultural systems to mitigate poverty and climate chang	0.084	0.000	0.338	0.084	0.057	**0.563**
010. Food and sustainable livelihoods for Sub-Saharan Africa	1.730	0.346	1.230	0.115	0.423	**3.845**
011. Maize for poverty alleviation and economic growth in Asia	0.726	0.294	0.245	0.095	0.341	**1.701**
012. Sustaining wheat production in South Asia, including rice-wheat systems	0.256	0.103	1.006	0.103	0.238	**1.706**
013. Food security for West Asia and North Africa	0.588	0.270	0.271	0.000	0.322	**1.451**
014. Agriculture to sustain livelihoods in Latin America and the Caribbean	1.409	0.266	1.218	0.174	0.739	**3.807**
015. Restoring food security and economic growth in Central Asia	0.162	0.081	0.071	0.041	0.048	**0.403**
016. New wheat science to meet global challenges	0.460	0.000	0.000	0.000	0.054	**0.513**
017. Apomixis: seed security for poor farmers	0.536	0.102	0.087	0.000	0.000	**0.725**
018. Biotechnology for food security	0.668	0.305	0.782	0.000	0.152	**1.907**
019. Biofortified grain for human health	0.172	0.000	0.062	0.000	0.059	**0.293**
020. Reduced grain losses after harvest	0.105	0.000	0.171	0.000	0.018	**0.294**
021. Technology assessment for poverty reduction and sustainable resource use	0.210	0.000	0.083	0.117	0.082	**0.492**
OUTPUT TOTALS	**11.452**	**5.236**	**9.848**	**1.621**	**8.388**	**36.545**

Table 1b. CIMMYT -- Research Agenda Requirements, by Output, 2003 (Estimate)

(expenditure in $ million)

Center Projects	Germplasm Improvement	Germplasm Collection	Sustainable Production	Policy	Enhancing NARS	PROJECT TOTALS
001. Maize and wheat genetic resources: use for humanity	0.659	1.575	0.000	0.315	0.315	**2.863**
002. Improved maize for the world's poor	0.917	0.417	0.506	0.000	0.442	**2.282**
003. Improved wheat for the world's poor	1.537	0.649	0.785	0.000	0.444	**3.415**
004. Maize for sustainable production in stressed environments	0.399	0.227	0.578	0.000	0.145	**1.349**
005. Wheat for sustainable production in marginal environments	0.689	0.359	1.447	0.000	0.216	**2.712**
006. Wheat resistant to diseases and pests	0.439	0.477	1.257	0.000	0.221	**2.393**
007. Impacts of maize and wheat research	0.000	0.000	0.000	0.637	0.233	**0.870**
008. Building human capital	0.000	0.000	0.000	0.000	4.237	**4.237**
009. Conservation tillage and agricultural systems to mitigate poverty and climate change	0.090	0.000	0.361	0.090	0.061	**0.602**
010. Food and sustainable livelihoods for Sub-Saharan Africa	1.848	0.370	1.314	0.123	0.451	**4.106**
011. Maize for poverty alleviation and economic growth in Asia	0.775	0.314	0.261	0.102	0.364	**1.816**
012. Sustaining wheat production in South Asia, including rice-wheat systems	0.274	0.110	1.074	0.110	0.254	**1.821**
013. Food security for West Asia and North Africa	0.628	0.288	0.290	0.000	0.344	**1.550**
014. Agriculture to sustain livelihoods in Latin America and the Caribbean	1.504	0.284	1.301	0.186	0.789	**4.065**
015. Restoring food security and economic growth in Central Asia	0.173	0.087	0.076	0.043	0.051	**0.430**
016. New wheat science to meet global challenges	0.491	0.000	0.000	0.000	0.057	**0.548**
017. Apomixis: seed security for poor farmers	0.573	0.108	0.093	0.000	0.000	**0.774**
018. Biotechnology for food security	0.713	0.326	0.835	0.000	0.162	**2.036**
019. Biofortified grain for human health	0.183	0.000	0.067	0.000	0.063	**0.313**
020. Reduced grain losses after harvest	0.112	0.000	0.183	0.000	0.019	**0.314**
021. Technology assessment for poverty reduction and sustainable resource use	0.225	0.000	0.089	0.125	0.088	**0.526**
OUTPUT TOTALS	**12.229**	**5.591**	**10.516**	**1.731**	**8.956**	**39.022**

Table 1c. CIMMYT -- Research Agenda Requirements, by Output, 2004 (Plan)

(expenditure in $ million)

Center Projects	PROJECT TOTALS
001. Maize and wheat genetic diversity for humanity	5.830
002. Livelihoods and risk in rainfed, stress-prone, foodgrain systems	6.825
003. Food security, markets, and livelihoods in Africa	5.830
004. Ensuring food security through sustainable intensification in densely-inhabited areas	6.825
005. Improving livelihoods and conserving natural resources in tropical agroecosystems	4.834
006. Policies and institutions that maximize research impacts	4.834
007. Sharing and managing knowledge	4.834
OUTPUT TOTALS	**39.812**

Table 2. CIMMYT Research Agenda - Allocation of Resources
(expenditure in $ million)

Allocation of Resources by Output
Logical Framework Format

Outputs:		**2002 (Actual)**	**2003 (Estimate)**
Germplasm Improvement		**11.452**	**12.229**
(Activity: Germplasm Enhancement & Breeding, plus Networks, as appropriate)			
Germplasm Collection		**5.236**	**5.591**
(Activity: Saving Biodiversity, plus networks, as appropriate)			
Sustainable Production		**9.848**	**10.516**
(Activity: Production Systems Dev & Mgmt, Protecting the Environment and Networks, as appropriate)			
Policy		**1.621**	**1.731**
(Activity: Improving Policies, plus Networks, as appropriate)			
Enhancing NARS		**8.388**	**8.956**
(Activity: Strengthening NARS - the three sub-activities, plus Networks, as appropriate)			
	TOTAL	**36.545**	**39.022**

		2002 (plan)	**2003 (Estimate)**
Increasing Productivity		**13.326**	**14.230**
of which:			
Germplasm Enhancement & Breeding		10.908	11.647
Production Systems Development & Management		2.419	2.582
Protecting the Environment		**7.023**	**7.499**
Saving Biodiversity		**5.203**	**5.555**
Improving Policies		**1.492**	**1.593**
Strengthening NARS		**9.501**	**10.145**
of which:			
Training and Professional Development		5.171	5.522
Documentation, Publications, Info. Dissemination		1.361	1.453
Organization & Management Counselling		1.580	1.687
Networks		1.389	1.483
	TOTAL	**36.545**	**39.022**

Table 3. CIMMYT Research Agenda Project & Output Cost Summary, 2002-2006 (in $ million)

Project	2002 (actual)	2003 (estimate)	2004 (plan)	2005 (plan)	2006 (plan)
001. Maize and wheat genetic resources: use for humanity	2.682	2.863			
002. Improved maize for the world's poor	2.137	2.282			
003. Improved wheat for the world's poor	3.198	3.415			
004. Maize for sustainable production in stressed environments	1.264	1.349			
005. Wheat for sustainable production in marginal environments	2.540	2.712			
006. Wheat resistant to diseases and pests	2.241	2.393			
007. Impacts of maize and wheat research	0.815	0.870			
008. Building human capital	3.968	4.237			
009. Conservation tillage and agricultural systems to mitigate poverty and climate change	0.563	0.602			
010. Food and sustainable livelihoods for Sub-Saharan Africa	3.845	4.106			
011. Maize for poverty alleviation and economic growth in Asia	1.701	1.816			
012. Sustaining wheat production in South Asia, including rice-wheat systems	1.706	1.821			
013. Food security for West Asia and North Africa	1.451	1.550			
014. Agriculture to sustain livelihoods in Latin America and the Caribbean	3.807	4.065			
015. Restoring food security and economic growth in Central Asia	0.403	0.430			
016. New wheat science to meet global changes	0.513	0.548			
017. Apomixis: seed security for poor farmers	0.725	0.774			
018. Biotechnology for food security	1.907	2.036			
019. Biofortified grain for human health	0.293	0.313			
020. Reducing grain losses after harvest	0.294	0.314			
021. Technology assessment for poverty reduction and sustainable resource use	0.492	0.526			
Total	**36.545**	**39.022**	**0.000**	**0.000**	**0.000**

Project	2002 (actual)	2003 (estimate)	2004 (plan)	2005 (plan)	2006 (plan)
001. Maize and wheat genetic diversity for humanity			5.830	5.974	6.143
002. Livelihoods and risk in rainfed, stress-prone, foodgrain systems			6.825	6.994	7.191
003. Food security , markets and livelihoods in Africa			5.830	5.974	6.143
004. Ensuring food security through sustainable intensification in densely-inhabited areas			6.825	6.994	7.191
005. Improving livelihoods and conserving natural resources in tropical agroecosystems			4.834	4.954	5.094
006. Policies and institutions that maximize research impacts			4.834	4.954	5.094
007. Sharing and managing knowledge			4.834	4.954	5.094
Total			**39.812**	**40.800**	**41.950**

Summary by Output:	2002 (actual)	2003 (estimate)	2004 (plan)	2005 (plan)	2006 (plan)
Germplasm Improvement	**11.452**	**12.229**			
Germplasm Collection	**5.236**	**5.591**			
Sustainable Production	**9.848**	**10.516**			
Policy	**1.621**	**1.731**			
Enhancing NARS	**8.388**	**8.956**			
Total	**36.545**	**39.022**	**0.000**	**0.000**	**0.000**

Table 4b. CIMMYT Allocation of Project Costs to CGIAR Activities, 2002-2006 (in $ million)

Project	Activity	2002 Actual	2003 Estimate
001. Maize and wheat genetic resources: use for humanity	Enhancement and Breeding (Maize)	0.295	0.315
	Enhancement and Breeding (Wheat)	0.295	0.315
	Saving Biodiversity	1.502	1.603
	Improving Policies	0.294	0.314
	Strengthening NARS--Training	0.135	0.144
	Strengthening NARS--Information	0.161	0.172
		2.682	2.863
002. Improved maize for the world's poor	Enhancement and Breeding (Maize)	0.858	0.916
	Production Systems (Maize)	0.107	0.114
	Protecting the Environment	0.196	0.210
	Saving Biodiversity	0.390	0.417
	Strengthening NARS--Training	0.390	0.417
	Strengthening NARS--Information	0.195	0.208
		2.137	2.282
003. Improved wheat for the world's poor	Enhancement and Breeding (Wheat)	1.439	1.537
	Production Systems (Wheat)	0.063	0.068
	Protecting the Environment	0.672	0.718
	Saving Biodiversity	0.639	0.682
	Strengthening NARS--Training	0.128	0.137
	Strengthening NARS--Networks	0.256	0.273
		3.198	3.415
004. Maize for sustainable production in stressed environments	Enhancement and Breeding (Maize)	0.373	0.398
	Production Systems (Maize)	0.068	0.073
	Protecting the Environment	0.472	0.504
	Saving Biodiversity	0.179	0.192
	Strengthening NARS--Training	0.034	0.036
	Strengthening NARS--Information	0.068	0.073
	Strengthening NARS--Org & Mgt	0.034	0.036
	Strengthening NARS--Networks	0.034	0.036
		1.264	1.349
005. Wheat for sustainble production in marginal environments	Enhancement and Breeding (Wheat)	0.545	0.582
	Production Systems (Wheat)	0.096	0.103
	Protecting the Environment	1.260	1.345
	Saving Biodiversity	0.336	0.359
	Strengthening NARS--Information	0.101	0.108
	Strengthening NARS--Org & Mgt	0.101	0.108
	Strengthening NARS--Networks	0.101	0.108
		2.540	2.712
006. Wheat resistant to diseases and pests	Enhancement and Breeding (Wheat)	0.410	0.438
	Production Systems (Wheat)	0.206	0.220
	Protecting the Environment	0.971	1.037
	Saving Biodiversity	0.446	0.476

Project	Activity	2002 Actual	2003 Estimate
	Strengthening NARS--Information	0.104	0.111
	Strengthening NARS--Org & Mgt	0.104	0.111
		2.241	2.393
007. Impacts of maize and wheat research	Improving Policies	0.490	0.524
	Strengthening NARS--Training	0.072	0.077
	Strengthening NARS--Information	0.072	0.077
	Strengthening NARS--Org & Mgt	0.072	0.077
	Strengthening NARS--Networks	0.108	0.115
		0.815	0.870
008. Building human capital	Strengthening NARS--Training	3.150	3.363
	Strengthening NARS--Information	0.122	0.131
	Strengthening NARS--Org & Mgt	0.580	0.620
	Strengthening NARS--Networks	0.116	0.124
		3.968	4.237
009. Conservation tillage and agricultural systems to mitigate poverty and climate change	Enhancement and Breeding (Maize)	0.085	0.090
	Protecting the Environment	0.228	0.244
	Saving Biodiversity	0.110	0.117
	Improving Policies	0.085	0.090
	Strengthening NARS--Training	0.033	0.035
	Strengthening NARS--Networks	0.023	0.024
		0.563	0.602
010. Food and sustainable livelihoods for Sub-Saharan Africa	Enhancement and Breeding (Maize)	1.730	1.848
	Production Systems (Maize)	0.576	0.616
	Protecting the Environment	0.654	0.698
	Saving Biodiversity	0.346	0.370
	Improving Policies	0.115	0.123
	Strengthening NARS--Training	0.010	0.011
	Strengthening NARS-- Information	0.008	0.009
	Strengthening NARS--Org & Mgt	0.115	0.123
	Strengthening NARS--Networks	0.289	0.308
		3.845	4.106
011. Maize for poverty alleviaton and economic growth in Asia	Enhancement and Breeding (Maize)	0.452	0.483
	Production Systems (Maize)	0.200	0.213
	Protecting the Environment	0.309	0.330
	Saving Biodiversity	0.151	0.161
	Improving Policies	0.164	0.176
	Strengthening NARS--Training	0.136	0.146
	Strengthening NARS--Information	0.047	0.050
	Strengthening NARS--Org & Mgt	0.090	0.096
	Strengthening NARS--Networks	0.151	0.162
		1.701	1.816
012. Sustaining wheat production in South Asia, including rice-wheat systems	Enhancement and Breeding (Wheat)	0.256	0.274
	Production Systems (Wheat)	0.409	0.436
	Protecting the Environment	0.579	0.618

Project	Activity	2002 Actual	2003 Estimate
	Saving Biodiversity	0.103	0.110
	Improving Policies	0.103	0.110
	Strengthening NARS--Training	0.154	0.164
	Strengthening NARS--Information	0.103	0.110
		1.706	1.821
013. Food security for West Asia and North Africa	Enhancement and Breeding (Wheat)	0.585	0.625
	Protecting the Environment	0.270	0.289
	Saving Biodiversity	0.186	0.199
	Strengthening NARS--Training	0.237	0.253
	Strengthening NARS--Information	0.034	0.037
	Strengthening NARS--Org & Mgt	0.067	0.071
	Strengthening NARS--Networks	0.071	0.076
		1.451	1.550
014. Agriculture to sustain livelihoods in Latin America and the Caribbean	Enhancement and Breeding (Maize)	1.038	1.109
	Enhancement and Breeding (Wheat)	0.260	0.277
	Production Systems (Maize)	0.417	0.445
	Production Systems (Wheat)	0.104	0.111
	Protecting the Environment	0.611	0.653
	Saving Biodiversity	0.329	0.351
	Improving Policies	0.090	0.096
	Strengthening NARS--Training	0.322	0.344
	Strengthening NARS--Information	0.183	0.195
	Strengthening NARS--Org & Mgt	0.246	0.263
	Strengthening NARS--Networks	0.207	0.221
		3.807	4.065
015. Restoring food security and economic growth in Central Asia	Enhancement and Breeding (Wheat)	0.162	0.173
	Production Systems (Wheat)	0.028	0.030
	Saving Biodiversity	0.061	0.065
	Improving Policies	0.040	0.043
	Strengthening NARS--Training	0.061	0.065
	Strengthening NARS--Information	0.010	0.011
	Strengthening NARS--Org & Mgt	0.020	0.022
	Strengthening NARS--Networks	0.020	0.022
		0.403	0.430
016. New wheat science to meet global challenges	Enhancement and Breeding (Wheat)	0.460	0.492
	Strengthening NARS--Information	0.026	0.028
	Strengthening NARS--Org & Mgt	0.026	0.028
		0.513	0.548
017. Apomixis: seed security for poor farmers	Enhancement and Breeding (Maize)	0.268	0.287
	Enhancement and Breeding (Wheat)	0.268	0.287
	Production Systems (Maize)	0.043	0.046
	Production Systems (Wheat)	0.043	0.046
	Saving Biodiversity	0.102	0.108
		0.725	0.774
018. Biotechnology for food security	Enhancement and Breeding (Maize)	0.439	0.468

Project	Activity	2002 Actual	2003 Estimate
	Enhancement and Breeding (Wheat)	0.229	0.244
	Protecting the Environment	0.782	0.835
	Saving Biodiversity	0.325	0.347
	Strengthening NARS--Training	0.076	0.081
	Strengthening NARS--Information	0.056	0.060
		1.907	2.036
019. Biofortified grain for human health	Enhancement and Breeding (Maize)	0.116	0.124
	Enhancement and Breeding (Wheat)	0.055	0.059
	Production Systems (Maize)	0.042	0.045
	Production Systems (Wheat)	0.020	0.022
	Strengthening NARS--Training	0.019	0.020
	Strengthening NARS--Information	0.022	0.023
	Strengthening NARS--Org & Mgt	0.019	0.020
		0.293	0.313
020. Reducing grain losses after harvest	Enhancement and Breeding (Maize)	0.053	0.056
	Enhancement and Breeding (Wheat)	0.053	0.056
	Production Systems (Maize)	0.009	0.010
	Production Systems (Wheat)	0.011	0.011
	Protecting the Environment	0.151	0.161
	Strengthening NARS--Information	0.018	0.019
		0.294	0.314
021. Technology assessment for poverty reduction and sustainable resource use	Enhancement and Breeding (Crops)	0.117	0.125
	Production Systems (Crops)	0.088	0.094
	Protecting the Environment	0.088	0.094
	Improving Policies	0.142	0.152
	Strengthening NARS--Org & Mgt	0.057	0.061
		0.492	0.526
		36.545	39.022

		2002 Actual	2003 Estimate
Summary by Undertaking:	Increasing Productivity	13.374	14.281
	Protecting the Environment	7.244	7.736
	Saving Biodiversity	5.205	5.557
	Improving Policies	1.525	1.628
	Strengthening NARS	9.197	9.820
	Total:	36.545	39.022

Table 5. CIMMYT Research Agenda, 2002-2003
Investments by Sector, Commodity, and Region (in $ million)

PRODUCTION SECTORS & COMMODITIES	2002 (actual)	2003 (estimate)	2006 (plan)
1/ ***Germplasm Improvement***			
Crops	**11.452**	**12.229**	**0**
Barley			
Maize	5.785	6.177	0.000
Wheat	5.667	6.051	0.000
Livestock			
Trees			
Fish			
TOTAL	**11.452**	**12.229**	**0**
1/ ***Sustainable Production***			
Crops	**9.848**	**10.516**	**0**
Barley			
Maize	7.386	7.887	0.000
Wheat	2.462	2.629	0.000
Livestock			
Trees			
Fish			
TOTAL	**9.848**	**10.516**	**0.000**
2/ ***Total Research Agenda***			
Crops	**36.545**	**39.022**	**0**
Barley			
Maize	17.023	18.176	0.000
Wheat	19.522	20.846	0.000
Livestock			
Trees			
Fish			
TOTAL	**36.545**	**39.022**	**0.000**

REGION	2002 (actual)	2003 (estimate)	2006 (plan)
Central/West Africa	1.461	1.560	0.000
Eastern/Southern Africa	12.061	12.878	0.000
East/Southeast Asia	2.192	2.340	0.000
South Asia	8.040	8.585	0.000
Central America/Caribbean	5.482	5.853	0.000
South America	3.655	3.902	0.000
West Asia and North Africa (WANA)	3.655	3.902	0.000
TOTAL	**36.545**	**39.022**	**0.000**

Table 6. CIMMYT Research Agenda, 2001-2006
Expenditure by Functional Category, and Capital Investments (in $ million)

OBJECT OF EXPENDITURE	2002 (actual)	2003 (estimate)	2004 (plan)	2005 (plan)	2006 (plan)
Personnel	21.528	19.458	20.145	20.649	21.235
Supplies and Services	16.451	16.425	16.455	16.939	17.503
Operational Travel	1.575	1.380	1.500	1.500	1.500
Depreciation	1.293	1.250	1.400	1.400	1.400
TOTAL	**40.847**	**38.513**	**39.500**	**40.488**	**41.638**
CAPITAL INVESTMENTS	**2002 (actual)**	**2003 (estimate)**	**2004 (plan)**	**2005 (plan)**	**2006 (plan)**
Physical Facilities					
Research	0.503	0.300	0.150	0.100	0.100
Training					
Administration					
Housing					
Auxiliary Units					
sub-total	**0.503**	**0.300**	**0.150**	**0.100**	**0.100**
Infrastructure & Leasehold					
Furnishing & Equipment					
Farming	0.215	0.100	0.200	0.150	0.150
Laboratory & Scientific	0.053	0.100	0.150	0.200	0.150
Office	0.019	0.020			
Housing					
Auxiliary Units					
Computers	0.154	0.250	0.320	0.350	0.350
Vehicles	0.412	0.580	0.650	0.500	0.500
Software	0.073	0.080	0.100	0.100	0.100
sub-total	**0.926**	**1.130**	**1.420**	**1.300**	**1.250**
TOTAL	**1.429**	**1.430**	**1.570**	**1.400**	**1.350**
CAPITAL FUND CASH RECONCILIATION	**2002 (actual)**	**2003 (estimate)**	**2004 (plan)**	**2005 (plan)**	**2006 (plan)**
Balance, January 1	18.740	8.525	8.575	8.825	9.075
plus: annual depreciation charge	1.293	1.250	1.400	1.400	1.400
plus / minus: disposal gains/(losses)	0.136	0.050	0.050	0.000	0.000
plus / minus: other	-10.215	0.000	0.370	0.250	0.150
minus: asset acquisition costs	-1.429	-1.250	-1.570	-1.400	-1.400
equals: Balance, December 31	**8.525**	**8.575**	**8.825**	**9.075**	**9.225**

Table 7. CIMMYT Research Agenda Financing Summary, 2002-2004 (in $ million)

	2002		2003		2004	
Member	**($ actual)**	**(nat. currency)**	**($ estimated)**	**(nat. currency)**	**($ plan)**	**(nat. currency)**
Unrestricted Contributions						
Australia	0.436	0.850	0.377	0.735	0.359	0.700
Belgium	0.076	0.087	0.086	0.086	0.086	0.086
Brazil	0.040		0.000		0.000	
Canada	0.654	1.035	1.239	1.950	1.263	1.950
China	0.130		0.120		0.120	
Denmark	0.663	5.000	0.529	4.000	0.529	4.000
Germany	0.239	0.250	0.180		0.180	
India	0.113		0.113		0.113	
Japan	0.763	94.559	1.009	121.080	1.009	121.080
Korea	0.050		0.050		0.050	
Mexico	0.090		0.090		0.090	
Netherlands	0.088	0.093	0.090		0.090	
Norway	0.267	2.000	0.267	2.000	0.200	1.500
Peru	0.020		0.020		0.020	
Philippines	0.012		0.012		0.012	
Portugal	0.050		0.000		0.000	
Sweden	0.277	2.800	0.304	2.800	0.301	2.800
Switzerland	0.234	0.400	0.291	0.400	0.292	0.400
Thailand	0.009		0.009		0.009	
USA	4.300		5.000		4.900	
World Bank	3.800		2.500		2.500	
subtotal	**12.311**		**12.286**		**12.123**	

	2002		2003		2004	
	($ actual)	**(nat. currency)**	**($ estimated)**	**(nat. currency)**	**($ plan)**	**(nat. currency)**
Targeted Contributions						
ADB (Asian Development Bank)	0.829		0.681		0.700	
Australia			1.613		1.659	
AusAID	0.303					
Australian Centre for International Agricultural Research	0.603					
CRC Molecular Plant Breeding	0.179					
Grains Research and Development Corporation	0.247					
Southern Cross University	0.005					
Austria						
IAEA (International Atomic Energy Agency)	0.007		0.002		0.002	
Azerbaijan						
Agency for Support to the Development of the	0.043					
Belgium						
Ministry of Foreign Affairs, Foreign Trade and	0.347		0.480		0.493	
International Cooperation						
Canada						
Agriculture and Agri-Food	0.038					
Canadian International Development Agency	0.270		0.674		0.693	
International Development Research Centre	0.008					
CGIAR						
Centro Internacional de Agricultura Tropica	0.016		0.053		0.055	
CGIAR Finance Committee	0.005					
International Food Policy Research Institute	0.127		0.138		0.142	
International Livestock Research Institute	0.003					
International Plant Genetic Resources Institute	0.008		0.002		0.002	
IWMI			0.063		0.065	
Standing Panel on Impact Assessment	0.031					
China						
CAAS (Chinese Academy of Agricultural Sciences)	0.300		0.300		0.308	
Lamsoo Milling Company	0.023					
Colombia						

Member	($ actual)	(nat. currency)	($ estimated)	(nat. currency)	($ plan)	(nat. currency)
CORPOICA (Corporacion Colombiana de Investigacion Agropecuaria)	0.041		0.108		0.111	
FENALCE (Federación Nacional de Cultivadores de	0.011		0.055		0.056	
Cereales y Leguminosas)						
Ministry of Agriculture and Rural Development	0.139					
Denmark						
Danish International Development Agency	0.159		0.139		0.143	
European Commission						
Rural Development and Food Security	2.402		1.796		1.848	
Ecuador						
Promsa	0.025					
FAO (Food and Agriculture Organization)	0.021		0.046		0.047	
Ford Foundation	0.006					
Foundation for Harvest Solutions	0.753					
France						
Ministere de l'Education Nationale, de la Recherche et de la Technologie	1.191		1.168		1.201	
DRIC (Delegation aux Relations nternationales et a la Cooperation)						
Club Cinq (Wheat Breeding)	0.099					
Germany						
Eiselen Foundation	0.068					
Federal Ministry of Economic Cooperation and Development	0.574		0.763		0.785	
University of Hohenheim	0.005					
India						
Maharashtra Hybrid Seed Co. Ltd. (Wheat Germplasm)	0.036					
IDB (Inter-American Development Bank)	0.095		0.040		0.041	
IFAD (International Fund For Agricultural Development)	0.439		0.215		0.221	
Iran , Islamic Republic of						
Ministry of Agriculture	0.283		0.380		0.391	
Japan						
APN (Asian Pacific Network for Global Change Reseach)	0.039		0.001		0.001	
Economic Cooperation Bureau, Ministry of Foreign Affairs	0.665		0.650		0.669	
Nippon Foundation	0.472		0.750		0.772	
Sasakawa Global 2000	0.009		0.006		0.006	
Korea , Republic of						
Rural Development Administration	0.104		0.094		0.097	
Mexico						
CODEPAP (Consejo de Desarrollo de la Cuenca de Papaloapan)	0.004		0.012		0.012	
CONACYT			0.042		0.043	
SAGAR (Secretaria de Agricultura,Ganaderia, Desarrollo Rural,	0.234		0.232		0.239	
Pesca y Alimentacion)						
Fundacion Guanajuato Produce A.C.	0.030		0.013		0.013	
Fundacion Hidalgo	0.042		0.006		0.006	
Fundacion Sonora	0.169		0.050		0.052	
ICAMEX (Maize and Wheat Improvement)	0.098					
Grupo Industrial Bimbo (Industrial Quality in Wheat)	0.039		0.036		0.038	
Miscellaneous Research Grants	0.128					
Netherlands						
DGIS (Directorate General for International Cooperation)	0.011					
Ministry of Foreign Affairs	0.175		0.430		0.442	
New Zealand						
Ministry of Foreign Affairs and Trade	0.117		0.134		0.138	
Norway						
Royal Norwegian Ministry of Foreign Affairs	0.019					
OPEC Fund for International Development	0.050		0.050		0.051	
Other	0.538		1.114		1.645	
Other Foundations	0.992		1.111		1.143	
Peru						
National Institute of Natural Resources	0.040		0.040		0.041	
Portugal						
Institute for International Scientific and Technological Cooperatior	0.119		0.081		0.083	
Rockefeller Foundation	2.350		2.643		2.719	

Member	($ actual)	(nat. currency)	($ estimated)	(nat. currency)	($ plan)	(nat. currency)
SCOPE (Scientific Committee on Problems of the Enviroment)	0.073		0.009		0.010	
South Africa , Republic of						
Agricultural Research Council	0.040		0.052		0.054	
National Department of Agriculture	0.051					
Spain						
Agrovegetal, S.A.	0.081		0.073		0.075	
Ministerio de Agricultura, Pesca y Alimentacion	0.212		0.212		0.218	
Sweden			0.020		0.021	
Switzerland						
Swiss Agency for Development and Cooperation	1.218		1.119		1.151	
Syngenta Foundation for Sustainable Agriculture	1.385					
United Kingdom						
Department for International Development	1.254		1.605		1.651	
UNDP (United Nations Development Programme)						
Africa Bureau	0.209		0.222		0.228	
Uruguay						
National Institute of Agricultural Research	0.114		0.186		0.192	
USA						
Cornell University	0.007					
Kansas State University	0.015					
Monsanto Company (Hybrid Wheat)	0.162		0.220		0.226	
Oklahoma State University	0.091		0.038		0.039	
Pioneer Hi-Bred International	0.027					
Stanford University	0.158		0.178		0.183	
United States Agency for International Development	1.259		3.670		3.776	
United States Department of Agriculture	0.357		0.299		0.308	
Washington State University	0.090		0.040		0.041	
World Bank	0.509		1.308		1.345	
subtotal	**23.495**		**25.460**		**26.689**	
TOTAL CONTRIBUTIONS	**35.806**		**37.746**		**38.812**	

Total Agenda Financing	2002 ($ actual)	2003 ($ estimated)	2004 ($ plan)
Member Contributions	**35.806**	**37.746**	**38.812**
+ Center Income	**0.739**	**1.276**	**1.000**
= Total Financing	**36.545**	**39.022**	**39.812**

Table 8a. CIMMYT Allocation of 2002 Member Financing to Projects by Undertaking (in $ million)

Project	Member	Total
001. Maize and wheat genetic resources: use for humanity	Australia	0.130
	Canada	0.088
	Denmark	0.087
	European Commission	1.489
	France	0.149
	Germany	0.109
	IFPRI	0.031
	IPGRI	0.008
	Japan	0.156
	MAHYCO	0.036
	Monsanto	0.065
	Rockefeller Foundation	0.197
	Unrestricted + Center Income	0.003
	USDA	0.130
	World Bank	0.004
Total		2.682
002. Improved maize for the world's poor	CIDA	0.004
	Colombia	0.038
	Germany	0.056
	IFAD	0.086
	Japan	0.020
	Mexico	0.124
	Monsanto	0.028
	Nippon Foundation	0.049
	Novartis Foundation	0.250
	OPEC	0.267
	Other Foundations	0.010
	Rockefeller Foundation	0.253
	Switzerland	0.013
	UNDP	0.308
	United Kingdom	0.164
	Unrestricted + Center Income	0.098
	USAID	0.269
	World Bank	0.100
Total		2.136
003. Improved wheat for the world's poor	Australia	0.156
	Bimbo	0.039
	China	0.300
	France	0.791
	Fundacion Guanajuato	0.030
	Fundacion Hidalgo Produce	0.042
	Fundacion Sonora	0.169
	Harvest Solutions	0.165
	IAEA	0.007
	Iran	0.085
	Mexico	0.028
	Miscellaneous Research Grants	0.059
	Other Foundations	0.238
	Rockefeller Foundation	0.013
	South Africa	0.037

Project	Member	Total
	SPIA	0.031
	Stanford University	0.158
	Unrestricted + Center Income	0.351
	USAID	0.494
	World Bank	0.005
Total		3.198
004. Maize for sustainable production in stressed environments	Colombia	0.0278
	Germany	0.1048
	IFAD	0.0900
	OPEC	0.0200
	Rockefeller Foundation	0.5623
	Switzerland	0.2384
	UNDP	0.0836
	United Kingdom	0.1225
	Unrestricted + Center Income	0.0100
	World Bank	0.0050
Total		1.264
005. Wheat for sustainble production in marginal environments	Australia	0.225
	CIDA	0.038
	Harvest Solutions	0.165
	Hohenheim University	0.005
	Iran	0.048
	Oklahoma State University	0.091
	Portugal	0.119
	Rockefeller Foundation	0.013
	Spain	0.127
	Unrestricted + Center Income	1.704
	World Bank	0.005
Total		2.540
006. Wheat resistant to diseases and pests	Australia	0.198
	Belgium	0.104
	Harvest Solutions	0.170
	IDB	0.011
	Japan	0.124
	Kansas State University	0.015
	Korea	0.093
	Miscellaneous Research Grants	0.025
	Rockefeller Foundation	0.013
	Spain	0.085
	United Kingdom	0.114
	Unrestricted + Center Income	1.125
	USDA	0.162
	World Bank	0.005
Total		2.241
007. Impacts of maize and wheat research	Denmark	0.072
	France	0.231
	IFAD	0.208
	Japan	0.015
	Norway	0.019
	Novartis Foundation	0.178
	Rockefeller Foundation	0.015

Project	Member	Total
	Switzerland	0.070
	Unrestricted + Center Income	0.002
	World Bank	0.005
Total		0.815
008. Building human capital	ADB	0.829
	Australia	0.101
	BARI	0.014
	Ford Foundation	0.006
	Iran	0.110
	Miscellaneous Research Grants	0.044
	Monsanto	0.049
	Other Foundations	0.754
	Rockefeller Foundation	0.518
	TAC	0.005
	Unrestricted + Center Income	1.486
	USDA	0.047
	World Bank	0.005
Total		3.968
009. Conservation tillage and agricultural systems to mitigate poverty and climate change	France	0.027
	Germany	0.031
	New Zealand	0.070
	Rockefeller Foundation	0.013
	United Kingdom	0.336
	Unrestricted + Center Income	0.081
	World Bank	0.005
Total		0.563
010. Food and sustainable livelihoods for Sub-Saharan Africa	Australia	0.074
	CIAT	0.016
	CIDA	0.088
	Germany	0.098
	IFAD	0.090
	IFPRI	0.096
	ILRI	0.003
	Nippon Foundation	0.222
	Novartis Foundation	0.568
	Rockefeller Foundation	0.462
	Sasakawa	0.009
	South Africa	0.014
	Switzerland	0.378
	United Kingdom	0.432
	Unrestricted + Center Income	1.291
	World Bank	0.005
Total		3.845
011. Maize for poverty alleviaton and economic growth in Asia	Australia	0.041
	OPEC	0.020
	Rockefeller Foundation	0.100
	Unrestricted + Center Income	1.535
	World Bank	0.005
Total		1.701
012. Sustaining wheat production in South Asia, including rice-wheat systems	APN	0.039
	Australia	0.017

Project	Member	Total
	Belgium	0.243
	IFAD	0.031
	Japan	0.124
	Lamsoo Company	0.023
	Miscellaneous Research Grants	0.027
	Netherlands	0.187
	New Zealand	0.047
	Rockefeller Foundation	0.013
	United Kingdom	0.110
	Unrestricted + Center Income	0.045
	USAID	0.647
	World Bank	0.155
Total		1.706
013. Food security for West Asia and North Africa	Australia	0.039
	Germany	0.022
	Rockefeller Foundation	0.013
	Unrestricted + Center Income	1.372
	World Bank	0.005
Total		1.451
014. Agriculture to sustain livelihoods in Latin America and the Caribbean	Agrovegetal, S.A.	0.081
	CODEPAP	0.004
	Colombia	0.056
	CORPOICA	0.041
	FENALCE	0.011
	France	0.049
	IDB	0.084
	IDRC	0.008
	INIA	0.114
	Mexico	0.143
	Miscellaneous Research Grants	0.091
	Peru	0.040
	PROMSA	0.025
	Rockefeller Foundation	0.066
	Switzerland	0.215
	United Kingdom	0.041
	Unrestricted + Center Income	2.489
	USAID	0.018
	USDA	0.018
	World Bank	0.212
Total		3.807
015. Restoring food security and economic growth in Central Asia	Azerbaijan Republic of	0.043
	FAO	0.021
	Germany	0.191
	Rockefeller Foundation	0.013
	Unrestricted + Center Income	0.040
	Washington State University	0.090
	World Bank	0.005
Total		0.403
016. New wheat science to meet global challenges	Australia	0.199
	Iran	0.040
	Rockefeller Foundation	0.013

Project	Member	Total
	Unrestricted + Center Income	0.257
	World Bank	0.005
Total		0.513
017. Apomixis: seed security for poor farmers	Apomixis Consortium	0.538
	France	0.044
	Rockefeller Foundation	0.013
	Unrestricted + Center Income	0.126
	World Bank	0.005
Total		0.725
018. Biotechnology for food security	Australia	0.152
	European Commission	0.913
	Japan	0.124
	Korea	0.011
	Novartis Foundation	0.372
	Rockefeller Foundation	0.245
	Southern Cross University	0.005
	Switzerland	0.008
	Unrestricted + Center Income	0.073
	World Bank	0.005
Total		1.907
019. Biofortified grain for human health	Mexico	0.035
	Rockefeller Foundation	0.012
	Unrestricted + Center Income	0.241
	World Bank	0.005
Total		0.293
020. Reducing grain losses after harvest	Canada	0.056
	Rockefeller Foundation	0.012
	Unrestricted + Center Income	0.222
	World Bank	0.005
Total		0.295
021. Technology assessment for poverty reduction and sustainable resource use	ARC	0.040
	Rockefeller Foundation	0.054
	SCOPE	0.073
	Unrestricted + Center Income	0.320
	World Bank	0.005
Total		0.492
Grand Total		36.545

Center Totals

	Total
Total Targeted Funding	23.495
Total Unrestricted Funding	12.311
Total Center Income	0.739
	36.545

Table 8b. CIMMYT Allocation of 2003 Member Financing to Projects by Undertaking (in $ million)

Project	Member	Total
001. Maize and wheat genetic resources: use for humanity	Australia	0.119
	Canada	0.233
	Denmark	0.057
	European Commission	1.699
	France	0.062
	Germany	0.061
	IFPRI	0.034
	IPGRI	0.002
	Japan	0.156
	MAHYCO	0.031
	MONSANTO	0.088
	Rockefeller Foundation	0.184
	Unrestricted + Center Income	0.074
	USAID	0.026
	USDA	0.032
	World Bank	0.004
Total		2.863
002. Improved maize for the world's poor	Canada	0.100
	CAPECO	0.023
	Colombia	0.043
	CONACYT	0.042
	Germany	0.061
	ICIPE	0.029
	Japan	0.124
	Mexico	0.024
	MONSANTO	0.066
	NCGR	0.010
	Novartis Foundation	0.606
	OPEC	0.010
	Rockefeller Foundation	0.284
	Novartis Foundation	0.385
	UNDP	0.222
	Unrestricted + Center Income	0.224
	USAID	0.026
	World Bank	0.004
Total		2.282
003. Improved wheat for the world's poor	Australia	0.127
	BIMBO	0.036
	China, Republic of	0.254
	France	0.039
	Fundacion Guanajuato	0.013
	Fundacion Higalgo Produce	0.006
	Fundacion Sonora	0.050
	Germany	0.265
	IAEA	0.002
	Iran, Islamic Republic of	0.114
	Mexico	0.024
	Other Foundations	0.000
	Rockefeller Foundation	0.010

Project	Member	Total
	South Africa	0.026
	Stanford University	0.178
	Apomixis Consortium	0.241
	Unrestricted + Center Income	2.026
	World Bank	0.004
Total		3.415
004. Maize for sustainable production in stressed ewnvironments	Colombia	0.022
	Germany	0.142
	OPEC	0.020
	Rockefeller Foundation	0.221
	Sweeden	0.020
	Switzerland	0.548
	Unrestricted + Center Income	0.093
	USAID	0.280
	World Bank	0.004
Total		1.349
005. Wheat for sustainble production in marginal environments	Australia	0.247
	Canada	0.100
	Iran, Islamic Republic of	0.065
	Oklahoma State Univ.	0.038
	Portugal	0.081
	Rockefeller Foundation	0.010
	Spain	0.127
	Unrestricted + Center Income	1.935
	USAID	0.026
	USDA	0.080
	World Bank	0.004
Total		2.712
006. Wheat resistant to diseases and pests	IDB	0.020
	Australia	0.351
	Belgium	0.480
	Japan	0.124
	Korea, Republic of	0.085
	Rockefeller Foundation	0.290
	Spain	0.085
	United Kingdom	0.232
	Unrestricted + Center Income	0.696
	USAID	0.026
	World Bank	0.004
Total		2.393
007. Impacts of maize and wheat research	Denmark	0.081
	France	0.236
	IFAD	0.087
	IFPRI	0.073
	IWMI	0.063
	Novartis Foundation	0.136
	Rockefeller Foundation	0.010
	Unrestricted + Center Income	0.154
	USAID	0.026
	World Bank	0.004
Total		0.870

Project	Member	Total
008. Building human capital	Australia	0.248
	Iran, Islamic Republic of	0.148
	Miscellaneous Research Grants	0.049
	MONSANTO	0.066
	Other Foundations	0.000
	Rockefeller Foundation	0.369
	Unrestricted + Center Income	2.062
	USAID	0.185
	USDA	0.015
	World Bank	1.095
Total		4.236
009. Conservation tillage and agricultural systems to mitigate poverty and climate change	France	0.030
	Germany	0.055
	New Zealand	0.081
	United Kingdom	0.194
	Unrestricted + Center Income	0.014
	USAID	0.225
	World Bank	0.004
Total		0.603
010. Food and sustainable livelihoods for Sub-Saharan Africa	Canada	0.233
	CIAT	0.053
	Germany	0.142
	IFPRI	0.031
	Nippon Foundation	0.353
	Novartis Foundation	0.106
	Rockefeller Foundation	0.010
	SASAKAWA	0.006
	South Africa	0.026
	United Kingdom	0.942
	Unrestricted + Center Income	0.020
	USAID	0.605
	USDA	0.064
	USAID	1.512
	World Bank	0.004
Total		4.106
011. Maize for poverty alleviaton and economic growth in Asia	Australia	0.041
	OPEC	0.020
	Rockefeller Foundation	0.905
	Switzerland	0.389
	Unrestricted + Center Income	0.430
	USAID	0.026
	World Bank	0.004
Total		1.816
012. Sustaining wheat production in South Asia, including rice-wheat systems	ADB	0.289
	APN	0.001
	China, Republic of	0.046
	IFAD	0.040
	Japan	0.124
	Miscellaneous Research Grants	0.019
	Netherlands	0.430
	New Zealand	0.054

Project	Member	Total
	Rockefeller Foundation	0.010
	United Kingdom	0.186
	Unrestricted + Center Income	0.017
	USAID	0.471
	World Bank	0.134
Total		1.821
013. Food security for West Asia and North Africa	Australia	0.026
	Rockefeller Foundation	0.010
	Unrestricted + Center Income	1.484
	USAID	0.026
	World Bank	0.004
Total		1.550
014. Agriculture to sustain livelihoods in Latin America and the Caribbean	IDB	0.020
	AGRICOM	0.010
	Agrovejetal , s,a.	0.073
	CODEPAP	0.012
	Colombia	0.043
	FENALCE	0.055
	France	0.054
	INIA	0.186
	Mexico	0.122
	Miscellaneous Research Grants	0.072
	Peru	0.040
	Rockefeller Foundation	0.010
	Switzerland	0.123
	United Kingdom	0.051
	Rockefeller Foundation	0.010
	Unrestricted + Center Income	3.047
	USAID	0.026
	USDA	0.108
	World Bank	0.004
Total		4.065
015. Restoring food security and economic growth in Central Asia	Rockefeller Foundation	0.021
	Australia	0.145
	FAO	0.046
	Germany	0.037
	Rockefeller Foundation	0.010
	Washington State University	0.040
	Unrestricted + Center Income	0.105
	USAID	0.026
Total		0.430
016. New wheat science to meet global challenges	Australia	0.087
	Iran, Islamic Republic of	0.053
	Rockefeller Foundation	0.010
	Unrestricted + Center Income	0.368
	USAID	0.026
	World Bank	0.004
Total		0.548
017. Apomixis: seed security for poor farmers	Apomixis Consortium	0.622
	France	0.049
	Rockefeller Foundation	0.010

Project	Member	Total
	Unrestricted + Center Income	0.064
	USAID	0.026
	World Bank	0.004
Total		0.774
018. Biotechnology for food security	ADB	0.392
	Australia	0.224
	European Commission	0.097
	France	0.699
	Japan	0.124
	Korea, Republic of	0.009
	Mexico	0.032
	Novartis Foundation	0.275
	Rockefeller Foundation	0.084
	Switzerland	0.058
	Unrestricted + Center Income	0.013
	USAID	0.026
	World Bank	0.004
Total		2.036
019. Biofortified grain for human health	Mexico	0.030
	Rockefeller Foundation	0.010
	Unrestricted + Center Income	0.243
	USAID	0.026
	World Bank	0.004
Total		0.313
020. Reducing grain losses after harvest	Canada	0.007
	Rockefeller Foundation	0.010
	Unrestricted + Center Income	0.267
	USAID	0.026
	World Bank	0.004
Total		0.314
021. Technology assessment for poverty reduction and sustainable resource use	Rockefeller Foundation	0.039
	ARC	0.009
	IFAD	0.087
	Rockefeller Foundation	0.120
	SCOPE	0.009
	Unrestricted + Center Income	0.227
	USAID	0.026
	World Bank	0.007
Total		0.525
Grand Total		39.022

Center Totals

	Total
Total Targeted Funding	25.460
Total Unrestricted Funding	12.286
Total Center Income	1.276
Total Allocations	39.022

Table 9: CIMMYT Research Agenda Staff Composition, 2002-2005

	2002 (actual) Hired by:		2003 (estimated) Hired by:		2004 (plan) Hired by:		2005 (plan) Hired by:		2006 (plan) Hired by:	
	Center	Other	Center	Other	Center	Other	Center	Other	Center	Other
Internationally- Recruited Staff (IRS)										
Research & Research Support	84	26	74	25	74	25	74	25	74	25
of which:										
Post-Doctoral Fellows	9	6	10	5	10	5	10	5	10	5
Associate Professionals	6	5	5	5	5	5	5	5	5	5
Training / Communications	5	0	5		5		5		5	
of which:										
Post-Doctoral Fellows										
Associate Professionals										
Research Management	5	0	5		5		5		5	
of which:										
Post-Doctoral Fellows										
Associate Professionals										
TOTAL IRS	**94**	**26**	**84**	**25**	**84**	**25**	**84**	**25**	**84**	**25**
Support Staff										
Outreach National Staff	121		108		108		108		108	
Mexico National Staff*	490		481		481		481		481	
TOTAL SUPPORT STAFF	**611**		**589**		**589**		**589**		**589**	
GRAND TOTAL STAFF	**705**	**26**	**673**	**25**	**673**	**25**	**673**	**25**	**673**	**25**

Part 3
CIMMYT's Interim Project Portfolio

Draft Project Descriptions with Medium-term Outcomes

Project 1. Maize and wheat genetic diversity for humanity

Featuring CIMMYT in the Challenge Program on Genetic Resources, and the Challenge Program on Biofortification

CIMMYT's pledge to conserve and facilitate the use of crop genetic diversity of maize and wheat for humanity, including for future generations, is an essential part of our mission. The issue is not only one of ethics—but also of institutional requirements, given CIMMYT's commitment to the Global Plan of Action for Plant Genetic Resources for Food and Agriculture as a means of implementing the Convention on Biological Diversity.

Fulfilling this pledge takes the Center into many areas of research: germplasm collection for *ex-situ* conservation; characterization of genebank entries; pre-breeding activities; applications of genomics; improved and more accessible information on stored genetic resources; management of intellectual property associated with germplasm; economic assessment of the value of genetic resources; analysis of policies relating to genetic resources and genetic diversity; conservation of wild relatives of maize and wheat; and *in-situ* conservation of maize and wheat genetic resources, along with information on gene flows under conditions of farmers' management. Through this project, CIMMYT aims to engage in these research areas in order to fulfill its pledge and meet its commitments.

The project will build on CIMMYT's strong commitment to the collection, characterization, and conservation of the genetic resources of maize, wheat, and their related species. Attention will continued to be paid to landraces and traditional varieties, but other materials such as advanced lines, cytogenetic stocks, and genetic populations will be included. With the advent of genomic technologies that will allow rapid analysis of large collections of materials, DNA isolated from appropriate materials will also be considered for inclusion in storage. The project will continue to feature close collaboration and partnership with the many institutions concerned with the conservation and proper use of plant genetic resources.

A critical component for facilitating access to and use of the available materials will be the expanded application of modern information technology. For example, information on the pedigrees of genebank entries, data on where they were collected, and spatial data showing where abiotic stresses such as saline soils prevail, can be combined to identify materials in the genebank with a high likelihood of containing specific traits. Some plant diseases or physiological responses are driven by strong environmental cues, such as a sudden increase in rainfall or drop in temperature. Again using GIS, we can develop maps showing where these environmental cues occur and locate materials from those

regions in our genebank, or even initiate new targeted collecting trips. By coupling these data with information about the genomic location of genes conferring such traits, it will be possible to trace which accessions contain such genes, thereby increasing the efficiency of breeding programs.

In this project, the role of bioinformatics will be especially important. Bioinformatics, defined as the tools that manage, analyze, and interpret biological information, will enable us to link vast amounts of data produced through genomics research to other kinds of data: pedigrees, trial results, and agronomic and socioeconomic data. Because of the increasing understanding of synteny (genetic similarities) among cereal species, this work will involve partnerships with many other research organizations. We anticipate that bioinformatics may transform our approach to crop improvement. Instead of relying on statistical analyses of large populations of plants to determine the probability that their progeny will carry certain traits, we may merely identify the desirable genes to be bred into the next generation of plants, knowing that those genes will be expressed under certain conditions.

The application of genomics will be an important component of project activities. Enhanced use of molecular fingerprinting will be needed to deepen the understanding of maize and wheat resources. As molecular markers are further incorporated into breeding programs as routine selection agents, additional marker systems and markers linked to genes of interest will need to be identified. Many of these efforts will be coordinated and conducted within this project, and the results—linked markers—incorporated into the other projects, more focused on developing improved varieties.

Beyond the current proven applications of fingerprinting, mapping, and selection, genomics offers unheralded abilities to investigate the genetic nature of almost any trait, at the entire genome level. The availability of the entire genome sequence for *Arabidopsis* and rice have already provided exciting opportunities, and efforts are underway in the public sector to sequence significant portions of the maize and wheat genomes. How exactly to use the entire sequence of a species with vast amounts of genetic resources still is to be determined, but the potential is clearly here today, and the project will need to develop appropriate strategies, many of which will involve partnerships with advanced institutes.

Within the next five to ten years, we will:

- Broaden our maize collections to include varieties from the African and Asian continents.
- Assess *in situ* conservation strategies, the incentives needed to make them feasible, the effects of gene flow within and between varieties, and the implications for policy analysis and interventions.
- Complete the scheduled regeneration of maize accessions.
- Complete the molecular characterization of key accessions of maize and wheat germplasm.
- Include additional materials such as cytogenetic stocks and genetic populations.

- Produce, store, and distribute molecular (DNA) samples of the most appropriate materials for ready use with modern genomic technologies.
- Develop and use pre-breeding techniques (conventional, cytological, and molecular) for maize and wheat.
- Identify the genetic bases of key traits (especially drought tolerance and apomixis) of importance in wheat and maize.
- Develop and use a comprehensive database system to enable global web-based access to information concerning the genetic resources in our care.

Project 2. Livelihoods and risk in rainfed, stress-prone, foodgrain systems
Featuring CIMMYT in the Challenge Program on Water and Food

A vast area in Eurasia is covered by rainfed, stress-prone, food-grain systems. These systems extend from Turkey and Eastern Europe, through Iran, Afghanistan, and northwestern Pakistan, to the Central Asian republics and western China. Similar production systems occur in central India and South America. Areas with comparable ecologies in southern Africa are included in Project 3 (see below). In much of this area, agro-pastoral systems are predominant, with livestock at least as important as grain production in farm family livelihoods. Crop production is often restricted to wheat (winter, facultative, or spring types), barley, and pulses. Maize production is locally important in some areas. The growing period is short and options for agroecosystem diversification limited. In some areas, only one crop can be harvested every two years due to insufficient rainfall. Food security in these areas depends very heavily on "wheat security," as the crop often provides more than 50% of the daily calories consumed.

The vast majority of rainfed, stress-prone, food-grain systems experience a rather unusual climate. The frequency of dry years compared to wetter, more productive years varies considerably among geographic regions and among locations within regions. In most rainfed environments it is during the wetter years that farmers make most of their income, thereby buffering the impact on livelihoods of drier, less productive years. During the wetter years, diseases can be a greater limitation to yield than water, and farmers need yield responsive cultivars with resistance to foliar disease. During the drier years, abiotic stresses (drought, heat, micronutrient imbalances), and root diseases and nematodes become the major problems.

Understandably, production practices and livelihood systems vary substantially over this huge area. Still, several common threads emerge:

- Rainfall is variable, rainfall use efficiency is low, and drought stress is common. Yields are low because much of the rainwater is lost through high evaporation rate from the soil, or from weed competition. On millions of hectares of cropland, little or no rainfall occurs after sowing, and crops rely on stored soil moisture and are often severely drought stressed.
- Higher rainfall conditions can occur intermittently throughout these agro-ecosystems but early season disease pressure and waterlogging, and late season terminal drought stress reduce system productivity.
- Land degradation is widespread, provoked by over-grazing of pastures, intensive tillage of agricultural land, and the grazing of crop residues. Soil erosion reduces

soil fertility and causes millions of tons of sediment to be flushed downstream annually, at times threatening downstream irrigation infrastructure and dams.

- Cereal-fallow monoculture is practiced in large areas to conserve moisture from one non-crop year to the next production cycle. To be effective, this requires proper mulch preparation, residue cover, and weed control. Monoculture often results in increased soil health problems, in particular nematodes and root rots, and is causing soil fertility to decline rapidly.
- Reduced tillage husbandry is slowly gaining acceptance by farmers, given that tillage energy costs are high, and current farming systems are not sustainable.

The challenge here is to foster the development of production and livelihood systems that improve local and regional food security; that reduce the risks associated with recurrent drought; that sensibly combine livestock and crop production activities; that make the most of limited or variable water resources; that help reduce land degradation; that effect the most efficient use of scarce inputs; that foster the improvement of input and product markets, and related institutions; and that contribute to system diversification, for more stable production of a wider array of crops.

CIMMYT aims to contribute to the development of such systems through this project, which will be staffed by a multidisciplinary team that includes social scientists, systems agronomists, and specialists in NRM; plant breeders and pathologists; scientists knowledgeable about participatory research methods and gender analysis; experts in seed systems; and specialists in biotechnology, among others. The project will feature five main themes: development of drought tolerant, input responsive, disease resistant wheat germplasm; resource conserving production technologies; crop diversification; policy analysis and advocacy to foster market development; and capacity building, for both individual scientists and institutions.

Featured in this project will be new, drought-resistant wheat varieties currently being developed at CIMMYT. These wheats are descended from crosses between different kinds of wheat and goat grass, one of wheat's wild relatives. The new wheats, with greatly enhanced seedling vigor, produce up to 30% more grain under tough growing conditions, even when water availability from all sources is restricted (under controlled conditions) to less than 200 mm per season. These wheats, currently undergoing international testing, also feature improved resistance to root rots and nematodes. When faced by highly variable rainfall patterns, these cultivars tolerate major high-rainfall diseases and are responsive to inputs, so farmers can benefit from any extra rainfall. Drought-tolerant maize cultivars developed by CIMMYT in other regions will be tested for adaptation in target agroecologies.

CIMMYT is also working with partners in Central and West Asia, and North Africa (CWANA), China, South America, and Ethiopia on reduced tillage, crop residue management, and conservation agriculture. Crop residues on the soil surface have numerous advantages: surface soil structure and, therefore, water infiltration rate are maintained; evaporation is reduced; drought is mitigated; soil biological activity is increased; biological pest control is enhanced; and soil organic matter, the basis of soil improvement, is increased. Surface residues also efficiently reduce soil erosion, both by

wind (due to the protective cover and wind impedance) and by water (due to the improved infiltration rate and reductions in water run-off velocity). Increasing problems due to micronutrient deficiencies, in particular zinc, are further evidence of the fast declining soil fertility in West Asia. Moreover, the reduction in soil tillage associated with residue retention (optimally zero tillage) reduces labor input, benefiting especially women and children, and allows for more diversification of the farm enterprise.

Research on zero tillage and surface residue retention has shown an increase in crop yields, but the demand for forage has been an obstacle to widespread adoption of these systems. Current systems, however, are often unsustainable, as land resources at times can sustainably support only a fraction of the livestock that graze there.

To break the soil degradation cycle, improve livelihoods, and reduce the downstream effects of soil erosion, systems must be devised, in conjunction with farm communities, to reduce tillage and return more organic matter to the soil. Building on past research, the project will develop conservation agriculture strategies and adapted varieties to increase system productivity, decrease soil erosion and degradation, and boost labor productivity. The project will also develop community-based strategies for forage management, as well as explore public policy options to foster continued progress.

Within the next five to ten years, we will:

- Help to increase water productivity and reverse declining soil fertility through expansion of cereal-legume rotations and increased crop diversification.
- Help in achieving the adoption of reduced tillage and other resource-conserving technologies, together with varieties specifically adapted to those conditions.
- Disseminate new wheat cultivars with increased drought tolerance, resistance to soil-borne diseases, and improved adaptation to moisture-conserving tillage practices.
- Improve the dietary value of wheat through the development of varieties that produce micronutrient-enriched grains (in particular Zn).
- Develop drought and heat tolerant maize germplasm with enhanced protein quality to help meet the demand for quality livestock feed.

Project 3. Food security, markets, and livelihoods in Africa

Featuring CIMMYT in the Challenge Program for sub-Saharan Africa, and the Challenge Program for Water and Food

Of all regions of the developing world, sub-Saharan Africa poses the greatest challenge for sustained improvement of rural livelihoods and agricultural productivity. Only in this region has per capita food production actually declined over recent years. Child malnutrition has increased, and widespread poverty persists. A combination of thin, infertile soils, uncertain and variable rainfall, outbreaks of the parasitic weed *Striga*, and poorly-developed markets and rural infrastructure has stalled efforts to improve the productivity and sustainability of agroecosystems. In some countries, conflict, ill-advised macroeconomic and agricultural policies, and/or a high incidence of HIV-AIDS have

exacerbated these problems. Recently, a blend of these factors led to widespread hunger and starvation in eastern, central, and southern Africa.

By choice, maize is overwhelmingly the most important starch staple for smallholder farm households in eastern and southern Africa. However, much of this maize is not produced for cash sale at harvest (when prices are low) but rather to avoid having to purchase maize in the pre-harvest hungry season (when prices are high). Maize is often produced in rotation or association with groundnut, beans, or other legumes, or cash crops such as cotton or tobacco. Safe storage of harvested grain is important, but difficult for farmers to achieve. Stored grain is vulnerable to several aggressive pests that can destroy food reserves in just a few months.

Livestock are an important household asset in many parts of sub-Saharan Africa, providing draft power for farm operations, manure to fertilize fields, and milk or meat products. Animals also serve as a capital asset that can be sold during hard times. Livelihood systems often feature a close integration of livestock and crop management, as well as a reliance on migration and remittances as a source of cash income.

The challenge here is to foster the development of production and livelihood systems that avoid unacceptable levels of loss in bad (e.g., drought) seasons; that are substantially more productive than existing systems in good seasons; that improve labor productivity so as to compensate for loss of family labor to migration or HIV-AIDS; that sustainably exploit relatively favorable niches in the landscape; that make the most efficient use of scarce and expensive purchased inputs; that take full advantage of locally available inputs such as leaf litter, cattle manure, crop residues, and green manure cover crops to maintain soil fertility and system productivity; and that foster market development to reduce input prices and improve product prices at the farm level.

Through this project, CIMMYT aims to contribute to the development of such systems. The project will be staffed by a multidisciplinary team that includes social scientists, systems agronomists and NRM specialists, plant breeders and pathologists, scientists knowledgeable about participatory research methods and gender analysis, experts in seed systems, and specialists in biotechnology, among others.

The project will feature national and regional partnerships with the public and private sectors, and NGOs. It will focus on improving system resilience and productivity in the face of biophysical and socioeconomic risk. This risk may stem from unfavorable weather, large changes in the availability or price of fertilizers, *Striga* outbreaks, soil exhaustion in some fields, the loss of stored grain, the loss of productive family members to disease, or political unrest.

One important project component will consist of revolutionary new maize materials that, compared to alternatives, are substantially more tolerant to drought and low soil fertility, and/or are more nutritious. The continued development of these breakthrough materials will be backstopped by CIMMYT's unparalleled global network of maize scientists. Some of this scientific support will consist of strategic research on the physiology of drought, and the possible application of molecular markers to rapidly identify stress

tolerant materials. Continued interaction with partners in Ethiopia will aim to provide suitable wheat germplasm to smallholder farmers in that country.

Participatory varietal selection of these materials through collaborative "mother-baby" trials will expand. Seed systems to further disseminate these materials will rely either on private sector entities or community-based seed production. In both cases, CIMMYT will support efforts to make good seed reliably available at fair prices to smallholder farmers.

The project will match the work on germplasm and seed with complementary research on crop and natural resource management. Existing CIMMYT-managed networks will help fit "best bet" soil fertility management practices to clearly defined land types and farmer categories. Farmer-participatory research, GIS, and crop modeling have been, and will continue to be, of great assistance in this process. Best bet practices include farm-level risk aversion strategies, new maize-legume rotations and associations; new approaches using very low levels of N fertilizer; and conservation agriculture practices for soil moisture conservation. Work on conservation agriculture will proceed hand in hand with the African Conservation Tillage Network and partner institutions. Policy and market analyses will be conducted to foster market development and to better integrate smallholder systems into national markets.

In *Striga* infested areas, project activity will include work on maize materials that are tolerant to a herbicide seed treatment effective in *Striga* eradication. And in Kenya, work will continue, in the context of local biosafety regulations and informed deliberation by civil society, to explore the possible release to farmers of genetically modified maize varieties resistant to stem borer, a highly damaging insect pest in that country.

A good deal of attention will also be placed on crop-livestock interactions because open grazing of cattle on crop residues reduces the amount of mulch available for the next crop cycle. Finally, the project will monitor and assess the consequences and impacts that can be attributed to project activities—on incomes, livelihoods, soil fertility management practices and soil health, and longer-term effects on natural resource quality and the environment.

Within the next five to ten years, we will:

- Help foster the adoption of maize germplasm that tolerates drought and low soil fertility by 20% of farm families managing maize systems in eastern and southern Africa.
- Prove the effectiveness of techniques that combat *Striga* and grain storage pests, and promote their generalized use.
- Develop a comprehensive set of decision aids for use by farmers and change agents to match resource-conserving practices with land types and farmer categories, and foster their generalized use.
- Document the medium-term consequences of the adoption of improved practices for incomes, livelihoods, soil and water resources, and the environment.
- Strengthen collaboration among public and private sector institutions and NGOs to more effectively address priority development concerns.

- Understand policy and institutional issues affecting the agricultural sub-sector and contribute to the policy-making debate.

Project 4. Ensuring food security through sustainable intensification in densely-inhabited areas

Featuring CIMMYT in the Rice-Wheat Consortium for the Indo-Gangetic Plains, and the Challenge Program for Water and Food

It is well known that most of the world's poor reside in rural areas of developing countries. It is, perhaps, less well known that a large proportion of these reside in densely populated rural areas where cropping systems are intensive and livelihood systems complex. Production from these areas sustain local farming communities, as well as neighboring cities. On a global level, improved food security and livelihoods for poor people depend heavily on "getting things right" in those areas where the poor are concentrated in enormous numbers. Most, but not all, of these areas feature irrigated systems. They include the irrigated Indo-Gangetic Plains, the lower Nile Valley, the irrigated portions of the Yellow River Basin, among others.

The challenge in these areas is to foster the development of farming systems that are more intensive and, at the same time, more resilient and sustainable than the current ones; that assure food-grain security while delivering a more diverse set of higher-value products; that use external inputs more efficiently; that generate more employment for the landless; that supply less expensive food for poor urban consumers; and, finally, that do all of this while conserving and improving soil and water resources. Of special concern is the need to foster efficient water use so as to help conserve water resources. Improved water productivity in crop production is necessary to free up scarce water for urban, industrial, ecological, and other competing uses.

Through this project, CIMMYT will contribute to the development of such systems, relying on a multidisciplinary team that includes social scientists, systems agronomists and NRM specialists, plant breeders and pathologists, scientists knowledgeable about participatory research methods and gender analysis, experts in seed systems, and specialists in biotechnology. The project will go beyond raising maize and wheat yields and will seek to improve system productivity and diversity, which may at times imply a decrease, not an increase, in resources devoted to cereal production. Instead of increasing input use for higher grain yields, the project will seek to improve nutrient and water use efficiency, which should ultimately lead to better harvests with fewer inputs.

The opportunities for developing such systems are immense. Experience in the Indo-Gangetic Plains, the irrigated portions of the Yellow River Basin, and similar areas has demonstrated the enormous potential of new system and resource management practices to increase yields while reducing input use, especially water. These resource-conserving technologies include zero tillage of wheat after rice; zero tilled, rice-based rotations on permanent beds, with rice grown as an aerobic crop followed by wheat, maize, legumes, or other crops; "parachute" establishment of rice seedlings; surface seeding of wheat after rice in low-lying, poorly drained portions of the toposequence; accelerated crop establishment to allow a third crop after wheat; substitution of pulses, maize, or potatoes

for wheat, facilitated by the use of permanent beds; laser-leveling of irrigated fields; and many, many more. Farmer trials in Bangladesh, China, India, Nepal, and Pakistan have shown farm-level water savings of over 50% with some of these practices, at the same time as yields increase and the use of fertilizer and other inputs decreases markedly. Fuel savings for tillage can reach 90%. In the future, fuel use in agriculture might be a small fraction of what it once was.

These outcomes and achievements are not theoretical: farmers on more than 500,000 hectares of irrigated land in the Indo-Gangetic Plains use these practices on a daily basis, as do farmers on over 200,000 hectares in China. Adoption is growing so rapidly that some call this movement the "tillage revolution." The project will foster the expansion of this revolution, in more areas, with more technical options, with expanded farmer experimentation, and with close attention to its effects on livelihoods, equity, food security, system diversity, water use, and land and water quality.

The project will continue to work with partners on developing high-yielding, disease and pest resistant maize and wheat varieties with high end-use and consumer quality, and in so doing will apply conventional, marker assisted, and participatory plant breeding, and participatory varietal selection. The project will focus specifically on developing maize and wheat varieties that are tailored to new resource-conserving practices such as zero tillage, crop residue mulch, permanent bed systems, and location-specific nutrient management. In addition, recently identified sources of novel genetic variation in wheat wild relatives will aid in the development of new varieties with tolerance to salinity, an abiotic stress threatening 60 million hectares of irrigated crop land.

Due to its good performance or preferred quality characteristics, a single wheat variety is often grown over extensive areas, making farmers in those areas more vulnerable to changes in the virulence of disease pathogens. Deploying a number of wheat varieties with diverse resistance to disease is one way to reduce "boom-and-bust" cycles in which high yields are produced until the disease resistance of the predominant variety breaks down, causing devastating losses over extensive areas. However, the approach used most by CIMMYT for avoiding such losses is to develop wheat varieties with resistance based on multiple minor genes that confer durable resistance, effectively protecting the wheat crop despite changes in virulence.

Given the strength of system interactions in these intensively cropped areas, the project will cultivate close partnerships with those NARSs and other institutions with skills in relevant subjects, e.g., rice researchers for rice-wheat systems, agricultural machine specialists and small private factories to manufacture zero tillage drills and bed formers, and maize and legume scientists to work on diversifying continuous rice-wheat rotations. At times, system level changes plus policy adjustments will be needed to foster shifts in cropping calendars and labor use patterns to take advantage of opportunities for additional diversification.

Finally, the project will energetically monitor and assess the consequences and impacts that project activities could have on incomes, livelihoods, natural resource quality, and the environment.

Within the next five to ten years, in collaboration with many partner institutions, we will:

- Help achieve the adoption of zero tillage and other resource-conserving technologies, together with specifically adapted maize and wheat varieties, in a significant proportion of cropland in densely inhabited and intensively cultivated areas of Asia, Africa, and Latin America.
- Help facilitate the adoption of rational crop rotations in target areas, which will result in more holistic cropping systems that will help the grain supply keep pace with demand and help ensure that food remains affordable for the poor.
- Work towards reducing water use in agriculture by over 20% (though the value of agricultural production will actually increase, thanks to system diversification) and substantially decreasing fuel use.
- Enhance farmers' market access by providing cereal varieties with specific, value-added, end-use quality traits, including enhanced dietary value (e.g., wheats with improved quality for making leavened, steamed, and flat breads, noodles, pasta, etc., and maize with higher quality protein).

Project 5. Improving livelihoods and conserving natural resources in tropical agroecosystems

The rural poor in tropical Latin America, including many indigenous groups, have long regarded maize as having a special, central place in their livelihood systems. In addition to being a staple food, maize is also an essential part of their cultural heritage. They often grow it in traditional *milpa* systems, where maize is associated with beans, squash, and chiles (in Mexico and Central America), or with cassava (South America). This maize is normally not produced for cash sale, but rather to avoid having to purchase it when prices are high. Part of the maize may be used to feed small numbers of livestock. Livelihood strategies may include the production of cash crops (e.g., coffee), manufacture of handicrafts, seasonal off-farm work, or remittances from family members who have migrated to cities or to the US.

Systems based on tropical maize are also pervasive in West Africa. It should be noted that wheat systems are seldom found in the tropics, except at high altitudes, e.g., the Quetzaltenango area of Guatemala, the highlands of Ecuador, or Ethiopia.

More recently, systems based on maize have come to dominate smallholder rainfed agriculture in tropical Southeast Asia and China. In these systems, maize is grown as a continuous monocrop, in rotation with lowland rice, or in rotation or association with upland rice or cassava. This maize is grown predominantly for livestock feed (though, curiously, because of the sheer size of Asian populations, a greater volume of maize is used in Asia for direct human consumption than in Latin America). Much of it is sold to market intermediaries, though some may be retained for feeding household livestock. The demand for meat and dairy products is exploding in East and Southeast Asia, and the demand for feed maize is increasing in proportion. Whether tropical maize is grown for food in Guatemala or for feed in the Philippines, a mounting demand for this commodity is triggering expansion of production into unsuitable areas such as fragile hillsides and

tropical forests. Despite this, households that rely heavily on maize production for their livelihoods tend to be poor.

Agroecosystems featuring tropical (non-temperate) maize may be distributed around the world, but they share common problems. Tropical maize in the developing world is grown at varying latitudes and altitudes—for example, the hot and humid lowlands; the warm subtropics and mid-altitudes; and the cooler tropical highlands. In the hot lowlands, high rainfall and temperature often give rise to acid, infertile soils. Weeds grow quickly and can swiftly overwhelm the crop. Because of extended growing seasons (sometimes 12 months long), pests and diseases can become lethal threats. Pest and disease hotspots are especially likely to develop when farmers grow maize continuously—up to three crops annually. Drought or waterlogging can damage crops. Insects and ear rots can spoil stored grain, which is of special concern to vulnerable households. Finally, soils and soil fertility can be degraded, particularly when fields are located on hillsides or land tenure is insecure.

The challenge here is to develop production systems that improve the livelihoods of poor farm households; that exploit ecological principles to help control weeds, pests, and diseases; that foster the conservation of soil and water; and that help meet increasing demand for food maize (in Latin America) and feed maize (in Asia). Through this project, CIMMYT aims to contribute to the development of such systems. In doing this, CIMMYT is aware that work to improve the productivity of maize in tropical agroecosystems is only an entry point into the larger question of improving livelihoods and reducing poverty, and that close collaboration with numerous other partners will be needed. Project staff will be a multidisciplinary team made up of social scientists, systems agronomists and NRM specialists, plant breeders and pathologists, scientists knowledgeable about participatory research methods and gender analysis, experts in seed systems, and specialists in biotechnology.

The project will feature the integration of high-yielding, stress-tolerant, nutrient-enhanced maize germplasm with resource-conserving technologies. It will develop and disseminate maize germplasm that is adapted to acid soils, tolerant of drought and low fertility conditions, tolerant of waterlogging, resistant to disease and insect pests, more nutritious thanks to improved protein quality and higher micronutrient content, and high-yielding when growing conditions are favorable. Germplasm enhancement will be implemented in Mexico and the regions, in partnership with key stakeholders. Its efficiency will be improved through more systematic use of marker assisted selection. Effective collaboration with the public sector will be essential for research but, given the rapidly changing intellectual property environment, new approaches will be sought to work more closely with the private seed sector and accelerate the dissemination of new varieties.

Weed and erosion control, higher water use efficiency, and improved soil fertility will be fostered through the introduction of resource-conserving practices, such as direct sowing without tillage, cover crops, crop residue management, mulch management, and alternative and more diverse cropping patterns. Development of these practices will require a substantial level of farmer participatory experimentation, which will also be

important in the iterative design and modification of zero tillage seeders and other implements that are suitable for smallholders. The project will foster system diversification to avoid continuous maize cultivation. This will require a combination of policy analysis and advocacy, market analysis, and farmer experimentation with alternative crops.

The longer-term consequences of the above practices—for example, on soil health, soil fertility, organic matter status, rate of erosion, and size and diversity of the weed seed bank—will be monitored, as will their scale consequences—for example, changes in water quantity and quality for downstream water users, or the pace and extent of siltation of downstream irrigation infrastructure. Impacts of technical change on livelihoods and well-being of the poor will be closely studied.

Within the next five to ten years, in collaboration with many partner institutions, we will:

- Improve the productivity and profitability of maize-based agroecosystems in tropical ecologies.
- Foster the adoption of conservation agriculture practices, especially zero tillage with mulch soil cover, on over one million hectares of tropical lowlands and uplands; this will bring about corresponding improvements in farmers' incomes and livelihoods, reductions in their production costs, and reductions in the rate of land degradation.
- Facilitate a substantial reduction in the area devoted to continuous maize production (especially in unsuitable areas) through successful system diversification.
- Assist in the effective dissemination and adoption of (biotic and abiotic) stress tolerant and nutritious maize varieties.
- Document impacts and consequences for farm family livelihoods and the environment of technical change in maize systems.

Project 6. Policies and institutions that maximize research impacts

The fact that CIMMYT's mandate is global, rather than regional or ecosystem-specific, means that research activities undertaken in response to the needs of specific target groups in particular locations still must make sense in the context of CIMMYT's overall research portfolio. A strong theme highlighted in CIMMYT's new strategic plan is the desirability of devolving a greater amount of adaptive research to regional offices, where it can be located closer to key partners and stakeholders. This does not mean, however, that there is no longer a need for centralized research on issues of broad strategic importance. If CIMMYT is to succeed in meeting its global mandate, applied or "downstream" research focused on location-specific problems must be complemented by strategic or "upstream" research focused on issues that transcend particular regions, ecosystems, or crops.

Strategic work based on comparative analysis across countries and regions is needed for a number of reasons: to understand changes affecting the economic, political, and institutional environments in which we operate; to identify cross-cutting issues that

transcend national and regional boundaries; to ensure that our overall portfolio of resources is being used efficiently and effectively; to identify key entry points at which policy interventions can improve the likelihood that our products and services will reach potential users quickly and effectively; and to ensure that when CIMMYT speaks out on issues of importance to the Center and its partners, it does so in a consistent and coherent way. Because these functions are global in scope and strategic in nature, they cannot be accomplished easily within the other projects, most of which address problems associated with particular regions, particular production systems, and in some cases particular crops.

Five activities of strategic global importance will be carried out under this project:

1. *Monitoring global trends.* With the rise of globalization, the world economy is becoming increasingly integrated. As borders become more open, international prices penetrate ever more easily into domestic markets, transmitting important signals about changes in supply and demand conditions. In response to these signals, goods, services, and production factors flow from surplus to deficit areas, altering production, consumption, and employment possibilities and influencing the nature and incidence of poverty. Producers and consumers of maize and wheat are affected by these changes, although often in different ways. In many developing countries, consumers of maize and wheat are benefiting from increased supplies and lower prices, whereas producers face increased competition from low-cost imports. In some countries, intensification of maize- and wheat-based farming systems is generating increased employment opportunities for agricultural laborers, although rising wage rates together with falling grain prices are encouraging farmers to reduce input use and shift from labor-intensive to capital-intensive production methods. All of these changes have important implications for maize and wheat farmers in developing countries, who must struggle to survive in an increasingly competitive environment. To ensure that our research continues to address the priority needs of these farmers, there is a need to monitor long-term trends in world maize and wheat markets, with an eye to identifying developments that may call for adjustments to our portfolio of activities.

2. *Setting overall priorities.* Like all research organizations, CIMMYT faces budgetary constraints that compel us to pay careful attention to priority setting. Research priority setting is a process of elimination: from among a large set of opportunities, scarce resources must be directed toward those most likely to generate the greatest amount of desirable impacts. Since CIMMYT holds a global mandate, priority setting for the Center must be based upon a comprehensive assessment of potential research and development activities worldwide. These potential activities must be ranked in terms of attractiveness, taking into account their expected cost, as well as their expected contribution to achieving CIMMYT's mission. To ensure that research priorities for CIMMYT as a whole are set appropriately, there is a need to carry out research priority setting in a centralized manner.

3. *Assessing impact.* Most of the donors who provide financial support for CIMMYT demand credible evidence that their funds are being used effectively. Thus there is

a need for CIMMYT to maintain a strong impact assessment capacity. Although some impact assessment work can be done at the project level through targeted case studies, a big disadvantage of case studies is that they cannot always be combined to provide a complete picture of the overall breadth and scope of the impact of CIMMYT's work. In order to paint such a picture, impact assessment efforts must focus not only on the impacts of individual CIMMYT projects, but also on the global impacts of CIMMYT's work, including the impacts associated with the "spillover benefits" that accrue as technologies diffuse internationally. Centralized coordination of the impact assessment function will not only allow assessment at the global level, it will also help to ensure that targeted impact assessment case studies carried out within individual projects are methodologically consistent and generate comparable results.

4. *Designing policy interventions.* CIMMYT's new strategy includes a renewed commitment to making sure that improved technologies make their way into farmers' fields. In the future, we will increase our efforts to strengthen technology delivery systems and remove constraints to successful adoption, especially of improved plant varieties and crop and resource management practices developed by ourselves and our partners. Experience suggests that constraints to adoption often are caused by bad policies and ineffective institutions—for example, weak extension systems that impede the flow of technical information, ineffective marketing systems that prevent farmers from obtaining key inputs, or inappropriate price policies that distort economic incentives to invest in new technology. Policy analysis can contribute to design interventions that could help overcome adoption constraints. Experimentation with alternative institutional arrangements and "learning by doing" can lead to faster and more widespread uptake of improved technologies. However, these types of activities are rarely successful when carried out in a purely local context. They are much more likely to be effective when based on insights derived from comparative analysis across countries, economies, and political systems. For this reason, central coordination is needed to improve the quality and effectiveness of CIMMYT's policy analysis and institutional design work.

5. *Advocating for change.* Policies can have impact only when they are implemented, and policies are implemented only when they have political support. For this reason, CIMMYT's new strategy includes a commitment to advocacy. Effective advocacy can be carried out at many different levels—local, national, regional, and global. Regardless of the level at which CIMMYT engages in advocacy, however, it is critically important that the messages being advocated be carefully considered, endorsed by management at the highest level, effectively communicated, and above all consistent. Ensuring these things requires a high degree of coordination that would be difficult to achieve if responsibility for advocacy were devolved to individual projects. Central coordination is therefore needed to ensure the effectiveness of CIMMYT's advocacy work.

Historically in CIMMYT, many of the activities that fall under this project have been carried out mainly by social scientists. While social scientists will continue to play an

important role in the project, the participation of biophysical scientists will increase significantly compared to past years. Experience has shown that activities such as research priority setting, impacts assessment, and policy design cannot be carried out effectively by external specialists. Opening them up to participation by scientists from a wide range of disciplines, who are actively involved in CIMMYT's technology development work, will help to instill a "product delivery" mentality, foster an impact assessment culture throughout the organization, and strengthen institutional learning and change processes.

Project 7. Sharing and managing knowledge

Projects 1 through 6 (described above) share a common feature: an emphasis on knowledge management. In this way, the projects, as a group, support one of CIMMYT's major long-term goals: to become a key player in a global innovation network that effectively mobilizes knowledge about maize and wheat systems in the service of sustainable development.

This project aims to make that goal a reality. It will provide a framework whereby communities of partners can harness their broad diversity of knowledge to create a public knowledge base on maize and wheat systems in developing countries. This knowledge base will be available to all, thereby serving vast numbers of users who were not actually involved in its development. Within this project, we will efficiently manage our knowledge and increase our capacity (and that of our partners) to provide a strong, open base of learning and more efficiently foster improvements in the livelihoods of the poor in developing countries.

Much of the knowledge created by research has commonly been available to only a fraction of the people who could potentially benefit from it. However, advances in information and communications technology are removing barriers to information sharing, thereby enabling agricultural innovations to have a much wider impact. The medium-term objectives for this project are to develop comprehensive resources to:

- Make available scientific information needed for effective research.
- Share knowledge developed through the work of CIMMYT and its partners, and other contributors worldwide.
- Build capacity through learning, collaborative research, and mentoring.

With respect to the first objective, it is obvious that the quality and usefulness of the knowledge that CIMMYT creates and shares with others depend, to a great extent, on CIMMYT's own access to information and knowledge. The research needs of CIMMYT and its partners are increasingly multidisciplinary, diverse, and information-intensive, especially given our global research mandate. To achieve this objective, we will improve CIMMYT's access to: information on new science; databases (including bioinformatics resources); scientific journals; molecular maps; plant pedigrees; genomic data; GIS data; international trial data; outcomes of systems diagnosis; policy briefs; impact studies; and other data and information developed through the research of CIMMYT and its partners. CIMMYT will improve its capacity to do this by upgrading the abilities of its staff and providing them with new tools and technology for information management. In this way,

information can be more readily made available to our scientists and partners, regardless of location.

With respect to the second objective, CIMMYT will create an open platform for sharing knowledge, information, and other resources (e.g., seed) with partners, stakeholders, and the general public. This knowledge-sharing environment will feature:

- A digital maize and wheat information center in which information resources are commensurate with the broad expertise of CIMMYT and its partners.
- "Communities of practice" that extend beyond CIMMYT's boundaries to include researchers and practitioners around the world who are committed to addressing farmers' needs.
- A knowledge bank that grassroots organizations can use to gain access to useful information and expertise, e.g., on technologies that may be suitable for the environment in which they work, or the outcomes of diagnostic or impacts studies.

These features are integral to the success of capacity building, the third objective of this project. This project will establish a strong service to build human capital among research partners, rural communities, and our own staff. CIMMYT has a decades-long history of effective work in human resource development and capacity strengthening, but our future work in this area must be based on a more precise assessment of needs and a more effective use of information technology.

A prioritized assessment of needs and demands will guide the development of instructional materials and media. We will partner with universities, advanced research institutes, NGOs, and private organizations in industrialized and developing countries to provide more learning opportunities and resources. Courses will be interdisciplinary and, at times, may count towards advanced degrees. The focus will be on developing flexible combinations of short courses that can be locally adapted and taught. Most instructional materials will be available and searchable through the Internet and other electronic formats, and will form an integral part of CIMMYT's digital knowledge base. We will also provide our learning materials in a format that will make them available to the many people who remain on the other side of the digital divide.

To preserve the personal mentoring and networking that have been strong features of CIMMYT training, we will continue to offer opportunities for day-to-day interaction with experienced people in the field and the lab. We will extend the impact of this interaction by creating and helping to sustain virtual learning communities in which course participants can benefit from continued interaction with one another and mentoring by other researchers.

Within the next five to ten years, we will:

- Invest in new information and communications technologies to develop an interactive information and knowledge sharing portal that gives CIMMYT staff, our partners, specific communities of practice, and the general public access to: methods, tools, data, and instructional materials; genetic resources; and expertise available from CIMMYT and its partners.

- Establish a strong learning and mentoring service that develops new courses and training modules; facilitates distance learning and the earning of advanced degrees; offers formal training directly; and establishes a network of local training partners in a large number of countries where we conduct our work.
- Conduct training needs assessments every two years to ascertain the capacity-building demands of our partners, and respond as needed.
- Host visiting scientists on short- or medium-term visits in all locations where we work, and provide them with the information they require.
- In collaboration with universities, provide support for post-graduate students who will conduct the experimental part of their thesis at CIMMYT or are working in an area related to our mission.
- Pilot the development of knowledge banks directed at meeting the needs of grassroots organizations in specific areas.

Draft Logframes for the New MTP Projects

Project 1: Maize and wheat genetic diversity for humanity

Overall goal	Indicators	Assumptions and risks
Genetic resources for maize and wheat will be preserved as a resource for all humanity, including future generations, and will also be actively used to help solve today's problems of poverty, malnutrition, and natural resource degradation. Modern molecular technologies will be used to the extent that they can contribute to these overarching goals.	Looking back from a distant future date, it will be concluded that maize and wheat genetic resources were properly and effectively conserved and used.	Financial resources will be forthcoming for indefinite conservation and use of plant genetic resources
Intermediate goal	**Indicators**	**Assumptions and risks**
Mechanisms will be in place for the secure preservation of maize and wheat plant genetic resources, and for their effective and efficient use, to foster sustainable livelihoods for farm families in those agroecosystems of the developing world where maize or wheat are important components.	Fully-funded financial, physical capital, and management structures for long-term conservation; links among genetic resources, pre-breeding, and crop improvement.	Financial resources will be forthcoming for indefinite conservation and use of plant genetic resources
Purpose	**Indicators**	**Assumptions and risks**
CIMMYT, other CGIAR centers, NARSs, public ARIs, private institutes, and other stakeholders will collaborate in genetic resource management and the effective application of advanced molecular technologies in crop enhancement for the benefit of developing countries.	Collaborative activity in genetic resource management; multi-stakeholder collaboration in using molecular techniques for problem-solving crop improvement.	Willingness of all stakeholders to work together in partnership; intellectual property issues do not constrain collaboration.
Outputs	**Indicators**	**Assumptions and risks**
1. Better collection, characterization, and conservation of genetic resources *ex situ*. a. Improved representation of African and Asian maize germplasm. b. Completed regeneration of maize accessions. c. Molecular fingerprints of maize and wheat germplasm. d. Storage of cytogenetic stocks and genetic populations. e. Storage of molecular materials (e.g., DNA) from critical accessions.	*Given the highly preliminary nature of this project structure, it would be premature to propose detailed indicators for outputs.*	

2. Better collection and conservation of genetic resources *in situ*. a. Effective and efficient strategies for *in situ* conservation. b. Information regarding gene flow within and between farmer varieties. c. Economics of *in situ* conservation strategies. 3. Improved and more widely available information on genetic resources. a. Web-based database systems for global access and use of genetic resource information. b. Information for policy related to genetic resources and genetic diversity. c. An information network established for genomic and phenotypic data integrating advanced genetic resources, genomic, and crop information systems, which will increase the efficacy of public and private plant breeding programs for the international community. 4. Technologies to facilitate breeding developed and made available to breeding programs. a. Physiological methods validated for field selection of germplasm with improved physiological phenotypes. b. Molecular-based breeding strategies for transferring important genes efficiently to maize and wheat germplasm. c. Efficient screening methods for selecting micronutrient-enriched maize, wheat, and triticale genotypes. *Challenge Program on Biofortification* 5. Novel germplasm with new genes/desirable traits for incorporating into breeding efforts developed through novel conventional and molecular technologies. a. Candidate genes and genomic regions underlying critical traits identified (e.g., drought tolerance and nutritional quality); functional characterization of those candidate genes or genomic regions accelerated. *Challenge Program on Genetic Resources* b. New genetic sources of selected traits available from the germplasm bank. (3) c. Identification of yield-enhancing traits and genes from a broad genetic resource base. (16) d. New stocks in 42- or 28-chromosome backgrounds, including new translocations from alien species and wheat relatives, provided to breeders. (3) e. Inbred lines with good male traits developed and improved for use in wheat hybrid production. (16) f. Maize, wheat, and triticale germplasm with higher concentrations or improved availability of micronutrients (iron, zinc, and vitamin A) for use in breeding programs and release in developing countries. (19) *Challenge Program on Biofortification*		

6. Apomictic maize. a. Improved knowledge of the developmental genetics of apomixis in *Tripsacum*. (17) b. Identification and isolation of major genes involved in apomixis expression. c. Improved knowledge of the factors affecting endosperm development in grain crops. 7. Capacity among research centers in developing countries expanded through collaboration and capacity building. 8. An extended global network of CGIAR centers, NARSs, public ARIs, and private institutes established for the effective utilization of advanced technologies for crop enhancement for developing countries.		
Activities	Milestones	Assumptions and risks
1. Prebreeding to produce new genetic stocks in 42- or 28-chromosome backgrounds. (3) 2. Empirical breeding combined with trait-oriented analytical and molecular approaches, including breeding simulation, to develop parental stocks for specific environments. (3) 3. Transfer of newly identified sources of yield traits, disease resistance, and quality using new sources of diversity such as synthetic wheats. (3) 4. Advanced wheat, triticale, and barley lines plus materials from the Wide Crosses Unit and the CIMMYT genebank screened for resistance to various diseases and pests at hot spots in Mexico and around the world. (6)	*Given the highly preliminary nature of this project structure, it would be inappropriate and premature to propose detailed milestones and indicators for activities.*	

Project 2: Livelihoods and risk in rainfed, stress-prone, foodgrain systems

Overall goal	Indicators	Assumptions and risks
Local and regional food security in target ecoregions will be improved, climate-related risk for livelihoods will be reduced, land degradation will be slowed or halted, and the incidence of poverty will decline.	National level food security measures; data from long-term experiments or farmer monitoring; results from surveys of poverty incidence.	National policies not unfavorable to agricultural development, including capacity-building for national institutions.
Intermediate goal	**Indicators**	**Assumptions and risks**
New conservation agriculture practices, more diverse cropping systems, and new wheat varieties, all of these compatible with improved livestock and crop residue management practices and less susceptible to the effects of drought, will be widely adopted by farm families in target ecoregions.	Adoption studies; secondary data on farm level technology use; time series studies comparing drought years with favorable years.	National and local policies do not hamper the adoption of suitable practices.
Purpose	**Indicators**	**Assumptions and risks**
CIMMYT and partners will work together in developing new, more stable and more efficient, productivity enhancing, resource conserving technologies, with supporting policies and processes of institutional development, for those rainfed, stress-prone agro-pastoral systems in Eurasia, central India, and Latin America where wheat (and to a lesser extent maize) is exceptionally important for local and regional food security.	Evidence of collaborative research and development activity; evidence of integration of social science and biophysical science; documents describing research outcomes; initial favorable reception by farmers to technical prototypes.	Willingness among all stakeholders to work together in partnership mode; activities to foster seed production successful.
Outputs	**Indicators**	**Assumptions and risks**
Information management 1. Agroecologies of rainfed stress-prone food grain ecosystems in Eurasia, India, and Latin America characterized and mapped. 2. Better understanding of farmers' practices and circumstances, gender roles in agriculture, factors affecting system productivity and profitability, and factors governing adoption of new technologies achieved and used in decision making and priority setting. 3. Better understanding achieved of the policies and institutions that influence livestock management and numbers, and of farm- and community-level crop residue management.	Documents on agroecological characterization, system and gender diagnostics, analysis of the common property and collective action dimensions of livestock and crop residue management, results from crop models over extended time periods.	Spatially referenced data are available in the public domain; common property and collective action issues are not utterly intractable; suitable crop models can be validated and reliably used for long-term analysis of system performance.

4. The risk of economic loss from the adoption of new system and resource management practices, in the context of highly variable climate, understood and quantified.		
System and resource management 5. Resource conserving technologies developed, tested, and adopted. These include retaining crop residues on the soil surface and zero or reduced tillage. 6. Management practices developed and tested by farmers and farming communities, to resolve conflicts between using crop residue for fodder and using it for mulch. 7. Overgrazing reduced through institutional and policy innovations. 8. Diversity in agroecosystems improved.	Studies of the adoption of RCTs and of system diversity; studies of the outcome of new crop residue management practices.	Common property and collective action issues are not utterly intractable; markets for diversification crops can be fostered.
Genetic improvement and seed 9. New wheat varieties developed and adopted by farmers. (Improved maize varieties developed and adopted in those areas where maize is locally important.) These include wheat materials that: a. are high-yielding and input-responsive; b. are substantially more drought-tolerant than alternatives; c. perform well under reduced tillage conditions with crop residue soil cover; d. resist root rots and nematodes, and e. maintain good tolerance to major high rainfall diseases.	Breeders reports and adoption studies.	Global germplasm exchange is not hindered.
Policies and impacts 10. Soil surface structure, water infiltration into the soil, soil water levels, soil biological activity, and soil organic matter improved. 11. Policy and market environment improved in support of system diversification. 12. Market environment improved in support of faster dissemination of improved varieties. 13. Near-term consequences of technical change fostered by the project estimated for incomes, livelihoods, and soil conservation. 14. Longer-term consequences of technical change estimated for livelihoods, equity, and trends in land quality.	Biophysical process research publications; reports from social science and biophysical impact studies; policy briefs published; records of positive interactions with policymakers.	Policy levers are available and can be used to foster diversification.
Partnerships and capacity building 15. Research coordination improved among multiple actors and stakeholders.	Network reports; NARS reports; evidence of specialization among research institutions.	Partner institutions are willing to collaborate.

Activities	Milestones	Assumptions and risks
1. Develop user-friendly GIS systems using publicly available, spatially referenced data, along the lines of the Country Almanac series (Output 1) 2. Conduct diagnostic surveys and other system-level diagnostic activities (Outputs 2 and 3) 3. Carry out community-based action research on crop residues as a common property and collective actions needed to reserve some crop residues for soil cover (Outputs 3, 6 and 7) 4. Conduct simulation modeling of the performance of strategies featuring zero tillage with residue retention over extended time frames to assess risk of loss, given climatic variability (Output 4) 5. Bring in key experts on the management of RCTs to help initial adaptation of RCT prototypes to new regions (Outputs 5 through 7) 6. Conduct researcher-controlled trials and farmer experiments on ways to improve soil structure, water infiltration, organic matter, and soil health (Output 5, 6 and 10) 7. Use participatory approaches to adapt and accelerate adoption of key technologies, among them reduced tillage and mulch systems using crop residues (Outputs 5 through 7) 8. Facilitate interaction and information sharing among public and private sector entities, NGOs, and farmer groups (Outputs 5 and 15) 9. Facilitate traveling seminars and farmer-to-farmer exchange (Outputs 5 and 9) 10. Support proponents of RCT development and adoption in key locations (Output 5) 11. Facilitate farmer testing of alternative crops (Output 8) 12. Conduct policy analysis and advocacy regarding marketing opportunities for alternative crops (Outputs 8 and 11) 13. Conduct Mexico-based and regional-based plant breeding and selection for improved wheat varieties, including varieties that tolerate drought and resist major high rainfall diseases, and root rots and nematodes (Output 9) 14. Screen improved wheat varieties for performance under zero tillage with crop residue retention (Output 9) 15. Use participatory varietal selection and participatory plant breeding in tailoring wheat materials to farmers' circumstances and accelerating their adoption (Output 9) 16. Strengthen seed systems as appropriate (Output 9) 17. Conduct policy analysis and advocacy regarding opportunities for improving wheat seed markets for faster varietal turnover (Outputs 9 and 12) 18. Implement farm level monitoring and long-term trials (Outputs 10, 13, and 14)	*Given the highly preliminary nature of this project structure, it would be inappropriate and premature to propose detailed milestones and indicators for activities.*	

19. Implement strategic research on biophysical processes concerning zero tillage with residue retention and implications for soil organic matter, soil structure, soil water holding capacity, and soil health (Output 10, 13, and 14) 20. Implement adoption studies at various levels (Outputs 13 and 14) 21. Develop project information management systems and use them to foster research coordination (Output 15)		

Project 3: Food security, markets, and livelihoods in Africa

Overall goal	Indicators	Assumptions and risks
Per capita food availability will begin to increase, the risk of starvation will be reduced, the incidence of child malnutrition will decline, livelihoods will become less risky, and the incidence of poverty will decline.	National level time series; measures of food availability per capita; time series measures of child malnutrition; results from surveys of poverty incidence.	Political and civil unrest are not excessive; national policies not unfavorable to agricultural development, including capacity-building for national institutions.
Intermediate goal	**Indicators**	**Assumptions and risks**
New conservation agriculture and soil fertility management practices, more diverse cropping systems, new and highly productive maize materials with drought tolerance and other virtues, and suitable risk management strategies (that take account of livestock management and off-farm employment) will be widely adopted by farm families in eastern and southern Africa.	Adoption studies; secondary data on farm level technology use; time series studies comparing drought years with favorable years.	Civil unrest does not make research and development activities excessively difficult; national and local policies do not hamper the adoption of suitable practices.
Purpose	**Indicators**	**Assumptions and risks**
CIMMYT and partners will work together on developing new input-use efficient, low risk, diversified, productivity enhancing, resource conserving technologies, with supporting market policies, for smallholder agricultural systems in eastern and southern Africa where maize is an important food staple and central to farm family livelihood strategies.	Evidence of collaborative research and development activity; evidence of integration of social science and biophysical science; documents describing research outcomes; initial favorable reception by farmers to technical prototypes.	Civil unrest does not make collaborative activities excessively difficult; improved markets for inputs and products can be fostered.
Outputs	**Indicators**	**Assumptions and risks**
Information management 1. Agroecologies and environments in eastern and southern Africa characterized at various scales, from germplasm megaenvironments to land type niches on a farm, and updated information obtained and used in decision making and priority setting, regarding farmers' practices and circumstances, gender roles, factors affecting system productivity and profitability, and factors governing adoption of new technologies. 2. Information gathered and used to define the spatial incidence and relative importance of biotic and abiotic stress factors that affect food systems in Africa.	Documents on agroecological characterization; system and gender diagnostics; the spatial incidence of system problems; decision support systems; and crop-livestock interactions.	Spatially referenced data are available in the public domain; civil unrest does not make diagnostic field studies impossible.

3. Decision support systems developed and widely used to match improved maize and wheat system technologies with land types and farmer categories. 4. Interactions between livestock management and crop management that are widespread in eastern and southern Africa understood and used in technology design and testing.		
System and resource management 5. "Best bet" soil fertility management technologies (including rotations and associations with legumes, use of manure, and management of low fertilizer levels) identified, adapted by farmers, and disseminated to 5000 farm advisers and over 40,000 farm families in Ethiopia (wheat systems) and in Kenya, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe (maize systems). 6. The risk of economic loss or gain that might be experienced by farm families during drought seasons when using "best bet" soil fertility management practices understood and quantified, including consequences for livestock enterprises and related feedback to cropping systems. 7. New *Striga* management practices adopted by at least 5000 farm families in Kenya. 8. Within an INRM framework, combinations of soil moisture conservation strategies (including reduced tillage with mulch), soil fertility management strategies, and drought tolerant maize materials tested by farmers, and consequences tested at watershed or higher levels of analysis. 9. Innovative strategies for control of storage pests tested by farmers.	Studies on the adoption of RCTs and new soil fertility management practices; quantitative information from models on downside system risk for various scenarios; information on trends in system diversity and other management practices.	Improved markets for inputs and products can be fostered; infrastructure does not continue to deteriorate; suitable crop models can be validated and reliably used for long-term analysis of system performance.
Genetic improvement and seed 10. More than 40 maize cultivars developed (and screened in farmer tests) that combine the following: a. drought tolerance, b. tolerance to low soil fertility, c. resistance to biotic stresses such as diseases (e.g., maize streak virus) and *Striga*, d. resistance to stem borers, e. resistance to storage pests, f. high protein quality, g. good performance when intercropped with legumes to maximize combined output, h. very early maturing maize for highly drought-prone areas, i. high yields, and j. suitable wheat germplasm developed and screened for performance under smallholder conditions in Ethiopia. 11. Insect resistant genetically modified maize materials developed in collaboration with Kenyan scientists and released by Kenyan authorities in the context of updated biosafety regulations and informed debate by civil society.	Breeders' reports and adoption studies; documents on civil society decision in Kenya on the release of GMOs; surveys on seed availability.	Global germplasm exchange not hindered; suitable decisions in Kenya on field diffusion of GMOs; policies do not hinder private sector and NGO actions in seed multiplication and distribution.

12. Seed of improved maize materials readily available to smallholder farmers in Angola, Ethiopia, western Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia, and Zimbabwe. 13. Improved maize materials with two or more of the traits listed above grown by at least 10% of farmers in eastern and southern Africa.		
Policies and impacts 14. Near-term impacts assessed of new maize and wheat system technologies with respect to farm family incomes and livelihoods and water and input use efficiency. 15. Longer-term impacts assessed of new maize and wheat system technologies on livelihoods, equity, resource quality, and the environment, and system resilience and sustainability, in the context of an INRM framework. 16. Policy and institutional issues affecting agriculture understood and used in at least two countries to influence the policy debate on technology adoption and input and product market development. 17. Input markets for fertilizer and seed, and output markets for maize grain and for alternative cash crops fostered through provision of information regarding market opportunities and through strengthening of partners.	Publications on biophysical processes research; reports from social science and biophysical impact studies; policy briefs published; records of positive interactions with policymakers; documentation of improved market performance.	Policy levers are available and can be used to foster improved input and product markets.
Partnerships and capacity building 18. Institutional collaboration and research coordination among the public, private, and NGO sectors strengthened in order to more effectively address priority development concerns. 19. Partner capacity strengthened through short courses, higher degree training, study tours and "learning by doing." 20. Key NARS networks strengthened and supported, and participation in additional networks or consortia expanded.	Network reports; NARS reports; evidence of specialization among research institutions; numbers of newly trained and enthusiastic staff.	Partner institutions are willing to collaborate.
Activities	Milestones	Assumptions and risks
1. Develop and apply easy-to-use GIS systems using publicly-available spatially referenced data, along the lines of the Country Almanac series (Outputs 1, 2, 3, and 12) 2. Use participatory techniques to define land type niches at the farm level, for use in technology targeting (Outputs 1, 2, and 3) 3. Develop project information management systems and use them to foster research coordination (Outputs 1, 2, 5-13, 18, and 20) 4. Implement GPS surveys, guided by available secondary data, to assess the spatial incidence of stress factors (Output 2) 5. Screen maize germplasm for tolerance to drought and low soil N via on-farm testing sites with partners from public sector extension, NGOs, and universities (Outputs 2, 10, 12, and 13) 6. Synthesize information on best bet technologies and prepare brochures, reports, newsletters, and training materials (Outputs 3, 5, 6, and 7)	*Given the highly preliminary nature of this project structure, it would be inappropriate and premature to propose detailed milestones and indicators for activities.*	

7. Conduct strategic research on long-term trends in the productivity and sustainability of cropping systems, nutrient dynamics in smallholder fields, and the N use efficiency (Outputs 6, 8, 14, and 15) 8. Conduct simulation modeling of the performance of farmer-developed whole farm nutrient management strategies over extended timeframes to assess risk (Output 6) 9. Conduct *Striga* management farmer trials, including organic practices and herbicide seed treatments, in western Kenya (Outputs 7, 10, and 13) 10. Use plant breeding to develop adapted, herbicide-resistant maize cultivars to control *Striga* using herbicide as a seed treatment (Outputs 7 and 10) 11. Implement, in collaboration with CIMMYT maize breeding activities in Mexico, a comprehensive maize germplasm development and evaluation program with partners in eastern and southern Africa (Outputs 10, 13, and 18) 12. Implement, in collaboration with CIMMYT wheat breeding activities in Mexico and elsewhere, a suitable wheat germplasm development and evaluation program with partners in Ethiopia (Output 10) 13. Develop nutritionally rich maize cultivars (QPM, micronutrients) adapted to regional biotic and abiotic stresses (Outputs 10 and 13) 14. Conduct feeding trials to test the nutritional value of QPM (Outputs 10 and 13) 15. Facilitate discussion within Kenya civil society of the advantages and risks of releasing genetically modified, insect resistant Bt maize in that country (Output 11) 16. Use biotechnology tools to develop, within strict national and CIMMYT's own biosafety guidelines, Bt maize materials effective against stem borer in Kenya and safe for use in farmers' fields (Output 11) 17. Provide maize seed for further multiplication and distribution to NGOs and farmer associations in Angola, Ethiopia, western Kenya, Malawi, Mozambique, Tanzania, Uganda, Zambia, and Zimbabwe (Outputs 12 and 13) 18. Collaborate with NARSs on seed production and delivery (Outputs 12, 13, and 18) 19. Provide short-term training for NARSs and other partners on economic evaluation, priority setting, and policy research (Outputs 14-17, and 19) 20. Write and use policy briefs to inform policy debates relating to the adoption of productivity improving, resource conserving practices, and input and product market development (Outputs 16 and 17)		

Project 4: Ensuring food security through sustainable intensification in densely-inhabited areas

Overall goal	Indicators	Assumptions and risks
Food supplies for the vast numbers of urban poor will be assured, livelihoods for an immense rural population will be increasingly diversified and sustainable, rural employment will be generated, the reliance on cereal production in rural livelihood strategies will be reduced, water use in agriculture will decline (making water resources available for alternative uses), and rural poverty will be reduced.	National data on trends in urban and rural per capita food availability; surveys on rural employment and poverty; documents on water use in agriculture at the river basin and field levels.	Technical change for non-cereal components of farming systems strengthened and accelerated; political difficulties across nations not excessive; national policies not unfavorable to agricultural development, including capacity-building for national institutions.
Intermediate goal	**Indicators**	**Assumptions and risks**
A greater number of new resource conserving technologies will be adopted by farm families in larger areas within target ecoregions, accompanied by more productive and disease tolerant (and, in the case of wheat, more genetically diverse) maize and wheat varieties. The tillage revolution will expand and increasingly feature more diverse agroecosystems.	Adoption studies; secondary data on farm level technology use, especially on the "tillage revolution," varietal replacement, and system diversity.	Political awkwardness across nations does not hinder cross-boundary research and development efforts; national and local policies do not hamper the adoption of suitable practices.
Purpose	**Indicators**	**Assumptions and risks**
CIMMYT and partners will work together on developing more resilient, sustainable, diversified, employment-generating, productivity enhancing, resource conserving technologies (with supporting policies) for intensive crop production and water management systems (typically irrigated) in South Asia, southern China, the lower Nile Valley and similar areas, with high population concentrations, and where wheat and maize are important for local and regional food security.	Evidence of collaborative research and development activity (including across regions); evidence of integration of social science and biophysical science; documents describing research outcomes; initial favorable reception by farmers to technical prototypes.	Willingness among all stakeholders to work together in partnership mode.
Outputs	**Indicators**	**Assumptions and risks**
Information management 1. Agroecologies of densely-inhabited, intensively-cropped irrigated systems characterized and mapped, especially in South Asia and North Africa.	Documents on agroecological characterization, system and gender diagnostics, and the spatial incidence	Spatially referenced data are available in the public domain.

2. Better understanding achieved and used in decision making and priority setting, regarding farmers' practices and circumstances, factors affecting system productivity and profitability, characterization of agroecologies, and factors governing adoption of new technologies.	of system problems.	
System and resource management 3. Crop and resource management practices for intensive, irrigated systems developed, tested and adopted in which grain yields are increased while water use, input use, and production costs are reduced. These include resource conserving technologies (RCTs) such as zero and reduced tillage, permanent bed systems, laser leveling, surface seeding, etc. 4. Water use efficiency ("crop per drop") and input use efficiency improved. 5. Groundwater depletion, salinity, and other processes of resource degradation slowed or reversed. 6. More diverse and productive farming and cropping systems (with a greater variety of high-value products and a reduced reliance on cereal crops) developed, tested, and adopted by farmers.	Studies of the adoption of RCTs and new system and water management practices; quantitative information water use efficiency and water savings in agriculture; information on trends in system diversity and other management practices.	Policy issues related to improved water management are not utterly intractable; policy levers are available and can be used to foster diversification.
Genetic improvement and seed 7. New maize and wheat varieties developed and adopted by farmers. These include materials that perform well with RCTs, that resist diseases, and that are adapted to such "problem areas" as the eastern Indo-Gangetic Plains. 8. Risk of disease epidemics reduced for major cereals in intensively farmed, irrigated areas, in part through increased crop genetic diversity in farmers' fields.	Breeders' reports and adoption studies; quantitative evidence of improvements in crop genetic diversity in farmer's fields.	
Policies and impacts 9. Policy and market environment improved in support of system diversification. 10. Near-term consequences of technical change (maize and wheat varieties, associated RCTs) estimated for incomes, livelihoods, water use in agriculture, and input use efficiency. 11. Longer-term consequences of technical change estimated for livelihoods, water use in agriculture, and trends in land and water quality.	Publications on biophysical research; reports from social science and biophysical impact studies; policy briefs published; records of positive interactions with policymakers.	Policy levers are available and can be used to foster diversification.
Partnerships and capacity building 12. Research coordination improved among multiple actors and stakeholders	Network reports; NARS reports; evidence of specialization among research institutions.	Partner institutions are willing to collaborate.

Activities	Milestones	Assumptions and risks
1. Develop user-friendly GIS systems using publicly available, spatially referenced data, along the lines of the Country Almanac series (Output 1) 2. Conduct diagnostic surveys and other system-level diagnostic activities (Output 2) 3. Use participatory approaches and community-based assessments to identify, adapt, and accelerate adoption of key technologies (Outputs 3 through 5) 4. Facilitate interaction and information sharing among public and private sector entities, NGOs, and farmer groups. In particular, facilitate interaction between farmer groups and private machine manufacturers regarding needs and demand for RCT implements (Outputs 3 through 5, and 12) 5. Facilitate traveling seminars and other means of farmer-to-farmer exchange (Outputs 3 through 5) 6. Support promoters of RCT development and adoption in key locations (Outputs 3 through 5) 7. Bring in key experts on RCT management to help initial adaptation of RCT prototypes to new regions (Outputs 3 through 5) 8. Implement strategic research on biophysical processes associated with the introduction of RCTs (Outputs 4, 5, and 11) 9. Obtain adapted germplasm of new, alternative crops from partner institutions, along with assistance in inserting these alternatives into cropping systems (Output 6) 10. Facilitate farmer testing of new alternatives to high value crops (Output 6) 11. Conduct Mexico-based and regional-based breeding and selection for improved maize and wheat varieties, including varieties adapted to the eastern Indo-Gangetic Plains and other "problem areas" (Output 7) 12. Screen improved maize and wheat varieties under zero tillage, beds, and other RCTs (Output 7) 13. Use participatory varietal selection and participatory plant breeding in tailoring materials to farmers' circumstances and accelerating their widespread adoption (Outputs 7 and 8) 14. Foster improvements in seed systems (Outputs 7 and 8) 15. Conduct epidemiological, crop surveillance, and crop loss assessment studies for Helminthosporium leaf blight complex and the rust diseases of wheat (Output 8) 16. Conduct policy analysis and advocacy regarding production and marketing of higher value products (Output 9) 17. Implement adoption studies (Outputs 10 and 11) 18. Carry out whole basin modeling of water balances (Output 11) 19. Implement farm level monitoring and long-term trials (Output 11) 20. Develop project information management systems and use them to foster research coordination (Output 12)	*Given the highly preliminary nature of this project structure, it would be inappropriate and premature to propose detailed milestones and indicators for activities.*	

Project 5: Improving livelihoods and conserving natural resources in tropical agroecosystems

Overall goal	Indicators	Assumptions and risks
For subsistence farmers in target ecoregions, food security will be assured and family resources will be freed for alternative uses. For non-subsistence farmers, production costs associated with more diverse agroecosystems will be reduced and (combined with more efficient markets) incomes will increase. Water and land degradation will be reduced, off-site effects of erosion will decline, and poverty will decrease. Maize supply will keep pace with the exploding demand for feed maize in Asia, without damaging the environment.	National data on trends in land degradation and in siltation of downstream irrigation infrastructure; national and regional trends in maize supply and marketing; surveys on livelihood strategies for subsistence farmers.	Livelihoods for subsistence farmers can continue to be diversified; cost-reducing practices for target farmers will be adequate to make their products locally and internationally competitive; national policies not unfavorable to agricultural development, including capacity building for national institutions.
Intermediate goal	**Indicators**	**Assumptions and risks**
New conservation agriculture practices, more diverse cropping systems, and new stress tolerant maize varieties will be widely adopted by farm families in target ecoregions.	Adoption studies; secondary data on farm-level technology use and system diversity.	Information sharing between Latin America and Asia can be achieved; national and local policies do not hamper the adoption of suitable practices.
Purpose	**Indicators**	**Assumptions and risks**
CIMMYT and partners will work together on developing new, more diversified, productivity enhancing, resource conserving technologies (and supporting policies) that feature ecological principles in pest, disease, and weed control, and that are suitable for rainfed agroecosystems in tropical areas of Latin America and Southeast and East Asia, where maize is important for family food security or as a source of income.	Evidence of collaborative research and development activity (including across regions); documents describing research outcomes; initial favorable reception by farmers to technical prototypes.	Willingness among all stakeholders to work together in partnership mode.
Outputs	**Indicators**	**Assumptions and risks**
Information management 1. Agroecologies of tropical rainfed ecosystems in tropical Latin America and East and Southeast Asia characterized and mapped.	Documents on agroecological characterization, system and gender diagnostics,	Spatially referenced data are available in the public domain.

2. Better understanding achieved and used in decision making and priority setting, regarding farmers' practices and circumstances, gender roles, factors affecting system productivity and profitability, and factors governing adoption of new technologies.	and the spatial incidence of system problems.	
System and resource management 3. Resource conserving technologies developed, tested, and adopted. These include zero and reduced tillage, green manure cover crops, and permanent mulch systems. 4. Damage to system productivity from weeds, pests, and diseases reduced through a combination of ecological approaches (more diverse agroecosystems, shading strategies, permanent mulch systems) and pest and disease-resistant maize germplasm. 5. Losses in system productivity (for legumes and maize) from acid and infertile soils reduced through acid-soil tolerant maize germplasm and proper management practices. 6. More diverse and productive cropping systems tested and adopted by farmers. 7. Food losses from storage insects and ear rots reduced through a combination of new storage practices and maize germplasm resistant to storage insects.	Studies of the adoption of RCTs and new system and land management practices; quantitative information on the success of ecological practices in pest, weed, and disease control; information on trends in system diversity and other management practices.	Policy levers are available and can be used to foster diversification.
Genetic improvement and seed 8. New maize varieties developed and adopted by farmers. These include materials that: a. are high-yielding; b. are tolerant of acid soils; c. perform well under zero tillage conditions; d. resist stem borers, downy mildew and other biotic threats; and e. are tolerant to drought or waterlogging, as needed.	Breeders' reports and adoption studies; quantitative evidence of varietal performance in farmer's fields.	Global germplasm exchange is not hindered.
Policies and impacts 9. The level reduced of farm family resources (cash, land, labor) required to produce maize adequate for annual family food consumption (for households that produce maize for their own use and to avoid purchasing it when it is expensive). 10. The level increased of net cash income from the sale of agricultural products emerging from maize based systems (for households that produce maize to sell for cash). 11. Policy and market environment improved in support of system diversification. 12. Expansion of rainfed upland systems into hillsides or forests slowed or stopped. 13. Soil erosion, reduction in water quality, and other processes of resource degradation associated with target systems slowed or reversed.	Publications on biophysical research; reports from social science and biophysical impact studies; policy briefs published; records of positive interactions with policymakers; survey or remote sensing data on trends in land use in hillsides and forest.	Policy levers are available and can be used to foster diversification.

14. Near-term consequences of technical change fostered by the project estimated for incomes, livelihoods, and soil conservation. 15. Longer-term consequences of technical change estimated for livelihoods, equity (including gender equity), and trends in land and water quality.		
Partnerships and capacity building 16. Research coordination improved among multiple actors and stakeholders, especially those with expertise in lowland or upland rice, cassava, "milpa" systems, crop-livestock interactions, and livelihood strategies for target farm families.	Network reports; NARS reports; evidence of specialization among research institutions.	Partner institutions are willing to collaborate.
Activities	Milestones	Assumptions and risks
1. Develop user-friendly GIS systems using publicly available, spatially referenced data, along the lines of the Country Almanac series (Output 1) 2. Use participatory approaches and community-based assessments to identify, adapt, and accelerate adoption of key technologies (Outputs 2 through 8) 3. Facilitate interaction and information sharing among public and private sector entities, NGOs, and farmer groups (Outputs 2 through 8) 4. Facilitate traveling seminars and other means of farmer-to-farmer exchange (Outputs 2 through 8) 5. Support promoters of RCT development and adoption in key locations (Outputs 3 through 7) 6. Bring in key experts on RCT management to help initial adaptation of RCT prototypes to new regions (Output 3 through 7) 7. Screen improved maize varieties for performance under zero tillage, green manure cover crops, mulch systems, and other RCTs (Outputs 3 and 8) 8. Implement strategic research on biophysical processes linked with the introduction of RCTs and implications for land and water quality, and soil land degradation (Output 4, 5, and 12 through 15) 9. Conduct Mexico-based and regional-based breeding and selection for maize improved varieties, including some adapted to acid soil conditions, low soil fertility, with resistance to storage insects, downy mildew and other biotic stress, and tolerant to drought or waterlogging (Outputs 4, 5, 7 and 8) 10. Conduct researcher-controlled trials and farmer experiments on ways to ameliorate soil acidity, including, but not limited to, lime application (Output 5) 11. Obtain adapted germplasm of new, alternative crops from partner institutions, along with assistance in inserting these alternatives into cropping systems (Output 6) 12. Facilitate farmer testing of alternative crops (Output 6) 13. Implement adoption studies at various levels (Outputs 9 through 15)	*Given the highly preliminary nature of this project structure, it would be inappropriate and premature to propose detailed milestones and indicators for activities.*	

14. Use participatory varietal selection and participatory plant breeding in tailoring maize materials to farmers' circumstances and accelerating their widespread adoption (Output 8) 15. Implement farm level monitoring and long-term trials (Outputs 9 through 15) 16. Conduct policy analysis and advocacy regarding marketing opportunities for alternative crops (Output 11) 17. Conduct diagnostic surveys and other system-level diagnostic activities (Output 2) 18. Develop project information management systems and use them to foster research coordination (Output 16).		

Project 6: Policies and institutions that maximize research impact

Overall goal	Indicators	Assumptions and risks
Through strategic global research, policy design, and advocacy, increase the impact of work done by CIMMYT and its partners by improving the allocation of research resources, increasing the efficiency with which research is conducted, and enhancing the rate of adoption of improved technology to improve the productivity, equity, and environmental sustainability of maize- and wheat-based farming systems.	Credible studies showing that CIMMYT research is having desired impacts while generating attractive returns compared to alternative investment opportunities.	Improved technologies developed by CIMMYT and its partners will continue to have significant impacts on improving the productivity and sustainability of maize- and wheat-based farming systems in developing countries.
Intermediate goal	**Indicators**	**Assumptions and risks**
Generate information and analysis that will allow researchers, research managers, donors, policy makers, and the general public to understand changes affecting the economic, political, and institutional environments in which international agricultural research is carried out; identify research and development issues that transcend national and regional boundaries; ensure that the resources of CIMMYT and its partners are used efficiently; identify entry points at which policy interventions can increase the likelihood that products and services generated by CIMMYT and its partners will reach potential users quickly and effectively; and ensure that when CIMMYT and its partners speak out on issues of importance, they do so in a consistent and coherent way.	Information and analysis generated by CIMMYT being used to inform research priority setting, research management, and policy making.	Affordable methods will be available to establish the chain of causality linking research investment to indicators of "ultimate impacts."
Purpose	**Indicators**	**Assumptions and risks**
CIMMYT and partners will work together on gathering information, conducting analysis, and developing innovative methods that can be used by researchers, research managers, donors, and policy makers to improve research resource allocation, increase research efficiency, and enhance the use of research results to improve the productivity and sustainability of maize- and wheat-based farming systems in the developing world.	Data sets, scientific publications, policy briefs, and new methods produced by CIMMYT and partners.	Developing countries remain committed to raising agricultural productivity as a way of improving the welfare of the poor.
Outputs	**Indicators**	**Assumptions and risks**
Global trends analysis 1. Long-term trends in the world maize and wheat economies monitored and documented in reports accessible to a non-technical audience 2. Future trends projected for global production, consumption, and trade of maize and wheat 3. Implications projected for maize and wheat technology needs in countries that are important producers or consumers of these crops	Information on global trends in the world maize and wheat economies.	Sharing of data and information is unimpeded.

Research priority setting 4. Technology needs of maize and wheat producers in developing countries assessed and documented 5. Likely returns to investment in alternative research and development activities estimated using ex ante impact assessment methods 6. Attractiveness of alternative research investments compared and ranked 7. Methods developed for conducting ex ante impact assessment and performing research priority setting 8. Capacity of researchers in developing countries to conduct ex ante impact assessment and priority setting strengthened	Information for more efficient research resource allocation; methods for conducting research priority setting.	Research resource allocation will be based on efficiency considerations, rather than political considerations.
Impact assessment 9. Adoption of improved technologies developed by CIMMYT and partners documented 10. Productivity gains attributable to adoption of improved technologies estimated 11. Income gains attributable to adoption of improved technologies estimated 12. Livelihood benefits attributable to adoption of improved technologies estimated 13. Methods developed for conducting ex post impact assessment studies 14. Capacity of researchers in developing countries to conduct impact assessment strengthened	Information documenting impacts of research and factors affecting technology adoption; methods for conducting impact assessment studies.	Impacts assessment function will be insulated from public relations function (impacts data will not be manipulated for publicity).
Policy analysis 15. Role of policies in influencing the effectiveness of agricultural research analyzed and documented 16. Role of policies in influencing the adoption and diffusion of improved technologies analyzed and documented 17. Policy constraints to diffusion of improved technologies identified 18. Policy interventions needed to remove existing constraints to diffusion of improved technologies identified 19. Capacity of researchers in developing countries to conduct policy analysis strengthened	Information to guide strategies for deploying new technology.	Policy interventions will be effective in removing constraints to adoption of improved technology.
Advocacy 20. Role of policies in influencing the effectiveness of agricultural research communicated to policy makers and the general public 21. Role of policies in influencing the diffusion of improved technologies communicated to policy makers and the general public 22. Policy interventions needed to remove existing constraints to diffusion of improved technologies communicated to policy makers and the general public 23. Capacity of researchers in developing countries to advocate effectively strengthened		CIMMYT will be able to advocate effectively for policy reforms.

Activities	Milestones	Assumptions and risks
Monitoring global trends 1. Monitor data on production and consumption of maize, wheat, and other commodities of global importance 2. Monitor data on international trade in maize, wheat, and other commodities of global importance 3. Monitor data on prices of maize, wheat, and other commodities of global importance 4. Monitor data on input use in production of maize, wheat, and other commodities of global importance Setting research priorities 5. Conduct studies to assess the needs of maize and wheat producers and consumers in developing countries 6. Develop methods for efficiently eliciting the needs of maize and wheat producers and consumers in developing countries 7. Conduct studies to identify research priorities for CIMMYT 8. Conduct studies to identify research priorities for CIMMYT's partners and stakeholders Assessing impact 9. Conduct large-scale studies to document global impacts of improved maize and wheat technologies developed by CIMMYT and partners 10. Conduct targeted case studies to document local impact of improved maize and wheat production technologies 11. Conduct studies to assess the returns to investment in maize and wheat research Designing policy interventions 12. Conduct comparative multi-country studies to determine the role of policies in influencing the effectiveness of agricultural research 13. Conduct comparative multi-country studies to determine the role of policies in affecting the adoption and diffusion of improved technologies for maize- and wheat-based farming systems 14. Design policy interventions to improve the effectiveness of agricultural research 15. Design policy interventions to accelerate the adoption and diffusion of improved technologies for maize- and wheat-based farming systems Advocating for change 16. Through publications and other communications media, publicize the policy reforms needed to improve the effectiveness of agricultural research investments 17. Through publications and other communications media, publicize the policy reforms needed to improve the adoption and diffusion of improved maize and wheat production technologies	*Given the highly preliminary nature of this project structure, it would be inappropriate and premature to propose detailed milestones and indicators for activities.*	

Project 7: Sharing and managing knowledge

Overall goal	Indicators	Assumptions and risks
Research for development of agricultural systems will be performed, and widely-shared goals of poverty reduction, livelihoods enhancement, biodiversity preservation, and natural resource conservation will be achieved more effectively and efficiently, at a lower cost, through the successful application of mechanisms for more rapid sharing of information.	Studies on rates of return to agricultural research and development that take into account the efficiency of information flow.	Other factors besides information exchange are not binding constraints to development.
Intermediate goal	**Indicators**	**Assumptions and risks**
Technical and general use information, and learning opportunities will be readily available to CIMMYT staff, partners, stakeholders, and the general public.	Data on the rate of use of the portals; studies on the pace, incidence, and value of information flow and capacity building.	Stakeholders have access to suitably fast internet connectivity.
Purpose	**Indicators**	**Assumptions and risks**
CIMMYT and partners will collaborate in establishing information portals, communities of practice, and capacity building opportunities for more effective sharing of relevant information.	Information on the contributions of different partners to building the new knowledge management structure.	Partners and stakeholders are willing to share information under the relatively informal structure of the community of practice.
Outputs	**Indicators**	**Assumptions and risks**
1. On-line technical portal developed and opened, with anticipated users including CIMMYT scientists and research partners, featuring technical data and tools required to effectively perform their duties. 2. On-line general information portal developed and opened, with anticipated users including students and the general public, featuring a comprehensive public knowledge base on maize and wheat systems in developing countries. 3. On-line technology targeting portal developed and opened, with anticipated users including NARS, private companies, and NGOs and other grassroots organizations, featuring information useful in selecting tools or technologies that may be attractive under clearly defined conditions. 4. "Communities of practice" fostered and supported whereby CIMMYT staff, partners, and global stakeholders can share information on specific topics or themes. 5. Ability to use the above knowledge management resources in capacity building for institutions and individuals strengthened.	Portals open, communities of practice in operation, training programs being implemented.	Funds will be available for the necessarily large investments in IT capital and human resources required to make this a reality.

Activities	Milestones	Assumptions and risks
1. Invest in updated tools, technology, and infrastructure for information management (Outputs 1 through 5) 2. Invest in improving the capacity of our own staff to effectively manage knowledge (Outputs 1 through 5) 3. Develop website and internet portals capable of providing information and data needed by scientists, partners, the general public, and grassroots organizations (Outputs 1 through 3) 4. Populate the technical portal with information on new science, databases (including bioinformatics resources); scientific journals; molecular maps; plant pedigrees; genomic data; GIS data; international trial data; outcomes of systems diagnosis; policy briefs; impact studies; and other information developed through research by CIMMYT and its partners (Outputs 1 and 5) 5. Populate the general information portal with information and data of use to the general public (Outputs 2 and 5) 6. Populate the technology targeting portal with decision rules that describe the (biophysical and socioeconomic) conditions under which particular technologies tend to perform relatively well—along with GIS data and a easy-to-use map viewer capable of generating simple GIS overlays (Outputs 3 and 5) 7. Establish a strong learning and mentoring service that develops new courses and training modules; facilitates distance learning and the earning of advanced degrees; offers formal training directly; and establishes a network of local training partners in a large number of countries where we conduct our work (Outputs 4 and 5) 8. Facilitate the formation of thematically based "communities of practice," to be self-governed (Output 4 and 5) 9. Conduct needs assessment for formal capacity building activities (Output 5) 10. Develop instructional materials and training modules in partnership with other stakeholders (Output 5) 11. Identify and establish links with local training partners (Output 5) 12. Maintain a mentoring service through opportunities to interact on a daily basis with experienced CIMMYT staff or other resource persons (Outputs 4 and 5) 13. Host visiting scientists in all locations where we work, thereby providing opportunities to interact on a daily basis with experienced CIMMYT staff and other resource persons (Output 5) 14. In collaboration with universities, provide support for post-graduate students who will conduct the experimental part of their thesis at CIMMYT or are working in an area related to our mission (Output 5)	*Given the highly preliminary nature of this project structure,it would be inappropriate and premature to propose detailed milestones and indicators for activities.*	