CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH
SCIENCE COUNCIL AND CGIAR SECRETARIAT

Report of the Sixth External Program and Management Review (EPMR) of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Review Panel: **Kenneth G. Cassman (Chair)**
Eric Danquah
Antonio J. Hall
Kenneth M. Menz
Maureen K. Robinson
Prosper Biabo

SCIENCE COUNCIL SECRETARIAT
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EXECUTIVE SUMMARY

ICRISAT today is a thriving research institute with a unique capacity to address poverty alleviation, food security, and natural resource protection in the SAT. The 6th EPMR Panel found a remarkable turnaround in the five years since the Center's 2003 review thanks to strong leadership and improved staff morale. The budget grew by 70% and is projected to continue growing over the next five years. Two regional programs have been established, one in West and Central Africa (WCA) and the other in East and South Africa (ESA), each with a regional Director and responsibility to plan, resource, and implement a research agenda to address region-specific constraints to food security and poverty. Funding for SSA programs rose to 60% of ICRISAT's total budget, and the Panel found substantial evidence of spillover from ICRISAT's germplasm research at headquarters to the SSA programs and NARS.

Several recent developments will have considerable impact on ICRISAT's operating environment going forward. The increasing demand for energy has stimulated the production of bio-based fuels, of which maize-based ethanol has influenced international prices of all major grain and oilseed crops worldwide, including ICRISAT's mandate crops. Severe drought in other parts of the world also contributed to food price shocks. The long-term global trend in hunger reduction has been reversed as the number of malnourished increased for the first time in decades. Disruption of financial markets and the specter of economic stagnation currently affect commodity prices and may have far-reaching effects on the rate of economic development in low income countries and on the capacity of donors to provide support. On the other hand, policymakers and donors have been reminded of agriculture's seminal role in alleviating poverty and contributing to political stability. As a result, a number of new donors are engaged in agricultural development, and invest mostly in large projects with high expectations for impact.

The CGIAR is in the midst of major reform, and Centers will become part of a Consortium. This new legal entity will deliver research results through multi-partner programs. The major donors will join a Fund that will make a commitment to provide longer-term funding to support these programs. This change will affect strategic planning, partnerships, and research funding at the individual Centers and throughout the agricultural development community.

The focus of ICRISAT's research is the semi-arid tropics (SAT), a region that is home to a disproportionately large share of the world's poor because of its harsh and uncertain climate, water scarcity, and generally poor soils. A majority of people in the SAT rely on agriculture for a significant portion of their livelihood, which makes this region particularly vulnerable to the adverse impacts of climate change.

Poverty alleviation will remain an enormous challenge in Sub-Saharan Africa (SSA) into the foreseeable future, and therefore agricultural development will remain a critical engine of economic growth. The SAT of Asia are also home to hundreds of millions in extreme poverty, and agriculture is a key driver of urban and rural poverty alleviation in this region as well. The Panel believes that ICRISAT must continue to work in both regions.

Many of the Panel's findings address ICRISAT's challenge to effectively achieve its mission in the SAT of two continents with distinctly different development stages and trajectories. While the Panel does not see a need to relocate ICRISAT headquarters to Africa, there is clearly the capacity to continue strengthening programs that target SSA, and to improve the potential for spillovers through a more explicit emphasis on spillover opportunities in strategic planning.

Indeed, the Panel believes that greater attention to strategic planning and research prioritization is the key to continued success. During the past five years, however, the Center's efforts in this area appear to have been driven largely by external pressure from the Science Council (SC) with little buy-in or commitment from staff. Given the changes in the external environment and within the CGIAR, it is crucial that ICRISAT take ownership of its strategic planning process and enhance the depth of analysis that underpins it. Better information, greater insight, and the ability to make difficult choices are required. A clear and balanced understanding of its organizational assets and expertise and the quality of its research outputs are essential components of this process. A sound strategic plan based on clearly defined priorities and explicit criteria provide the roadmap to focus on the Center's mission—in times when resources are plentiful and when they are scarce. Enhanced strategic planning and prioritization is the answer to questions about the balance in resource allocation between Asia and Africa, and also about the balance of effort across the research—development continuum.

The quality of the Center's research is at a level comparable with other CGIAR Centers as measured by the most common indicators of staff quality and publication productivity and quality. Most senior research staff mentor graduate students, a few are on editorial boards of SCI-international journals, and a large proportion are asked to review journal articles. ICRISAT should, however, aim higher with regard to publishing in the more widely accessible and more heavily cited journals in the SCI. To achieve this goal, the Panel urges the Center to incorporate plans for publication in the annual staff review process, and in annual cycles of setting work plans at the project and program level. Fragmenting research results into multiple journal articles should be avoided as the scientific impact of the total body of work gets lost in the pieces. The Panel notes with some concern the difficulty it had in getting consistent and reliable data on performance metrics (particularly for publications and training). Systematically maintaining accurate records is crucial to help the Center respond both to its own needs of planning and monitoring, and for external evaluation.

The Center's key mechanisms for internal quality control are the annual staff evaluations and CCERs. Performance evaluations should be based on output levels that account for a scientist's assigned responsibilities—including research, project management, grant writing, and training. The full range of creative outputs must also be considered and valued accordingly, such as publications, germplasm release, models, and software. In the past two years, CCERs were conducted with the purpose of providing recent information about program performance to the EPMR. For the most part, the Panel considered the CCERs to be helpful and credible although the assessment of the quality and productivity of research outputs was generally weak.

ICRISAT has a strong tradition of an impact culture that is reflected in its publications, workshops and systematic impact evaluations. The Center includes impact pathway design in project planning. Greater efforts to assess the impact of NRM research is encouraged because impacts are variable and more difficult to gauge than from the release and uptake of improved varieties. Impact assessment must also serve research prioritization and contribute to better understanding of spillover effects between the regions and the when, where, why and how of the technology adoption process.

GT-IMPI is home to most of the Center's social science expertise and has responsibility to contribute to Center-wide strategic planning and prioritization. The program has a sound level of research output. It receives a high proportion of its funding from 'non-core' sources, which

reflects a positive donor view of its performance and its seminal role within the Center. GT-IMPI's comparative advantage is the opportunity to influence the deployment of ICRISAT research resources across regions, programs and project levels, in such a way as to maximize impact. Surprisingly this role is not strongly visible in Theme goals. The Panel suggests a meta-analysis of the Center's impact assessments as an efficient means to improve its understanding of the technology adoption process in the SAT, and to use the insight gained in priority setting and also for feedback into the technology development process.

GT-IMPI could be especially helpful in reconciling the 'tension' between ICRISAT's location-specific, impact-oriented downstream work and the delivery of IPGs. This could be accomplished by developing and testing hypotheses about the adoption process associated with location-specific work and about the expected impact from technology adoption. The Panel sees this as a legitimate research activity in its own right and fully compatible with the directions mentioned above. The Panel commends GT-IMPI for re-invigoration of the village level studies in recent years, which resulted in a forthcoming $10 million dollar grant from the BMGF.

GT-CI was highly commended by the CCER on Crop Improvement and Biotechnology which reviewed these programs in 2007. Also the current Panel found a high level of activity across five MTP projects, with many advances on a broad range of topics. In addition to generating excellent applied science outcomes in the form of new cultivars for release by the NARS and new germplasm for breeding programs, GT-CI has produced other important IPGs in collaboration with GT-BT and GT-IMPI. These include conservation, characterization, and packaging of its unique core germplasm collections for greater accessibility and use by the NARS and private sector. Efforts to understand and break the bottlenecks that constrain diffusion of improved varieties to poor farmers in the SAT are also notable.

The GT-CI has devolved a substantial portion of its breeding activity to the stronger NARS and private sector partners in Asia. This transition provides an opportunity to invest in other areas, such as in the greater use of biometric analyses to understand germplasm response across multi-environment trials conducted by the Center and its partners in Asia and SSA. Such work represents a comparative advantage in genetic improvement of the mandate crops, an advantage that could be further reinforced by support from crop simulation and geo-spatial analysis. The Panel urges the GT-CI to ensure that testing environments include low soil fertility locations typical of conditions faced by farmers.

The majority of ICRISAT's biotechnology research is conducted at headquarters in Patancheru, India, although the BecA facility at ILRI currently allows limited molecular marker and genotyping work in Nairobi, Kenya. Development of maps for mandate crop genomes and markers for traits of interest constitute an important part this program. Bioinformatics tools for data storage, management and access constitute another significant line of work. Phenotyping protocols for resistance to biotic and abiotic stresses have been developed, as have transformation protocols and embryo rescue techniques for wide hybridization. Work on functional genomics for resistance to stress has been initiated, as has testing transgenically introgressed transcription factors for drought and pest resistance. Significant funding from the GoI and the GoAP has allowed considerable enhancement of GT-BT facilities, which enables the provision of services to researchers within and without ICRISAT and to the development of partnerships with the private sector.

During the last five years, substantial advances have been made on all fronts of GT-BT's research portfolio, and the future pipeline is well supplied. The first product from MAB in India (a pearl millet hybrid resistant to downy mildew, produced using GT-BT markers) was released during the review period. The Panel commends the GT-BT for its excellent work, and also for a good functional balance between investment in the use of biotechnology to investigate strategic issues versus the provision of tools for crop breeding and germplasm characterization. The Panel views as high priorities efforts to accelerate progress in development of high density reference maps for mandate crops and the establishment of a baseline capacity for routine use of genomic tools to support crop breeding in WCA and ESA.

The objective of the GT-AE is to play a leadership role to enhance productivity, protect the resource base, and increase the efficiency of utilization of those resources in SAT agricultural systems. It also provides agronomic context to guide the efforts of the other Themes.

Current foci for GT-AE work include risk management, high value crops, cropping system diversification, and soil nutrient management. Crop simulation models have been used to address climate change, fertilizer management, crop adaptation, climate analysis, and yield gap issues. Spatial analyses have been incorporated in several lines of research, and some advances have been made on the crop-livestock interface. Watershed management work, especially in Asia, has continued. Farmer participatory research was emphasized in a number of projects.

Some of the research being conducted by GT-AE is now mature and can be devolved to the NARS. Other research lacks clear justification in relation to the Center's core mission. Both categories should be de-emphasized. In contrast, there is a critical need to expand research capacity and effort to build on current work in the areas of geospatial analysis, crop and ecosystem modeling, remote sensing, and risk management in relation to climate variation. Work in these areas can help leverage research on biometrical analysis of germplasm performance in multi-location trials and impact assessment.

ICRISAT has a strategic grasp of where partnerships add value and has defined the span of potential partners in a thoughtful, pragmatic way. Current partnerships include other CGIAR Centers and the Challenge Programs, and the NARS, ARIs, private sector, civil society groups, NGOs, communities and farmer groups. Its collaborative research with the Indian research organizations has grown in recent years at both the strategic level (biotechnology research) and for downstream work on watersheds and technology dissemination. The Center's engagement with the private sector is also notable. In the period under review it has engaged in several large projects, including BMGF projects and the CGIAR Challenge programs. Such large projects are likely to increase in the future, both as a result of the CGIAR change and of entry of new donors who fund multi-partner projects. There is need for ICRISAT (and other Centers) to become better managers and partners in these large, often multi-partner, projects.

ICRISAT plays an important role in developing research capacity for agricultural development in the SAT and has trained a large number of research scholars, fellows and interns during the review period. Inadequate record keeping, however, did not make it possible to draw conclusions about the volume and quality of training, or the regional distribution of these efforts. The Panel believes the Center should establish better standards and expectations both for mentoring research scholars and also for publications from scholar's thesis.

In the last five years, ICRISAT has made a substantial commitment to improving its governance and management, and building a prudent and sustainable financial framework. Having strengthened ICRISAT's governance by carefully reforming its structure, composition and practices, the Center's Board needs to focus on maintaining the quality of its work and its responsibility to be independent and fully engaged. The Board requires clearer and more integrated information in order to monitor performance and help define strategies. The decision to renew the DG's contract for a third, five year term places an increased burden on the Board to maintain a well balanced relationship with the DG in which the independence and rigor of the Board is carefully preserved.

ICRISAT has benefited from good leadership and management. Morale among staff is high and the staff's commitment to the Center's mission is evident. ICRISAT anticipates that 23% of its scientists will retire within the next five years, which places a burden on management to anticipate the shape of ICRISAT's future research priorities and find ways to cultivate the talent and organizational culture that will sustain the Center's research agenda. In addition, ICRISAT must become a more diverse organization, bringing more women into management and on to the scientific staff, and continuing to broaden the geographic diversity of its scientists.

During the period of the review, ICRISAT's financial performance and financial management have been excellent. The Center's current financial success was built on the ability to stabilize core funding, attract significant support from India and successfully compete for grants for special projects. In 2008, ICRISAT had 250 restricted grants in its portfolio. Having established a strong track record in resource development, ICRISAT should increase efforts to acquire larger projects that reduce the risk of mission drift and are more cost effective to manage.

ICRISAT has also introduced innovative efforts to engage in private sector partnerships through the creation of Agri-Science Park (ASP). The partnerships formed within ASP generated substantial revenue for research, operations and capital improvements. The financial value of ASP to ICRISAT as well as the pace of growth makes it difficult to discern whether ASP's mission is to generate revenue or to advance the Center's mission. The scale and structure of ASP needs to be more transparent, particularly to the Board.

In conclusion, agricultural development holds the key to progress on reducing poverty and hunger in the SAT of Africa and Asia. But agricultural indicators, such as input use, adoption of new varieties and yield increases show relatively little improvement in most areas. Given this situation, the frontlines of the battle against poverty are located in farmer's fields and small rural villages of the SAT. Yet it is not unreasonable to envision an SAT free from poverty and hunger within the lifetime of the young scientists and scholars working at ICRISAT today. While the Center can be proud of its achievements in the last five years, it should not rest on its laurels because there remains a formidable challenge ahead. Fortunately, with good strategic planning and attention to building research capacity in a few key areas, the Panel believes that the Center is poised for success in building programs to accomplish its mission.

LIST OF RECOMMENDATIONS

CONTEXT

1. The Panel recommends that ICRISAT continue to enhance investments in personnel and infrastructure in the SSA and use the potential for spillover to SSA as one of the explicit criteria used in prioritization of strategic investments in research conducted at the Patancheru headquarters.

STRATEGIC PLANNING AND PRIORITY SETTING

2. The Panel recommends that ICRISAT take ownership of and celebrate the strategic planning and research prioritization process based on: (i) proactive engagement of staff, Board, stakeholders, partners, and donors; (ii) analysis and understanding of recent crop yield and production trends, and projected growth in production and demand for its mandate crops, (iii) scenario analyses that utilizes geospatial analysis, ecosystem and crop modeling, and an appropriate socioeconomic framework.

SCIENCE QUALITY AND IMPACT

3. The Panel recommends a thorough analysis of past and likely future research spillovers between Africa and Asia to guide ICRISAT resource allocations between those two regions.

RESEARCH PROGRAM

GT-Social science (IMPI)

4. The Panel recommends that ICRISAT capitalize on its core social science strengths to enhance activities in three areas and their interactions:
   - research prioritization and project planning (at all levels within the Center);
   - technology development and adaptation; and
   - impact assessment.

5. The Panel recommends that GT-IMPI work on the development of hypotheses that determine the IPG potential of ICRISAT's downstream work on technology development, testing and adaptation.

GT-Crop Improvement

6. The Panel recommends that ICRISAT expand expertise and research capacity in advanced biometrics for analysis of germplasm performance across multi-location environments using data generated across the network of multi-environment trials conducted by the Center and its partners across the Asian and African SAT.

GT-Biotechnology

7. The Panel recommends that ICRISAT scale up its activities in marker development through strategic partnerships and resource targeting to accelerate the generation of high density reference maps that facilitate gene tagging for MAS in the mandate crops.

8. The Panel recommends that ICRISAT establish minimal biotechnology facilities in Bamako or Niamey to allow DNA extraction, low throughput PCR-based genotyping and direct access to the bioinformatics platform at headquarters.

GT – Agroecosystems

9. The Panel recommends that ICRISAT build a core team with expertise in systems analysis, crop modeling, climate analysis, geo-spatial analysis, and economics located in Africa as a Center-wide resource for research, strategic planning and impact assessment, and to concentrate the efforts now dispersed across regions.

10. The Panel recommends that ICRISAT move rapidly to de-emphasize current mature lines of work, particularly in GT-AE (e.g. watershed management in Asia, microdosing, Africa market gardens, dryland eco-farms), and work that can be performed by the NARS (e.g. jatropha, pongamia, chickpea in rice-fallows) to free up resources needed for new initiatives.

PARTNERSHIPS AND CAPACITY BUILDING

11. The Panel recommends that ICRISAT reorganize the structure and oversight of training and capacity building, and develop output quality criteria, as well as explicit expectations for mentoring and supervising research scholars, research fellows, and interns by ICRISAT scientists.

GOVERNANCE, MANAGEMENT AND FINANCE

Governance

12. The Panel recommends that the Board bring greater rigor to the assessment of its own performance, and emphasize, in the orientation for new members, the responsibility of the Board to sustain its independence and its effectiveness.

13. The Panel recommends that ICRISAT create succinct documents that synthesize 5-year trends in financial performance, priority setting and performance to give the Board more efficient and transparent access to information critical to oversight.

14. The Panel recommends that the Board adopt a multi-source evaluation process for the Director General that is rigorous and balanced and that provides the Board with more inflected and diverse inputs to the process. In addition to senior staff, the Board and DG should annually agree on a list of partners, donors and peers to be asked to participate in the evaluation.

Management

15. The Panel recommends that training be provided to senior scientific and administrative staff about how to develop and manage large projects, and how to balance research and project management.

16. The Panel recommends that ICRISAT's leadership clarify the role of PDMO in priority setting and send a clear signal about the drivers and determinants for establishing priorities for resource development.

17. The Panel recommends that ICRISAT must present ASP's mission, structure and relationship to research in a more transparent fashion and re-assess ASP, either to narrow the ventures it pursues, or, in the interests of minimizing risks to the Center's reputation, create a different structure with clearer boundaries between it and the Center.

1 CONTEXT

1.1 Terms of Reference and Conduct of the 6th EPMR

This is the 6th External Program and Management Review (EPMR) that ICRISAT has undergone since it was established in 1972. The composition of the Panel and their biodata are provided in Annex 1. The EPMR Panel was guided by the general objectives of EPMRs: (a) to provide the CGIAR members with an independent and rigorous assessment of the institutional health and contribution of the Center; and (b) to provide the Center and its collaborators with assessment information that complements or validates their own evaluation efforts. The Terms of Reference for conducting EPMRs and the list of the Science Council's (SC) strategic issues to the review Panel are given in Annex 2. The review was conducted in two phases: The first phase from August 19-30 2008, and the second from January 25-February 8, 2009. Site visits by EPMR team members to regional project locations in India, ESA, and WCA occurred in August and October 2008. The EPMR itinerary and field visit reports are provided in Annex 3. The review focuses on the six-year period (2003-2008) since the 5th EPR and EMR, which were completed in 2003. The summary of ICRISAT's implementation of the 5th EPR and EMR recommendations and the EPMR Panel's assessment are provided in Annex 4.

The Panel made every attempt to conduct the review in an objective and transparent manner with a focus on the future as well as the past. The Panel drew from the following sources of information to complete its analysis: Extensive documentation provided by ICRISAT, and the SC and CGIAR Secretariats (Annex 5) and data provided by ICRISAT to the Panel in response to its particular needs; briefings and discussions with the DG, senior management team, and other research, management and administrative staff during the first phase, and with partners and stakeholder particularly during the field visits; partner and stakeholder survey, the results of which are presented in Annex 6; solicited feed-back from the major donors in developed and developing countries and CGIAR Center DGs and other stakeholders contacted; analysis of the CVs of professional staff providing information on their personal career and research merits during 2003-2007; review of Governing Board (hereafter called the Board) agendas, minutes and other documentation, observations of the Board in action (August 2008 meeting) and interviews with individual Board members.

The Panel expresses its appreciation to ICRISAT DG William Dar, senior management; particularly Dave Hoisington and Cynthia Bantilan who helped organize the review, and staff in the West and East-Africa offices; all other research and administrative staff and the Board for facilitating this review in a responsive and efficient manner, and for the hospitality in all locations the Panel visited.

1.2 Change in the Global Environment and the SAT

The semi-arid tropics (SAT) are hot and relatively dry regions that sit between the humid/sub-humid monsoon zones and arid deserts. They are delimited by mean temperature and the amount of water available to support crop growth. During the growing season, there is high evaporative water demand, and erratic rainfall distributed during a monsoonal rainy season that typically lasts about three months. The dry SAT have a mean annual temperature of >20°C and a length of growing period (LGP—when rainfall and stored soil moisture can support crop growth) of 75-120 days; the moist SAT have similar mean annual temperature and a LGP of 120-180 days. The SAT are also highly variable with regard to soils, but soils tend to be of low native fertility. The SAT includes 55 developing countries and cover most of West, East and the southern part of

central Africa, most of India, central Myanmar, north-eastern Thailand and northern Australia, most of Mexico; and large parts of eastern and central South America.

The SAT are home to a disproportionately large share of the world's poor and hungry because of their large geographical extent, harsh and uncertain climate, water scarcity, and generally poor soils (Table 1.1). Although the intensity of extreme poverty (less than USD 1 per day) is greater in sub-Saharan Africa (SSA), the total number of poor is considerably larger in Asia because of its much larger population. On both continents, the poor in SAT regions are at high risk from the adverse impacts of climate change, and the natural resources on which agriculture depends is prone to soil degradation and a high degree of variability in rainfall.

Table 1.1 Area, population and number of poor in SAT: Asia and Africa (Source: World Development Report, 2008[2])

	Asia	sub-Saharan Africa	Total
Area in SAT (Million Sq. km)	1.52	4.98	6.50
Total population in SAT countries (billions)	1.60	0.61	2.21 (100%)
Population below 1USD a day in billions (% of total population)	0.42 (26%)	0.25 (41%)	0.67 (30%)
Population below 2USD a day in billions (% of total population)	1.06 (66%)	0.42 (68%)	1.48 (67%)

After decades of complacence about global food security, the recent spike in food prices and increase in hunger and extreme poverty have rekindled awareness amongst policymakers, academics, and donors about the tenuous balance between food supply and demand, and about the seminal role of agriculture in alleviating poverty. At issue is how these events and demographic trends affect ICRISAT's ability to obtain resources to support its mission and its strategic plans for the future.

1.2.1 Changes in the External Environment

There have been more changes in global commodity and financial markets in the past five years than at any time during ICRISAT's history. This period was marked by an unprecedented global economic expansion in which growth was greatest in the world's most populous developing countries, including China, India, Brazil, and Russia. Rising incomes led to skyrocketing demand for energy, livestock products, and feed grains, which in turn caused an abrupt spike in the prices of all major food crops. As food prices rose to record levels, the negative impact fell most heavily on the urban and rural poor in low-income countries. Many of these countries are located in ICRISAT's target area—the SAT.

Global economic growth also drove increased demand for energy in general, and petroleum in particular. The relatively low cost of petroleum from 1990-2005 stimulated expansion of automobile-based transportation systems in both developed and developing countries despite the fact that discovery of new petroleum reserves fell increasingly behind the rate of petroleum use. Petroleum prices climbed steadily and by mid-2008 prices were more than four-fold greater than average prices in the late 1990s. High petroleum prices motivated governments worldwide to establish policies and incentives to expand energy production from renewable resources. Some countries promoted biofuel production from sugar or starch crops into ethanol, and oilseed crops

[2] World Development Report, 2008: Agriculture for Development. The World Bank, Washington DC.

into biodiesel. Incentives were especially strong in the USA where ethanol production capacity from maize grain increased three-fold, from 13 billion L/yr in 2004 to more than 40 billion L/yr by the end of 2008. Current ethanol production levels require about 30% of total USA maize output (equivalent to about 12% of global maize production). This rapid increase in maize demand led to a large increase in maize prices because use of maize for ethanol gave much greater profit than use for livestock feed or human food. As a result, maize production area expanded at the expense of USA soybean and rice area, which in turn caused large increases in the international price of these and other major grain and oilseed crops worldwide, including ICRISAT's mandate crops. Although petroleum prices have fallen markedly since their July 2008 peak, it is likely the USA will maintain favorable policies to support continued expansion of biofuel production capacity as per the current legislative mandate, and this will continue to exert pressure on the global food supply-demand balance, which in turn will maintain pressure on global prices of ICRISAT's mandate crops.

Because fertilizers require a substantial amount of energy in their production, the rise in energy prices also resulted in an increase in fertilizer prices. Transportation costs increased as well, which in turn affected the cost of fertilizer and other inputs available for use in the SAT. Governments that subsidized fertilizer carried a greater burden to maintain these subsidies. Under these circumstances, the affordability and timely distribution of fertilizer nutrients became a critical issue in parts of the SAT.

Food riots and protests against high food prices broke out in scores of developing countries. Some countries banned exports of staple food crops like rice and wheat. The long-term global trend in hunger reduction was reversed as the number of malnourished and hungry increased for the first time in decades, threatening the Millennium Develop Goals (MDG) of a substantial decrease in global hunger by the 2015. Although food prices have moderated in recent months due to a meltdown in international financial markets and a deceleration in economic growth rates worldwide, the tenuous balance between food supply and demand was exposed. Indeed, once global economic development gets back on track, food and energy demand will rise as well, which will once again pressure the global food system to ramp up production quickly.

These events have raised awareness among donors about the importance of ensuring adequate food production capacity in developing countries with adequate land and water resources to support it. The specter of climate change and the growing body of evidence that food production and poor farmers in developing countries are at greatest risk from climate change has also caught the attention of major donors. It is therefore likely that increased funding will become available for research institutions that have the capacity to address these issues. Because SAT agriculture depends heavily on a small number of crops that are adapted to the harsh SAT environment, ICRISAT is well placed to address these issues through its focus on pro-poor crops within its mandate, and on increased water productivity (yield per unit of available water) through genetic improvement and innovative crop and soil management practices.

1.2.2 Changes in the Funding Environment

The good news is that the recent food crisis highlighted the importance of agriculture as a critical engine of economic growth and poverty alleviation in developing countries, especially in the SAT where a large portion of the population relies on agriculture for its livelihood. Recognition of this seminal role has caught the attention of policymakers, academics, and donors in agricultural development. The greatest new sources of funding have come from the Government of India (GoI), Indian state governments, the private sector, and large non-profit foundations, such as the

Bill and Melinda Gates Foundation (BMGF), the Rockefeller foundation, and the Buffet Foundation. The World Bank also is increasing its support of agriculture-oriented projects. Sustained and rapid economic growth in China and India has allowed these countries to increase substantially the funding of their national agricultural research and systems (NARS). Of particular note for ICRISAT is the fact that the GOI has now become a major donor with allocation of USD5.8 million in 2008. In fact, the two largest donors to ICRISAT's 2008 budget are the BMGF and the GOI, which together provided more than 25% of the Center's total budget, almost all of it restricted to special projects.

The late 1990s and early 2000s were difficult times for CGIAR Centers like ICRISAT, IRRI, and CIMMYT. Funding levels decreased steadily as global food supplies were in surplus and commodity prices remained chronically low. Output from econometric models did not favor investment in agricultural development compared to investment in other sectors due to the low value of agriculture. Where food shortages occurred, they were easily overcome with donations from developed countries with surplus production more than willing to reduce their excess supply.

Given this situation, ICRISAT entered the current review period after having gone through a challenging period of retrenchment. Total funding decreased from about USD32 million in 1993 to USD23 million at the beginning of the current review period in 2003. Unrestricted core funding in 2003 represented 41**%** and has continued to fall: In 2007 only 32% of funding was unrestricted, which is similar to the 35% average core funding across the CGIAR Centers. Because other CGIAR Centers, advanced research institutions (ARIs), and NARS were in a similar situation, competition amongst these organizations for a decreasing pool of funding resources has intensified. Such competition sometimes led to lack of coordination and duplication of effort amongst CGIAR Centers[3]. Donors worried about the associated inefficiencies while NARS were concerned about the competition.

ICRISAT has responded to these funding challenges by achieving a large increase in special project funding. Total funding increased from USD24 million in 2003 to USD40 million in 2008. This increase has come about through better relations with the GOI and increased support from both traditional and new donors, such as the BMGF. Despite a steady decrease in unrestricted core funding, current plans call for further expansion of total funding resources based on projections for continued increases in special project funding. Clearly there has been a remarkable turnaround in financial resources available to the Center in the past five years.

1.2.3 Changes to the CGIAR System

At the Annual General Meeting 2008, CGIAR members approved in principle an Integrated Reform Proposal. Its key elements are: establishing a *CGIAR Consortium* as a legal entity to provide research results and a *Fund* from which funding is directed to "*mega-programs"* to be implemented by the *Consortium Centers* and their partners. The *Consortium* will be responsible for developing and periodically updating a *Strategy and Results Framework* to guide all research in the CGIAR. While Centers can pursue restricted project funding bilaterally (outside the *Fund*), these projects are subject to full cost recovery and *Consortium* review for their consistency with the results framework. Center accountability will be through "*performance agreements*" with the *Consortium Board* and *Consortium* accountability through "*performance contracts*" with the *Fund* (as

[3] CGIAR 2008. Bringing together the best of science and the best of development. Independent Review of the CGIAR System. Technical Report. http://www.cgiar.org/pdf/agm08/agm08_CGIAR-technical-report.pdf

far as *mega-programs* are concerned). This change will limit the freedom of donors to direct their funding within the system and significantly reduce the autonomy of individual Centers, changing the responsibilities of the Center Boards. It is also expected that the *Consortium Board* will implement, as a first order of business, some structural changes among the Centers that likely will involve mergers.

1.2.4 Changes in NARS and Private Sector

The NARS of India, China, and most of SE Asia have strengthened significantly with the exception of Myanmar. But even in India and China, research capacity and infrastructure in harsh SAT regions still lag the investments made in more favorable agricultural zones. SSA saw very little increased investment by NARS and there was political strife and uncertainty during much of the review period (Sudan, Ivory Coast, Chad, Zimbabwe, Kenya, etc). Investment by major foundations, such as the BMGF, Rockefeller Foundation, and the McKnight Foundation, has increased substantially, helping to increase the total amount of support.

Another recent positive change is the emergence of private sector investment in agriculture in parts of the Asian SAT. There are now several large seed companies and input supply dealers building infrastructure to market their products in India. While promising, investment thus far has focused on the most favorable production areas, not the harsh SAT environments within ICRISAT's mandate. Although some of these companies work on ICRISAT's mandate crops, e.g. sorghum, pearl millet, and pigeonpea, and use ICRISAT's genetic resources and technologies, they commercialize their products in more favorable production zones. A few employ state-of-the-art biotechnology to facilitate their crop improvement efforts and are looking ahead to expand their offerings to farmers in less favorable SAT areas. ICRISAT is partnering with some of these companies on upstream research and enterprise development. In contrast, private sector investment in SSA has been much slower than in Asia, and it has been negligible in rural areas located in the SSA-SAT.

1.2.5 Changes at ICRISAT

In the years immediately proceeding the current review period, ICRISAT faced a number of challenges regarding governance, financial support, and human resources. In addition, the Board membership underwent frequent changes as did senior management positions. Financial resources were decreasing, which resulted in staff separations and low morale. In the past five years there has been a remarkable turnaround in funding, and the stability of Board membership and senior management. ICRISAT today is a thriving research institution with a highly motivated staff, excellent facilities and infrastructure, and an exciting future. The panel commends the Board, management, and staff for achieving this turnaround, which provides the foundation for future success.

Despite this turnaround, ICRISAT was confronted by additional challenges during the current review period. Decreased funding for agricultural development in the USA, EU, and Japan has forced most of the major donors to focus on countries with greatest need. SSA is one of these regions, and thus donors have pushed the CGIAR in general, and ICRISAT in particular, towards a larger emphasis on SSA. Indeed, the most prominent recommendation from the 5th EPMR was to "*move ICRISAT's headquarters and all programs, except its strategic genetic resources program, from India to SSA*". In response, ICRISAT argued that it was cost-effective to keep strategic upstream research at its headquarters in India, but agreed to increase the proportional allocation of its budget to SSA and to enhance its research infrastructure and number of scientists at its regional

programs in ESA and WCA. From 2003 to 2007, the resources allocated to SSA have increased from about USD11 million to USD19 M, with WCA and ESA by 2007 in receipt of comparable levels of total support. As a percentage of the Center's budget investments in SSA have also increased to 60% of total funding (54% in 2003), In contrast, the total number of internationally-recruited (IRS) and regionally-recruited scientists (RRS) based in the two SSA regional programs fell slightly, from 37 (equivalent to 52% of total scientists in 2003) to 36 (equivalent to 43% of total scientists in 2008), while during this same period the total number of IRS and RRS at headquarters rose from 34 to 48. In part, the increase in headquarters staff results from a succession plan to ensure continuity in key projects led by a number of senior scientists who are soon to retire (see Section 6.3).

At issue is the reason for the discrepancy between funding allocation, which favors SSA, and scientific staff allocation, which favors Asia. Closer examination of budget allocations shows that this discrepancy is due to three cost categories that are higher in SSA: (i) staff salaries, (ii) "pass-through" funds on special projects in SSA (9% of total funding in SSA versus 3% in Asia), and (iii) travel costs. The bottom line is that the costs of research are higher in SSA than in Asia.

Of particular note during the past five years is the rapid economic development that has occurred in India and other Asian SAT countries. This growth provides the wherewithal for governments to make larger investments in its NARS. In fact, agricultural research capacity in India and some other Asian SAT countries has increased substantially. Despite this increase, there remain strong arguments for keeping ICRISAT's headquarters at Patancheru:

- there are more than 400 million people in extreme poverty in the Asian SAT;
- there remain tremendous biophysical, economic and social challenges to alleviating poverty and improving food security in the Asian SAT;
- the impoverished in the Asian SAT are some of the most vulnerable people in the world to climate change because of relatively high population density;
- there continues to be relatively small public-sector investment in the Asian SAT, relative to more favorable areas, and private sector investment by seed, input, and equipment companies also targets more favorable agricultural zones because SAT farmers tend to have less money to purchase such inputs;
- the ICRISAT headquarters research facility and farm land represent a unique assemblage of soils, including alfisols and black vertisols, allowing the conduct of both upstream crop improvement and natural resource management (NRM) research with substantial potential for "spillover" of international public goods (IPG) to other locations in the Asian and African SAT zones with desirable traits for yield, disease resistance, and end-use quality. Notable examples in the past five years include: peanut varieties released in 17 SSA countries; pearl millet varieties released in 4 SSA countries; sorghum varieties and hybrids in 13 SSA countries, and chickpea varieties in 4 SSA countries. In addition, screening methods for disease resistance developed at headquarters are used in the ESA and WCA programs, and simulation models were adapted and validated for ICRISAT's mandate crops under SAT conditions.

The fundamental question is whether ICRISAT can effectively and efficiently serve less developed SAT regions from its headquarters in India. Based on logistics, cost, and the capacity for spillover from upstream research, the EPMR panel agrees with ICRISAT and believes that headquarters should remain at Patancheru for the foreseeable future with the following provisos:

The Panel recommends that ICRISAT continue to enhance investments in personnel and infrastructure in the SSA and use the potential for spillover to SSA as one of the explicit criteria used in prioritization of strategic investments in research conducted at the Patancheru headquarters.

1.2.6 ICRISAT's Implementation of 5th EPMR Recommendations

The EPMR Panel concludes that ICRISAT has responded appropriately to the recommendations of the last EPR and EMR, especially with regard to enhancing programs in SSA while maintaining strategic research at the Patancheru headquarters and a strong regional program in Asia (for details see Chapters 4 and 6, and Annex 4).

2 STRATEGIC PLANNING AND PRIORITY SETTING

During the EPMR review period, ICRISAT has had to plan and act in the midst of a highly volatile and challenging environment—both as part of an Alliance of Centers that shares a common commitment to poverty alleviation and as an independent entity with a large and important mission that it must advance. Throughout this period, ICRISAT has been required to balance the pragmatic requirements of building adequate financial stability and total funding resources with the need for a coherent strategy that would carry it forward as these financial goals were achieved.

As the only international agricultural research organization with a focus on the SAT, ICRISAT has a large and challenging mandate. A large portion of the population in SAT countries falls below the poverty line (Table 1), and a majority of that population depends on agriculture for a significant part of its livelihood. Resource-poor SAT farmers must contend with chronic biophysical constraints to crop growth, such as drought, nutrient deficiencies, and lack of access to or affordability of inputs (including improved germplasm and fertilizers), as well as poor infrastructure and markets to enable sale of surplus production. These are all constraints that the Center must understand to achieve its mission.

In addition, the poor in the SAT face socioeconomic constraints that no center can address alone. These include, among others, good governance and policy making at national and local levels and the degree of national investment in the NARS.

Given the constraints that face poor farmers in the SAT, and the complex interactions among them, good strategic planning is critical if ICRISAT is to guide resource acquisition efforts and effectively prioritize the allocation of its resources to focus on those issues for which the Center has a comparative advantage. Moreover, organizational structure should follow function, which means that a clear strategy and cohesive work plan is fundamental to formulating the most appropriate framework within which to organize programs and projects.

The Center's most recent strategic plan, *ICRISAT Vision and Strategy to 2015*, was adopted in 2006. The past two years have brought substantial changes to ICRISAT, with the prospect of more to come. The recent adoption of a major change initiative within the CGIAR will recast the way Centers organize their work, seek support, and approach partnerships with CGIAR Centers and many other players. Large investments from private donors relatively new to the CGIAR Centers will demand the production of more concrete and measurable results and bring the potential for greater donor micro-management. With these developments in mind, the Panel has tried to evaluate whether ICRISAT's current plan and the Center's overall approach to planning and prioritization will position the Center to strengthen its effectiveness and build on its comparative advantages going forward.

2.1 ICRISAT's Mission and Strategic Plan

ICRISAT Vision and Strategy to 2015 defines with the Institute's mission as:
"To reduce poverty, enhance food and nutritional security, and protect the environment of the SAT by helping empower the poor through science with a human face."

The goal is:
"To mobilize cutting edge science and institutional innovations for poverty alleviation, food security, human development, and environmental protection for poor rural families in semi-arid farming systems of Asia and SSA."

The process used to develop the Center's strategy to 2015 appears to have engaged internal and external stakeholders in visioning exercises. The plan document also suggests that the strategy development process included analysis of: (i) external opportunities and constraints, (ii) internal strengths and weaknesses, and (iii) assessment of significant trends likely to shape ICRISAT's future. It relied heavily an analysis performed by Ryan and Spencer (2001)[4] that evaluates the relationship between poverty and agriculture in the SAT to help identify research outputs with the greatest potential impact. Additional consideration was given to more recent factors, such as the MDGs and the CGIAR System Priorities. Despite these efforts, the Panel had difficulty in finding clear evidence of a thorough analytical framework in the documentation provided to the EPMR Panel, and it is not clear whether the 2015 Vision and Strategy was a comprehensive planning effort or a repackaging of ICRISAT's earlier plan to 2010.

This strategic plan to 2015 attempts to align the Center's research programs and priorities with the CGIAR System Priorities adopted in 2005. The organizational structure around which the plan is developed includes a matrix of three regions and four global themes, and a strategy for knowledge management and sharing. The four global themes —Biotechnology (GT-BT), Crop Improvement (GT-CI), Agroecosystems (GT-AE), and Institutions, Markets, Policy and Impact (GT-IMPI)—are integrated across each of the three regions—Asia, WCA and ESA. The regional structure resulted from a recommendation in the 2003 EPR to decentralize ICRISAT's research and management into SSA. The four global themes reflect a consolidation of research programs between 2003 and 2005 based both on recommendations in the 2003 EPR and additional restructuring undertaken by the Center (see Chapter 4, Table 4.1).

ICRISAT plans and reports it research in its MTPs. The 2007-2009 MTP established a portfolio of 10 projects that were super-imposed on the existing GT and regional program matrix. MTPs after 2007 report ICRISAT's implementation of its strategic plan—goals, outputs, impacts and resource allocations—based on these 10 projects. The development of this 10-project framework, which should be a critical extension of the plan, appeared to be disconnected from the strategic planning process.

2.2 Integrated Germplasm and Natural Resource Management: Value as an Overarching Strategy

ICRISAT's success in achieving its goal "to mobilize cutting edge science and institutional innovations for poverty alleviation" depends on widespread adoption of its research products at the farm level. It is impossible, however, for ICRISAT to plug every hole in the research-to-development continuum and, as a consequence, the Center must rely on partnerships to assure a meaningful level of success. The degree to which ICRISAT should get involved with "last mile" technology adoption is a critical strategic issue identified consistently in survey responses from the institute's donors, stakeholders, and partners. In fact, there was a wide range of viewpoints about the appropriate balance between development versus science. For example, major donors and private sector partners tended to emphasize the importance of strategic research, while some,

[4] Ryan J. and D. Spencer. 2001. Future challenges and opportunities for agricultural research in the semi-arid tropics. ICRISAT.

but not all, of the NARS and NGOs felt that a greater emphasis on farm- and community level impact was justified. Opinions on ICRISAT's place on this continuum also reflected the differing circumstances and partners in each of ICRISAT's regions--not surprising given the intent in decentralizing ICRISAT to be responsive to these differences in shaping regional priorities and strategies.

In recognition of the challenge inherent in this balancing act, ICRISAT bases its overall strategy on a research approach that:
"….. *adopts integrated germplasm and natural resource management (IGNRM) as its overarching strategy to attain scientific excellence in agriculture in the SAT, focusing on key livelihood and income opportunities to improve the well-being of the poor with equity, multidisciplinarity, sustainability, and community participation as core values."*

The Panel was not convinced of the value of the IGNRM paradigm as a framework for research at the Center. The addition of the "G" to INRM may have value in an intra-Center context in that it potentially strengthens and aligns work across global themes, but it is a highly imprecise concept for use beyond that. The "G" adds little to the concept of INRM, which encompasses biophysical (including crop and soil management, *and* germplasm), as well as cultural, social and economic issues, and, therefore, does not appear to present a construct that is useful outside the Center itself. Integration of the kind intended is most evident and inevitable in the decentralized African regional offices where activities are closely tied to very specific operating environments that demand and reward integrated strategies. The IGNRM framework appeared less evident and of noticeably less value at the "global" headquarters where the themes are more independent drivers of overall activity.

Of particular importance is the degree to which the IGNRM framework helps resolve the balancing act with regard to the research-development continuum. Ultimately this balance depends on the Center's judgment about:

- the type of research that can lead to impacts of greatest magnitude relative to its mission;
- of these high impact opportunities, those research areas in which it has a comparative advantage vis-à-vis other institutions, organizations, and the private sector;
- the research and outreach capabilities of potential partners in each country and region.

Given these strategic issues, the IGNMR framework seems too open-ended and general and may actually hinder prioritization. In contrast, the Center's unique competence to conduct research on pro-poor SAT crops and on improving crop water productivity (i.e. yield per unit of available water) in the face of erratic and insufficient water supply, which are the primary constraints to increased food security, are not as prominently featured in the strategy. Indeed, the EPMR Panel believes that ICRISAT's core competencies in these two areas should be given greater visibility in its current strategy and in future strategic planning.

2.3 Priority Setting

Maintaining relevance and achieving impact from ICRISAT's programs requires conscientious and consistent efforts to prioritize research and to guide resource allocation and resource acquisition.

Effective research prioritization relies on a process that considers:

1. A conceptual framework to help identify the most important constraints, that if solved, would have the greatest potential impact with regard to ICRISAT's mission and mandate;
2. Cost, timeframe, and probability of success in developing international public goods (IPGs) research that alleviate the identified constraints;
3. ICRISAT's comparative advantages to address these constraints in relation to other potential research and development institutions, NARS, NGOs, and the private sector;
4. Regional priorities, stakeholder needs and the strengths of key partners, and active involvement of partners and stakeholders in the priority setting process;
5. Donor interest and willingness to provide support for a given program area or project.

In the 1990s and early 2000s, ICRISAT was widely recognized for its work in research prioritization using a quantitative econometric framework with explicit criteria to evaluate the potential impact from investment in different types of research to improve crop yields and farmer incomes. At one time, ICRISAT led the CGIAR Centers in developing such tools, and the research was published in peer reviewed journals. Given this strong foundation, the EPMR team was surprised at the relative lack of clarity and details about the methods used for research prioritization to develop the Center's strategic plans during the past five years. In particular, in the presentations and documentation provided to the Panel, there was a notable lack of discussion about:

- trends in the yields, production area, and total production of ICRISAT's mandate crops, and the reasons for those trends;
- expected trends in future demand for these mandate crops;
- trends in the natural resource base, especially with regard to soil quality and fertility and climate;
- trends in NARS research capacity and in the capacity of the private sector to provide germplasm, inputs, and information;
- use of geospatial analysis, simulation models, and remote sensing data to evaluate potential impact of improved germplasm, improved natural resource management, or both, across the SAT in Asia and SSA;
- the criteria and methods used for research prioritization and allocation of resources.

As the Panel evaluated ICRISAT's research, it found it difficult to identify a consistent rationale for priority setting. There is no doubt that an organization that relies on substantial short-term restricted funding to accomplish long-term basic research will struggle to maintain its control over the shape and content of projects, the adequacy of funding, and the time needed to achieve results. This is particularly true of a center in the process of an aggressive turnaround. The Panel is not insensitive to the challenge embodied in this situation. Nevertheless, while prioritization exercises were evidently conducted, it was difficult to see the options discarded versus the options accepted and the rationale for those decisions. Without a more rigorous and transparent prioritization process, there is danger that projects become a response to short-term opportunities

in the marketplace or a trend of the moment such that the Center's portfolio loses focus on its core mission.

In contrast, trends in yield and production area of several mandate crops indicate significant trends that should be understood in order to formulate an effective research program. Whereas sorghum area in India decreased by 22% and sorghum yields were essentially unchanged from 1996-2006, both yield and area increased by 18% in WCA, which combined to give a 39% increase in total sorghum production (Table 2.1). Did the reduction in sorghum area in India result from displacement of sorghum in the moist SAT by higher value crops such that average yields remained stagnant or fell slightly because a larger proportion of the remaining sorghum was produced in the drier SAT with lower and more variable yield potential? If so, did this trend mask the positive impact of ICRISAT's work on sorghum drought and disease resistances and watershed management to improve water productivity? What was the reason for both the expansion of sorghum area in WCA and also the large increase in average yields? It seems that WCA has achieved a significant increase in sorghum yields and total production that deserves recognition and possible replication elsewhere. Did the increase in sorghum production contribute to a reduction in poverty and greater food security? Is there anything in the WCA sorghum story that could be replicated in ESA where increases in sorghum yield and production area has been much slower? Perhaps these data for SSA crop production are not reliable, and if so, it seems a concerted effort is needed to obtain a reliable source of data for crop production trends in SSA. The Panel notes other trends in area and yield of the mandate crops that deserve attention as input to priority setting.

Table 2.1 Trends in area, yield, and total production of ICRISAT's mandate crops in selected regions of the SAT based on 3-year averages, 1995-97 vs 2005-07

Crop	Region/country	Area (M ha)		Yield (kg/ha)		Production (MMt)	
		1995-97	2005-07	1995-97	2005-07	1995-97	2005-07
Sorghum	India	11.2	8.7	827	850	9.3	7.4
	ESA	4.0	4.6	1,022	1,083	4.1	5.0
	WCA	12.7	15.0	870	1,028	11.1	15.4
Pearl millet[1]	India (from CMIE)[2]	9.9	9.1	687	879	6.8	8.0
	WCA	14.9	17.2	693	858	10.3	14.7
Groundnut	Asia	13.0	13.0	1,588	1,844	20.6	24.0
	Africa	8.2	9.0	819	978	6.7	8.8
Chickpea	Asia	10.2	9.9	747	783	7.6	7.7
	EA	0.3	0.4	609	766	0.2	0.3
Pigeonpea	Asia	3.7	4.1	691	750	2.5	3.1
	ESA[3]	0.4	0.5	602	678	0.2	0.3

Source: FAOSTAT data accessed on 2nd February, 2009

ESA= Sum of data for Eastern Africa+ Southern Africa+

WCA=Sum of data for Middle Africa+ and Western Africa+

[1] Pearl millet data sources: all millet data for WCA from FAOSTAT and pearl millet data for India from CMIE 1990-91 to 2005-06

[2] Time periods for calculating the average of pearl millet data for India are 1994-96 and 2004-06

[3] Pigeonpea data for Eastern African counties only, no data available for Southern African countries

The Panel notes that the Center placed greater emphasis on mandate crop trend analysis in the 1990s, and that these efforts were curtailed as funding levels declined. It is also noteworthy that there are plans to renew forward-looking analysis of crop production trends and prices. We

commend these intentions and believe they are crucial as input to effective research prioritization.

ICRISAT's strategic planning would be greatly enhanced with a more thorough analysis and understanding of mandate crop production trends, use of geospatial and simulation scenario analysis, and an econometric analysis framework with explicit prioritization criteria to quantify the magnitude and extent of impact on food security and poverty alleviation consistent with the Center's mission and goals. Drawing from its own impact assessment and adoption studies, the Center should seek to better understand the factors responsible for these trends and the degree to which ICRISAT's research products contributed to them. Understanding the distribution of benefits among different regions and different segments of the population is also critical for prioritization, including benefits to urban and rural poor, women and children, and minority ethnic groups.

2.4 Approach to Planning

The EPMR Panel anticipates that ICRISAT may need to undertake either a significant revision to its current plan or a new strategic planning process in response to the EPMR and the CGIAR change initiative. In light of this, the Panel considered whether ICRISAT was prepared to engage in a more meaningful planning process than was evident during the period under review.

The process by which the current 10-project portfolio in the MTP was developed does not serve as a good model. With the adoption of the 2015 Vision and Strategy in 2006, ICRISAT chose to organize its 2006-2008 MTP around three regional mega projects rather than by its global themes. The Science Council's commentary about this change noted that it contributed to "…a loss of focus and identity of research…," compounded by the lack of budget detail below the mega-project level. Its recommendation was to develop "theme-oriented MTP projects with budgets…on the order of USD2-3M, each containing 1-5 Outputs." In response, beginning with the 2007-2009 MTP, ICRISAT's strategic framework includes a sub-structure of 10 projects that dis-assemble and re-assemble the Center's research activities for the purpose of planning, monitoring and evaluating results.

The Panel considers the Science Council's concerns to be reasonable. ICRISAT's response, to create an unwieldy, opaque project portfolio, has been the subject of considerable debate within the EPMR Panel, not least because ICRISAT characterizes the resulting structure as a burden imposed on them. But the burden seems somewhat self-inflicted, and the Panel questions why ICRISAT didn't respond to the SC's concerns by devising a structure that was responsive but maintained the Center's intentions with respect to their strategic plan.

As it now stands, ICRISAT has organized its management and research structure so that research operations are managed and executed through the matrix (global themes and regions), but research is planned and reported through the 10 projects. The Panel believes that this structure becomes an impediment to good strategic planning. The Panel is also concerned about the attitude of staff about the structure, which gives Project leaders responsibility without authority because budgeting and evaluation flow through the global theme-regional program matrix. Therefore, the new project structure has required a substantial investment of time and effort with little, if any, reward.

To explicate its plan (or to signal adjustments to it), ICRISAT produced a number of strategy documents, called Operational Research Strategies. Rather than provide increased clarity about ICRISAT's strategy, no single document was clear enough or persuasive enough to provide crisp, coherent insight into the planning and priority-setting processes. In many ways these documents reinforce the notion that the Center needs to undertake a fundamental rethinking of its research portfolio and priorities rather than re-group and rename existing activities. The documents reviewed by the Panel included:

- ICRISAT Vision and Strategy to 2015
- ICRISAT Regional Strategy for Asia
- ICRISAT Regional Strategy for WCA
- ICRISAT Regional Strategy for ESA
- Operational Research Strategy-BioPower
- Operational Research Strategy-Climate change
- Operational Research Strategy-Health and Nutrition
- Operational Research Strategy-High Value Crops
- Operational Research Strategy-Land degradation
- Operational Research Strategy-Water Scarcity

The primary motivation for strategic planning and priority setting at ICRISAT during the past five years appears to have been largely driven by external reporting requirements and the need to increase resources as quickly as possible. As a result, the Center has missed an opportunity to use the strategic planning process as a learning experience to understand its past successes and failures, to engage staff and the Board in analyzing emerging challenges and opportunities, and to reach consensus on future goals and objectives. Rather than a mechanistic response to external demands for strategic plans, ICRISAT should commit to a more proactive and comprehensive research prioritization process that engages staff and Board, along with a wide cross section of stakeholders, partners, and donors.

Given the complexity of constraints to improved crop productivity and alleviation of poverty in the SAT of Asia and SSA, an increasing number of potential partners, greater competition among institutions to supply the needed research, and the impending change in CGIAR System management that will require greater collaboration among Centers on a number of "mega-programs," it is imperative that ICRISAT improve its planning and research prioritization processes.

The Panel recommends that ICRISAT take ownership of and celebrate the strategic planning and research prioritization process based on: (i) proactive engagement of staff, Board, stakeholders, partners, and donors; (ii) analysis and understanding of recent crop yield and production trends, and projected growth in production and demand for its mandate crops, (iii) scenario analyses that utilizes geospatial analysis, ecosystem and crop modeling, and an appropriate socioeconomic framework.

The EPMR Panel also endorses the CCER on governance and support services recommendation for ICRISAT to create a strategic business plan. This level of planning becomes increasingly important to long-term financial planning and effective resource allocation.

Despite criticisms of the current plan and related documents, the EPMR team believes that ICRISAT's current programs and projects are relatively well targeted and that the outputs from them are both exciting and substantial. Excellent work is unnecessarily obscured by inadequate

expressions of it in the Center's core long-term and medium-term planning documents. In particular, we commend the Center for considering gender issues and the role of women in agriculture in setting research priorities *at the project level*. For example, the work of Dr. Sreedevi has ensured that women and other vulnerable groups are appropriately represented and empowered (via collective action) in designing interventions within ICRISAT's watershed management research. The proactive engagement of women in WCA and ESA projects on bioreclamation of degraded soils, participatory evaluation of groundnut and sorghum varieties, and post-harvest grain handling to reduce the risk of aflatoxin are other examples. But gender issues need to be elevated to Center-wide prominence in strategic planning efforts as one of the explicit criteria used in a more concerted research prioritization process.

Ultimately ICRISAT's future success depends on a strong strategic planning process that will require increased capabilities in research prioritization. The Center must determine which special projects are consistent with its core strategy to avoid diversions and distractions, identify the most appropriate partners for collaboration, and which private sector companies can best contribute to its mission. Although funding availability has increased markedly in the past two years, the global financial meltdown and past experience tells us that funding for agricultural research and development may not always be so favorable. In such an uncertain environment, a strong strategic plan and well developed research priorities based on core competencies provide the only effective roadmap to navigate through both good times and bad because the need for ICRISAT's research outputs is unwavering.

3 SCIENCE QUALITY AND IMPACT

Evaluation of the quality and impact of ICRISAT's staff and programs is a critical component of this EPMR. The Panel based its assessment on a number of indicators used to assess scientific quality and on direct interaction with staff—all of whom impressed the Panel as competent, up-to-date with current issues, and enthusiastic about their work.

3.1 Staff Science Quality

3.1.1 Metrics for Assessing Staff Quality

Staff quality was assessed on the basis of information provided in staff CVs.[5] The Panel looked at publishing rates in different venues, mentoring of graduate students, membership on editorial boards of journals, and manuscript reviewing. These metrics provide an indication of scientific productivity, recognition by peers, and degree of engagement with students, who are tomorrow's SAT research leaders. We found it more difficult to assess individual staff outputs of germplasm (which is not released directly by ICRISAT, but rather through national programs), or outputs embodied in software and computer models. For germplasm, IPGs are reported as germplasm releases by the GT-CI program and by projects rather than as an output attributable to an individual IRS or RRS. The Panel believes this is reasonable because germplasm development is a long-term team effort. Overall, based on aggregate data on germplasm releases for each mandate crop, the Panel believes that ICRISAT breeders have a commendable record of productivity indicative of a high quality crop improvement program (see section 4.3).

A more detailed evaluation of staff science quality focused on a twenty-five member subgroup of staff who had significant interactions with the Panel in Asia, WCA and ESA. They are clearly a leadership group within the Center, and are among the most active of ICRISATs research scientists. In addition, they represent a reasonable mix of themes and geography. With one exception, theme leaders, regional program directors and the DDG Research were excluded from this subgroup because management duties is likely to place a significant constraint on their research productivity. Part of the evaluation focused on staff publication records and associated indicators of science impact (awards, editorial appointments, activity as referees, keynote addresses). For publications, the most stringent indicator of quality was *publications in SCI journals and degree of citation.*

3.1.2 Analysis of Staff Science Quality

Based upon *all* ICRISAT IRS and RRS curriculum vitae, research staff published more than two refereed journal articles, and more than one other type of peer reviewed publications per year (Table 3.1). Although a majority of IRS/RRS staff publish one or more papers per year, there appears to be 30-40% who don't. Nearly all IRS were active in supervising graduate students and about 50% of RRS were similarly engaged. A significant number of IRS serve on journal editorial boards and review papers for scientific journals. Other staff (postdocs etc) also make significant contributions, although as expected, less than senior staff.

[5] CVs were collected from research staff as at the end of 2008 and cover a period of five years, irrespective of employer.

Table 3.1 Annual publication numbers for ICRISAT staff based upon curriculum vitae from 2003-2007

Staff category	Number of staff	Publishing rate annually in peer- reviewed journals	% staff that publish 1+ annually in peer-reviewed journals	% staff supervising students	% staff in journal editorial boards	% staff that review for journals
IRS	35	2.9	58	91	39	54
RRS	49	1.8	70	47	13	46
IRS+RRS	***84***	***2.3***	***65***	***65***	***24***	***48***
Other[a]	39	0.8	39	27	0	17

[a] "Other" category includes Post doctoral fellows, Visiting scientists, Associate scientists

The subgroup of 25 staff published approximately 150 papers in SCI journals in the period under consideration, or 1.2 papers/yr. This was about one-half the total number of journal articles published by all ICRISAT scientists. By eliminating the two most prolific authors in this group (who produced 19 and 31 papers, respectively), the mean dropped to 0.9 papers/yr. These numbers closely approximate average CGIAR performance. The Panel's evaluation suggests scope for improvement. First, while the average rate of publication in the higher quality international journals was competitive with other Centers,[6] a considerable number of staff were below the one SCI paper/yr level. Second, under the label "peer reviewed journal" the publication rate in high quality international journals tends to be obscured. Third, only three members of the group were on the editorial boards of high quality international journals. On a positive note, over half had been asked to referee manuscripts for competitive international journals, and a similar number had received awards and had given keynote addresses during the review period – all these are signs of international recognition.

Bantilan et al. (2006)[7] explored the question of the relative "value" of a paper published in an indexed journal versus one in a regional journal, arguing that the latter, with a lower subscription cost, is more accessible to the regional NARS. This argument is incomplete if it diminishes paper quality due to lower standards for acceptance. On balance, it seems that identifying more effective methods for increasing accessibility of key findings to NARS would be a better solution. Some stakeholders who responded to the 2008 EPMR Stakeholder survey felt that relevance and ease of access to ICRISAT papers is greater for papers published in international journals than articles in ICRISAT´s own publication series. Stakeholders did, however, rank ICRISAT's quality of research as good to excellent. Finally, the current assessment regarding high quality journals has many points in common with the assessment of the 5th EPR (p.22 of their report) on the topic of publication quality.

At issue is whether this level of publication and publication quality meet, exceed, or fall below expectations for scientists at an international research organization. It is clearly below the target of two SCI journal papers per year mentioned in ICRISAT's response to the Management CCER. The Panel believes that an average of two SCI publications per year may be too rigid, given the

[6] Staff quality in other EPMR reports.

[7] Bantilan, MCS, Chandra, S., Keatinge, D., Pradeep, M. 2006. Research quality at ICRISAT: Separating the grain from the chaff. SAT eJournal 2:1-15.

other responsibilities of ICRISAT staff, such as research management, writing and managing grants, interacting with NARS and stakeholders, and producing other types of IPGs such as germplasm, models and databases. A minimum individual target around one per year may be more reasonable. Yet it appears that many ICRISAT scientists fall below this lower benchmark. This may or may not be of concern, depending upon other outputs expected of individual scientists, but it begins to be a concern if the aggregate quality and scientific productivity of the Center falls below levels expected of a major international center.

More fundamental than the publication numbers *per se* in ensuring a high quality scientific staff is the setting of realistic expectations of individual staff achievements in publication and other creative outputs. These must be consistently communicated during the annual review process. The Panel was told that ICRISAT does not currently have a Center-wide set of expectations for scientific outputs and their quality, or a consistent process of staff evaluation in this regard across the GT x regional program matrix. Therefore, the Panel strongly urges that a framework be imposed to ensure that staff are clear about expectations for both quantity and quality of publications so they can make plans to meet them. This framework should include strategic planning at the project and program levels to identify and encourage publication of scientific outputs in high quality, high impact journals.

3.2 ICRISAT Research Outputs

Data submitted by ICRISAT to the CGIAR Performance Management database, combined with ICRISAT's internal records for 2003/2004, shows that publication output has been rising significantly (absolutely and even proportionately with respect to staff numbers) during the review period (Table 3.2).

Table 3.2 ICRISAT publication output, 2003-2007

	2003	2004	2005	2006	2007
Journal articles in SCI	NA	NA	83	77	116
Journal articles total	86	83	139	179	207
% of SCI-index articles			59	43	56
Peer reviewed books and book chapters	82	93	84	76	79
Scientific staff numbers	89	101	107	118	121

Source: 2005-2007 data from ICRISAT's submission to CGIAR Performance Measurement database; 2003/2004 from ICRISAT records

This applies to non-SCI journals, in particular. There is no obvious trend in the proportion of SCI articles. Books and book chapters have held steady in absolute terms but have fallen as a proportion of journal articles. The Panel believes the increase in the ratio of refereed journal articles to book chapters is a positive trend. Comparison of ICRISAT publication output with other CGIAR Centers suggests that ICRISAT is doing reasonably well.[8]

At the Panel's request, ICRISAT conducted a citation search (through Google Scholar) of their publications over the 2003-2007 period. These data were analyzed by the Panel and results are presented in Table 3.3. In general, citation information is more readily available for SCI articles. For example, in a contemporary study of CGIAR social science publications, citation information

[8] CGIAR Performance Measurement results

was available for 90 per cent of ICRISAT's SCI articles. Citation information for non-SCI articles is much less, so only 53 ICRISAT articles in this category could be evaluated.

Table 3.3 Citation analysis of ICRISAT publications, 2003-2007

Publication outlet	# of publications reached by citation search	% of publications with ≥ 1 citation	% of publications with >3 citations
SCI articles	272	71	34
Other journal articles	53	42	8
Book/Book chapters	43	51	9
Other[1]	177	44	7

[1] Miscellaneous documents, including internal ICRISAT circulars, reports and brochures

ICRISAT SCI articles are cited at a rate much higher than non-SCI articles (Table 3.3). Indeed, only 42% of the non SCI-journals received *any* citations over the whole 5-year period. The majority received no citations. In contrast, 71% of SCI journals were cited at least once. The comparison of SCI and non-SCI articles is telling because citation indicates quality in that ICRISAT's research is being read by other scientists and utilized in some way in their research. The most heavily cited articles tended to be in biotechnology and genetics although there were one or two from the social sciences and NRM among the top 10 most cited ICRISAT papers - see Appendix for most heavily cited articles. A total of 1756 publications were included in this Google Scholar search, and only 545 (31%) could be reached. But that did include a high proportion of the publications in the Center's own e-journals and newsletters, regional journals and conference proceedings. These had a low citation level.

There were some examples where articles of a relatively applied nature were submitted to journals totally outside the agricultural science mainstream. This obviously reduces the visibility of a paper because it does not reach the most appropriate audience.

Several ICRISAT's papers are clearly first-class and cutting edge (e.g., papers on the core and mini-core collections for mandate crops[9], on transformation protocols[10], on markers for disease/parasite tolerance[11], on stratification of multi-environment trial sites[12] on crop modeling as an aid to management decisions under climatic variability[13], on social capital build up[14]. Others have the potential to become breakthroughs on the world scene, but have been split up

[9] Upadhyaya, HD, Dwivedi, SL, Gowda, CLL, Sube, S. 2007. Identification of diverse germplasm lines for agronomic traits in a chickpea (Cicer arietinum L.) core collection for use in crop improvement. Field Crops Res. 100:320-326.

[10] Kumar et al. 2004. Agrobacterium tumefaciens-mediated genetic transformation of pigeon pea (Cajanus cajan (L.) Millsp.).J.Pl.Biotechnol. 6:69-75)

[11] Haussmann, BIG, Hess, DE, Omanya, GO, Folkertsma,RT, Reddy,BVS, Kayentao,M, Welz, HG, Geiger, HH.2004. Genomic regions influencing resistance to the parasitic weed Striga hermonthica in two recombinant inbred populations of sorghum. Theor. Appl. Gen. 109:1005-1016.

[12] Mgonja, MA, Chandra, S, Obilana, AB, Monyo, ES, Kudita, S, Chisi, M, H.M. Saadan, HM, Chinhema, E. 2008. Stratification of sorghum hybrid testing sites in southern Africa based on grain yield. Field Crop Res. 108:193-197.

[13] Cooper, PJM, Dimes, J., Rao, KPC, Shapiro, B., Shiferaw,B., Twomlow, S. 2008. Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change?. Agric.Ecosyst. Env. 126:24-35

[14] Bantilan, MCS, Padmaja, R. 2008. Empowerment through social capital build-up: Gender dimensions through technology uptake. Exptl. Agric. 44: 61-80.

and published in pieces, with some of those sections being targeted to inappropriate journals. For example, the value of potentially important research on drought tolerance in groundnut is diminished because its physiological component work was fragmented into three or more publications in different journals, only one of which had high visibility. The Panel believes this splitting has severely reduced the scientific impact of this potentially breakthrough work.

The GT-CI supplied a substantial amount of germplasm and breeding materials of the five mandate crops and the small millets to NARS across the world (Document: Exchange of germplasm and breeding materials 2003-07), with 58% of breeding materials going to Asia and 34% to Africa. During the review period, NARs released 85 varieties based on ICRISAT germplasm/breeding material. This is an impressive output that is detailed in section 4.3. Other quality outputs are also listed in the relevant sections of Chapter 4.

Blue sky research

The issue of the appropriate role of "blue sky research" is complex because ICRISAT is an applied research institution. ICRISAT classifies VASAT (see section 4.6) as blue sky research. The Panel disagrees. From the Panel's perspective blue sky research is high risk but high potential impact, focused in areas that represent the frontiers of current knowledge. Some of the Center's work on examining the value of transgenes as sources of drought tolerance in groundnut seems to fit the high risk/high potential impact (for generation of new knowledge) much more closely than VASAT, as does the inter-specific crosses being made with wild relatives of domesticated peanut to introduce new sources of disease and insect resistance, and additional genetic diversity. New topics the Panel considers as candidates for blue sky research include efforts to understand the physiological responses of grain-number/size/quality to episodes of high temperature stress in the mandate crops because climate change is expected to result in more frequent episodes of high temperatures.

3.3 Internal Mechanisms of Quality Assurance

3.3.1 CCERs

One purpose of the CCERs is to be a tool for the Board by which it can exercise oversight of research quality among other things. During the period of this review ICRISAT conducted three CCERs relevant for assessment of the Center's research components: GT-IMPI and KMS (including VASAT), GT-CI and GT-BT, and GT-AE. The TORs of the CCERs were consistent and clear about the two main purposes: a) to facilitate Board oversight and decision making in strategic issues; and b) to provide essential inputs to EPMR. This latter purpose likely influenced the timing of the CCERs that was relatively close to the EPMR. Among the tasks listed in the TORs, assessment of the relevance and quality of science was explicitly mentioned, but the task was described in terms of priority setting, relevance for CGIAR priorities and development goals, and impact, rather than quality *per se*. All CCERs concluded that quality was generally high, but the lack of in-depth analysis left the Panel in a difficult position.

In the CCER on GT-AE, discussion of scientific quality was largely absent although some of the recommendations were related to quality. The GT leaders' role in scientific leadership and quality oversight was recommended to be strengthened and more routine use of monitoring & evaluation to be emphasized. The CCER on GT-CI and GT-BT included assessment of quality on the basis of two criteria: publication quantity and nationally and internationally recognition as shown by awards. The CCER also considered that outcomes and impacts such as: (i) steady flow of breeding lines and other materials; (ii) area covered with improved varieties; (iii) reduction in

cost of production and environmental safety due to resistance developed; and (iv) number of NARS scientists and farmers trained, were indications of high research quality. The CCER on GT-IMPI and KMS did not contain any explicit analysis of quality, but there was reference to the number of studies ending up in refereed journals. This CCER made a few recommendations that relate to quality; for example, to strengthen the quality of research on scaling up processes (echoed in this Panel's assessment). Attention was also given to handling of social science data and adding experimental components to data collection so as to expand its utility for different kinds of analysis, such as impact assessment.

3.3.2 Staff Evaluation

Performance appraisal of staff is one of the main mechanisms for monitoring and rewarding scientific quality and productivity. ICRISAT research staff assessment is based on a previously established Work plan with a listing of objectives or activities and Training and Development plan. The reporting includes outputs/milestones achieved on the agreed objectives, list of publications and list of training attended. There is no explicit request to identify the different types of publications (e.g. SCI journal articles, vs. non-peer reviewed publications), and we believe that journal quality should be discussed in planning future publication efforts.

3.3.3 Internal Publication Review

All manuscripts intended for publication are first sent to the GT leader, who sends the paper for peer review, as an initial step. Internal reviewers are used where possible; otherwise external reviewers are used. Review comments are taken into account by authors and could result in decision by the GT leader to withhold submission. The Panel wonders whether the more experienced people have sufficient time available to fully engage with this process? A more important function for internal review may be to implement strategies to identify high visibility research outputs and to work as a team to publish them. The Panel questions the value of a routine internal review process because the most competent to perform the reviews are typically those who do not have time to do so. Other mechanisms to improve quality include mentoring and "mini-sabbatics" of 1-3 months during which time a scientist can focus entirely on publishing.

3.3.4 Records and Data

The Panel was concerned by the quality of record keeping at the Center in relation to science quality. Current processes do not appear to be working very well. There were multiple sources of data regarding publications, for example. The Center's submission to the CGIAR's Performance Measurement database was considered the most reliable. The data collected from other ICRISAT sources (as disaggregated by Global Themes or summarized for citation analysis) differed significantly from the Performance Management data set. (Similar observations were made with respect to training data, see Chapter 5). There appears to be a need for standardized record collection at institutional level, establishing explicit criteria and definitions, and the design of data storage for effective retrieval for multiple purposes (such as internal monitoring, CGIAR System's requests, and external reviews).

The Panel did not look in detail at the collection, storage and use of research data. The CCER on GT-IMPI and KMS made recommendation regarding social science data with which the Panel concurs. Other main data sets, such as genetic resources data seem well handled and accessible. The Laboratory Information Management System developed by ICRISAT was considered to be of

high quality by the CCER on GT-CI and GT-BT and has been adopted by other users thus generating an important outcome.

3.4 Impact Assessment Processes and Culture

In the annual CGIAR Performance Measurement System (PMS), ICRISAT's scores for Impact Culture were ranked 'above average' among CGIAR Centers, based upon publications, workshops, and systematic impact evaluations undertaken. The current Panel judges the methodology and coverage of impact assessment of agricultural research, as conducted by ICRISAT, to be sound. An impact assessment culture has been evident at ICRISAT for many years and that culture remains strong at various levels within ICRISAT. It is continually featured in Center presentations and in discussions with center scientists. The many impact assessments that were conducted have been made publicly-available through various outlets (primarily in printed format), and methodologies have been clearly and transparently described. More recently, there has been a trend to encourage each GT to incorporate impact delivery pathways into research proposals and to undertake impact assessments of their own activities with guidance and advice from staff in GT-IMPI.

During the review period, the major IPG outputs in relation to impact assessment have been:

- development and refinement of methodologies to capture the economic dimensions of research prioritization and impact assessment; this has included capturing a poverty alleviation dimension to evaluation of technology evaluation and the production of a framework for assessing the impact of natural resource management research[15]
- definition of the increased role of livestock in the SAT, leading to the incorporation of livestock into the ICRISAT work program[16]
- documentation of the necessity for community engagement in watershed management and corresponding practical interventions[17]

One current and novel initiative between ICRISAT and ACIAR relates to impact assessment of human capacity building in agricultural research.[18] Two ICRISAT scientists chosen for case study analysis were, in 2006, involved with global research on short-duration pigeon peas. Subsequently, two more ICRISAT scientists were chosen in 2007 with respect to human capacity building on sorghum research involving genetic transformation, crop modeling and experimental protocols. This attempt towards a more formalized and economically-oriented evaluation of scientific capacity- building is a path breaking endeavor.

A greater investment in impact assessment and documentation of client adoption of research outputs is required, in some areas. This is particularly so in topics for which impacts are harder to gauge or are variable, such as micro-dosing, hybrid seed technology adoption, African Market Garden, soil and water management.

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[15] Shiferaw B, Freeman HA and Swinton SM (eds) 2005. Natural resource management in agriculture: Methods for assessing economic and environmental impacts. Wallingford, UK: CAB International. 386 pp

[16] Parthasarathy Rao P, Birthal PS and Ndjeunga J. 2005. Crop–Livestock Economies in the Semi-Arid Tropics: Facts, Trends and Outlook. ICRISAT 68 pp

[17] ICRISAT 2005. ICRISAT in Asia: Archival Report 2005.

[18] Longmore, C, Gordon, J and C Bantilan (2007) Assessment of capacity building: overcoming production constraints in rabi sorghum in India and Australia. ACIAR Impact Assessment Series 48, 13 pp.

There has been significant assessment of ICRISAT's inter-regional research spillovers.[19] However, no recent overall summary of the ICRISAT studies is available to provide an indication of the total economic benefits in the SAT that result from ICRISAT research. A meta-analysis of ICRISAT's past quantitative work on impact assessment should be undertaken to estimate the overall economic benefits from ICRISAT research, with the goal of providing information for research prioritization.

Impact assessment processes should, where possible, explicitly recognize the complementarities with IPGs, via their interaction with research prioritization and research planning. This theme of linking downstream, applied research work with IPGs also features in section 4.2.5. A particular point made here is that *the tools of impact assessment can play a major role in achieving this* - by identifying key agroecological, and other, constraints to uptake and by uncovering and facilitating mechanisms for technology transfer. The outputs from such work can be legitimate IPGs themselves, and, would provide a stronger intellectual base for ICRISAT's downstream, applied work, which would help counter criticisms that downstream work is of local benefit only and therefore should not be done by a CGIAR Center like ICRISAT. Greater effectiveness in downstream work done may also result.

A key aspect of the whole impact assessment and spillover context at ICRISAT is the Asia/Africa nexus. The debate about the relative emphasis to be placed by ICRISAT on the two continents has featured strongly in previous reviews. Yet sufficient information and analytical framework on a core parameter, namely, the likely research spillovers from Asia to Africa (or vice versa) for various types of potential research endeavors seems to be lacking. A thorough analysis of the likely spillovers between these two regions, starting with production statistics on an agroecological basis would help to inform priority setting for ICRISAT and it partners, and would help in allocating research resources between the two continents. The approach used could be a significant IPG of use to other Centers, NARS, and donors.

The Panel recommends a thorough analysis of past and likely future research spillovers between Africa and Asia to guide ICRISAT resource allocations between those two regions.

The maps provided by FAO in their study on farming systems and poverty may be helpful.[20]

One component of the recommendation would be a meta-analysis of past spillover studies (perhaps by a person independent of ICRISAT). This would be useful in of itself, both for quality control and for making an overall estimate of the economic benefits accrued to date by ICRISAT. There is a separate question as to whether impact assessment, at least from the perspective of germplasm development, could become a more routine and comprehensive function within ICRISAT, by soliciting ongoing feedback from clients who receive the germplasm. It is recognized that some complications could be inherent in the approach because private sector seed companies may be reluctant to reveal information that may have commercial confidence connotations. In areas where private sector seed companies do not operate, such as most of the SAT in WCA and ESA, feedback from clients who receive germplasm is important and is a feature of ICRISAT work in those regions.

[19] Shiferaw B, Bantilan MCS, Gupta SC and Shetty SVR 2004. Research spillover benefits and experiences in interregional technology transfer: An assessment and synthesis. ICRISAT 140 pp.
[20] http://www.fao.org/farmingsystems

To enhance the poverty orientation of ICRISAT's impact assessments, an income distribution measure has featured in some recent work. The Panel commends this. Ideally, a poverty alleviation aspect would be included in all impact assessments. This is not made as a formal recommendation since it is understood that this will require additional data acquisition costs and may exceed resource availability.

3.5 Overall Assessment

The overall assessment is that the quality of scientific outputs at ICRISAT is sound, and that the Center is doing a reasonable job balancing the goals of scientific quality and development impact. The Panel believes the research outputs contribute substantially to food security and alleviation of poverty in the SAT. Field visits indicated that ICRISAT is sensitive to the variable strength of its NARS partners and adjusts the balance accordingly.

In general, the CCERs were not very helpful in assisting the EPMR Panel come to their conclusions in the chapter. There was a lack of rigor in their analysis of science quality, partly due to how the assessment framework was laid out in the TOR.

Although ICRISAT's publication ouputs compare favorably with other CGIAR Centers, there is room for improvement in terms of publication quality. For example, given the greater citation level for the Center's publications in SCI journals, the Panel believes that greater emphasis should be placed on publishing in these. This objective could be reinforced by GT leaders and Regional Directors in the annual scientist review process. ICRISAT's own monitoring of publication output quantity and quality should be improved.

ICRISAT has a strong culture of impact assessment (also see section 4.2). More could be done in the impact assessment area, for example in conjunction with GT-AE on microdosing, and in baseline data collection. The linkages from impact assessment back to research planning and priority setting should be strengthened.

4 RESEARCH PROGRAM

4.1 Research Program Structure and Changes in 2003-2008

ICRISAT plans and manages its research through a matrix of Global Themes (GT) and regions (Asia[21], ESA and WCA). The Center's project portfolio has gone through several organizational changes since the 5th EPMR (Table 4.1).

Table 4.1 Global Themes and MTP Projects 2003-2007

2003[a]	2004[a]	2005[a]-2008	2006-2008[b]
GT1: Harnessing biotechnology for the poor	GT1: Harnessing biotechnology for the poor	GT-BT: Harnessing biotechnology for the poor	Project 2 Project 3 Project 4
GT2: Crop management and utilization for food security and health	GT2: Crop management and utilization for food security and health	GT-CI: Crop improvement, management and utilization for food security and health	Project 5 Project 6
GT3: Water, soil and agro-biodiversity management for ecosystem health	GT3: Water, soil and agro-biodiversity management for ecosystem health	GT-AE: Land, water and agrobiodiversity management – agroecosystem	Project 7 Project 8 Project 9
GT4: Sustainable seed supply systems for productivity	GT4: Sustainable seed supply systems for productivity	GT-IMPI: Institutions, market, policy and impacts	Project 1
GT5: Enhancing crop-livestock productivity and systems diversification			Project 10 Project 11[c]
GT6: SAT futures and development pathways	GT5: SAT futures and development pathways		

[a] GTs were presented as Projects in MTPs
[b] New project structure as presented in MTPs
[c] Project "Other" eliminated in MTP 2008-2010

In 2004, in response to recommendations of the 5th EPMR, ICRISAT modified its GT programs relative to those originally established in ICRISAT's Vision and Strategy document in 2001 and in 2005 the Center further reduced their number to four:

- GT on Institutions, Markets, Policy and Impacts (GT-IMPI)
- GT on Crop Improvement, Management and Utilization for Food Security and Health (GT-CI)
- GT on Harnessing Biotechnology for the Poor (GT-BT)

[21] In the matrix, Asia does not have a regional director, and is not managed explicitly the way WCA and ESA are managed although the DDG-R is the *de facto* "Regional Director" for Asia and chairs the Asian Regional Coordination Committee. To the Panel it seems that Asia is a "default" concept that comprises mostly the research activities at headquarters. In fact, unlike the SSA regions, the degree to which there is any strategic planning and priority setting for the Asia SAT as a whole it is not clear to the panel.

- GT Land, Water and Agrobiodiversity Management – Agroecosystem Development (GT-AE)

In 2005, following the 5th EPMR, ICRISAT reorganized its locations in SSA into two regional "hubs", western and central Africa (WCA), and eastern and southern Africa (ESA), and decentralized research management by appointing regional directors. These directors have both responsibility and authority, through budgeting and staff evaluation, for planning and implementation of the research agenda in their respective regions.

In 2006, ICRISAT developed an MTP 2007-2009 that presented a new research portfolio of 10 MTP Projects and a Project 11, "Other", that contained non System Priority activities. This project structure was superimposed on the existing GT x Region matrix. Despite these changes, the GTs have remained the principle units for internal research organization during the past eight years.

GT-IMPI covers the MTP Project 1 *Improving policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT.* It contributes to other Global Themes, especially with regard to disciplinary expertise in the social sciences.

GT-CI and GT-BT have responsibility for five of the MTP Projects as listed below. Although the project titles emphasize the crop improvement dimension, they all include strong elements of genetic resources and biotechnology research.

- Project 2: Sustaining biodiversity of sorghum, pearl millet, groundnut, pigeonpea and chickpea for current and future generations;
- Project 3: Producing more and better food of the staple cereals and legumes of the west and central Africa (WCA) SAT (sorghum, pearl millet and groundnut) through genetic improvement;
- Project 4: Producing more and better food from staple cereals (sorghum and millets) and legumes (groundnut, chickpea and pigeonpea) at lower cost in the eastern and southern Africa (ESA) SAT through genetic improvement;
- Project 5: Producing more and better food at lower cost of staple cereals and legume hybrids in the Asian SAT (sorghum, pearl millets and pigeonpea) through genetic improvements;
- Project 6: Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (sorghum, pigeonpea, chickpea and groundnut) through genetic improvements.

GT-AE covers MTP Projects 7-9:

- Project 7: Reducing rural poverty through agricultural diversification and emerging opportunities for high-value commodities and products;
- Project 8: Poverty alleviation and sustainable management of land, water, livestock and forest resources, particularly at the desert margins of the Sahel and the dry lands of ESA (SSA Desert Margins Program SWEEP);
- Project 9: Poverty alleviation and sustainable management of land, water, livestock and forest resources through sustainable agro-ecological intensification in low- and high potential environments of the semi-arid tropics of Africa and Asia.

The MTP Project 10, *Virtual academy for the semi-arid tropics (VASAT) in Asia and West and Central Africa,* is a multi-partner coalition facilitated by ICRISAT.

4.2 Global Theme IMPI

4.2.1 Overview

GT-IMPI has a broad research mandate and the Theme has a high level of responsibility for collaboration with other themes, as well as input to Centre-wide strategic planning and prioritization. The program has a good level of research output, despite this mandate breadth. GT-IMPI receives a high proportion of its funding as 'non-core'. This reflects a positive donor view of GT-IMPI performance and potential. However, it does tend to weigh against the notion of achieving a critical mass of strategic activities. GT-IMPI's comparative advantage is the opportunity to influence the deployment of ICRISAT research resources at both Centre-wide, program and project levels, in such a way as to maximize impact. Surprisingly this does not feature very explicitly in Theme goals. The types of activities that build on this comparative advantage would include ensuring that lessons from ongoing impact assessments are taken into account in priority setting and for technological development. It would also include being pro-active regarding geographic and commodity research targeting, and making use of geospatial analysis in conjunction with GT-AE. Such activities are ongoing to a degree, but the suggestion is that a further move in this direction is warranted.

GT-IMPI could help in reconciling the 'tension' between ICRISAT's location-specific, impact-oriented downstream work and the delivery of IPGs. This could be done via seeking generic hypotheses and conclusions from the location-specific work. The Panel sees this as a legitimate research activity in its own right and fully compatible with the directions mentioned in the previous paragraph.

There has been a re-invigoration of the village level studies in recent years, and that has resulted in a forthcoming USD10 million grant from BMGF.

4.2.2 Background

The historical evolution of GT-IMPI was well-documented in the 2007 CCER. Since 2005, GT-IMPI has been one of four global themes intersecting with three regional programs. GT-IMPI has overarching goals to:

- help generate policy options, tools, methods, lessons, and investment strategies that contribute to improved food security, livelihood resilience and poverty reduction while protecting the environment of the production systems in the semi-arid tropics;
- inform and provide strategic direction on and prioritization of research issues through strategic assessments and studies on poverty dynamics, development pathways and growth opportunities in SAT agriculture;
- address the complex challenges and emerging constraints facing agriculture in the SAT which requires a multifaceted approach that encompasses innovations in policy, institutions and new technologies;
- tackle the urgency of identifying development pathways and alternative livelihood options with critical interventions to address poverty, water scarcity and marginalization in the rural semi-arid tropics;
- identify binding constraints to agricultural transformation and produce information and knowledge that will contribute to an understanding of agricultural transformation in the SAT with reference to the drivers of socioeconomic, institutional and political change at the micro and macro levels.

GT-IMPI has heavy research responsibilities in other themes as well as a 'research cum service' roles at Center-wide level. ICRISAT states that its goals 'have broadened to include sustainable resource management, equity, gender, health and environmental concerns and farm and policy level implications'. This is a frighteningly broad set of issues. If implemented as stated, a number of these goals would fall within the realm of GT-IMPI.

Theme expenditure rose from USD3.7 million in 2003 to USD4.9 million in 2007, with unrestricted funds falling from USD1.42 million to USD0.78 million during that period. GT-IMPI has been successful in attracting funding from special projects - the source of over 70% of Theme funding.

GT-IMPI has 15 senior staff members, including special project officers - seven are located in India, with eight in Africa. There has been a positive increase in core competencies and staff numbers within GT-IMPI in recent years. Examination of staff CVs indicates that, broadly speaking, people with the requisite experience and training are being hired. An augmentation of staff with people who have science plus economics expertise could help strengthen cross theme linkages, although that skill combination is scarce.

GT-IMPI has worked with an impressive list of research partners - NGOs, NARS, private sector, other CGIAR Centers, and other ARIs. Field visits by the Panel confirmed the quality and productivity of these partnerships. In India, the relationship with ICAR/NCAP (National Center for Agricultural Policy) is extremely close.

4.2.3 The 5th EPR Recommendations and ICRISATR Response

Each of the two recommendations implicitly or explicitly suggested more integration of the socioeconomic and biophysical teams, and sought to gather IPGs from this integration.

There were two recommendations in the 5th EPR closely relating to what is now GT-IMPI. The first related to the Center's prior GT4 "Sustainable seed supply systems for productivity'. The recommendation was to 'anchor' the seeds work in other appropriate Global Themes, so that interdisciplinary work would be enhanced and resources used more efficiently. This recommendation has been implemented by ICRISAT, with the work now being primarily anchored in GT-IMPI and GT-CI.

The second recommendation of the 5th EPR suggested that social science resources be re-allocated from what was GT6 (SAT futures and development pathways) to other global themes. GT6 has been disbanded as result of the recommendation. Despite a deployment of socioeconomic staff to work with other Themes, the social science discipline remains highly visible at the institution level. There was a statement that 'non social scientists' would lead other Themes, but, at least for GT-AE, a social scientist would be equally capable of providing the necessary leadership.

4.2.4 Response to 2007 CCER

The 2007 CCER covered GT-IMPI and KMS. In general the recommendations of most direct relevance to GT-IMPI were well addressed by ICRISAT. Two of the recommendations require re-visiting. The first related to the distinction between "scaling up" and research into the "process" (of scaling up). This issue is addressed in subsequent sections. The second CCER recommendation concerned the low allocation of core ICRISAT budget to GT-IMPI and recommended that core funding should increase, or there was risk of weakening the important corporate services and advisory role undertaken by GT-IMPI. The allocation of core funding to GT-IMPI does remain relatively low. Some of GT-IMPI's 'corporate services' functions are difficult to fund from restricted funding. While this Panel commends the ability of the Theme to grow in the current economic climate, it recognized the effect on GT-IMPI's internal role. It may be possible to conceive some of the corporate services roles more within a research context (see later). Nevertheless, the risk identified by the CCER remains.

4.2.5 Progress, Achievements, Impacts and Assessment

GT-IMPI is responsible for the research activities in ICRISAT MTP Project 1.
The major foci of GT-IMPI over the last five years have been:

- the production of outlook information on trends in major mandate crops–including highlighting the increased role of livestock in the mandate area[22]
- compilation of impact assessments of ICRISAT research have been undertaken
- new methodologies for impact assessment have been developed[23]
- common policies on varietal release, seed certification and phytosanitary regulation for many parts of Africa and local level seed supply systems implemented and promoted, in conjunction with other programs
- improved understanding on how to enhance livelihood strategies for women[24]
- maintenance of and access to GT-IMPI databases on village level studies and key commodity output parameters
- re-invigoration of the village level studies

Referring specifically to the village level studies, the first generation of village level studies was undertaken in India during 1975-1985. Following a period of dormancy, village level studies are again underway in India and now also in Africa. The Panel recognizes the potential value of these studies. The earlier series of studies provided great insight into poverty and policy issues at the village level. In order to gain maximum economic impacts from the village level studies, underlying hypotheses or research questions and potential users of the information can be specified; those specifications will influence the nature and scope of the data gathering and analysis. Insofar as village surveys can be open-ended in nature, the Panel suggests aligning the data collection and analysis as closely as possible to the strategic direction of GT-IMPI and other

[22] Parthasarathy RP, Birthal PS and Ndjeunga J. 2005. Crop-livestock economies in the semi-arid tropics: facts, trends and outlook. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for Semi-Arid Tropics, 68pp.
[23] Shiferaw, B., H.A. Freeman, and S.M. Swinton, eds. 2005. Natural Resource Management in Agriculture: Methods for Assessing Economic and Environmental Impacts, London: CABI
[24] C. Bantilan MCS and R. Padmaja 2008. Empowerment through social capital build-up: Gender dimensions in technology uptake. Experimental Agriculture, Volume 44, p.61-80

GTs (e.g. farmers' perceptions of climate change), without pre-empting other high payoff avenues that are identified.

Over 40 policy briefs have been produced and made available on the ICRISAT web site by GT-IMPI during the evaluation period – a most impressive achievement. Most are high quality; a small number less so, and there is some redundancy. More quality control might be in order, although the concept of making such documents available in a timely and accessible fashion s a good one.

GT-IMPI has increased research output since the last EPR. From the period 2003-2008, the total number of publications and reports for economics and policy was 429 (with 49 of those being in press). This compares to 244 in the previous five year period. Book chapters, journal articles and institute-level reports have increased significantly while conference paper numbers have fallen. This change is in line with the 5th EPR recommendations. These changes reflect an increase in staffing and funding, as well as a re-orientation towards outputs of higher quality.

The socioeconomics field is more applied, than *some* of the science disciplines and the group's service role is reflected in the relatively high number of Institute-level publications. Comparing research quality across Themes thus becomes difficult. The key research quality parameter to emanate from the group over the last 5 years has been in the area of impact assessment – both methodology and practice. Overall publication quality is viewed as adequate, after giving due consideration to factors such as relevance and the service function to the Center overall.

GT-IMPI work is judged to be highly relevant to ICRISAT's mandate. The document 'Research Management at ICRISAT' prepared by ICRISAT for the 6th EPMR indicated the key role of GT-IMPI in providing information in setting ICRISAT research priorities. GT-IMPI has historically been very active and successful in the impact assessment, priority-setting arena within ICRISAT, and beyond, so this strength is a cornerstone for the theme (see also Chapter 3).

Ongoing 'impact assessments' are said by ICRISAT to feed back into the resource allocation process and this must surely be the case at some level. The degree to which this is formalized is unclear. Could the impact assessments be more explicitly seen as being part of a feedback/priority setting loop? For example, if a new variety is only taken up within a limited geographic range, is it understood exactly what has restricted adoption to that range, and whether any research or other activity can be undertaken to extend the range of applicability? These types of thought processes may be inherent now, in some fashion, but the model could be more explicit, and timely, in feeding into research priority setting, and into project planning (see Chapter 2).

The Panel sees this impact assessment/priority setting/research planning task as critically important at project, program, Theme and Center levels. We suggest that the role of GT-IMPI could be strengthened (with concomitant resource support to facilitate data collection and integration with subsequent decision making and project planning). Some refining/sharpening of Theme goals to reflect this thrust would also be in order.

The Panel recommends that ICRISAT capitalize on its core social science strengths to enhance activities in three areas and their interactions:

- **research prioritization and project planning (at all levels within the Center);**
- **technology development and adaptation; and**

- **impact assessment.**

These three areas are integrally related. They can be seen as a continuum with feedback loops from area (2) to area (1) and from area (3) to (2) and (1). There is scope for these feedback loops to be made more explicit, systematic and value-adding for decision making at all levels, including project planning and implementation. Prerequisites for this occurring in an optimal fashion are staff with appropriate skills (which are in place) and resource availability (presently lacking) as well a corporate framework that allows the flow of information to be meaningfully processed at the relevant level within the organization (project/theme/institution). There is scope for such a schema to become an IPG, by transferring it, or elements of it, to NARS.

As a subsidiary point, the Panel thinks that GT-IMPI could play a stronger role in defining recommendation domains, complementary to the GT-AE suggestion for a core ICRISAT group in the GIS/modeling arena.

Planning of IPGs

One of the CCER recommendations related to the distinction between 'scaling up' and research into the 'process' of scaling up. The current Panel agrees that there can appear to be a dichotomy between devoting research resources to the achievement of direct, tangible, on-ground impacts (scaling up) versus producing IPGs about the scaling up process. The achievement of the former implies a greater focus on problems and issues of a more localized nature. This may be in conflict with the concept of IPGs, where outputs 'spillover' to users/clients beyond national borders and are therefore more generic. However, it should be possible, in a number of situations, to embrace location-specific downstream work within an IPG framework, under a technology adoption/impact assessment umbrella.

Most simply and obviously, an IPG could be framed in terms of 'proof of concept' hypothesis (e.g. do farmers adopt micro-dosing or not). The more difficult-to-formulate hypotheses could delve into one or more subcomponents of the issue under downstream testing. In these cases, more imagination would be required in order to identify the issues *a priori.* For example, regarding the work on drip irrigation in West African market gardens, a hypothesis could relate to the definition of a critical mass of irrigation equipment sales needed to make the supply of equipment sustainably profitable for a private sector supplier of such equipment. The concept of critical mass definition could be viewed as an IPG. In other cases, key research questions may only be revealed through *ex post* analysis of the initial testing phase.

One area where ICRISAT has already moved to conceptualize 'local level' technology adoption/impact within an IPG framework is with some of the seed systems work in Africa. With seed supply having been identified as a constraint, a set of research issues have been defined around the seed supply question. Some of these issues, once resolved and documented, are legitimate IPGs. More successes along these lines are within reach, but resources, probably under GT-IMPI leadership, would be required. It is suggested that ICRISAT take action to identify where these opportunities lie and to follow up accordingly. This potential to resolve some of the tension between downstream scaling out type work and the production of IPGs should be pursued with vigor, as the potential intellectual, and practical benefits (enhanced uptake of technologies) to ICRISAT are large (ref. Annex 2, Strategic Issue # 5). Work along these lines would provide another mechanism for integration between GT-IMPI and other Themes.

The Panel recommends that GT-IMPI work on the development of hypotheses that determine the IPG potential of ICRISAT's downstream work on technology development, testing and adaptation.

Seed systems in Asia

Seed systems work features prominently within the current GT-IMPI program. It is closely, and appropriately, aligned with other global themes. The GT-IMPI role has been to work on policy aspects (harmonizing legislation, sanitary and phytosanitary regulations etc) and in assisting smallholder private growers to organize themselves into meaningful seed suppliers in a situation where alternative supply mechanisms are simply non-existent. This line of work is justified, and there is good linkage with GT-CI in a genuinely joint effort (ref. Annex 2, Strategic Issue # 7).

Work on seed distribution systems within GT-IMPI has wound down in Asia as recommended in the 1997 EPMR. That recommendation was based upon the notion that the private sector could do a satisfactory job of seed distribution in Asia. While that may be true for hybrid seeds, there is still a role for the public sector in the distribution of open pollinated seeds in Asia. The Panel is not advocating the engagement of GT-IMPI in a close connection with 'hands-on' delivery of open pollinated seeds to Asian farmers (cf. West Africa), but the Panel believes that there could be an IPG-type role for GT-IMPI in analyzing the development of the seed delivery and supply sector in Asia. This would involve such matters as: description of the evolution of the system; analysis of the effectiveness of various systems (including OP versus hybrids) on the poor, and how best to position ICRISAT in the milieu of the changing seed supply parameters (role of the private sector etc). In short, analyzing economic and policy aspects of the systems (especially from a poverty alleviation viewpoint) and helping to position ICRISAT's ongoing germplasm improvement work in Asia appropriately in relation to the emergent socioeconomic trends. If undertaken, this would be a logical counterbalance to the work in Africa and would demonstrate an appealing strategic approach to project definition according to region.

Gender

ICRISAT was one of the first IARCs to recognize women's important role in agricultural production in the SAT. Strategies to incorporate a gender perspective in its program include: a) using female illiteracy to calculate the equity index, which in turn was used to prioritize research themes; b) setting up a multidisciplinary Gender Analysis Committee; c) organizing Women Farmers' Days in India and Africa; d) mainstreaming participatory research, gender and social analysis in the crop improvement and NRM projects. More importantly, the characterization of the impacts of new technologies and the most effective pathways for their adoption, including differentiating benefits by gender, age and wealth groups, now comprise research activities that contribute substantially to improving technology diffusion.

There have been a series of core research outputs from ICRISAT staff during the evaluation period that effectively address the gender impact (and potential impact) of technology, and other social changes in the SAT. One ICRISAT GT-IMPI staff is explicitly charged with research into gender issues and she works full time on that. In addition, other Theme members have directly or indirectly addressed gender in their research.

Bantilan and Padmaja (2008) explored how, and to what extent, women and men have benefited from social capital build-up (the ability of men and women farmers to develop and use various kinds of social networks and the resources that thereby become available) in technology uptake,

and the role of women in this process. In a series of case studies relating to ICRISAT's groundnut production technology, the process of technology uptake leading to empowerment was systematically documented through three stages of the adoption pathway in three villages in Maharashtra, India, and complemented by a broader quantitative study of the uptake process covering villages in surrounding districts.

ICRISAT's Village Level Studies undertaken in India and sub-Saharan Africa continue to provide better understanding of livelihood options, household economics and needs of poor farmers that helped to design suitable technology and formulate appropriate policies. The farm-level surveys incorporate gender-related dimensions such as the labor participation of women, the role of women in decision making in agricultural production, consumption, nutrition, education, etc., access to and control of resources, participation in and access to social networks and build-up of social capital and empowerment. Gender differences are also considered in sampling, and in the development of suitable methods, and instruments, for collection of gender-disaggregated data, analysis and documentation of impact of the project on women in terms of nutrition and food security, welfare and empowerment.

There have been studies on the impact of HIV/AIDS on livelihoods in rural areas. One such study was conducted in India and one is ongoing in Africa. These studies are inherently gender specific.

Overall the Panel is impressed with the attention paid by GT-IMPI to gender at the project level in designing and evaluating their research activities.

Regional Programs

The regional focus of GT-IMPI in WCA has identified the following priority areas – it is closely aligned with the overall global program, but appropriately more limited in scope. The primary foci are

- marketing and agro-enterprise - this marketing/business thrust represents an attempt to link smallholders from the region with commercial markets on both the input and output side; this is a sensible approach given the smallholders history of (relative) 'commercial isolation'
- analyses of the dynamics of poverty – primarily through the 'village level studies' approach; again this seems appropriate against the background of an extremely limited knowledge base
- enhancing the roles of institutions in agricultural research and creating marketing opportunities for smallholder producers; it is not so clear why there is a particular focus on 'institutions' versus other avenues for enhancing agricultural research and marketing.

For the ESA and Asian regions, objectives are not especially distinguishable from the broader global GT goals. Again, this would seem to be appropriate, given the stronger resourcing available in those two regions (cf WCA). However, earlier in the report, the Panel commented on the desirability of tightening up Theme goals.

The enhancement of funding for the village level studies will obviously boost that area relative to some others. Opportunities could be sought within the village level studies program, to slant the data collection and processing such that some other GT goals could be simultaneously be achieved from that intensive effort.

Partnerships and capacity building

An impressive list of research GT-IMPI partners has been documented by ICRISAT for the Panel and verified in the field visits. NGOs, NARS, private sector, other CGIAR Centers, other ARIs are all included. In India, the relationship with ICAR/NCAP is extremely close, giving GT-IMPI a direct line into Indian government policymaking, both from the point of tailoring technologies to fit the prevailing socio-political environment and from the point of view of understanding where policy may hinder technology uptake. There have been staff exchanges in both directions between the two institutions. Looking beyond India, key government departments in partner countries have been routinely engaged via direct collaboration in projects, and via workshops. Apart from partnerships with other social science disciplines, there are also partnerships with biophysical scientists both within ICRISAT, and beyond. This adds further responsibility to GT-IMPI for partnership building - that responsibility appears to have been well-handled by the GT-IMPI team. At the regional level, the seed systems work (the West Africa Seed Alliance) brings together a diverse group of organizations to help develop a competitive seeds industry. This work is now extending to Eastern and Southern Africa. The seeds work is increasingly being integrated with work of relief organizations with view to providing seed supply efforts a more permanent operating platform, rather than being *ad hoc* responses to climate or other crises.

There has been a long-running and notable interaction with ACIAR under the broad umbrella of impact assessment. This has led to benefits for both parties and beyond, and it has been an excellent example of collaboration between ICRISAT and a like-minded institution, drawing upon the strengths of each.

GT-IMPI has conducted/organized more than 35 workshops and training programs across its locations from 2003 onwards. The training workshops aim to strengthen the capacity of its partners and enhance the skill levels of the staff associated with the theme. The topics covered include the full range of expertise available in GT-IMPI, but with some focus on:

- Decision support tools for determining SAT futures
- Village Level Studies
- Market studies
- Adoption and impact studies
- Methods of assessing the impact of natural resource management research
- Research need assessment and agricultural research priorities for South and West Asia
- Impact assessment tools in West Africa.
- Inter-regional sharing of lessons from watershed management

Even an advanced research group like NCAP in India expressed great appreciation for the linkage with ICRISAT. That appreciation stemmed partly from professional contact with ICRISAT staff, and partly from the access that ICRISAT provides to the broader international research community.

4.3 Crop Improvement Global Theme (GT-CI)

4.3.1 Overview

Five MTP projects are conducted under the aegis of GT-CI, three in Asia and two Africa. The Asia-based projects deal with conservation and characterization of genetic resources of the mandate crops (MTP Project 2), and crop improvement through hybrid (MTP Project 5) and OPV (MTP Project 6) technologies, and cover the full range of mandate crops. In Africa, the projects

cover WCA (MTP Project 3) and ESA (MTP Project 4). The WCA project is limited to pearl millet, sorghum and groundnut whereas the ESA project works with all of the Center's mandate crops.

GT-CI was highly commended by the CCER on Crop Improvement and Biotechnology which reviewed its activities in 2007. The current Panel found a high level of activity across all five projects, with many advances on a broad range of topics, and we concur with the positive evaluation of the CCER. Interestingly, the current Panel found indications that a number of CCER recommendations were already in the early, but substantial, stages of implementation. As well as generating excellent applied science outcomes in the form of new cultivars for release and breeding lines for its mandate crops, GT-CI has produced or is in the process of producing (in collaboration with GT-BT and GT-IMPI) other important IPGs. These include conservation, characterization, and packaging for end-user access of its unique germplasm collection for mandate crops, and systematic and broad-ranging efforts to understand and break the bottleneck that current seed systems impose on the diffusion of improved materials to poor farmers in the SAT.

The Panel identified a few suggestions and recommendations in addition to those found in the recent CCER, which it endorses. It believes that the GT-CI, which has begun to devolve a substantial portion of its breeding activity to the stronger NARS and private sector partners in Asia in accordance with the general IARC mandate, needs to seize the opportunity this offers to apply modern statistical analyses to the data generated by the broad network of multi-environment trials conducted by the Center and its partners in Asia and SSA. Doing this would provide the GT-CI with a unique comparative advantage in genetic improvement of the mandate crops, an advantage that could be further reinforced by cross linkages with the crop simulation and geo-spatial analysis skills already available at the Center. The Panel urges the more widespread use, by GT-CI and its partners, of selection under conditions of low (i.e., close to current farmer practice) and moderate soil fertility conditions. Until the constraints of access to and use of inputs by the poor farmers are removed, low fertility will continue to be a feature of many production systems in the SAT.

4.3.2 Background

During the review period the unrestricted funding for GT-CI remained fairly stable at about USD2.1 million per year and restricted funding rose from USD2.6 to USD5.9 million per year. A total of 45 scientists work in GT-CI (6 in WCA, 13 in ESA and 26 in Asia).Although the GT-CI and GT-BT are strongly interlinked in some aspects of their activities, they are treated separately by the Center for purposes of expenditure and staffing, and much of their respective activities are independent. The information presented by the Center for GT-CI is organized on the basis of MTP projects, GT-BT has no specific MTP Project assigned. Consequently, and for the purposes here the Panel has organized its report on the basis of MTP Projects. Where the cross-GT linkages are important, we have highlighted this fact.

4.3.3 The 5th EPR Recommendations and ICRISAT Response

The 5th EPR recommended (Rec. # 2) that ICRISAT a) maximize the synergies between GT-CI and GT-BT and work with their partners to generate IPGs for the SAT, and b) rebuild and re-engineer its crop improvement program and further enhance a two pronged breeding strategy for Asia and Africa. The EPMR also recommended the Center's seed systems research be anchored in the appropriate global themes (Rec. # 5) and that anticipated problems in marketing transgenic materials be addressed. Finally, it recommended (Rec. # 4) that integrated pest management

(IPM)/integrated disease management (IDM) activities be prioritized to address constraints, solvable via IPM/IDM, that are important in Africa.

Broadly speaking, ICRISAT has responded positively and effectively to the relevant 5th EPR recommendations. GT-CI and GT-BT have worked together very well in characterizing the germplasm collections for mandate crops, and in developing and using markers for *Striga* resistance and other traits. Breeding programs in Africa for pearl millet, finger millet, sorghum and groundnut have been strengthened while advances in breeding have continued in Asia. Some 85 varietal releases by ICRISAT and partners have been made during the 2003-2007 period, 23 of which were in Africa and most of the remainder in Asia. For groundnut, which accounted for almost half of the varietal releases across crop species, the Africa: Asia release ratio was almost 50:50. GT-CI has been working closely with GT-IMPI on seed system issues across all levels from farmer groups through to harmonization of regional seed legislation and regulations. The Host Plant Resistance (HPR) component of *Striga* control (a joint effort between the GT-CI and GT-BT) was combined with the IDM efforts led by GT-AE to reduce the incidence of this parasitic weed, which is a widespread constraint in African cropping systems. GT-CI has worked well with NARS partners in diffusing germplasm and breeding material and with regional organizations and NGO's to improve seed systems.

In Asia, GT-CI has devolved a great deal of breeding work to its NARS partners. In Africa, where the NARS are weaker, GT-CI continues to work closer to the downstream limit of this activity. That is, instead of releasing pre-breeding material, ICRISAT is developing varieties for adaptive testing by NARS and release to farmers.

4.3.4 Response to 2007 CCER

The GT-CI CCER (2007) overlapped almost completely with the review period for the present EPMR. The CI-CCER made very positive observations about the GT-CI program. First, the GT-CI objectives were considered to be well planned and aligned with CGIAR System Priorities. Second, the Panel observed excellent collaboration and team spirit within and between GT themes, within and between regions, and between the Center and their partners. Third, the Panel observed that the outputs of ICRISAT's work were recognized both nationally and internationally. The CCER report also provided useful information on the quality and impact of the science in this program.

Ten of the 14 CCER recommendations referred to GT-CI. ICRISAT accepted most of these recommendations, offering caveats to a few of them. The current Panel concurs with the broadly positive opinion of the CCER and its recommendations, and will offer further recommendations of its own in the analysis that follows. In the course of its visits to ICRISAT locations in Africa and Asia, the current Panel was able to establish that many of the recommendations of the CCER were in the initial stages of implementation. Examples of this are the West African Seed Alliance, Farmer Participatory Varietal Trials (FPVS), the BMGF Tropical Legumes II Project, and the finger millet breeding program.

4.3.5 Progress, Achievements and Impacts

Sustaining Biodiversity

ICRISAT's MTP Project 2 has a global responsibility for effective conservation and utilization of biodiversity of the mandate crops. During the period under review, ICRISAT's Plant Genetics unit managed 118,882 accessions of its five mandate crops and six small millets assembled from 144 countries. Knowledge, technologies, and information on genetic resources have been generated and shared with other partners. These include core, mini-core collections and trait specific germplasm which have been identified and evaluated and composite collections and reference sets developed and genotyped for utilization and new knowledge shared with partners. The core and mini-core collections have been sources of important traits in chickpea, pigeon pea, finger millet, foxtail millet and groundnuts. Fifteen publications in six international journals have come out of this work in the last 5 years[25]. The Panel commends ICRISAT for the excellent stewardship of the world's germplasm collection of ICRISAT's mandate crops and the IPG's generated during the review period.

Project 2 has included ICRISAT's work within the Generation Challenge Program (GCP) on phenotyping. ICRISAT plans to assemble, characterize and evaluate new germplasm from regions/countries not represented in the current collection. For the genetic resources present in the gene bank, ICRISAT will identify gaps in the database and characterize those germplasm accessions for which information is lacking. The attention of the Panel was specifically drawn to the need for increased collection of sorghum and pearl millet land races in WCA. As the collection activity progresses it will become necessary to revisit and update the currently existing core and mini-core collections. The Panel commends the GT-CI for the achievements of Project # 2 and notes that the current situation indicates a full pipeline of exciting outputs and the expectation of continued progress during the next review period.

Crop Improvement in WCA and ESA

In Africa, GT-CI is responsible for two MTP Projects (3 and 4). Work in Project 3 has targeted, among other things: i) sampling and evaluating landraces of pearl millet, heterotic diversity, specific adaptation and seed availability studies in the same species; ii) developing hybrid Guinea sorghum [A, B and R lines) based on West African germplasm and recurrent selection of guinea-race sorghum for reduced stature; iii) studies on the physiology and heredity (using molecular markers) of photoperiod sensitivity in pearl millet and sorghum, and the effects of photoperiod sensitivity on adaptation (this work links into domain mapping and modeling work conducted by GT-AE); iv) management and breeding effort to reduce aflatoxin levels in groundnut and improve resistance to major foliar diseases and groundnut rosette virus; v) a multi-pronged approach (management and breeding –both conventional and with molecular markers) to reduce the effects of *Striga*; vi) nurturing the private seed sector (in combination with GT-IMPI); and vii) exploring the possibility of biofortification of grains using breeding.

[25] For example: Upadhyaya, H.D. (2005). Variability for drought resistant related traits in the mini core collection of peanut. *Crop Science* 45: 1432 - 1440.
Upadhyaya, H.Y., Salimath, P.M., Gowda, CLL and Singh, S. (2007). New early maturing germplasm lines for utilisation in chickpea improvement. *Euphytica* 157: 195-208.

Significant achievements and impacts during the period under review include:

- identification of heterotic relationships in sorghum and pearl millet germplasm adapted to WCA conditions following synergies between GT-CI and GT-BT and the use of SSR markers to study genetic resources of the crops. Current work on validation of the groupings will provide very useful information for the development of hybrids; sorghum A-lines developed from diverse germplasm adapted to Soudanian, and northern Guinean zones.
- diversity of breeding material used by NARS enhanced. This broadening breeding populations used by farmers. The number and diversity of varieties grown in the sub-region has increased; early maturing varieties of sorghum and pearl millet have achieved significant higher yields on-farm; early maturing groundnuts escape terminal drought and fetch high market prices.
- improved methodologies developed for integrating breeding of groundnut, sorghum and pearl millet populations and varieties with crop management strategies to overcome key environmental and socio-economic constraints and dissemination of information to partners.
- efforts by the West African Seed Alliance (WASA), a public-private alliance to currently beginning to establish a sustainable commercial seed industry to ensure that small scale farmers have affordable, timely and reliable access to adapted quality seed (ref. Annex 2 Strategic Issue #7). WASA is building a good basis of regional regulatory harmonization.
- S*triga* management in pearl millet and sorghum developed and widely used.
- several notable publications in peer-reviewed journals[26].

Work on Project 4 has included, among other things: i) breeding for yield and disease and pest resistance in sorghum, pearl and foxtail millet; ii) breeding for yield and resistance to biotic stresses in groundnut; and iii) breeding and adaptation studies in pigeonpea and chickpea.
Significant achievements and research impacts during the period under review include:

- increased production of groundnuts resulting from release of varieties resistant to the rosette disease in Malawi, Mozambique, Uganda and Zambia. Adoption studies in Uganda indicate that 50% of farmers have adapted rosette resistant varieties. The infector row technique for screening for resistance to rosette, which involves maintaining stocks of infected plants and its aphid vector has been an important element of progress on this front.
- high yielding pigeonpea varieties (extra short for low altitudes and medium-long duration for mid altitudes), 1.6 – 3.2 t/ha compared to 0.1 – 0.6 t/ha and resistant to *Fusarium* wilt have been adopted in Malawi, Tanzania and Kenya
- sorghum varieties with resistance to pests and diseases and high yielding adopted in Kenya and Tanzania; high yielding and disease resistant millet varieties adopted in Eritrea, Kenya and Uganda.
- mapping of zones of adaptation of improved multiple released varieties across the ESA region completed for seven sorghum varieties (Macia, Kuyuma, Pirira1 (ICSV112), Pirira 2, SV3 and SV4) and 5 pearl millet varieties (ICMV 8808, Okashana 2, SDM2040), PMV2 and SDMV89005) to demonstrate areas of potential spillover.
- stratification of sorghum variety testing sites for pearl millet and sorghum has been completed[27].

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[26] For example: Waliyar F, Traore A, Fatondji D and Ntare BR 2003: Effect of irrigation interval, planting, and cultivar on *Aspergillus flavus* and aflatoxin contamination of peanut in a sandy soil of Niger. *Peanut Science* 30: 7-84; Haussman BIG., Parzies HK., Presterl T, Susic Z, and Miedaner T. 2004. Genomic regions influeincing resistance to the parasitic weed, *Striga hermontica* in two recombinant inbred lines. *TAG* 109: 1005-1016.

[27] Mgonja MA, Chandra S, Monyo ES, Obilana AB, Chisi M, Saadan HM, Kudita S, and Chinhema E 2006: Stratification of SADC regional sorghum testing sites based on grain yield of varieties. *Field Crops Res.* 6:11-30;

- finger millet breeding program is showing signs of success, and well characterized germplasm (agro-morphological characters) for this crop available for sharing with partners
- a number of good publications in peer-reviewed journals are outputs from this project[28].

The Panel was favorably impressed with the quality and ambition of the breeding and adaptation programs conducted by scientists associated with MTP Projects 3 and 4. All the programs viewed or discussed during the field trips showed clear signs of activity and innovation. Contributions by MTP Projects 3 and 4 to seed system development in their respective regions were significant (ref. Annex 2. Strategic Issue #7).

Both projects 3 and 4 (with its Africa Harvest partner) include in their research portfolio research into biofortification with Fe and Zn of cereal grains, through conventional breeding or genetic engineering. Some work has also been done in India[29]. Other work has shown there is some degree of association between increased levels of these metals in the grain and levels of phytate, which reduces metal bioavailability and may negate any gains based exclusively on concentrations of target metals in grain. The CCER recommendation #14 made reference to the need to address bioavailability. The Panel was informed that the GT-CI had begun to address this issue.

The Panel sees the work done on testing site stratification (see footnote above) and mapping of adaptation zones for sorghum varieties as a convenient entry point for further development of a more systematic approach for leveraging data from multi-environment yield trials as means to: (i) better understand genotype x environment (G x E) interactions, and (ii) better predict the performance of newly developed germplasm with specific traits across the range of SAT environments.

Crop Improvement in Asia

In Asia, GT-CI is responsible for two MTP Projects (5 and 6). The concentration of scientists in the Asia region coupled with the strong NARS has facilitated significant achievements and on-farm impacts in mandate crops. For pigeonpea, the first CMS-based hybrid (ICPH 2671) was launched during 2008 and 40 tons of seed was produced by 26 seed companies in 2007. On-farm impact is expected from this novel product following cultivation of about 8,000 ha in 2008 in India. Significant achievements have also been made in the development of screening methods for traits such as salinity tolerance; as well as root traits[30]. These new methods are contributing to enhanced breeding efficiency.

Mgonja MA, Chandra S, Obilana AB, Monyo ES, Kudita S, Chisi M, Saadan HM, and Chinhema E. 2008. Stratification of sorghum hybrid testing sites in southern Africa based on grain yield. *Field Crops Res*. 108:193-197.

[28] Gwata ET, Silim SN, Mgonja MA 2006: Impact of a new source of resistance to *Fusarium* wilt in pigeonpea. *Journal of Phytopathology* 154 (1): 62-64. See also footnote 27 above.

[29] Velu G., Rai KN, Muralidharan V, Kulkarni VN Longvah T and Raveendran TS 2007: Prospects of breeding biofortified pearl millet with high grain iron and zinc contents. Plant Breeding 126 (2): 182-185.

[30] Srivastava N, Vadez V, Krishnamurthy L, Saxena KB, Nigam SN and Rupakula A 2007: Standardization of a screening technique for salinity tolerance in groundnut (Arachis hypogaea) and pigeonpea (*Cajanus cajan*). *Indian J. Crop Science*, Vol. 2 (1): 209-214. Gaur P.M., Krishnamurthy L. and Kashiwagi J. 2008: Improving drought-avoidance root traits in chickpea (*Cicer arietinum* L.): Current status of research at ICRISAT. *Plant Production Science* 11: 3-11.

The Panel notes that some of the publications were co-authored by scientists from NARS and other CGIAR Centers[31], an encouraging sign about the extent of GT-CI links with other institutions. In total, 308 peer reviewed articles were published in a range of journals over the review period.

The Panel notes that GT-CI has worked on a number of other traits to improve cultivar adaptation or grain quality. Some examples are the diversification of CMS background in sorghum and pearl millet from A_1 CMS to others, reduction in cycle duration, dual purpose varieties in groundnut, salinity tolerance in sorghum, pearl millet, chickpea and groundnut, and heat tolerance in pearl millet and chickpea. A number of crops/trait targets have been passed on to national programs or dropped altogether in Asia, (e.g., resistance to *Striga*, downy mildew in sorghum, hybrid development in sorghum and pearl millet, development of finished varieties in chickpea, breeding for resistance to pests (*Spodoptera*, aphids, jassids) in groundnut) (ref. Annex 2 Strategic Issue #3). The Panel commends this GT for balancing its research portfolio to focus on issues where it has a clear comparative advantage. However, it notes that the bottom line should be to assure that the breeding programs in Africa are adequately backstopped in areas where there is lack of infrastructure or expertise.

The Panel is not convinced of the need for having two MTP projects distinguished by whether the focus was on open-pollinated or hybrid varieties. Given that technologies for open pollinated and hybrid breeding have a great deal in common, such a division seems artificial. The Panel, therefore, strongly encourage ICRISAT to merge these MTP projects.

The promising trend toward devolving a good deal of the breeding effort to NARS in Asia opens a new opportunity for GT-CI. This trend provides the potential to extend GT-CI's network of multi-environment trials in Asia, and extending it to African networks would further enhance the possibilities to advance understanding of GxE interactions and other effects important to breeding. In turn, this offers the opportunity for GT-CI to engage in data analysis procedures for many objectives (e.g., classification and ordination of testing environments, study of the patterns of GxE interactions, and, in combination with crop simulation modeling, the possibility of classifying year x location results to inform the selection process). The Panel notes that individual NARS would be unable, in isolation, to undertake this kind of effort. In this activity, GT-CI has a clear comparative advantage. (ref. Annex 2 Strategic Issue #3).

ICRISAT claims that a number of varieties of the mandate crops (e.g. groundnut variety ICGV 86015 in Niger and pearl millet variety ICMV 221 in Eritrea) developed at Patancheru have been evaluated, released and adopted in various countries in ESA and WCA. At the same time, and unsurprisingly, there are indications that improved lines and populations of sorghum and millet developed in Asia were found to be unadapted in the WCA region. This observation reinforces the need to maintain active breeding programs at all mega-environments of the SATs.

[31] Bidinger FR, Bhasker RAG, Negusse A, Mohammed AA, Obilana AB and Jones RB 2005: Topcross hybrids as an entry into commercial seed production of pearl millet in eastern Africa. *Experimental Agriculture* 41: 335-356. Nigam, S.N., Chandra, S., Sridevi, K.R., Bhukta M., Reddy, A.G.S., Rachaputi, N.R., Wright, G.C., Reddy, P.V., Deshmukh, M.P., Mathur, R.K., Basu, M.S., Vasundhara, S., Vindhia Varman, P. and Nagda, A.K. (2005). Efficiency of physiological trait-based and empirical selection approaches for drought tolerance in groundnut. *Annals Appl. Biol.* 146:433-439.

4.3.6 Priority Setting and Linkages with other GT's

Breeding objectives for all the programs in all crop species were clearly stated and the ranking assigned to the various traits seemed appropriate. Across MTP Projects 3 through 6, linkages with GT-IMPI, GT-BT and GT-CI appeared to be robust.

4.3.7 Publications, Partnerships and Capacity Building

During the review period, staff of GT-CI published 36 books, 131 book chapters and 308 journal articles. Publication rates per scientist during the review period were uneven, with very high rates (over 4 papers/yr in SCI journals) for scientists associated with MTP Project #2, and low rates (with one exception), close to 0.8 papers a year) for scientists associated with MTP Projects 3, 4, 5 and 6. Because these latter scientists also produce breeding lines and/or cultivars, ICRISAT needs to find a way to record these outcomes and value them in a transparent manner as part of the annual performance review process.

In discussions with partners during field trips, partners interviewed expressed consistent levels of satisfaction with their collaboration with ICRISAT, both in India and in Africa. In Africa, scientists from NARS readily recognized the weaknesses of their organizations and the important role GT-CI played in providing germplasm and advice to breeders. An important development in Asia is the Hybrid Parents Research Consortia, a set of public-private partnerships with seed companies involved in producing and distributing sorghum, pearl millet and pigeonpea hybrids. GT-CI is also involved in the Bioproducts Research Consortium and plays a key role in the sweet sorghum for ethanol consortium.

During the review period, staff of GT-CI mentored 46 interns, 22 research scholars. Special training courses totaled 39, and 155 research fellows were hosted by GT-CI.

4.3.8 Cross Regional Integration

The Panel was unable to form an opinion as to the degree of inter-regional planning and prioritization of breeding objectives. There is clearly much traffic between regions for germplasm exchange. The analyses of core and mini-core sets of mandate crops to determine heterotic groupings are of great value to the breeding process at all locations. Finally, the recommendation made in section 3.Y for a thorough analysis of past and future likely spillovers between Africa and Asia to guide ICRISAT resource allocations between regions is highly relevant to future strategy and implementation of the CI program.

4.3.9 Overall Assessment

The Panel was favorably impressed by the work of the GT-CI. Field visits and presentations in both Asia and Africa confirmed the impressions, gleaned from other documents, of active and well focused breeding programs. The work on germplasm conservation and characterization using phenotypic and molecular markers to develop core and mini-core collections is outstanding. This work will need revisiting as the collections are strengthened by more pearl millet and sorghum material from WCA.

Table 4.2 Germplasm supplied globally during 2003 – 2007

Crops	World	Africa	Asia
Sorghum	7440	412 9 (56%)	2195 (29%)
Pearl millet	3647	1540 (42%)	1729 (47%)
Chickpea	8923	55 (.01%)	7522 (84%)
Pigeonpea	3294	433 (13%)	2912 (88%)
Groundnut	4793	793 (17%)	3908 (82%)
Small millets	4271	1428 (33%)	2813 (66%)
Total	**32368**	**8378**	**21079**

Germplasm and breeding material exchanges have taken place at high rates, and an average of 400 nursery trial sets per year are distributed to NARS. Although variable across crops (Tables 4.2 and 4.3) the global Asia: Africa ratio for germplasm and breeding material exchange is about 2:1, an imbalance which likely influenced by the relative strengths of NARS partners in these regions. The Panel believes the important issue here is the sheer number of materials provided to African partners. The Panel endorses the CCER recommendation #2 that emphasizes the importance of maintaining data bases on request for material and feed back, a recommendation accepted by the Center. It also notes the important number of sets of small millet (presumably mostly finger millet) material exchanges, something which may signal increased interest in this cereal.

Table 4.3 Breeding material supplied globally during 2003 – 2007

Crops	World	Africa	Asia
Sorghum	9215	6505 (68%)	2473 (27%)
Pearl millet	27113	6321 (23%)	19208 (70%)
Chickpea	11525	999 (0.1%)	7204 (63%)
Pigeonpea	9099	3135 (35%)	5920 (65%)
Groundnut	4798	3526 (73%)	1222 (24%)
Small millets	272	272 (100%)	0 (0%)
Total	**62022**	**20758**	**36027**

The rate of variety releases has trended downwards during the review period (about 16 /yr) compared to the period covered by the 5th EPR (about 25/yr). This may possibly reflect the degree of success achieved by GT-CI programs. Despite this trend, the Panel still believes that these releases remained an important scientific component of the program during the review period, particularly in groundnut. Importantly, there have been increases in areas cropped to some of the mandate crops. Some of this comes under the heading of new developments (e.g., pigeonpea in Tanzania, chickpea in Myanmar), in other cases it reflects re-establishment of mandate crop area after successful improvement of disease resistance (e.g., groundnut in WCA and ESA). The downward trend in rate of variety release noted above may be a signal that the GT-CI needs to rebalance its research portfolio between maintenance breeding for yield and disease/pest resistance and new horizons (e.g., "new" crops such as finger millet; new frontiers in old "crops" such as medium height Guinea race sorghum; or new analytical tools to handle G x E effects) (ref. Annex 2 Strategic Issue).

Breeding efforts directed to evaluating materials under moderate and low (i.e., closer to current farmer practice) fertility conditions seen by the Panel in WCA deserve greater attention. Until the constraints of access to and use of fertilizer inputs by the poor farmers are removed, low soil

fertility and multiple nutrient deficiencies will remain a major constraint to productivity of many production systems in the SAT. Defining the appropriate soil fertility conditions for this endeavor is a challenge in itself, and geospatial analysis and modeling provide an important complement to support this effort (see section 4.5). Particular attention should be paid to re-screening material selected under medium fertility under conditions of low fertility.

Success in developing screening technologies for devastating diseases such as groundnut rosette virus has helped the potential to reduce yield loses from these biotic constraints. We anticipate that on-farm impact will increase as more disease resistant varieties become available to farmers. Multi-pronged approaches to *Striga* control hold considerable promise, and marker-assisted breeding is increasingly used as markers become available. Developments in hybrid technology (Guinea sorghum in WCA, pigeonpea in Asia) hold promise for the future. The Panel strongly commends this work.

During site visits to WCA and ESA, the Panel was able to observe that local germplasm banks were filled to capacity. This will constrain any expansion of breeding efforts in these regions and poses additional problems where increased collection of local land races is needed to strengthen the germplasm banks at Patancheru. It also notes the GT-CI CCER (Rec. # 3) recommends an increase in accessions in these banks. The Panel urges ICRISAT to find ways to expand storage volume or explore other alternatives (e.g., moveable racks) to improve space use efficiency in these facilities.

Staff publication rates were variable, ranging from very high to very low. The Panel was unable to form an opinion on the contributions made by individual staff members to variety development, and encourages the GT-CI to produce this information for use in staff performance evaluations, and for consideration in future reviews. While we recognize that germplasm development and release requires a team effort, it is also essential to equitably evaluate and reward creative outputs of different types, such as germplasm, software, and publications.

GT-CI has played an important role in addressing the seed system issue at a range of levels from supranational to farmer and farmer group training and advice (ref. Annex 2 Strategic Issue #7). Much remains to be done, but current initiatives hold great promise and deserve commendation.

Given the expectation that a feature of global change will be increased frequency of episodes of high temperature stress, the Panel considers that GT-CI should develop, in conjunction with GT-AE, adequate protocols for screening for high temperature tolerance in the mandate crops. These screens should concentrate on the phases of crop development that are critical for grain number, grain size and grain quality determination. Each phase needs to be examined separately. As noted in Sect. 4.4.5 of this report, simple screens using shifts in sowing date towards the warmer period of the year have pitfalls and may generate unreliable results. This work will likely require partnering with ARI's. Collaboration with GT-AE could lead to the definition of model-usable temperature response functions. Once tolerant and susceptible materials are identified, work with GT-BT could lead to the detection of markers.

The Panel notes the relatively high proportion of staff assigned to the Patancheru in relation to WCA and ESA (partly, but certainly not totally, explained by the need to sustain Project # 2 as a Center-wide resource). Given the commendable devolution of breeding activities in Asia to NARS and private sector partners, the Panel suggests that ICRISAT seek ways to reinforce the

breeding programs in WCA and ESA by re-balancing human resources from the Asia-based programs to the African regional programs.

The sorghum program in ESA has started to use modern biometric techniques to extract more information from the results of regional multi-environment trial. One of the effects of the commendable devolution of breeding to NARS in Asia has been the expansion of the multi-environment trial network in that region. The Panel believes this conjunction of developments represents an opportunity to re-establish GT-CI comparative advantage in Asia, to better inform breeding decisions across the SAT, and to hasten genetic gains in yield and resistance to biotic and abiotic stresses in all regions of the SAT. It suggests that ICRISAT partner with one or more ARIs that has extended track records in this topic, and establish a core team to focus on developing data collection, data storage and data analysis procedures for dealing with the results obtained in multi-environment trials at a higher level of complexity. Opportunities for generating new knowledge and understanding using these techniques are enormous in a Center, which already has core and mini-core germplasm sets for the mandate crops and has acquired skills in crop simulation modeling and geo-spatial analysis.

The Panel recommends that ICRISAT expand expertise and research capacity in advanced biometrics for analysis of germplasm performance across multi-location environments using data generated across the network of multi-environment trials conducted by the Center and its partners across the Asian and African SAT.

4.4 Biotechnology (GT-BT)

4.4.1 Overview

The majority of ICRISAT's biotechnology research is carried out at the headquarters in Patancheru, India, although the Biosciences for Eastern and Central Africa (BecA) facility at ILRI currently allows some limited molecular marker and genotyping work in Nairobi. GT-BT generates genomic tools needed to increase the effectiveness and speed of crop improvement and the molecular characterization of mandate crop germplasm held in custody by ICRISAT. The development of maps for mandate crop genomes and markers for traits of interest constitute an important part of their work. Bioinformatic tools for data storage, management and access constitute another significant thread. Phenotyping protocols for resistance to biotic and abiotic stresses have been developed, as have transformation protocols for genetic engineering and embryo rescue techniques that open the way for wide hybridization. Work on functional genomics for resistance to abiotic stress has been initiated, as has contained greenhouse and field testing of genetically engineered transcription factors for drought and *Bt* genes for pest resistance. Agreements with (and funding from) the GoI and the GoAP has allowed considerable expansion of GT-BT access to facilities. This has allowed, among other things, for the provision of services to users within and without ICRISAT and to the development of partnerships with the private sector.

During the last five years, substantial advances have been made on all fronts of GT-BT's research portfolio, and the pipeline is currently well supplied. Notably, the first product derived from MAB in India (a pearl millet hybrid resistant to downy mildew, produced using GT-BT markers) was released during the review period. The Panel commends the GT-BT for its excellent work, and particularly for having maintained the right balance (for an IARC) between biotechnological advances and the provision of tools for crop breeding and germplasm characterization. This high degree of success, which opens a broad range of new opportunities, carries with it the need for

rigorous prioritization to avoid losing focus in the years ahead. Important issues will be the definition of strategies that will accelerate progress in the development of high density reference maps for mandate species (in part through the development of strategic partnerships with ARIs, and careful nurturing of the human resource and equipment bases needed to ensure the routine use of genomic tools for crop breeding in WCA and ESA.

4.4.2 Background

The GT-BT was established in 2001 to harness biotechnological approaches to complement and strengthen ICRISAT's crop improvement efforts by developing genomic, genetic engineering, wide-hybridization, and diagnostic tools and approaches that could be used to improve ICRISAT's mandate crops. Currently, GT-BT is an important component of ICRISAT's research efforts, a critical resource for the MTP projects (especially for project #2) and provides service functions for other global themes (principally, but not exclusively, GT-CI) and partners. It has attracted additional funding from the GoI and the GoAP.

Specifically, biotechnology research at ICRISAT is directed at:

- developing genomic tools to efficiently tap beneficial alleles for traits in mandate crops
- improving the efficiency, effectiveness, speed and precision of plant breeding for specific traits through use of marker technology
- developing diagnostic tools to detect viral infections, toxic contaminants of crops, transgene presence, and to check seed in large scale seed production systems.

During the review period the unrestricted funds for GT-BT increased from USD0.9 to USD1.2 million, restricted funding rose from USD1.3 million to USD3.0 million. GT-BT has 26 senior staff, sixteen located in India three in ESA and two in WCA.

Although GT-CI and GT-BT are strongly interlinked in some aspects of their activities, much of these are independent and distinguishable. They are treated separately by the Center for purposes of expenditure and staffing, and there are no specific MTP projects assigned to GT-BT. For the purposes of this review the Panel has treated GT-BT as a separate entity, with goals, research, staffing and funding that are distinguishable from the other GTs. Where there are cross-GT linkages, we have highlighted them.

4.4.3 The 5th EPR Recommendations and ICRISAT Response

The 5th EPR commended ICRISAT for its efforts at integrating biotechnology into crop improvement and applauded GT-BT for its achievements in the development of transformation systems and transgenic products in some of its mandate crops. The 5th EPR made two key recommendations. Rec. # 1 was that ICRISAT continue to undertake strategic research on genomics and transgenic product development; and together with other CGIAR Centers and relevant partners address the issues on IPR, biosafety and public acceptance of transgenic crops. ICRISAT accepted this recommendation. The current EPMR Panel believes that ICRISAT has adequately addressed this recommendation. Documentation of molecular diversity of sorghum, chickpea, pigeon pea and groundnut through extensive genotyping has been completed, leading to the production of markers, used by GT-CI, to generate composite collections of chickpea and sorghum; work is in progress on construction of genetic maps of groundnut, chickpea, and pigeonpea; and transformants of chickpea and groundnuts carrying transcription factors for drought tolerance and of chickpea and pigeonpea carrying *Bt* genes for insect resistance have been produced. Protocols for the assessment of impacts of transgenic crops on non target

organisms have been developed, and an IP policy has been implemented in cooperation with other CGIAR Centers. Within the limits of expertise represented on the EPMR review team, the Panel believes that ICRISAT's IP policy is appropriate.

Rec. #2 was that GT-BT maximize the synergies with GT-CI and partners to generate IPGs for the SATs. During the review period, a marker developed by GT-BT for downy mildew resistance led to the release of a pearl millet hybrid resistant to downy mildew (the first marker assisted breeding product to be released in India), and the current pipeline holds promising markers for several other disease and abiotic stress resistance traits, as well as product quality traits.

4.4.4 Response to 2007 CCER

The review period of the GT-CI and GT-BT CCER (2007) almost overlapped with that of the current review. In general terms, the CCER approved the GT-BT work, a position that this Panel endorses. It also provided useful background information for the current review. The CCER recommended that ICRISAT: (i) increase efforts on reference map construction, (ii) improve the focus of transgenic work, and (iii) complete the development of MAS software. During the review period GT-BT developed a reference map for groundnut; is working on the one for chickpea with the ICAR National Research Center for Plant Biotechnology (NRCPB); and is involved in the sorghum genome sequencing project.[32] Foundations are being laid for maps of other mandate crops (pigeonpea, finger and pearl millets). Transgenic research has been limited to two or three prioritized products for the three mandate legume crops, and five other potentially interesting developments have been stopped or put on hold. iMAS and LIMS software have been released and work on other bioinformatic and data management tools is in the pipeline. GT-BT has also established links with IRRI and CIMMYT under the Generation CP to facilitate further progress on MAS software. The Panel concludes that GT-BT made substantial progress in meeting the CCER recommendations, all of which the Panel endorses.

4.4.5 Progress, Achievements and Impact

Noteworthy among recent impacts of combined GT-BT and GT-CI efforts has been the release of pearl millet hybrid HHB 67-2 (State Varietal Release Committee, Haryana, 2005), which is highly resistant to downy mildew. This is a first for ICRISAT and for India in MAB. According to a document made available to the Panel, in the first year of adoption this allowed farmers in India to avoid USD6.7 million in yield losses.

The GT-BT program has generated a number of other IPGs. These include information analysis systems for MAS (iMAS); and protocols and information-analysis systems for molecular characterization and gene mining of crops, and their pests, diseases and biological control agents, have been developed. In MTP Project 2, genotyping of reference collections of mandate crops has contributed strongly to the use of core and mini-core collections, and has permitted the analysis of genetic diversity among accessions for establishment of heterotic groupings. Development of embryo-rescue protocols for mandate species has opened the way (via wide hybridization) for introgression of alleles for disease and insect resistance and other traits e.g., CMS) from wild relatives into crop species. Transformation protocols for mandate crops allows the production of transgenics involving particular genes/transcription factors as sources of disease, pest and abiotic stress resistance.

[32] Paterson *et al*. (2009). The *Sorghum bicolor* genome and diversification of the grasses. Nature: 457-556.

The MAS research at the ICRISAT headquarters has been facilitated by the availability of efficient methods for screening individual plants for resistance to biotic and abiotic stresses. This has allowed accurate phenotyping of large numbers of germplasm accessions, mapping populations and breeding populations. Progress has been made in screening for drought[33] and salinity tolerance[34], and in searching for sources of resistance to fungal pathogens (*Ascochyta*, *Botrytis* and *Fusarium*) of chickpea.[35]

Work has progressed in precise phenotyping for a number of traits related to resistance to biotic and abiotic stresses in the mandate crops. One example has been the work on drought tolerance in groundnut. Here GT-BT has deployed the full range of its comparative advantages (mini-core collection for groundnut, field screening facilities in Sadore, the weighing lysimeter/rain out shelter in Patancheru, contained glasshouse facilities in Patancheru, capacity for genomic analysis, and expertise in transgenics). This is an impressive example (probably unequalled in the world) of how to address a complex issue at all levels from markers to plots in the field. This has the potential for real progress in understanding the contribution roots make to drought tolerance and to explore the value of transgenes under realistic field conditions. Unfortunately, the quality of the work done to date has been masked by a poor strategy for publication of the results. The Panel encourages the continuation of this type of work for other mandate crops (some are already underway) and strongly suggests a publication strategy that ensures good visibility of the results.

Effective and efficient use of molecular markers in research and breeding requires access to high throughput, low-cost per sample genotyping services. GT-BT has established, as part of its' Center of Excellence in Genomics (funded by GoI), a Genotyping Services Laboratory (GSL). The GSL is providing some 100,000 SSR data points each month to ICRISAT and many collaborators globally. Since its establishment in 2008, almost 1 million datapoints have been provided. GT-BT is encouraged to acquire high-throughput sequencers to meet expected increase in demand and develop a business model to recover costs of the services provided. Genotyping services have also been undertaken at the BecA laboratory in Nairobi but this has been within the confines of funded project activities.

Wild species have been extensively used as donors of disease and pest resistance and other useful agronomic traits in work conducted jointly by GT-BT and GT-CI. Some successful examples include: source of CMS in pigeon pea, sources of resistance to late leaf spot and early leaf spot in groundnuts, sources of resistance to *Helicoverpa armigera*, pod fly and pod wasp in chickpea, and resistance to *Helicoverpa* and *Spodoptera* in groundnuts.[36] ICRISAT is working at developing 'synthetic groundnut' by combining the genomes of the parents of the amphidiploids. Attempts to broaden the genetic base of groundnuts have led to successful crosses between *A. hypogaea* and

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[33] Kashiwagi J., Krishnamurthy L., Upadhyaya H.D., Krishna H., Chandra S., Vadez V. and Serraj R. (2005). Genetic variability of drought-avoidance root traits in the mini-core germplasm collection of chickpea (*Cicer arietinum* L.). *Euphytica* 146 : 213-222.

[34] Vadez V, Krishnamurthy L., Gaur P.M., Upadyaya H.D., Hoisington D.A, Vashney R.K., Turner N.C., Siddique K.H.M., (2007). Large variation in salinity tolerance is explained by differences in the sensitivity of reproductive stages in chickpea. *Field Crops Res.* 104: 123-129.

[35] Pande S, Gaur PM, Sharma M, Rao JN, Rao BV and Kishore G.K. 2007: Identification of single and multiple disease resistance in desi chickpea genotypes to *Ascochyta blight*, *Botrytis gray* mold and *Fusarium wilt*. *J. SAT Ag. Res.* 3 (1).

[36] Mallikarjuna N., Jadhav D., Kranthi K.R. and. Kranthi S, (2004a). Influence of foliar chemical compounds on the development of *Spodoptera litura* (Fab.) on interspecific derivatives of groundnut. *J.Appl.Ent.*128 (5): 321-328.

A. glabrata, *A. kretschmeri* and *A. chiquitana* and the transfer of genes conferring resistance to insect pests and fungal and viral diseases into cultivated species.[37]

ICRISAT has genetically transformed chickpea, groundnut, and pigeonpea using the *Agrobacterium* transformation system, and has developed strategies to develop marker-free transgenic plants. Transgenic plants containing stable genes for resistance to viruses (groundnut), insect pests (pigeonpea, chickpea, and sorghum), fungal pathogens (groundnut, pigeonpea and chickpea), tolerance to drought stress (groundnut and chickpea) and elevated levels of beta-carotene (groundnut and pigeonpea) are at different stages of development. Biosafety containment greenhouses are available at the Patancheru site and ICRISAT is aware of public concerns about the regulatory processes and safety requirements of the genetically engineered products.

A network platform centered at Patancheru has been established, jointly with the Department of Biotechnology (GoI), to develop, analyze and commercialize transgenic crops. This platform, the DBT-ICRISAT Platform for the Translational Research on Transgenic Crops (PTTC) will provide state-of-the-art facilities to ICRISAT, NARS and small to medium private sector seed companies. Current plans call for large-scale production of transgenic events, and the rapid molecular and phenotypic analysis of these events, including initial field trials in containment facilities. Links to other institutes will provide the required safety and regulatory inputs to ensure that the identified products reach farmers in a timely manner without compromising safety and regulatory assessments. It is anticipated that such a facility will allow ICRISAT to develop a range of transgenic events in the mandate crops that will have a spillover in other locations, and especially for SSA.

GT-BT has continued to invest effort in bioinformatics, diagnostic tools, and in increasing the density of markers on maps of mandate crops. New technology (DArT) has been introduced and work on marker platforms (e.g. SNPs) is on-going. This strategy is particularly relevant for complex traits which cannot be easily manipulated using conventional techniques. Examples are terminal drought and salinity, two important abiotic stresses encountered in the SATs. The use of ESTs provides an efficient way of identifying novel genes and it is encouraging that some 11,900 ESTs have become available through GT-BT's work on chickpea. GT-BT is encouraged to continue these efforts in comparative and functional genomics.

Work on phenotyping, decision support tools for MAS and MAB, genetic and genomic resources of mandate crops, drought tolerance and training courses in these techniques has been funded by the Generation CP.

4.4.6 Priority Setting and Linkages with other GT's

The objectives set for GT-BT work during the review period are clear and well aligned with the role expected of this global theme in the context of ICRISAT's mission. Linkages with GT-CI appeared both robust and effective. The Panel commends the staff of these two GT's for taking full advantage of the opportunities to interact.

[37] Mallikarjuna N., Pande S., Jadhav D.R, Sastri C., and Rao J. N., (2004b). Introgression of disease resistance genes from *Arachis* kempff-mercadoi into cultivated groundnut. *Plant Breeding* 123 (6): 573-576.

4.4.7 Publications, Partnerships and Capacity Building

Several papers authored by GT-BT staff (alone or in combination with GT-CI or partners) are clearly cutting edge.[38] The publication rates of some scientists were well below the one SCI paper per year level; others were well above the average. The general view of the Panel is that ICRISAT should encourage all scientists to place greater emphasis on publishing in high impact journals to enhance the global scientific image of the Center. In cases where the output in refereed international journals was less than adequate, the Panel suggests assessment of the cause of low productivity.

GT-BT has partnered very effectively with ARI's (e.g., Plant Genome Mapping Laboratory, University of Georgia), and local institutions (e.g., ICAR's National Research Center for Plant Biotechnology). GT-BT's success in getting GoI funding for the Center of Excellence and its joint Department of Biotechnology/ICRISAT Genotyping Services Laboratory are clear indicators of its capacity to interest other institutions in its work. They have worked with ICARDA on chickpea, and EMBRAPA on groundnut. The GT-BT plays a role in connecting with the private sector through the Ag-biotech Innovation Center and the Hybrid Parents Research Consortium.

Capacity building in Asia and SSA has featured prominently in GT-BT's agenda. During the period under review, a total of 11 training workshops (MAS, LIMS, iMAS, Phenotyping) were organized in Asia or ESA. The rotation of workshop venue between Asia and ESA is commendable. ICRISAT is encouraged to partner with institutions in WCA to organize similar workshops to build capacity in the biotechnologies in WCA. Many of the staff take part in student mentoring, and some of the better theses to come out of ICRISAT-university partnerships had GT-BT mentors.

4.4.8 Cross Regional Integration

GT-BT has strong connections with the BecA laboratory in Kenya, and collaborates with members of GT-CI in ESA and WCA. They are also linked, as part of the *Striga* work, with the Laboratoire de Biologie Moleculaire Appliqué, University of Bamako, and other universities in Kenya, Uganda and South Africa.

4.4.9 Overall Assessment

GT-BT is an extremely important GT in ICRISAT's present and future. The Panel was particularly impressed by the excellent balance achieved between GT-BT and GT-CI, and the capacity to attract interest and funding, and develop partnerships with ARI's and departments of the GoI and the GoAP. The range and quality of the products of research during the review period has been outstanding. On a cautionary note, the Panel notes that this high degree of success, which opens a broad range of new opportunities, carries with it the need for rigorous prioritization to avoid losing focus in the years ahead.

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[38] Bhatnagar-Mathur *et al*., 2007; Kumar S.M., Syamala D, Sharma K.k. and Devi P. (2004). *Agrobacterium tumefaciens*-mediated genetic transformation of pigeon pea (*Cajanus cajan* (L.) Millsp.). *J. Pl.Biotechnol.* 6: 69-75; Haussmann *et al*., 2004; Qi X, Pittaway T.S. Lindup S., Liu H, Waterman E, Padi F.K., Hash C.T, Zhu J, Gale M.D. and Devos (2004). An integrated map and a new set of simple sequence repeat markers for pearl millet, *Pennisetum glaucum*. TAG 10: 1485-1493; Nelson *et al*., 2009.

The work, completed or in progress, using genomic tools to develop composite and reference sets of genetic resources using genomics approaches, together with work on transformation protocols, markers for traits of interest (one already in the field), and other advances make ICRISAT an outstanding example for this area among IARC's.

The internal developments in bioinformatics are excellent, as demonstrated by the design and adoption of the workflow laboratory information management systems (LIMS), the integrated MAS software and the ICRIS (ICRISAT Crop Resources Information System). The Panel encourages GT-BT to complete the work necessary to develop an integrated information management and analysis system that provides the required entry, query, access and analysis interfaces capable of meeting the demands of ICRISAT and the NARS in the SATs.

The Panel is pleased to see synergies between GT-BT and GT-CI and considers such interactions crucial in ensuring that biotechnologies are used to fulfill ICRISAT's mission.

The scale and the opportunities for GT-BT exceed the Center's capacity and the Panel is pleased to see that ICRISAT has developed important partnerships. Because the magnitude of the opportunities is so extensive and attractive, ICRISAT must be ruthless in prioritization in the area of functional genomics. Generation of high density reference maps will be crucial for the deciphering of candidate genes for complex traits. This cannot be done by ICRISAT alone and will require strategic partnerships and the integration of currently available linkage data produced through the use of newer affordable high-throughput markers (e.g. Diversity Array Technology (DArT) markers) with the multiple genetic linkage maps of the mandate crops generated through other technologies. A focus on discovery of QTLs (but keeping a good balance in the biotechnologies) that will target the genes that govern pro-poor traits (e.g., stress and disease related genes linked to productivity of the mandate crops) is essential, and progress to identify such genes has been promising.

The Panel recommends that ICRISAT scale up its activities in marker development through strategic partnerships and resource targeting to accelerate the generation of high density reference maps that facilitate gene tagging for MAS in the mandate crops.

ICRISAT is encouraged to adopt large scale marker assisted breeding technologies in the mandate crops as progress in genome information, especially in sorghum, makes this feasible. Enhancement of the facilities at Patancheru by acquisition of state-of-the-art facilities to handle the high throughput needs may become important.

As IPGs become available for MAB, essential molecular facilities will be needed in SSA, and ICRISAT is encouraged to meet this need in the regional programs especially, WCA. DNA extracted in countries outside the two biotechnology hubs (the GSL and the BecA lab) is far easier to transport across national borders than plant material. PCR for diagnostics is essential in countries for rapid diagnosis of diseases. Such activities undertaken in satellite stations with national partners are a powerful capacity building tool in addition to meeting the other research needs e.g. trait mapping, diversity studies, and especially marker assisted breeding in the regions.

The Panel recommends that ICRISAT establish minimal biotechnology facilities in Bamako or Niamey to allow DNA extraction, low throughput PCR-based genotyping and direct access to the bioinformatics platform at headquarters.

4.5 Agroecosystems (GT-AE)

4.5.1 Overview

The objective of the GT-AE is to produce tools, approaches and methods that are effective in advancing agricultural research and development for improvement of the livelihoods of poor farmers in the highly risk-prone areas of the SAT. Within ICRISAT, it plays a leadership role in seeking to preserve or improve the resource base and the efficiency of utilization of those resources in SAT agricultural systems, and in providing context to guide the efforts of GT-CI and GT-BT. In its activities, GT-AE often requires the collaboration of GT-IMPI.

During the review period, the GT-AE invested significant efforts –together with GT-IMPI, to establish, first INRM and later, IGNRM, as research frameworks for the GT and the Center. Current foci for the GT-AE work include risk management, high value crops, cropping system diversification, and soil nutrient management. Crop simulation models have been used to address climate change, fertilizer management, crop adaptation and yield gap issues. Spatial analyses have been incorporated in several lines of research, and some advances have been made on the crop-livestock interface. Support for watershed management work, especially in Asia, has continued. Farmer participatory research has been emphasized in many projects.

Staff associated with GT-AE have increased their publication rate in high quality journals and decreased the number of conference papers produced during the review period, but continued efforts are needed to ensure that all scientists publish regularly in appropriate and demanding journals.

Staff of the GT-AE have worked with a wide range of partners in developing and disseminating their work, and have shared the mentoring of MSc and PhD theses with staff of many universities in Africa, India and other parts of the world.

Some of the research being conducted by GT-AE is mature and/or can be devolved to the NARS and some research lacks clear justification. Both categories should be de-emphasized. By contrast, work on other topics shows considerable promise and can be expected to yield important new knowledge during the next review period and deserves heightened priority and provision of additional expertise in some areas.

4.5.2 Background

During the review period the GT-AE had a sharp increase (USD3.7 million to 7.4 million per year) in restricted funding and a smaller increase (USD0.8 million to 1.5 million per year) in unrestricted funding, together with an increase in staffing (22 to 29). A notable feature of this period has been the changes in institutional status of the watershed projects in Asia as a result of contradictory recommendations in the 5th EPR (2003) and the GT-AE CCER (2006).

4.5.3 The 5th EPR Recommendations and ICRISAT Response

The most important recommendations of the 5th EPR relating to the GT-AE were to:

- phase out the previous NRM GT that focused on Asia (Rec. #3),
- prioritize and consolidate IPM and IDM work (Rec. #4), and

- incorporate crop/livestock work into a new GT3, accompanied by a shift in emphasis to a landscape level perspective, and an increase in staff (Rec. #6).

The subsequent GT-AE CCER disagreed with Rec. #3 above, but the Center has made progress in the implementation of the other two recommendations, especially in the case of the crop/livestock interface and work on *Striga* in Africa in the IDM/IPM area.

4.5.4 Response to 2006 CCER

The GT-AE CCER (2006) provided context for the current evaluation. Most of the information about projects, outcomes and impacts was contained in the three "field visit" reports (Asia, WCA and ESA) on which the CCER is based, and some parts of these proved useful in the current EPMR. The methodology used to compile the main report was inappropriate and the result is rather diffuse.

The GT-AE CCER recommendations were numerous (23 total). The main threads of the recommendations were:

- The need for improvements in geo-spatial targeting and validation of research, and greater emphasis on cropping systems-level and agro-ecosystem research and analysis (Recs. #1, #5, #14, #19, #22).
- The need for better M&E, impact and outcome evaluations (including more staff assigned to the issue and better product identification), and the need to consolidate the IGNRM paradigm (Recs. #7, #8, #9, #12, #18, #20, #21).
- Livestock issues identified as requiring attention included research on the value of livestock for market-led intervention in ESA, and on better understanding potential downside risk from livestock rearing (Recs. #1 and #6).
- "Highly-relevant, well-focused cutting-edge research" for the watershed projects (Rec. #15), more comprehensive studies of water issues (Rec. #10), more careful targeting of water issues in the drier and wetter portions of the SAT (Rec. #11), and a scoping study for watershed work in Africa (Rec. #19).
- The need for improved cross-regional integration (Recs. #17, # 18).
- More careful targeting of (and/or more investment in) upstream research in the Desert Margin and African Market Garden (AMG) work (Recs. #2 and #3).

The GT-AE has made some important advances in relation to some of these recommendations, e.g. more systems analysis, investment in livestock-crop interactions, risk analysis, geo-spatial analysis, greater care in defining products and IPGs, and continued progress seems likely given recent initiatives. Efforts have been invested in improving impact assessment and creating a culture of impact assessment, but insufficient staff trained in this discipline has been a constraint. On other issues, advances were harder to identify (particularly in relation to watershed work, and the science component in the AMG, SEF and DMP work).

CCER Recs. #14 and #15 call for special comment given that these were in direct opposition to the 5th EPR Rec. #3 (phasing out of watershed work in Asia). As noted above, these CCER recommendations led to changes in the institutional status of the watershed research projects during the review period, which may have hampered repositioning the work in this area.

4.5.5 Progress, Achievements and Impact

This section is organized along the lines of the eleven issues used in the GT-AE Highlights 2003-2008 document. This was preferred to a commentary organized along the MTP Project structure, which is not a functional management framework (see sections 2 and 6), and because MTP Project 9 includes many more issues than either of Projects 7 and 8. One of the issues listed in the GT-AE document (*Assessment of input supply projects under relief and recovery programs in Zimbabwe*) was relatively unimportant, and the DMP has been abandoned for lack of funding. The Panel offers no comments on either issue.

1. Lessons from NRM intervention and adoption processes

The GT-AE (together with the GT-IMPI) has invested effort into understanding the adoption processes for NRM interventions, in generating a framework for the Center (IGNRM), and in examining alternatives for impact assessment in an NRM context. The five principal lessons arising from the study of the adoption process were flexibility, the need for a tool-box of technologies and practices, the requirement for short term economic gain, the need for an appropriate policy environment, and community participation.

GT-AE and GT-IMPI collaborated in trying to generate a framework, termed IGNRM, to guide the work of the Center.[39] Indeed, it is a cornerstone of the Center's overall strategy as described in Section 2. This paradigm expands the INRM framework by explicitly incorporating the use of improved crop varieties and seed systems in NRM interventions. The Panel was not convinced of the value of the IGNRM paradigm. While the addition of the "G" to INRM may have value within the Center to bring GT-BT and GT-CI into closer collaboration with the GT-AE, it also runs the risk of turning this highly imprecise concept into dogma and catch-phrases. As any good agronomist knows, the "I" in INRM also includes the "G" along with a host of other cultural, social and economic issues.

GT-AE has also been involved in impact assessment in relation to NRM research, although this has been primarily driven by GT-IMPI.[40] Because it is much more difficult to document adoption of NRM research products, compared to release of improved varieties, the Panel believes these efforts to have been useful and commends ICRISAT for addressing the issue.

The attempts to formalize frameworks for the analysis of the intervention and adoption processes of NRM research products can be counted as moves towards meeting CCER Recommendations #7, #9, #12, #18, #20, and #21.

In the future, continued attention by Senior Management will be needed to ensure that the few hard-and-fast rules that have been identified (e.g. ex-ante and ex-post impact assessment, and continuous M&E during project execution), together with the five principal lessons derived from the study of adoption of NRM interventions, are systematically used to ensure that all Center-sponsored projects conform, in concept and in execution, to these guidelines. In all three regions,

[39] Twomlow S, Bekele S, Cooper P, Keatinge JDH. 2008: Integrating genetics and natural resource management for technology targeting and greater impact of agricultural research in the semi-arid tropics. Expl.Agric. 44:235-256

[40] Shiferaw B, Freeman HA, Swinton SM. 2005: Natural resource management in agriculture: Methods for assessing economic and environmental impacts. CAB International: Wallingford. 386 pp

the limited availability of sufficient GT-AE staff trained in impact assessment is currently a limitation to doing this.

2. Spatial analyses

The GT-AE has made significant strides to incorporate spatial analyses into its work in all three regions, and across a range of topics that include recommendation domain mapping for photoperiod sensitivity in cereals, the geography of potential gene-flow pathways, targeting of watershed management technologies, and soil micronutrient deficiency mapping. This work is the natural complement to crop simulation modeling, climate risk assessment, and evaluation of climate change scenarios. The work completed during the review period can be regarded as an effective initial response to the CCER recommendations to increase the emphasis on spatial analysis and landscape level work (also a 4th EPMR recommendation).

The Panel encourages the Center to deepen and broaden this work and their capacity to conduct it because it is essential to ensure the output of IPG' s from NRM research, and also for strategic planning and research prioritization (see Section 2).

3. Systems simulation modeling

During the review period GT-AE scientists have made important advances towards both adapting appropriate models of the DSSAT and APSIM suites to suit the particular features of crop management for the SAT[41], and in developing genetic coefficients and new response functions for photoperiod sensitivity in pearl millet and sorghum[42]. Some work using simple water balance and soil organic carbon (SOC) models has also been initiated. Importantly, crop simulation models were used to inform analyses of fertilizer microdosing adoption in ESA, as tools for the exploration of crop adaptation to rainfall patterns, and for yield gap analysis. Connections between this work and that on GIS analyses, climate change and climate risk work is strong. In future, it will be important to ensure strong collaboration across Center locations for this work (CCER Recs. #22 and # 17).

4. Climate risk management and climate change

Work on climate risk management and climate change in ESA has progressed very well. A consortium of partners was formed and a series of proof-of-concept projects formulated and funded with completion dates spanning the interval 2007-2012. These proof-of-concept projects are sufficiently up-stream as to ensure the generation of IPGs (ref. Annex 2, Strategic Issue # 5). Work is also progressing on the Water and Food CP for the Limpopo basin, although this activity encountered some start-up difficulties. Taken as a whole, these activities indicate a well supplied research pipeline and raise expectations for continuing progress.

Importantly, a set of tools for climate risk analysis has been identified and tested. Farmer perceptions of climate risk have been explored and results suggest several avenues for climate risk management tactics, provided improvement in climate forecasting capabilities as found in initial studies can be shown to hold in other areas of the SAT. Use of simulation modeling of crop economic responses to fertilizer under highly variable climate would seem to be a useful next

[41] Cooper PJM, Dimes J, Rao KPC, Shapiro B, Shiferaw B, Twomlow S. 2008: Coping better with current climatic variability in the rain-fed farming systems of sub-Saharan Africa: An essential first step in adapting to future climate change?. Agric.Ecosyst. Env. 126:24-35

[42] Folliard A, Traoré PCS, Vaksmann M, and Kouressy M. 2004: Modeling of sorghum response to photoperiod: a threshold–hyperbolic approach. *Field Crops Res*. 89:59-70.

step to gain farmer interest and confidence in using these risk management tools. Another research output was the identification of "analogue locations", which are locations in which current climate mimics expected climate for other locations *after* climate change has occurred. The Panel believes that ICRISAT's overall strategy of dealing with current climate risk management is the most effective first step to address concerns about the impact of climate change in the SAT (ref Annex 2, Strategic Issue #4).

In order to build on these initial successes and to ensure that the high temperature features of climate change (especially, brief 1-3 day episodes of high temperature stress) are adequately anticipated, current models for mandate crops will need to be improved to ensure that effects on seedling establishment, grain number determination and grain size and quality are correctly captured. Climate variability analyses must also be performed to adequately characterize the duration and intensity of high temperature stress episodes and, if possible, to improve forecasting skill for this climate variable. This is a major task, as very little work has been done anywhere in the world on these issues, and it will require cooperation with ARIs.

Other interfaces that need careful attention are those undertaken together with GT-CI and GT-BT on high temperature tolerance. Solid protocols are needed to develop appropriate screens for high temperature stress tolerance in the critical developmental phases of the crop growth cycle and, hopefully, identify markers for them. Simple germplasm screens based on shifting the time of sowing to the warmer periods of the year have many pitfalls (e.g., indirect effects of changes in radiation levels and photoperiod) and run the risk of producing unreliable results.

ICRISAT´s prior experience in modeling and remote sensing, and the location of its field research sites across a wide range of SAT environments in Asia and SSA, provide a clear comparative advantage to conduct this research. We believe the Center should establish a strong core team dealing with these issues, and although it would be an institute-wide resource, the team could be located in either the ESA or WCA regional offices. Excellent inter-regional collaboration is a pre-requisite for continued progress in these research areas (CCER Recs. #17 and #22).

5. Soil organic carbon sequestration

The Rothampsted soil carbon dynamics model has been simplified and tested successfully in WCA, and 28 sites in India have been benchmarked for C sequestration purposes. SOC simulations were performed using APSIM for a single Patancheru site, and CENTURY has been tested to examine the effects of pigeon pea management on SOC. A large proportion of the SOC sequestration work is linked to the watershed work in Asia. Straightforward ex-post comparisons (without replication or initial benchmarking) for SOC were made for two watersheds at Patancheru. Despite publication of these field-based comparisons, close examination of this work leads to questions about the validity of its conclusions and its overall quality.

Although the SOC sequestration issue is an important one, and some of the initiatives reported under this topic are interesting, the Panel does not believe it can be continued without significant investment to upgrade the depth and breath of the research. However, the Panel would not recommend making such an investment because other priorities, such as an expanded capacity in crop and ecosystem modeling, geospatial analysis, and climate risk management are deemed of much greater importance.

6. Water resources management

The GT-AE Highlights document reports inputs by ICRISAT staff (who contributed expertise) to an India-wide survey of watershed projects conducted by the GoI in 2006-08, work on chickpea as a rabi crop after rainfed rice, and some disconnected water quality and run off /soil loss surveys for Asia. Work in Africa involved: (i) the SWNnet consortium exercise (2003-7) in ESA and WCA; (ii) studies on the combined affects of planting basins, microdosing and improved cultivars in SA, (iii) the Water and Food CP for the Volta Basin in WCA.

The Volta Basin project information is poorly presented (and seems to have had serious implementation problems as indicated by other information available to the Panel), and the remaining topics lack unity and a clear guiding strategy. On a microscale level, work on planting basins, zai, tied ridges and other water conservation/concentration procedures were being conducted in India, WCA and ESA, but little new research was being conducted on these techniques, which the Panel regards as mature. The only further research on these topics that appears to be justified relates to the assessment of implementation. Some progress seems to have been made in SWMnet, which is now part of a new ASARECA project : Natural Resource Management and Forestry.

In assessing the water resources management and SOC sequestration efforts, the Panel made due allowance for the changes in institutional status of the watershed work during the review period. It also noted that the CCER recommended "highly-relevant, well-focused cutting-edge research" for the watershed projects (Rec. #15), more comprehensive studies of water issues (Rec. #10), and more careful targeting of water issues in the drier and wetter portions of the SAT (Rec. #11). The Panel felt there was little evidence of a clear strategy for moving forward in the generation of robust, science-based IPGs linked to these topics.

Spatial variability in nutrient availability (within fields or across fields) is likely to be an important factor affecting crop water use and residual soil water at harvest, yet the Panel found little evidence (the microdosing/water balance/nutrient balance experiment in WCA excepted) of work in this area. Two phrases from the GT-AE CCER report are appropriate here: "the context of the grand challenges that ICRISAT faces" and "highly-relevant, well-focused cutting-edge research".

ICRISAT needs to undertake a major review of this work, which should identify a few major strategic strands (e.g., constraints to water productivity, optimization of rabi crop management as a function of residual soil water store, etc.) that would provide the basis for future staffing decisions and resource allocation. This work should be tightly linked to the proposed modeling and geospatial core team.

7. Integrated nutrient management

The main thrusts of this work were micronutrient deficiency surveys in India[43], and different aspects of macronutrient microdosing adoption in ESA and WCA. The WCA work on microdosing is poorly presented in the GT-AE Highlights 2003-2008 despite the fact that one of

[43] Rego TJ, Sahrawat KL,Wani SP, Pardhasaradhi G. 2007: Widespread deficiencies of sulfur,boron, and zinc in Indian Semi.arid tropical soils: On farm responses. *J.Plant Nutr*. 30:1569-1583. Sahrawat KL,Wani SP, Rego TJ, Pardhasaradhi G, Murthi KVS. 2007: Widespread deficiencies of sulphur, boron and zinc in dryland soils of the Indian semi-arid tropics. *Current Sci*. 93:1428-1432.

the few experiments shown to the Panel that appeared to be breaking new ground on the microdosing /crop water balance was located in WCA.

ICRISAT's research has clearly documented the existence of micronutrient deficiencies in parts of the Indian SAT. The work published on this topic identifies micronutrient deficiencies in a limited number of districts, but the titles of the papers written about the topic imply a much more ubiquitous occurrence. Further research should focus on documenting the extent and severity of this constraint, and do so in partnership with the NARS to ensure standardized methods and access to data from testing sites across the relevant geographic domain. Spatial variation in soil parent material and land use should be given appropriate attention.

The Panel believes the knowledge generation phase for response to micro-dosing is basically mature. Challenges remain in the understanding the adoption process and measuring the impact -both economic and biophysical. Formal impact assessments of micro-dosing have been limited, largely because of lack of trained staff, and because it is not clear that there are significant production areas where this technology has been widely adopted without substantial logistical support from ICRISAT, NGOs, or other organizations.

ICRISAT should concentrate on wrapping up current research on this topic and restrict staff involvement in microdosing work to an advisory role to partners engaged in scaling up adoption. At some point, and if there is more widespread adoption, follow up impact assessment would be worthwhile.

8. Systems diversification and intensification

The main examples of work in this area in WCA were the African Market Garden scaling out and on-station economic evaluation of the same, field-testing of the bio-reclamation of degraded lands techniques, biophysical testing and economic evaluation of the Sahelian Eco-Farm/Dryland Fruit Plantation, screening for adaptation of fruit tree species, and on selection of high temperature resistant cultivars of vegetables (the latter, jointly with AVRDC). In Asia, work revolved around potential biofuel sources (sweet sorghum, *Pongamia* and *Jatropha*) and rabi season chickpea (and a suite of other appropriate crops) in rice fallows.

As noted in the CCER (Rec. # 3), the WCA work is very applied in nature and generation of new knowledge is limited (ref. Annex 2, Strategic Issue # 5). The Panel received very strong and enthusiastic feed back from end users, and it is unlikely that the NARS in the region could, alone, mount an equivalent effort. The current impact of this work is very strongly dependent on the notable capacities for innovation and lateral thinking of the very experienced senior scientist who leads these projects (and is nearing retirement). ICRISAT needs to find a way to shift the emphasis of this work upstream without throwing the baby out with the bathwater.

The work on bio-fuel sources in India may contribute to improve the livelihoods of the rural poor and provide incentives for recovering degraded lands and/or providing alternative sources of income for poor farmers or landless rural population. However, the following questions remain:

- Where does the comparative advantage of ICRISAT lie in the matter of *Pongamia* and *Jatropha*?
- Where are the careful analyses of trade-offs and optimization that are essential to guide the crop improvement and management efforts for sweet sorghum?

The Panel found very little evidence that the NARS of India could not handle the issues relating to use of *Pongamia* and *Jatropha*, either for land reclamation/livelihood improvement or as sources of biodiesel feedstock (ref. Annex 2, Strategic Issue # 6). The Panel also noted there is a great deal of promotional work on these species financed by the GoI and by large players in the private sector.

In contrast to work on secondary biofuel crops, the Panel commends ICRISAT on its work on sweet sorghum as a feedstock for ethanol, which has led to collaboration with private sector partners in establishing a commercial-scale sweet sorghum ethanol industry. The enabling technologies for this system is based on ICRISAT's comparative advantage with sorghum genetic resources and breeding, which appears to have led to identification of sorghum inbred lines and hybrids that can produce stems with high sucrose content with minimal loss of grain yield. Such germplasm raises the overall value of the crop because, in addition to grain, the aboveground vegetative biomass can be extracted for sugar to produce biofuel, and the residual forage after extraction provides an excellent feed source for cattle, sheep and goat. Validation of claims that establishing a sweet sorghum biofuel industry is pro-poor through economic analysis of the benefits that accrue to rural and urban poor is needed. A modest effort on life-cycle contribution to greenhouse gas reduction compared to gasoline might also be warranted as a component of the broader climate change efforts within the Center. The Center should avoid the appearance of trying to "sell" sweet sorghum as a "smart" crop, something which seem to suggest that a farmer can produce stover, grain and syrup *without any trade-offs* between these objectives (a thermodynamic impossibility). If ICRISAT has data to support this contention, it needs to be published in a rigorously peer-reviewed journal. Otherwise, the claims should be toned down. Comparisons of crop water consumption between sweet sorghum and sugar cane, which ignore differences in crop duration and sugar yield per unit of water used, are another example of a tendency to oversell. The work needs to avoid oversell and focus on the real scientific challenges underlying the optimization (to suit particular target environments) between the products of sweet sorghum (fodder, syrup and grain) (ref. Annex 2, Strategic Issue # 6). There is an important opportunity to use modeling and geospatial analysis tools to target the most appropriate SAT cropping systems for sweet sorghum cultivation and poverty alleviation. Equally, the economic basis for using sweet sorghum cultivation as an entry point for agricultural system transformation through higher input rates needs adequate assessment. ICRISAT, building on its comparative advantages, has the potential to do both.

The Panel believes that ICRISAT needs to reposition its efforts on agricultural diversification. This repositioning will have to be nuanced and suited to each initiative.

9. Crop-livestock interface

The 5th EPR recommended (Rec. #6) that strategic research in crop-livestock systems should be transferred to Africa, with special reference to landscape level research, and recommended an increase in staff. The CCER team made two explicit recommendations on the role of livestock research in the ICRISAT portfolio (use of spatial analysis combined with a market led intensification strategy with a crop livestock focus; systematic analysis of the downside risks of crop-livestock systems; Recs. # 1 and #6). ICRISAT has accepted these recommendations and in 2008 began to take significant action on this issue, including the appointment of new staff assigned to work on market-led changes in technology.

While it is still early days, the Panel commends ICRISAT for having gotten the ball rolling in a set of projects that have a high likelihood of producing IPGs. The work in WCA revolves around

animal nutrition and flock/herd demography techniques, while in ESA, the focus is on opportunities for market-led changes in technology from extensive rearing to more intensive practices. A value chain approach is central to these efforts and ICRISAT is partnering with, among others, ILRI. Another project targets water productivity in crop-livestock systems of Ethiopia and Zimbabwe, and ILRI is also a partner there. There has been some good work coming out of the ICRISAT-ILRI partnership on the subject of stover.[44]

While the Panel commends the Center for revitalizing work at the crop-livestock interface, it also noted gaps in the overall strategy. Center documents (e.g., Harvesting the seeds of success, Chap. 5) repeatedly make reference to the crop-livestock interface, but attempts to tackle the issue are often very crop-centered (e.g., the most prominent issue is stover quality as fodder). In many areas of the SAT poor farmers are running crop-livestock enterprises, and the connections between the two activities go a long way beyond the fodder quality of crop stover. There are issues of nutrient refuging, efficiency of nutrient recovery and cycling, livestock induced land degradation, optimization of grain and stover trade-offs, crop-livestock relative importance according to environment (and drought intensity) which are crying out for attention within a holistic framework that includes the spatial dimension.

The Center needs to do much more if it wishes to close the gap between its declarative statements and its effective activity. The Panel strongly urges the Center to revisit this issue to evaluate the possibility of a more holistic vision for this topic. ICRISAT should build on its current links with ILRI to ensure that this issue does not fall through the gaps which separate the mandates of the two institutes. The CGIAR move towards multi-institutional programs may offer an opportunity to expand this work.

10. Integrated Disease Management and Integrated Pest Management

The 5th EPR recommended prioritization and consolidation of IPM and IDM work, with the emphasis to be placed on African issues. ICRISAT accepted this recommendation and emphasized work on *Striga*. The section on IDM in the GT-AE Highlights 2003-08 is very poorly presented and provides no insight at all on ongoing work. However, the Panel was able to appreciate (and was very favorably impressed by) the work on *Striga* in both WCA and ESA. The Panel commends the overall strategy guiding this work. Some IPM work involving trap species was also shown to the Panel in WCA. More effort needs to be put into clarifying research hypotheses, outcomes and impacts from IPM work. It should be noted that the Host Plant Resistance component of the IDM/IPM is dealt with by the CI GT, and that the Panel was shown some very good work in this area in their visits to WCA, ESA and India.

4.5.6 Priority Setting and Linkages with other GT's

The methods and criteria used for priority setting within the GT-AE program were difficult to discern, which is also an overall condition for the Center (see Section 2). The Panel reviewed the Operational Research Strategy documents for Climate Change, Land Degradation, Water Scarcity and High Value Agricultural Products. Although of uneven quality, none of the four documents provided much insight into the process of priority setting. The Panel doubts these documents

[44] Bidinger F. R. and Blümmel M. (2007). Effects of ruminant nutritional quality of pearl millet [*Pennisetum glaucum* (L) R. Br.] stover. 1. Effects of management alteratives on stover quality and productivity. *Field Crops Res.* 103: 129-138. Blümmel M. Bidinger F. R and Hash C. T. (2007) Management and cultivar effect on ruminant nutritional quality of pearl millet [*Pennisetum glaucum* (L) R. Br.] stover. Effects of cultivar choice on stover quality and productivity. *Field Crops Res* 103: 119-128.

could be of genuine help to the Board, to Senior Management, to the GT Leaders or to individual scientists in making decisions about how to go about their work, what to emphasize, and what to leave aside.

The Panel believes that the GT-AE (and the Center as a whole) needs to make the priority setting process clearer, with specification of participants in each exercise and identification of all options considered (i.e., not just the option finally selected). The documents setting out the results and the rationale for preferring the options finally selected must be explicit and must be designed to inform the decision making process at Board, management, theme leader and individual scientist levels.

Connections between the GT-AE and the other global themes appear to be good. The Panel commends the GT-AE for their work with GT-IMPI on impact assessment in the NRM context (Shiferaw et al., 2005) and for their attempts to introduce the IGNRM paradigm. Although the Panel remains unconvinced of the rationale advanced for IGNRM as an improvement on INRM, the attempts to formulate this paradigm shows that the GT-AE has taken the lead in a Center-wide effort to improve connectivity between global themes. The GT-AE also collaborates with GT-IMPI on impact assessment of individual Gt-AE initiatives (e.g., AMG and SEF). The IPM work on *Striga* appears to be well connected with the GT-BT/GT-CI efforts to strengthen HPR against this parasite. The GIS work in WCA on photoperiod sensitivity domain mapping for cereals is a nice example of cooperation between GT-AE and GT-CI.

4.5.7 Partnerships and Capacity Building

During the review period staff of the GT-AE were involved in mentoring 72 MSc and PhD candidates (research scholars), developed undergraduate courses and have mentored 98 interns and 32 research fellows. Given the strength of ICRISAT research teams vis-à-vis those of many universities and NARS in the SAT, this has the potential for enormous impact. The Panel commends the GT-AE for this activity.

Staff of GT-AE have worked, during the review period, with a wide range of partners in developing and disseminating their work. These include the NARS of many countries in Asia and Africa, National Meteorological Services of many countries, other Centers of the CGIAR System, other research institutes or consortiums; regional organizations; and international development and aid institutions; NGO´s and private sector partners. GT-AE played a role in the Desert Margin Program and the Water and Food Challenge Project and partnered and/or provided expertise for metanalyses of watershed work in India led by ICAR and helped the Ministry of Agriculture and Cooperation (GoI) develop a system for rehabilitating degraded common lands. Farmer field schools were used to disseminate information about microdosing and AMG.

These partnerships seemed to be working well. The partners with whom the Panel had the opportunity to meet expressed, with very few exceptions, a high degree of appreciation. The Panel´s evaluation of this dimension of the GT-AE´s work would have benefited from a more systematic report on these activities, perhaps along the lines of the research, publications and student thesis information included in the GT-AE Highlights 2003-2008.

4.5.8 Cross-regional connections

The watershed team in Asia has commenced working in diffusing the community watershed management concept to Africa in combination with ASARECA, and financial support from the GoI for this activity is expected. Initial work with the APSIM crop simulation model system served as a starting point for crop simulation modeling in Africa. The micro-dosing technique pioneered within the Center at Sadore in the 1990's and further developed in ESA has now been re-transferred to WCA in its more advanced form.

4.5.9 Overall assessment

The Panel concludes that the GT-AE has produced some IPG's during the review period and looks well set to produce more in the short term via the stronger of its new lines of research, although whether these IPGs were planned or not is moot. Some of the NRM work is too far downstream (or lacking in upstream/downstream balance). Extenuating circumstances for this may be found (e.g., weakness of NARS for AMG/SEF work or microdosing) in some cases, in others (e.g., watershed work, biodiesel feedstock work), none are apparent.

The GT-AE (and the Center) has laid much emphasis on the IGNRM framework as a guiding principle. While accepting the importance of promoting cross-GT interactions in Center research projects, the Panel believes the framework is of limited value in guiding research planning and evaluation. By contrast, systematic application of some of the lessons and principles distilled from the efforts of GT-IMPI and GT-AE to understand the adoption process for NRM interventions would be helpful in project design, execution and assessment.

During the review period the GT-AE has made considerable progress in research on climate risk and climate change management, remote sensing and geo-spatial analysis. Future progress seems assured by work in the pipeline. This provides the Center with a considerable comparative advantage in both regional and global terms, and this work is essential for the rapid development of many aspects of the Center's research, including crop improvement, biotechnology, and impact assessement. The new Climate Change Challenge Program may offer opportunities to sustain the execution of this recommendation.

The Panel recommends that ICRISAT build a core team with expertise in systems analysis, crop modeling, climate analysis, geo-spatial analysis, and economics located in Africa as a Center-wide resource for research, strategic planning and impact assessment, and to concentrate the efforts now dispersed across regions.

A number of themes currently being studied at the Center involve either mature technologies (e.g. watershed work, microdosing), are too applied in nature (e.g., AMG and DEF), can be handled by the private sector and/or NARS (e.g., *Jatropha*, *Pongamia*, rabi chickpea), or have not progressed (DMP, Food and Water Challenge Program for the Volta basin).

The Panel recommends that ICRISAT move rapidly to de-emphasize current mature lines of work, particularly in GT-AE (e.g. watershed management in Asia, microdosing, Africa market gardens, dryland eco-farms), and work that can be performed by the NARS (e.g. jatropha, pongamia, chickpea in rice-fallows) to free up resources needed for new initiatives.

The Panel notes that this process will need to be nuanced and suited to the current situation for each theme. Unless implementation assessment appears to be appropriate, staff involvement in watershed work in India and microdosing in Africa should be limited to a consultancy role. Because of the weakness of the NARS in WCA, special arrangements may be needed to ensure that achieved gains in applied science in the AMG/DEF are protected.

Work proceeding at the crop-livestock interface is promising and deserves continued support. As noted above, the dimensions of this interface are much more numerous than those currently considered. ICRISAT should devote efforts to broadening the scope of this work and build on its current strong links with ILRI to maximize the possibilities for rapid advancement of these themes.

Water and nutrients (both macro and micro) are and will continue to be dominant constraints to the livelihood of poor farmers in the SAT, but the time has come to build on earlier successes and launch out into fresh approaches that may produce new IPGs in future. Nutrient/water interactions and their effects on water productivity (kg grain/ha or kg grain+stover/ha per mm available water) or definition of drought patterns as affected by climate variability and crop (nutrient determined) water uptake do not seem to figure very highly on the Center's current research agenda, something which contrasts starkly with the expectations currently placed on finding markers or using transgenes to improve drought tolerance of mandate crops.

The Panel believes that ICRISAT is very well placed to build on its comparative advantages to optimize the sweet sorghum product mix according to target cropping systems, to map the geographical distribution of these systems, and to assess the likely pro-poor effects of sweet sorghum cultivation under current or intensified management practices.

The Panel was provided with insufficient information to permit an evaluation of the broad thrust of the IDM/IPM work. An exception to this statement is the *Striga* work, which the Panel strongly commends.

The Panel commends the GT-AE for its efforts in the mentoring of research scholars, research fellows and interns, and urges the GT to rapidly adopt measures designed to strengthen the effectiveness of this activity as indicated in Sect. 5 of this Report. The Panel also commends GT-AE for the care with which it has nurtured good relationships with a very broad range of partners and urges GT-AE to sustain these efforts in what is, by its very nature, a never-ending battle.

Finally, the Panel believes that the GT-AE (and the Center as a whole) needs to make the priority setting process clearer, and needs to produce prioritization position papers which can better assist the decision making process at Board, management, theme leader and individual scientist levels.

4.6 VASAT-Virtual Academy for SAT

4.6.1 Introduction

The Virtual Academy of SAT (VASAT), based in ICRISAT's KMS unit, is a consortium that brings together a diverse group of government, development and higher education partners from Asia, WCA, and the USA, in addition to FAO, the CGIAR System and other CGIAR Centers. The initiative seeks to utilize advances in information technology and open-distance learning to make

agricultural knowledge more accessible to stakeholders—including research scientists, research institutions, NARs, private sector professionals, development partners and other intermediaries. The project also holds out a vision of reaching communities and farmers directly as access to technology, including internet connectivity, community radio, satellite digital radio and cell phones, becomes widespread. ICRISAT's contribution to content focuses on the SAT region and the Center's mandate crops.

VASAT is Project 10 in the MTP. Funding for the program during the EPMR review period has been complex and precarious because of the size, number and duration of grants from donors and other Centers, which can be characterized as small, few and short. From 2004 through 2006, VASAT received a total of USD350,000 from the CGIAR's ICT-KM System office unit through a competitive bidding process. The project received unrestricted support from ICRISAT that totaled USD770,000 in 2007 and is projected to receive approximately USD900,000 in 2008. BMGF has made a grant that will enable development of a rigorous method for impact assessment, and is considering a large multi-partner grant for VASAT that would involve 11 CGIAR Centers, 15 NARS and ARI partners. ICRISAT's specific role in the project relates to the portal hosting system and capacity building.

The number of staff on the project is small but KMS has leveraged the talent and time of a substantial number of fellows and interns with software design and technology skills to do much of the development of VASAT activities and IT infrastructure.

4.6.2 Recommendations from the 5th EPR and CCER on KMS

At the time of ICRISAT's 5th EPR, what was then called the Virtual University for the SAT had just been established. Launched in June 2003, almost coincident with the submission of the EPR report, the recommendation on VASAT in the EPR report is both speculative and skeptical, recommending that ICRISAT should rationalize the role, scope and objectives of the project and remove the word "university" from its title as inaccurate and misleading. ICRISAT accepted the recommendation with respect to the name, but pulled back from the implied criticism of the project underlying the recommendation. The present EPMR panel supports ICRISAT's response as there is now more information about the scope, need, and potential impact of the VASAT effort.

VASAT was also evaluated as part of the CCER on GT-IMPI and KMS in 2007. Two overlapping recommendations were made with respect to the project. The CCER recommended strengthening the research design of VASAT interventions by developing a research proposal that would include independent evaluation of first generation VASAT activities to improve the design of second generation trials. It also recommended independent impact evaluation to assess the extent to which the VASAT model is dependent on particular contexts or can be generalized to other settings and different conditions. ICRISAT accepted the intent of the two recommendations and received funding to pursue improvements to the research design of VASAT interventions as well as to evaluate the impact of its work to date, principally in India, Afghanistan, and Niger.

The CCER on GT-IMPI and KMS was particularly thorough in its evaluation of KMS and its interrelated units—Learning Systems Unit (LSU), Information Systems (home to VASAT), and ICRISAT's Library. The CCER noted that ICRISAT's technology infrastructure is exceptional. The global leader of KMS is a member of the Research Committee and is therefore in a position to work with the Center's management to assess the level and quality of technology support

available to research scientists, regional projects, and management. The Library is also singled out in the CCER for the level of innovation it has shown in building and sharing ICRISAT's knowledge in SAT agriculture. The senior staff of KMS are active in CGIAR-wide activities to build efficient and accessible information and knowledge systems and are active collaborators with NARs, ARIs, universities, research libraries, development agencies and others to improve specialist and public access to research information.

4.6.3 Assessment

The Panel evaluated whether VASAT contributes to ICRISAT's mission, whether it has comparative advantages over other Centers or partners in leading or providing a home to the initiative, and whether, given positive answers to these questions, it is positioned to succeed (ref. Annex 2; Strategic Issue # 8).

ICRISAT's principal contribution to VASAT content is the Center's knowledge of SAT agriculture and the Center's mandate crops. In its strategic plan, ICRISAT gives VASAT a notable place in its efforts to ensure that its upstream research and IPGs move downstream to NARS and other end users in the form of as accessible, well organized and adaptable knowledge. In addition to this role, the Center's MTP also identifies areas in which VASAT itself will generate IPGs, principally through its work on creating the underlying architecture (i.e. IT platforms and models) required to create, share and use knowledge that benefits the poor. While the Panel did not agree with the characterization of the project as "blue sky", this is largely a concern about semantics and is not considered to be material for the Panel's evaluation.

VASAT proposes to create a "granular" structure for content to make it easier to find, use and adapt information. Knowledge (IPGs) will be put into digital formats that allow adaptation to a wide array of technologies—web, radio, video, and cell phone. Because VASAT has a relatively small percentage of ICRISAT's resources, the project has been forced to be deliberate about its strategies and its growth, enabling it to avoid heavy investments in IT technologies that quickly become obsolete. VASAT now enters phase 2 after a solid phase 1 period with greater flexibility to capitalize on new technology developments and with a track record of establishing productive partnerships.

In phase 2, VASAT has the potential to pick up momentum at a moment when it and ICRISAT's leadership of it possess a number of comparative advantages, and the external environment runs in its favor. Access of NARS and extension services, local community and end users to internet connectivity, community radio, satellite digital radio, and cell phones, although not equal across all regions, is much more reliable and more extensive than it was in 2003, and is expected to continue to expand rapidly. A body of research on distance learning allows VASAT to begin its work at a productive point on the learning curve. The emergence and widespread acceptance of wikis, blogs and twitters demonstrate the rapid adoption of interactive, two-way communication in which information is developed, shared, debated and expanded through the participation of many individuals, a central feature of VASAT's long term goals.

ICRISAT possesses a combination of comparative advantages with respect to VASAT. These advantages include: (i) a mission and research program that supply relevant knowledge and IPGs, (ii) expertise about challenges and opportunities to agricultural development in the SAT of Asia and SSA, (ii) recognized leadership within the CGIAR System for creating efficient technological strategies designed to be shared and adapted, (iv) a track record of working in collaboration with a broad array of partners, including major universities, to extend knowledge

and information about the SAT, and (v) access to a large pool of computing talent and expertise. In addition, while VASAT is in development, ICRISAT offers the project a network of influential and experienced partners in India, at both the national level and within NARs, which can utilize an array of VASAT's strategies and products and facilitate the evaluation of outputs and impacts. Work in India has been funded by the Indian Council of Agricultural Research and brings together seven partners including two agricultural universities, GB Pant University for Agriculture and Technology, and University of Agricultural Sciences..

The Panel does have concerns with VASAT's emphasis on information structure, formats and access to knowledge, and the lack of determinants of end user acceptance. While the EPMR Panel believes VASAT is an important component in the Center's efforts in capacity building, there are also other approaches to fulfilling this role. VASAT's success will depend on clear strategies for scaling up and out, good mechanisms for monitoring and evaluation, and the ability to broaden adoption, remain current with changing technologies, and access resources. The last is particularly important. While ICRISAT can lead VASAT, the risks of the project must be shared. Through 2007, ICRISAT provided the majority of funds for VASAT. The project now demands a long-term financing strategy. ICRISAT must utilize its advantages with respect to this initiative but facilitate a more sustainable position with respect to the role and contributions of its partners.

5 PARTNERSHIPS AND CAPACITY BUILDING

5.1 Partnerships

5.1.1 Introduction

In ICRISAT's strategy to 2015, the Center's vision is stated simply as the improved well-being of the poor in the semi-arid tropics. Throughout the 6th EPMR, the Panel noted the size of ICRISAT's mandate and the relatively modest resources available to achieve it. This does not make the vision or the mandate unreasonable or unrealistic; it does place a special burden on ICRISAT to be strategic in setting goals and in deploying its resources. Among the most critical of these resources is the Center's ability to use the quality and relevance of its work, its reputation, and its management capacity to build partnerships.

ICRISAT has a strategic grasp of where partnerships add value and has defined the span of potential partners in a thoughtful, pragmatic way. These partnerships are both internal, involving CGIAR Centers (IARCs) and the challenge programs, and external, engaging the NARS, ARIs, private sector, civil society groups, NGOs, communities and farmer groups.

The evaluation of each of ICRISAT's global themes and the VASAT project (Chapter 4) includes pertinent assessments of the nature, intent and quality of partnerships for a range of specific research activities. This section looks more broadly at partnerships in terms of their strategic value in advancing the Center's mission and vision, and in contributing to capacity building. It also considers in more detail the partnerships ICRISAT has with IARCs and through the challenge programs. The Panel believes the Center's general ability to form good partnerships is critical, but that, in the face of prospective changes within the CGIAR System, positive partnerships with those in the System are likely to be predictive of a center's ability to develop and contribute to competitive multi-partner, multi-year mega-projects.

5.1.2 Partnerships with Institutions outside the CGIAR

In addition to using partnerships to leverage and disseminate its work, the Center sees partnerships spurring cutting edge research as well as assuring that research is demand driven and well targeted. While this is evident in many of its partnerships, it is particularly evident in the work undertaken with the private sector. In this area, where the Center has been notably active, public good is generally well balanced with the motivations of private enterprise. In fact, ICRISAT appreciates the extent to which these partnerships introduce business discipline and redistribute the risks associated with moving knowledge and innovation into the public domain. The Panel considered ICRISAT's substantial experience collaborating with the private sector and in realizing financial support from it through these partnerships to be positive. It also concluded that the experience offers some cautionary lessons that ICRISAT should acknowledge and learn from (Chapter 6).

ICRISAT reports 190 organizations as partners and collaborators. This encompasses not just a significant span of partners but also partnerships of differing intensity and duration. ICRISAT's relationship with the host country, India, is a good illustration of the value of a partnership developed along many dimensions. A track record of good work undertaken with national and local governments, the NARs and Indian research institutions has created trust, credibility and good will and strengthened relations with the host country. This has yielded not only increased investments by India in the Center but also access to a network of individuals and organizations that can benefit each of ICRISAT's research themes and its work in SSA. Benefits are considered

to flow two ways; NCAP, an advanced research institute in India, expressed great appreciation for its linkages with ICRISAT, noting professional contact with the Center's staff and access through ICRISAT to the international community. Comparable sentiments were expressed to EPMR Panel members by representatives of the National Research Center for Plant Biotechnology (NPCPB), and CAZRI (Central Arid Zone Research Institute).

Among the global themes, GT-IMPI has played a strong role in both working with partners in its principal research areas and in facilitating partnerships involving work in all three regions and other global themes. The Center's approach to partnerships is exemplified by GT-IMPI and GT-CI's seed systems work (the West Africa Seed Alliance), which brings a number of the Center's staff and programs together with a diverse group of organizations to help develop a competitive seeds industry. The seed systems project is now extending to ESA. It is also being increasingly integrated with the work of relief organizations interested in giving seed supply efforts a more permanent operating platform, rather than being *ad hoc* responses to severe drought and other crises. The Panel considered this particular set of projects and partnerships a good illustration of the extent to which ICRISAT's purposes and strategy for partnerships are shaped and prioritized by regional considerations. Unlike India where both the NARS and the private sector play effective roles in hybrid seed development and distribution, many NARS and the private sector in SSA are not sufficiently developed to do this.

Partnerships have also benefited the Center's work in crop improvement, biotechnology and knowledge management through linkages with major research universities in the U.S., Europe, Asia and SSA, and strong and improving working relationships with national governments and regional research organizations and coordinating entities in Africa.

It is worth noting that the stakeholder survey did not reveal any significant problems with ICRISAT duplicating work done elsewhere or crowding out NARS and other partners. During field visits, Panel members did receive feedback from a number of sources that partners wish to be consulted earlier in project planning and resource development in order to be able to have their experience and perspective valued at as early a point in the planning process (and during subsequent iterations) as possible.

5.1.3 Partnerships with CGIAR Centers and the Challenge Programs

CGIAR Centers (IARCs)

The EPMR solicited feedback from each of the directors general of the IARCS (15) and received responses from eight. The Centers were asked to address questions relating to ICRISAT's research priorities, the quality of the collaborations, whether the Center is a good partner, and the potential for future collaborations. The feedback reflected experiences with ICRISAT that spanned the five year period of the review, a period during which the Center was highly focused on re-gaining its financial footing, decentralizing its programs and management, and aligning its priorities with those for the system as a whole. The Panel appreciates that a Center that worked with ICRISAT in the first years of the turnaround may have a different, less positive view of ICRISAT as a partner than Centers with collaborations undertaken in the last few years. With this in mind, the Panel believes that the Center is undoubtedly a better partner today than it might have been in the recent past.

The feedback also uncovered a common dilemma when Centers have overlapping environmental and crop mandates, and projects sit side-by-side in common geographic locations. There is

clearly a potential for periodic "jostling" among Centers for the right to engage in a particular activity or to lead projects where "ownership" can be claimed by others. ICRISAT was taken to task by a number of directors for crossing boundaries. This could probably said of the reciprocating Center. It was also criticized for periodically taking on more than it could deliver. As the Center has rebuilt its financial position, increased its research staff and established good leadership for WCA and ESA, the Panel believes the ability to deliver and the consistency of results will improve. A number of the Centers indicated an interest in working collaboratively with ICRISAT on new projects, based on recent experiences and also a perception of ICRISAT as a strong partner. Certainly, its recent projects with ILRI on crop/livestock interactions indicate the potential quality and mutuality of the Center's inter-Center partnerships going forward.

Challenge programs

ICRISAT has been involved in the first three CGIAR Challenge Programs since their inception in 2004. The Center has played a role in HarvestPlus, Generation, and the Water and Food challenge programs, either as a consortium member (GCP) or through commissioned competitive projects (H+ CP and WFCP). It has some involvement in one of the sub-Saharan CP (SSA CP) learning sites.

The level of funding ICRISAT receives from challenge programs has increased from USD932,000 in 2004 to an estimated expenditure of USD2.3 in 2008 (Table 5.1).

Table 5.1 Funding levels for ICRISAT projects under the CPs

CP	2004	2005	2006	2007	2008[a]
GCP	0.542	0.497	0.570	0.759	2.357
H+ CP	0.258	0.319	0.302	0.306	0.213
WFCP	0.132	0.776	0.945	0.751	0.765
SSA CP	0	0	0	0	0.062
Total	**0.932**	**1.592**	**1.817**	**1.816**	**3.397**

Source: ICRISAT Audited financials (2004-2007); [a] Estimate

The GCP has 22 partners; and ICRISAT is second behind IRRI in GCP funding. One of the GCP sub-program leaders has a 0.50 FTE appointment as an ICRISAT staff and is located at the Center's headquarters. The level of GCP fund remained in the range of USD500,000 to 600,000 from 2004 through 2007, but is projected to double in 2008 as a result of its role of the GCP's tropical legumes project funded by BMGF. GCP funding to ICRISAT has focused on research on sorghum drought tolerance in SSA; groundnut wild relatives; bioinformatics tools (LIMS and iMAS), molecular characterization of sorghum, pearl millet, finger millet, chickpea, groundnut and pigeon pea; and capacity building. GCP is a 10 year program that ends in 2013. Funds for the program are projected to fall rapidly after 2009. As the GCP winds down, it is important for ICRISAT to develop a plan to secure funding to continue those aspects of its GCP research consistent with the Center's research priorities and strategic plans.

For HarvestPlus, ICRISAT has collaborated on micronutrient biofortification of four of its mandate crops (sorghum, millet, groundnut and pigeonpea). Part of the program's funding has gone to upgrade ICRISAT's analytical capacity for micronutrients. Research for improving iron and zinc content of pearl millet is centered at ICRISAT and has progressed rapidly with a high iron/zinc variety planned for official release in 2011. However, donor pressure to focus the CP in fewer crops may lead to reduced work on sorghum, pigeon pea and groundnut.

In terms of project funding, ICRISAT's involvement in the Water and Food Challenge Program has been the most notable. WFCP-funded research is located mostly within GT-AE, but in 2004-2005 also within GT-IMPI, GT-CI and GT-BT. ICRISAT is not a consortium partner, but derives its support from competitive projects it applied for and received. It is involved in the WFCPs crop-water productivity program and leads two projects in WCA and ESA for which it received a significant grant.

The EPMR solicited feedback from the three challenge programs in which ICRISAT participates. Observations ranged from information that was useful but tactical or technical in nature to information that the Panel considered important for ICRISAT to incorporate in future project planning. Among the latter were comments relating to the Center's tendency to be optimistic in stating its abilities and capacities. ICRISAT is not considered alone among Centers in doing this, but the suggestion that ICRISAT be more cautious and realistic in these matters is worth heeding to ensure being seen as a credible partner. The other feedback the Panel wishes to share involves the need to identify good staff leadership for projects from the start. A project that involves significant funding and multiple partners needs to begin well and strong research and management talent is the minimum starting point.

5.1.4 Assessment

During the period of the review, ICRISAT's work with partners appears to have strengthened. The range and standing of partners also appears to be strong. The Panel believes that the Center has been particularly enterprising in exploring the potential of the private sector to be valuable partners in advancing the mission of centers like ICRISAT.

In its efforts to move IPGs downstream to farmers and others, partnerships play a critical role. In this regard NARs remain the Center's most important partners, but pose the greatest challenge because of the variability of institutional capacity among them. While ICRISAT works to enhance the capacity of NARs and extension activities through training, fellowships and support for post-doctoral candidates, informal capacity building also occurs as collaborative projects are planned and implemented. In addition to its work with NARs, ICRISAT has developed complementary partnerships with civil society organizations, farmer groups, and development agencies that facilitate the downstream impact of ICRISAT's research. The Panel's site visits in India and Africa confirmed the extent of these partnerships and their contributions to ICRISAT's goals in partnering and capacity building.

The Panel considers the strategy that ICRISAT has identified to guide its work with partners a good beginning but that it needs to be implemented more systematically and supported by a stronger framework for project planning and prioritization. Good partners are an asset, poorly identified partners can result in loss of time and, ultimately, capacity to deliver impact.

As the Center's restricted funding grows and the size of grants increases, partnership is a central strategy for delivering results. The Center needs to be attentive to its experience with challenge programs and attentive to the assessment of its partners and colleagues in these programs. This is a large part of ICRISAT's future success and the Center must take this opportunity to improve its performance in this arena.

5.2 Training and Capacity building

5.2.1 Nature and Scope of Individual Training Activities at ICRISAT

ICRISAT and its staff invest considerable efforts in a variety of capacity building activities. These include distance outreach to change agents and farmers (VASAT, LSU´s e-learning material), training courses on particular topics for groups of participants, the capacity building inherent in research partnerships, and individual training activities. The recipients of the last fall into three categories:

- Research scholars—MSc and PhD candidates who conduct the research component of their thesis at ICRISAT. The mentoring of this research is shared between a Center staff member and a scholar's university.
- Research fellows—mid-career scientists from the NARS who spend up to one year at the Center and are mentored by a member of staff.
- Interns—undergraduate students who acquire practical work/study experience at the Center. Often, this work counts towards the award of an intern's first degree, and mentoring arrangements between ICRISAT and the intern's university apply.[45]

The Panel relied for its evaluation on a range of information from KMS/LSU, and additional information on training activities from HR and the Panel's review of the global themes, where the majority of scholars, fellows and interns, are mentored or supervised. The Panel also used the 2007 KMS-CCER, which looked closely at the LSU, and during the field visits to India and Africa interacted with scholars, interns and university staff involved in mentoring and training activities.

One challenge the Panel faced in evaluating training and capacity building was incomplete, out of date or conflicting reporting on training activities. Training activities are spread across ICRISAT—within each theme, in LSU, in HR—but data is not uniformly collected or aggregated, which complicates the task of assessing levels, quality and impact of training or identifying trends. The fact that intern and research fellow data did not discriminate with regard to short- or longer-term training (from a visit of 2 days to over a year for interns and about 9 months for research fellows) presented a particular complication for the assessment. The KMS CCER contained a number of recommendations designed to address challenges in this area.

5.2.2 Training Output

In its assessment the Panel considered the trainees according to the relative length of their stay at the Center (less or longer than 3 months; Table 5.2). The Panel viewed these categories of trainees and the time factor useful indicators in assessing the output and quality of training activities. Out of the 182 trainees registered as research fellows, only 32 (21%) stayed longer than 3 months; only 6 stayed longer than 6 months. The Panel believes that the mid-career research training characteristic of research fellows must be long enough to provide an opportunity for a meaningful expansion of knowledge and experience and to build a mentoring relationship with a supervisor. A period of less than 3 months does not seem adequate.

[45] ICRISAT defines interns as spending maximum of 6 months and Research Fellows as spending up to a year at the Center.

Table 5.2 Number of individual trainees by type, 2003-2008

Type of training	2003	2004	2005	2006	2007	2008[a]	Total	% Women
Intern (≥3 m)	78	42	71	42	70	30	333	52
Research Fellow (≥3 m)	8	7	4	8	5		32	47
Research Scholar, all	11	8	19	11	25	12	86	43
Total	97	57	94	61	100	42	451	50
"Short-term" interns	43	41	48	58	37	22	43	41
"Short term" research fellows	64	66	87	80	65	39	401	40

[a] Data set is not complete for 2008

About half the interns (250) stayed less than 3 months. Of those at the Center for short periods a third received specific technical or skill training on such things as the library, computing, and farm machinery, for instance, rather than research-oriented training. The Panel believes that technical or skill-related training is fundamentally different from research-oriented training and should not be combined for reporting purposes.

Among the trainees with ICRISAT for longer than 3 months, 50% were women; a slightly larger proportion of interns were women than fellows or scholars. This level of participation by women in these training activities is commendable. This contrasts with the low number of women in short-term training courses (only 16%). The participation of women in this level is often heavily affected by the rate at which their institutions nominate them to attend the courses.

ICRISAT has trained individuals from some 40 countries, the majority (81%) from India (Table 5.3). This is particularly the case with research scholars and interns. Research fellows have a more diverse nationality background. Twelve percent of the trainees came from developed countries, which the Panel considers positive. The chart makes clear the inequality across all categories between Asia and Africa. Distance from Asia and a lack of resources may provide reasons for the small number of African participants in training programs, but the Panel believes the Center must find ways to address this by increasing opportunities in Africa as well as in India, particularly for research fellows and scholars from Africa.

Table 5.3 Regional and national origin of individual trainees

Type of trainee	Africa	India	Asia (w/o India)	Developed countries
Intern	2	86	3	12
Research Fellow	16	28	12	16
Research Scholar	3	80	1	14
Total	3	81	4	12
Short-term trainees	6	66	13	11

It was difficult to determine accurately the distribution of training across the themes. The data reported in the KMS CCER (and updated by the Center) and by the themes are not consistent. It appears from one set of data that the volume of degree training has been equal, about 30% in both GT-BT and GT-CI. In this data set, GT-AE and GT-IMPI only had 8% each of graduate training. From other information is would seem that GT-AE has had a large number of research scholars many of whom have been Africans.

5.2.3 *Quality of Research Scholar Training*

The Panel attempted to evaluate the quality of Research scholars based on the publications derived from theses. The source data was a list of publications provided by the Center organized by research scholar.[46] The list included 50 individuals who had been degree students at ICRISAT since 2000. Half of the 50 had studied biotechnology; most of the balance had studied crop improvement. There was only one social science and one NRM scholar among the group. Information for the 50 scholars was incomplete. Of 34 for whom information was available, 25 (74%) were PhD students and the rest were MSc students. Out of these, 20 showed that the thesis was published 0-6 years after the stay at ICRISAT (on average 2.3 years later).

Of the 50, 34 had published—a total of 34 SCI journal articles and 39 non-SCI articles and other publications (excluding their degree thesis). Twenty scholars had published at least one SCI journal article. The rate of publication is influenced by the time from completion of study and the thesis, but it is reasonable to expect that a thesis should lead to at least 2 high quality journal publications where the student is the first author. ICRISAT graduate trainees fall far from standard. Eighteen (36%) had no publications other than the thesis. In one third of the publications the research scholar was not the first author; however these publications may not have derived from the thesis. The Panel recognizes that publication expectations of the host university have a large influence on student's publication productivity, but it would like to see ICRISAT work to improve the publication output of research scholars who spend significant time at the Center. The Center should also systematically request its graduate alumni to inform it on any publications that have been published based on research conducted at the Center.

5.2.4 *Responses by ICRISAT to CCER Recommendations*

The KMS CCER recommended that ICRISAT review its investment in individual capacity building activities, compile information on trainee distribution, current selection practices, supervision procedures, IPR protection and costs and benefits to ICRISAT of these activities. The overall objective was to provide a strong basis for documenting the Center's contribution to capacity-building IPGs and developing a more consistent Center-wide set of procedures and policies. The EPMR Panel fully endorses this recommendation and would go further in suggesting that the Center identify an experienced senior scientist to oversee Center-wide capacity building, clarify expectations for mentoring and supervision, and develop quality targets for training, particularly with respect to research scholars. The Panel was informed that the report of a sub-committee of the Research Committee charged with conducting an internal review guided by the CCER recommendation was accepted in April 2007. Since then, however, the status of implementing the recommendation was not clear to the Panel. Based on the quality of data provided to the EPMR Panel, the starting point for the internal review may have been less favorable than assessed in the CCER. The Panel concludes that the Center response to the CCER recommendations is not satisfactory, and believes that the Center would benefit greatly from taking a thorough and probing look at maximizing its investment in training for its benefit as well as for the benefit of the fellows, scholars and interns involved.

5.2.5 *Assessment*

ICRISAT has the potential to leverage its scientific expertise, facilities and access to funding for training in a manner that is considerably more powerful than available at most universities in the SAT. The Center can offer to interns, research scholars and research fellows strong link to current

[46] The data were particle as they were provided as of courtesy of willing scientists/mentors.

science and exposure to a marketplace of ideas and the habit of continuous learning. Interns working on Center research projects often gain their very first exposure to scientific research and development at ICRISAT. If ICRISAT can contribute, in proportion to its comparative advantages, to attract young undergraduates, produce truly inquisitive, able and committed PhD and MSc graduates, and enlarge the perspectives of its research fellows, it will have a huge impact on the NARS and universities in the SAT, and produce important Pig's. The Panel met some impressive ICRISAT research-fellow alumni in India (e.g., Dr. Yadav at CAZRI, Dr. Joshi at NCAP) and in the African NARS. Research scholars interviewed at Niamey and Patancheru believed that ICRISAT successfully taps significant pools of local talent. By and large, university partners interviewed by the Panel hold ICRISAT in high regard. Commenting on ICRISAT's capacity building, NARS and NGOs in both Asia and Africa were uniformly complimentary about the Center's training courses and expressed a wish for greater access to them. Of the stakeholder respondents, a majority (48%) assessed ICRISAT's capacity building as good; 17% considered this activity excellent. Taken together, all these indicators suggest that ICRISAT is doing a very good job in the capacity building domain.

It is within this positive context that the Panel considers it important that ICRISAT raise expectations and improve its internal procedures and practices with respect to scholars, fellows and interns. The overlapping responsibilities for training between LSU and HR need to be clarified, and a better process for administering and tracking training activities and participants is important to implement. More important, participants in the scholar, fellow and intern programs need to have goals that enable them to maximize their experience with ICRISAT. This includes expectations about minimum time commitments and research productivity.

It is not unreasonable for ICRISAT to expect that those it accepts to its training programs will establish and work to fulfill goals for publishing. This suggestion is not an effort to encroach on the role of a trainee's university but to communicate to prospective training candidates ICRISAT's commitment to quality research. It is also important for ICRISAT to establish a stronger framework for the role of research scientists as mentors and colleagues to those in the training program, establishing procedures for accepting scholars and benchmarks for the number of scholars and fellows to be supervised at any one time.

Training and capacity building need due recognition as part of the outputs and achievements of the Institute. Structuring the program to achieve IPGs and communicating achievements will build broader recognition for this function and ICRISAT's contributions to donors and partners may help in this effort.

The Panel recommends that ICRISAT reorganize the structure and oversight of training and capacity building, and develop output quality criteria, as well as explicit expectations for mentoring and supervising research scholars, research fellows, and interns by ICRISAT scientists.

The Panel adopts the GT-IMPI-KMS CCER recommendation (Rec. #3, p.51 of CCER report) that the Center review its investment in individual capacity building, develop a consistent Center-wide set of procedures and policies, and ensure adequate documentation of the outcomes and impacts of all Center capacity building activities.

6 GOVERNANCE, MANAGEMENT AND FINANCE

6.1 Introduction

In the last five years, ICRISAT has made a substantial commitment to improving its governance and management, and building a prudent and sustainable financial framework. In response to the extensive external review conducted in 2003 (5th EMR), the Center brought its practices in all three areas to impressive standards. The CCER on governance and management conducted in 2007 confirms ICRISAT's progress.

The present EPMR comes immediately on the heels of the governance and management CCER. ICRISAT might have leveraged more value from both the CCER and the EPMR had it scheduled the CCER, over which it had greater discretion in terms of its timing, at the midpoint between the 5th and 6th EPMRs.

With that noted, the Panel appreciated the CCER's thoroughness and the relevance of its recommendations. Among its strengths were a significant evaluation of ICRISAT's facilities and capital needs, particularly in West Africa, and an extensive commentary on ICRISAT's fund development and communications activities.

Mindful of the demands placed on the Center's financial and human resources by the timing of the two reviews, the Panel approached the external review with the goal of meeting its responsibilities without unnecessary duplication of effort. Given the quality of the CCER and its currency, the Panel has undertaken to focus its evaluation on a forward looking set of governance, management and finance issues that ICRISAT, from a current position of relative strength, is in a position to address. These include preserving the rigor and independence of the Board, assuring that ICRISAT can attract and retain a talented and diverse research staff, and clarifying the direction and purpose of an expanding array of entrepreneurial activities undertaken through the Agri-Science Park (ASP).

6.2 Governance

During the five-year period covered by its last external review, ICRISAT faced an array of challenges, including significant financial and management problems. The 2003 review was divided into two parts—a program review (EPR) and a management review (EMR), each with a separate Panel. The EMR noted that during the period covered by its review, the Center had experienced four directors general, four Board chairs and 40 individual Board members. While the leadership tumult alone might have justified a separate management review, the approach also signaled an awareness within the CGIAR System that governance and management are not subsidiary or supporting features of a Center's effectiveness.

The 2003 EMR prompted a thorough revamping of the Center's governance and significant reform of its practices. As a result of the EMR, the Board's composition became more diverse along many dimensions, including a broader array of expertise and greater balance among the interests and perspectives of multiple stakeholders, including the host country.

In particular, the 2003 review recommended changes to assure the continuity, quality and independence of the Board. To minimize the potential for real or perceived conflicts of interest, the review recommended that host country representation not exceed three members and that these members not be eligible to serve as chair of the Board. The review also recommended the

adoption of uniform terms and expectations for the performance of all members of the Board, and regular Board evaluations to fine tune practice and performance. The Board has been consistent in conforming to these practices.

During the period of the current review, the CGIAR completed a Stripe Review of Center Governance, which addressed the optimum size and composition of Center Boards. ICRISAT has adopted the relevant recommendations in the Stripe Review. Consequently, the Board has reduced its size from 15 to 12, and increased the number of members with business and financial expertise (Table 6.1). Even at a smaller size, the Board maintains appropriate expertise in the sciences, although with the Center's increasing focus on producing IPGs linked to NRM, ICRISAT would benefit from recognized expertise in this area at the Board level.

Table 6.1 Governing Board Members, February 2009

Name	Gender	Nationality	Discipline	Term Dates Start	Term Dates End
Dar William D.[1]	M	Philippines	Horticulture	01 Jan, 2000	31 Dec, 2009
Rai Mangala[1]	M	India	Plant breeding	15 Jan, 2003	Indefinite
Pestieau Caroline[1]	F	Canada	Economist	01 Apr, 2003	31 March, 2009
Bie, Stein W[1]	M	Norway	Soil science	01 July, 2003	30 June, 2009
Ikeazor, Philip	M	Nigeria	Finance and Audit	26 July, 2006	25 July, 2009
Bennetzen, J.L.	M	USA	Biotechnology	24 Oct, 2007	23 Oct, 2010
Mwanakatwe Margaret	F	Zambia	Finance	02 Nov, 2007	01 Nov, 2010
Poole, Nigel	M	British	Microbiology	01 May, 2008	30 Apr, 2011
Molapo Qhobela	M	Lesotho and South Africa	Plant Pathology	01 May, 2008	30 Apr, 2011
P Ramakanth Reddy	M	India	Public Admin.	01 May, 2008	Indefinite
Nanda Kumar, T.	M	India	Public Admin.	01 Oct, 2008	Indefinite
Williams, Meryl	F	Australia	Fisheries	01 Oct, 2008	30 Sep, 2011

[1] Board members whose term carries over from the 5th EMR.

The Board meets twice a year, with executive committee meetings convened as needed between meetings. Meeting sites alternate between India and other regions in order to provide the Board with the opportunity to gain first-hand knowledge of the Center's programs and to meet with partners and stakeholders. The Board has four committees: a consolidated executive and finance committee, an audit committee, a nominations committee, and a program committee that functions as a committee of the whole. The Board has recently revised its policy for Board chair succession, removing the provision limiting eligibility to committee chairs. This change provides the small Board with greater flexibility to identify its leadership.

6.2.1 Sustaining Board Effectiveness

Since 2003, the Board has been diligent in maintaining its performance. In 2006, the nominations committee recommended that a member of the Board be asked to resign because attendance at Board meetings had fallen short of expectations. In another instance, the committee after reviewing the strategy for the Board's composition recommended that a Board member's term not be renewed in the interest of identifying a candidate with the skills and background required by the Board going forward. These actions are both exemplary and rare. It is one thing for a Board to have minimum expectations or a strategy for Board recruitment; it is another for the

Board to act on them. This was a powerful manifestation of the Board's commitment to uniformly high levels of performance and reinforced the expectation that each member of the Board, despite other commitments and responsibilities, must make serving on ICRISAT's Board a priority.

As of June 2009, with the exceptions of a host country representatives and the DG, the cadre of Board members tasked in 2003 with re-invigorating ICRISAT's governance will have rotated off the Board. Through these members, the Board has retained a strong institutional memory both of a governance function in disarray and its reform. As it loses those who experienced first-hand the adoption of practices that have assured an effective Board, the present Board and its immediate successors risk becoming complacent.

Those who have joined the Board in recent years have the good fortune to oversee an organization that is stable, well managed, and financially sound. As the mechanics of reform become less visible and the products of reform become second nature, the Board needs to spend more time attending to the quality of its work. A Board is meant to challenge management; it is meant to be a constructive, healthy irritant as part of its stewardship of the Center's mission and the resources invested in achieving it. The Board wants to avoid becoming gratified bystanders.

The Panel sees lapses in Board performance that can easily accumulate and encourages the Board to avoid complacency. The August 2008 Board meeting the Panel attended (and the agendas, background materials and minutes of previous Board and committee meetings) show a Board swamped with information, little of it organized to draw the Board's attention to the issues that matter most or the questions that need to be addressed. Staff made lengthy, power point-driven presentations that absorb almost all of the Board's budgeted time and present information not in the Board book or not there in comparable form. Board members are truly bystanders for most of their substantive time together.

The Panel expected to see resistance to this trend expressed in the meeting evaluations and the Board's own self-assessment, and was surprised that it did not. For this meeting and others, the evaluation of both Board and committee meetings appears perfunctory. The annual Board self-assessment does not appear to have provoked much self-scrutiny in recent years. The Board does not take time to evaluate the Board chair or the leadership of committees.

The most recent Board self-assessment did generate a handful of notable suggestions—including a request for more succinct information, a desire for updates between Board meetings on key financial and programmatic results between Board meetings, and a request for more time for active participation—but no discussion at the Board meeting itself about these suggestions or the value of acting on them. Board self-assessments (and meeting evaluations) might not be instruments of social science but they do provide a useful and accessible way to build the Board's ownership of its responsibilities. In addition the regular evaluation of the form and content of meeting agendas, background materials and routine communications is a healthy assertion of the Board's right to shape the content and value of its work, not passively accept what it receives from management. The overwhelming impression within the Panel is of a creeping indifference to evaluation and self-scrutiny that needs to be addressed.

The Panel recommends that the Board bring greater rigor to the assessment of its own performance, and emphasize, in the orientation for new members, the responsibility of the Board to sustain its independence and its effectiveness.

6.2.2 Improving Oversight

The Board is asked to absorb an enormous amount of information in advance of each meeting and then receives an additional layer of information in the course of the meeting itself. Good Board oversight is about discernment—having the right information in a format that makes it legible and easy to interpret.

In theory, Board committees help to make this challenge more manageable, but ICRISAT's committee structure, although functional, does not offer enough relief. Principally, this is because the program committee is a committee of the whole and the flow of information is more a tsunami than a stream; while the consolidation of the executive and finance committees has the opposite effect—providing not enough financial information to the full Board, thereby making it difficult for the Board to connect financial issues more broadly with other issues, such as priority setting and results. Bits and pieces of financial as well as other information are scattered throughout the Board book and the meeting. Much of the data, whether about budget, human resources, projects or resource development are often year-to-year, too incremental to see trends and inquire about them. Information appears and re-appears in somewhat different contexts making it difficult for a Board member to knit information together in order to provide oversight or advice. It is particularly difficult to connect the financial and programmatic data presented in the budget and program reports with the comparable data presented in reports on resource mobilization and the activities within the Agri-Science Park.

In an increasingly complex operating environment, the Center's Board lacks the tools to connect the dots, to ask good questions or to think critically and strategically about the Center as a whole. Given the intense but episodic nature of governance, the Board requires clearer and more integrated information in order to monitor performance, participate in planning and advise staff.

The Panel recommends that ICRISAT create succinct documents that synthesize 5-year trends in financial performance, priority setting and performance to give the Board more efficient and transparent access to information critical to oversight.

6.2.3 Board and DG Relations

At its March 2008 meeting, the Board agreed to extend the DG's contract for an additional five year period at the end of which the DG will have served for 15 years. CGIAR Centers have established that, as a general rule, 10 years is a reasonable maximum term of service for Center DGs. The practice errs in favor of regular and predictable turnover over open-ended employment agreements. Within the system, ten years is thought to provide a DG and Board with continuity and enough time to get significant institutional goals or transitions accomplished. It also provides a Center and its Board with the periodic opportunity to look for new or different leadership skills, or to rethink Center strategy. Not incidentally, it helps to prevent governance inertia, where the Board becomes wedded to the *status quo* and overly dependent on the DG.

The Panel does not question the Board's decision with respect to the renewal of the DG's contract. The current DG has been effective in stabilizing and growing ICRISAT's financial security, building a strong management team, and meeting the Center's scientific mandates. The CGIAR System is in the process of substantial reform and ICRISAT will benefit from having in place a DG who is knowledgeable about the system and has well established relationships with donors.

Having decided to move outside the standard practice in this area, the Board has an increased burden to maintain a well balanced relationship with the DG in which the independence and rigor of the Board is carefully preserved. One signifier of this is a thoughtful and thorough annual evaluation of the DG and carefully developed performance goals and expectations.

The culture of ICRISAT is relentlessly positive. If budget surpluses have been achieved in five consecutive years, the pressure to return surpluses every year is substantial; all outputs are achieved each year without fail; all goals are met and exceeded; among CGIAR Centers ICRISAT leads, etc. There is nothing wrong with a positive culture, but it doesn't relieve the Board of the responsibility to assure itself that the DG, on whom the Board relies heavily to meet its own legal obligations, is evaluated constructively and with as much balance and objectivity as possible.

Other than feedback from the senior management group, the current DG evaluation process has a limited number of inputs. It is not clear to the Panel that the engagement of senior staff, even in confidential personal interviews, has given the Board the perspective it needs. Staff input was characterized by one Board member as overly careful. Soliciting staff feedback is a delicate part of a DG evaluation for both Board and staff. While candor can be encouraged, it cannot be compelled.

The Board has few duties as serious as its duty to retain effective management and to hold management accountable for results. In the view of the Panel, the renewal of the DG's contact for an additional five years increases the Board's responsibility to conduct a thorough, constructive annual review.

The Panel recommends that the Board adopt a multi-source evaluation process for the Director General that is rigorous and balanced and that provides the Board with more inflected and diverse inputs to the process. In addition to senior staff, the Board and DG should annually agree on a list of partners, donors and peers to be asked to participate in the evaluation.

6.3 Management

As noted earlier in this chapter, the CCER on governance and support services included a comprehensive review of ICRISAT's administrative practices, including HR, finance, communication and resource development.

In addition, the CCER on GT-IMPI and KMS provided a thorough assessment of a number of the Center's management support activities, including library services, technology infrastructure, the training and capacity building programs provided through the LSU, and major technology-driven initiatives in knowledge sharing conducted through AGROCURI and VASAT.

The review Panel proposes to focus in this report on a handful of management issues that it believes are of long-term and strategic value to ICRISAT as it moves forward. In this section, the Panel will review the Agri-Science Park as an element of ICRISAT's resource development strategy. VASAT, a part of the Center's research project portfolio, is reviewed in Chapter 4.

6.3.1 Management Structure

Management at ICRISAT benefits from a well defined but interlocking set of teams that facilitate planning, communication and decision making. The management group encompasses the DG, the deputy director general of research (DDG-R) (recently appointed at the time of the EPMR), the directors of the African regional programs (which had new leadership in WCA), and the directors of communication, finance, H.R. and operations, and the project development and marketing office (PDMO). One of the four global theme leaders serves as a member of the group on a rotating basis. All of the members of the management group with the exception of designated theme leader report directly to the DG; the global theme leaders report to the DDG-R.

A research committee, chaired by the DDG-R, is charged with aligning the research agenda with the Center's strategic plan and monitoring quality. It also has the responsibility to ensure that research priorities are reflected in grant-seeking rather than driven by them. This is a very large committee, involving 15 members of the staff. The Panel was concerned that its size made its responsibilities, particularly for priority setting and the evaluation of research quality, difficult to fulfill. The research committee also reviews and approves the partnerships and projects that are undertaken in conjunction with the Agri-Science Park. This oversight role appears to be shared with ASP's advisory committee, which includes the DG and the director of PDMO and at least one current member of the Board. Given the overlapping terms of reference and the composition of the advisory committee, the Panel suggests that the Center clarify where the authority to approve and monitor ASP initiatives is located.

Additionally, there are regional coordination committees that meet twice a year to further develop ICRISAT's regional structure, allocate unrestricted resources, align research and other activities among the regions and within the themes, and conduct joint performance evaluations of staff.

Since the 2003 EPR and EMR, which recommended a decentralized, regional structure for ICRISAT, the Center has created an effective management structure in the regions and at the headquarters in India that empowers the regional units and facilitates alignment in research and resource development.

In an otherwise straightforward management structure, the Panel encountered one aspect of the structure that it considered both unnecessary and counterproductive. Project coordinators, drawn from the research staff, are assigned to each of the 10 projects presented in the MTP. Consequently, as MTPs are prepared, the Panel believes that project coordinators have a singularly unrewarding assignment—assembling plans, outputs and expected outcomes for research activities over which they have no authority for either budgets or performance.

ICRISAT's senior management points openly to the external pressures that required it to produce the current project portfolio. This turns the annual development of the MTP into a process more about compliance than institutional ownership, and reduces its perceived value as a tool for interim planning and evaluation. The lack of institutional ownership is compounded by the project coordinator's lack of authority to assess either the quality of the information she or he assembles or the rigor with which targets and achievements are proposed or achieved. With this last concern in mind, the Panel believes the MTP should be managed more directly by those with

greater responsibility for assessing results and more control over planning, priority setting and resource allocation.

6.3.2 HR Assuring a 21st Century Workforce

The CCER on governance and support services includes a strong analysis of the challenges that ICRISAT faces in building a workforce that positions it for the future. These principally entail succession planning, particularly for senior staff, diversity and competitiveness.

ICRISAT anticipates that 23% of its scientists will retire within the next five years. This represents a significant loss of experience, professional standing, relationships with partners and peers, and institutional memory. It places a burden on management to begin to anticipate the shape of ICRISAT's future research priorities and find ways to cultivate the talent and organizational culture that will sustain the Center's research agenda.

At the other end of the spectrum and looking at "younger" research staff, as of 2008, the percentage of IRS who received their PhDs in the past five years was 8.6%; the percentage of regional scientists who received their PhDs in the same period was a healthier 21%. If ICRISAT's goal is "to mobilize cutting edge science and institutional innovations for poverty alleviation," it must strive to refresh and continuously update the resource represented by the research staff.

In addition to bringing new skills and perspectives to its work, ICRISAT must become a more diverse organization, bringing more women into management and on to the scientific staff, and continuing to broaden the geographic diversity of its scientists. Thirty percent of internationally recruited staff come from just two countries—India and Kenya; when IRS and regional scientists are combine, 73% of the research staff come from India. At present, women comprise only 10 percent of management and only 20 percent of the research staff. The latter number, achieved principally through positions created by new project, funding represents a substantial improvement over the period of the review.

The level of turnover at present is low, making it hard to build a pipeline of rising talent and expertise. The growth in restricted project support makes it difficult to offer reasonable job security. The market is competitive for the kinds of talent that ICRISAT will increasingly seek. And the CCER noted ICRISAT's low scores the 2006 CGIAR Stakeholder Perceptions Survey about hiring and retaining an excellent staff, speculating that the Center may continue to experience image problems associated with its earlier financial and management difficulties.

In the face of these challenges, ICRISAT has begun to work with its present staff to build its internal capacity to adapt to change, initiated more focused staff recruitment, and used a number of interim strategies to recruit the expertise and diversity it will need going forward. The HR unit attempts the broadest possible recruitment as opportunities to hire arise. It intentionally seeks women candidates, and candidates who can add to ICRISAT's geographic diversity. Staff have participated in workshops on leading and working in teams, and learning to respect and value differences; women scientists have been encouraged to take leadership courses, and a new recruitment scheme focused on younger scientists has enabled approximately 10 young scientists to advance their careers through work with senior research staff. None of these initiatives will yield immediate results, but the Panel views each of these activities as important to continue. The program for young scientists, in particular, is handicapped by the pressure on all research staff to find grants to support their research. Younger staff are at a disadvantage in proposing projects, and the projects they succeed in getting off the ground are often small and short-term.

The mentorship skills of senior staff are uneven, and adequate performance in this arena is not a significant criterion in annual performance evaluations but should be.

ICRISAT also adopted a recommendation in the CCER to create a new job classification system that is integrated and flexible. At a time when education and training are increasingly international not just local or regional, a personnel system that rewards the geographic scope of a recruitment—international versus national—over recruitments that seek the best qualified candidate regardless of location seems self-defeating, counterproductive and, increasingly, discriminatory. The Panel hopes that ICRISAT will take this opportunity to build a contemporary H.R. structure that relies on qualifications, experience and performance for compensation and advancement, and fosters a diverse and inclusive work force.

ICRISAT has been able to call on a committed and able staff to accomplish a significant turnaround in its programs and finances over the period of the review. Its ability to continue to be responsive in the face of new demands and a different era in the life cycle of the international agricultural research Centers requires that it continuously renew its human resources. The Panel considers its current efforts to be moving in the right direction but encourages the Center's leadership to place a higher priority on the strategic importance of these issues, to establish more ambitious goals and expectations, and to expect managers to play a more direct part in making succession planning successful.

6.3.3 Morale and Organizational Culture

In 2008, ICRISAT completed surveys at all its locations of the professional staff and local staff, the latter for the first time. The survey of professional staff had a response rate of 55 percent (86 respondents); the survey of local staff elicited 582 responses, a response rate of 71 percent. The Panel considers the survey of local staff an important part of sustaining a broad sense of ownership and participation in the Center and an important tool for management in gaining feedback that might otherwise not be consistently or broadly expressed. It also considers the response rate for the professional staff survey to be unacceptably low; an effort should be made to find out what has either depressed or discouraged participation.

The CCER on governance and support services recommended that the surveys of professional staff include demographic data, which has yet to be implemented. This information (and an improved response rate) would add important dimensions to the survey. The Panel endorses the recommendation in the CCER and encourages the Center to implement the recommendation at the first opportunity.

The profession and local staff surveys were not identical although there were a few areas of overlap. Morale among local staff is clearly high. The staff were positive on a number of key indicators including awareness of vision and mission, a collaborative work environment and job satisfaction. The survey indicated the unhappiness of local staff with compensation, which salary surveys and the Center's experience with recruitment show sharply lagged the private and government sectors.

Between the two surveys there is agreement that ICRISAT's vision is clearly communicated. The professional staff were also positive about their jobs contributing to the Center's objectives. They expressed more ambivalence than local staff about how performance is evaluated and rewarded.

The professional staff survey included explicit questions about the Center's management style and culture and whether the staff had the freedom to express their opinions. The scores in these areas were the lowest reported and considered by the Panel to be low—2.8 and 2.7, respectively, on a scale of 4.0. The same question in the local staff survey about the freedom to express opinions also received the lowest score (a mean response of 3.7 out of 5.0). In looking at the surveys, meeting with staff and Board, and observing the Board and committees at work, the Panel was impressed by the high morale and common sense of purpose and achievement reflected throughout ICRISAT. At the same time, it is concerned by evidence that the drive to demonstrate success, and to a certain extent, success itself, has made it hard to express a divergent view, to be critical, or to admit failure or ambiguous results.

The EPMR faced a measure of this problem in the volume of self-congratulatory material that appeared throughout the background materials. The Board meeting attended by the Panel provided a glimpse of its consequences. In report after report, goals are met or exceeded, all anticipated outputs achieved, fund raising is ahead of schedule. In fact, for fiscal 2009, the budget will show a surplus because a fully anticipated adjustment to salaries was not reflected in the budget presented to the Board. The goal for the capital campaign was half achieved before it was approved by the Board because of commitments to an Agri-Science Park project. The failed bid to host a challenge program did not appear to be an opportunity to learn and improve the way large, collaborative projects are conceived and structured. Instead, it appeared to be a chance to blame the result on a process that the Center described as biased from the start. When the Board invited the staff to talk about potential risk taking, "blue sky" research, a long and tedious program committee meeting was spent listening to staff tell the Board, not what it thought might be attempted if given the opportunity, but how much of what the Center currently did was already "blue sky."

When an organization has accomplished what ICRISAT has over the last five years, the Panel appreciates that it risks appearing unfairly critical in taking the Center to task for reporting nothing but good news or engaging in periodic overstatement, but the compulsion to always succeed can lead to muting dissent, distorting results, and failing to take risks. It can also diminish the credibility of ICRISAT among its peers because chronic, self-proclaimed success is simply difficult to believe. This is not an issue for which the Panel can make a simple recommendation. Nevertheless, the Panel strongly recommends that the DG and senior management team, with firm and continuous prodding from the Board, become more comfortable with periodic failure, be prepared to establish a goal that will be very difficult to achieve but worth the effort, and assign itself the job of encouraging the staff at every level to feel free to express their opinions.

6.3.4 Resource Development

ICRISAT has rebuilt its current financial success on the ability to stabilize core funding, attract significant support from India and successfully increase its ability to compete for grants for special projects. In 2003, ICRISAT's total budget was USD23.6 million with restricted support of USD11 million. By 2007, the total budget had grown to USD37.6 million, with most of that growth attributable to an increase in restricted support. During the same interval, ICRISAT's cash reserves also grew, indicating a conservative strategy with respect to expending core funding, matched by effective management of its reserves.

During the review period, the DG and staff achieved an exceptionally strong turnaround. The DG has worked steadily to rebuild the confidence of donor countries in ICRISAT's mission and

its ability to deliver results. Particularly notable are the relationships that ICRISAT has developed with the Indian government and the state government of Andhra Pradesh. In 2003, the leading donors to the Center were the USA (USD4.2 million) and the World Bank (USD2.4 million). By 2007, India, which had not ranked among the top 10 donors five years earlier, provided USD3.5 million in unrestricted and restricted support, placing it among the top five. Support from India is projected to increase dramatically in 2008, rising to USD5.8 million.

The Center has also been successful in building an experienced Project Development and Marketing Office (PDMO) and creating within ICRISAT a culture of fund raising. In 2007, 64 percent of the Center's proposals were funded. In evaluating ICRISAT's experience with resource development, the Panel has tried to look beyond the totals, which are impressive, to the underlying size and purpose of the grant portfolio, and whether the experience of the past five years has positioned ICRISAT to compete effectively in the next five years for the resources it needs. ICRISAT faces a restructuring of the CGIAR System that will favor large, multi-partner projects. While ICRISAT may have strong competitive instincts, it will need to demonstrate that it can compete for larger and more complex grant-supported projects than it has in the past. In the Panel's interviews with donors and partners, a number commented on occasional lapses in ICRISAT's management of projects and in submitting timely and accurate project reports. Managing fewer grants for larger amounts contributes to solving problems of this kind, but the Panel also emphasizes the need to provide stronger training to Center staff on research management and project management. Successfully competing for funds is one thing, managing them to deliver the promised results on time and at the anticipated levels of quality is another.

The recommendations in the 2003 EMR with respect to resource development were basic and straightforward and reflected the overall lack of focused fund raising capacity within the Center. The recent CCER reflected the substantial improvements in the Center's fund raising capacity. It recommended strengthening the internal capacity for grant seeking across the Center and among younger staff, and urged improvements in ICRISAT's communications practices to enhance its reputation and profile. The CCER also addressed the disproportionate number of small grants in the current portfolio and recommended a concerted effort to seek larger awards as well as stressing the importance of establishing good cost controls to recover expenses and fund overhead. ICRISAT is moving forward on these recommendations. It has instituted a policy to move the Center toward full cost recovery on special projects, and can already demonstrate improvements in the number of grants it received that exceed USD500,000.

The CCER suggested a number of potential new resource development strategies, including a capital campaign, the development of an endowment for the genetic resources and an individual donor program. In the EPMR Panel's opinion these particular recommendations need to be reconsidered in light of the impact of the global recession on grant making and charitable giving and the priority the Center places on more critical resource development.

The resource development goals through 2015 proposed to the Board at its August 2008 meeting build from the Center's current success and include:

- Achieve USD58 million in total funds (2008 projection is USD40 million; the goal involves a USD2.5 million increase per year in restricted funds)
- Sustain core funding at USD15 million
- Increase the total number of scientists by 25 percent
- Have 50 percent of scientific staff costs covered by restricted funds by 2010, and 75 percent by 2015

- Increase recovery of overhead costs to 15 percent from 8 percent

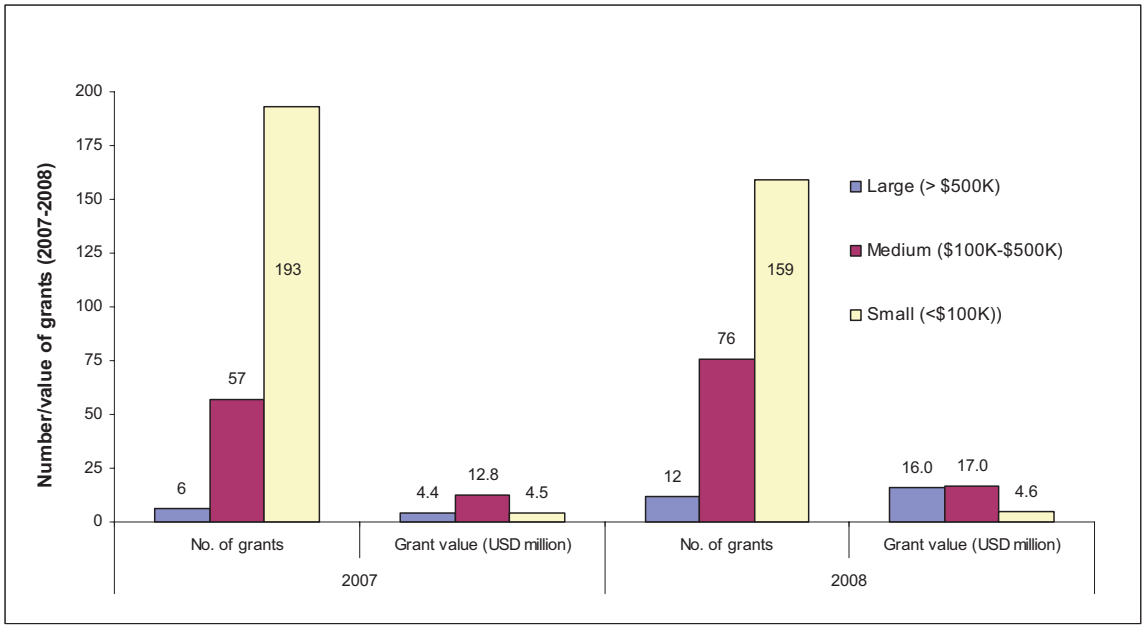
Profile of Restricted Support

In 2007, ICRISAT's restricted support totaled USD21.8M. For 2008, restricted support is projected to rise to USD23.5 million with USD16 million of that amount attributable to grants that exceed USD500,000. Funding through CPs has remained gradually increased over the past four years, and is estimated to have doubled to USD3.4million in 2008 (see Table 5.1).

Funds from foundations and trusts increased dramatically from USD1.7 million in 2007 to estimated USD8.6 million for 2008, reflecting substantial investments by BMGF mainly for crop improvement programs. These types of funds are projected to comprise 90% of ICRISAT's non-CGIAR special projects funding. While success in this arena is a positive trend, the impact of the collapse of the financial markets on foundation and trust endowments makes future support from these sources difficult to project and plan around.

For 2008, ICRISAT projects 250 restricted grants in its portfolio. Nearly 160 are smaller than USD100,000, making the average grant size approximately USD30,000. This is an improvement over 2007 when the grants in this category totaled 193 and the average value was in the range of USD23,000 (Figure 6.1). Grants at this size have disproportionately large transaction costs associated with their acquisition and management and pose serious challenges to effective monitoring and evaluation. The number of small grants also raises questions for the Panel about priority setting and the management of results. Although some small grants can be aggregated to achieve a critical mass of support for specific projects, the disproportionately large number of small grants creates inevitable challenges in conducting research with enough security and long enough time horizons to make a difference.

Figure 6.1 Projected trend in number and value of grants (2007-2008)



Volume puts pressure on the ability of ICRISAT to put together strong proposals, including good budgets and a good system for tracking costs and preparing reports. It also puts stress on the Center's ability to utilize grants within projected timeframes. In this regard, the Center is

challenged to manage its own success. While a problem linked to success is usually better than one linked to failure, an ongoing problem with matching productivity to the pace and availability of resources can quickly lead to donor and partner disillusionment with ICRISAT's ability to deliver on its promises. The Panel earlier noted feedback on this issue. The current systems within PDMO and the finance department are not wholly consonant, which is a contributing factor at least to the challenges of grants management. As a consequence, there is a need to look at whether it is time to adopt a more comprehensive management information system, with a new interface design as a first step.

ICRISAT has made some progress in securing larger grants. In 2008, it projects 12 grants with values over USD500,000, totaling USD16 million and doubling the number of grants of this size. Each of the themes is the recipient of at least two of these grants demonstrating the Center's an ability to build support of this nature in each theme. Two of the large grants, including one from BMGF totaling USD6.4 million in 2008 (USD20.6 million in three years), are for projects that cut across global themes and regions.

One of the characteristics of ICRISAT's very large awards is the degree to which they involve partners and pass through funding. Of USD16 million projected for 2008, USD6.9 million will be distributed directly to partners; USD9 million will remain with ICRISAT. The Panel is impressed by the evidence that funders are demonstrating such confidence in ICRISAT and that investments in the Center's research will grow by USD9 million. Nevertheless, the extent of pass through funding is not reported in a sufficiently transparent way. The budget presentations to the Board do not adequately explain the degree to which restricted support will "stick" to ICRISAT and its research programs as opposed to flowing through to partners with a small capture of overhead. This handicaps financial oversight but also prevents the fullest possible discussion of the balance and levels of investments in the research agenda and the expected results

Given the projected shift to mega-project funding that is part of the CGIAR change initiative, the critical arena for success is leading the development of large proposals (mega-projects), or being included as a significant partner in such projects,. The increasing average size of grants from sources such as BMGF clearly offers ICRISAT a way to increase its capacity to develop these kinds of proposals and manage large-scale projects.

The Panel recommends that training be provided to senior scientific and administrative staff about how to develop and manage large projects, and how to balance research and project management.

6.3.5 Priority Setting

In any organization that depends on restricted support to fund its programs, there is a perennial concern with mission drift and the erosion of meaningful priority setting. Organizations that depend on restricted support for a large percentage of their operating budgets are vulnerable to year-to-year fluctuations in restricted support and must learn to plan and manage to minimize their risk while still preserving the integrity and sustainability of their missions. The fact of the matter is that many NGOs operate effectively from year to year with budgets almost wholly based on "soft" money, and still manage to plan and prioritize effectively. The CGIAR Centers, which have enjoyed a history of core, unrestricted support, have come to contemporary resource development and grants management late.

ICRISAT with 50 percent of its budget linked to restricted support has mastered the process of raising money and has made progress in enabling the staff to participate in this process. Its underlying systems for budgeting and managing projects are growing stronger. The area in which the Panel found the greatest vulnerability and risk was in priority setting. The evidence for this was the number of extremely small grants that are simply too incremental and short term to provide long-term research value to ICRISAT, and the tendency to package and re-package ICRISAT's research activities to capture the funds available for the research of the moment.

While the Research Committee, PDMO and the directors of the themes are charged with aligning resource development with research priorities, the Panel noted the rate at which planning documents were recast or existing research activities were re-named to attract new support. This appears to be the explanation for the creation of the Biopower Operational Strategy, which has its own web site, and the New Sahel Program, in which existing programs are gathered, tweaked and pitched as cutting edge.

The Panel fully appreciates that funding requests are often tailored to a donor's priorities and that parts of a project will be emphasized in order to make their alignment with a specific donor's preferred area of investment clear. Nevertheless, for the initiatives highlighted above and others, PDMO by its own description appears to have played a "catalytic" role. To the Panel, this appears to take the Center's resource development office further than it should in shaping project and proposal development, and creates the impression that opportunity rather than priorities drive fund raising.

The Panel recommends that ICRISAT's leadership clarify the role of PDMO in priority setting and send a clear signal about the drivers and determinants for establishing priorities for resource development.

6.3.6 Agri-Science Park

Introduction and Overview

The Agri-Science Park@ICRISAT represents an innovative effort on ICRISAT's part to engage in partnerships with the private sector. Unlike conventional resource development efforts in which corporations invest in NGOs for philanthropic or public relations purposes, Agri-Science Park (ASP) creates relationships in which the business interests of the partners involved are acknowledged and ICRISAT's mission and research objectives are potentially enhanced.

The development of ASP has been facilitated by the government of Andhra Pradesh, which in 2003 designated ASP@ICRISAT an agri-biotech park, part of the state's Genome Valley Initiative. With the designation came substantial investments in infrastructure and programs, and a network of relationships with the region's private sector. As a result, ASP has grown substantially since its founding, and is poised to grow at an even faster rate in the next few years.

At the time of the review ASP@ICRISAT described the following as housed under the umbrella of ASP:

- Ag-biotech Innovation Center (AIC), a platform for established companies to set up R&D facilities within ASP, with access to ICRISAT's facilities. It currently involves eight partners and nine collaborative research agreements

- Agri-business incubator (ABI), technical assistance in science and management for start-up agricultural companies. There are 48 current members (60 over the program's five year history).
- Hybrid Parents Research Consortium (HPRC), members contribute small, annual grants each year for five-years.[47]Products developed with consortia grants are available free to public sector institutions; no exclusivity is given to any partner.
- Bio-products Research Consortium, 11 private companies engaged in developing biopesticides, growth promoters and bio-fertilizers
- NutriPlus Knowledge Center, a start up project that will provide a platform for R&D in food processing
- Sweet Sorghum for Ethanol Research Consortium provides technical support to ethanol distilleries. Currently, four companies are members with interest from three others
- SAT Eco-venture, an eco-tourism program being developed with the GoAP's tourism department

Although all the units are under the umbrella of ASP, a number predate the formation of ASP and continue to be managed as projects directly by ICRISAT; AIC, the proposed Nutriplus Knowledge Center and SAT Eco-venture are formal projects of ASP. ABI, which has operated as a five year project with the GoI's Department of Science and Technology, is scheduled to expire in 2008 and may move directly under ASP's management if the project is renewed.

The Panel appreciates the energy and enterprise that characterize ASP, and is supportive of the use of partnerships to transfer innovation into the marketplace in ways that will benefit the poor. A number of the operating units within ASP have demonstrated the potential of these relationships, including the Hybrid Parents Research Consortium, which focuses on three of ICRISAT's mandate crops and counts 40 seed companies among its members.

In 2008, the projects managed directly by ASP were projected to bring a total of USD800,000 to the Center plus USD192,000 in direct support for ICRISAT research through AIC collaborative research agreements with research partners. In addition, the three research consortia, including the Hybrid Parents Research Consortium, were projected to generate USD724,000 in 2008 for research projects. Over the course of the review period, ASP@ICRISAT generated USD420,450 in capital investments, principally for labs and glass houses. The Nutriplus project, as envisioned, will also entail significant capital investment.

The model that has emerged from the creation of ASP has sparked interest elsewhere. ICRISAT's experience in India has led to invitations to start comparable programs in Mozambique and West Africa. Based on this experience and additional expressions of interest, ASP proposes to offer a fee-based consultancy to provide advice and expertise to others on replication of the concept.

ASP@ICRISAT Structure

To assess ASP, the Panel first had to grapple with the number and range of operating units, the underlying financial and management structure of the program, and the scale and nature of the research collaborations between partners and the Center. In reviewing these issues, the Panel was struck by the continuous morphing of ASP, and a persistent lack of clarity about where ASP projects are managed and overseen, and where and how income and expenses are reported. As

[47] Time-based partial exclusivity is provided to consortia members on a case-by-case basis. NARS have access to all materials.

ASP has grown, it has become increasingly hard to keep its many moving parts in view. Units and activities are named and renamed, some are characterized as strategic business units (SBUs) others are not, and financial transactions are treated euphemistically. Rents, for instance, are fees, participating businesses are both partners and members, and a partner or members total "contribution" to ASP, both fees and research support, are captured in collaborative research agreements.

Among the value propositions that ICRISAT actively promotes is the direct link between the private sector partnerships that form within ASP and ICRISAT's own work and. To safeguard this link, ASP operates within a policy framework established by the Board and has contractual arrangements with each partner intended to balance private and public interests and safeguard the latter. Advisory and review mechanisms, including the involvement of the Research Committee, are intended to avoid undertaking projects at odds with ICRISAT's research priorities and policies, including IP, and to minimize reputational risk.

The Panel considers this framework to be convoluted but theoretically sound. The problem with ASP is one of scale and transparency. As ASP has grown, the efforts to tie projects to ICRISAT's mission and priorities show signs of strain. From the initial partnerships with seed companies and applied research, ICRISAT's partnerships with the private sector now encompasses initiatives with much weaker links to its mission, among them a business incubator, complete with technical assistance on managing start up companies, a potential tourism activity, albeit with agricultural and environmental overtones, and a consultant service for putting the ASP model in place elsewhere. Other initiatives are more credibly aligned with the ICRISAT's mission but oversell their potential benefits, the principal example being the relatively new Nutriplus initiative, which is discussed below.

Financial Contributions to ICRISAT through ASP

ASP has made solid financial contributions to ICRISAT, but the underlying nature of the contributions—fees, research or capital—are hard to distinguish. Direct contributions to the Center's research projects through the Hybrid Parents Research Consortium are significant. Those that derive from the collaborative research agreements generated within AIC are relatively small. More substantial is income derived from fees of various kinds and capital investments. ICRISAT states emphatically that "…[ASP] is not a tenant facility, and private sector companies cannot enter unless they develop [agreements] to do partner research with ICRISAT's scientists…." The financial results presented for AIC made the assertion questionable. The total income generated by AIC in 2007 is reported as USD942,000, the total value of research grants attributable to it could not be accurately determined based on the information supplied to the Panel, but appeared to total USD61,150. On projected 2008 income of USD800,000, the value of the research grants provided through the partnership agreements improved and was projected to rise to USD192,315.

Although the proposed Nutriplus Knowledge Center includes the donation of structures and labs from a private partner, it is also claims potential benefits for each of ICRISAT's themes, which the Panel considered a stretch. The clear benefits are more likely to be in earned income and capital improvements than in direct contributions to the Center's research agenda. The Panel views ICRISAT's need to justify ASP as mission driven as complicating rather than clarifying what ASP represents to the Center's its bottom line and its strategy for building partnerships with the private sector.

Conclusions

The Panel believes that the scale and structure of ASP needs to be more transparent, particularly to the Board. The most comprehensive reports on ASP are provide to the Board the director of PDMO, who serves as ASP's managing director; these don't provide a sufficient basis for oversight of the program. In financial reports prepared for the Board by the finance office, ASP's numbers disappear into the overall results for restricted and earned income. The costs of staffing and managing ASP are aggregated with the salary and administrative costs for other restricted expenditures. More critically, the inability to grasp the basic financial facts about the sources and uses of ASP income make if difficult to look closely at whether ASP's mission is to generate revenue or to advance the Center's mission. At the moment, the Panel believes these two goals are not fully compatible, but also realizes that the financial value of ASP to ICRISAT if properly acknowledged makes it a major contributor (ref. Annex 2 Strategic Issue # 9).

The Panel recommends that ICRISAT must present ASP's mission, structure and relationship to research in a more transparent fashion and re-assess ASP, either to narrow the ventures it pursues, or, in the interests of minimizing risks to the Center's reputation, create a different structure with clearer boundaries between it and the Center.

6.3.7 Communications

The CCER covered ICRISAT's communications efforts in depth and suggested a number of ways in which communications could be improved. The CCER made four recommendations—on science publishing, ICRISAT's annual report, public awareness and writing and design services. The Center's formal response to these recommendations was positive, but to the EPMR Panel follow through since completion of the CCER (2007-2008) has been insufficient.

In a competitive and increasingly visual culture, organizations give careful consideration to their visual identity and graphic design. In a contemporary communications program, the style and content of written material is produced not to gratify internal audiences but to attract the attention and respect of outside audiences who can range from scientific experts and potential collaborators to policy makers and the general public. ICRISAT's corporate identity is dated and its written style incorporates too much overstatement, distracting from real accomplishments. The Panel's views were echoed by Board members in the course of interviews. The CCER was very clear in these matters and constructive in its suggestions and recommendations. The EPMR Panel urges the Center to revisit its communications strategy and focus more heavily on the opportunity it has to leverage its research work and organizational success through improvements in this area.

6.4 Finance

6.4.1 Introduction

During the period of the review, ICRISAT's financial performance and management have been excellent. It is among the strongest of the CGIAR Centers in financial terms and has the financial personnel and policies in place to support prudent planning and decision making.

From 2003 to 2007, ICRISAT experienced a financial turnaround. It has had consecutive surpluses totaling USD10.7 million, and cumulative earned income totaling USD12.6 million. During the review period, ICRISAT's reserves grew from USD 8.4 million at the end of 2003 to USD14.5 million at the end of 2007.

Through 2007, the CGIAR PMS used four financial parameters to evaluate a Center's financial performance (beginning in 2008, these are reduced to two—adequacy of reserves and cash management on restricted operations). For the years covered by the review, ICRISAT's performance has exceeded the recommended ranges, demonstrating sound financial health in terms of terms of reserves and working capital management. It has also had clean audit opinions for the last five years. Table 6.2 below summarizes ICRISAT's results from 2003 to 2007; projections for 2008 are comparable and appear to be on track.

The recent CCER on governance and management commended ICRISAT for sound financial management. It made five recommendations in the area of financial management, most of which have been implemented. Action on a recommendation to develop a strategic business plan has been delayed until the completion of the EPMR and decisions with respect to CGIAR System changes become clearer.

Table 6.2 CGIAR Financial Indicators and ICRISAT's Performance[48]

Indicator	CGIAR Approved Range	2003	2004	2005	2006	2007
Reserves (No. of Days)	75 to 90	167	124	122	114	148
Liquidity (No. of Days)	90 to 120	284	197	184	171	206
Cash Management Ratio	Less than 1	0.48	0.55	0.54	0.27	0.14
Indirect Cost Ratio	-	22.9	22.8	23.0	23.1	23.3
Audit Opinion	UQ[1]	UQ	UQ	UQ	UQ	UQ
Reserves (USD million)		8.4	8.9	9.3	10.4	14.5
Surplus (USD million)		0.6	3.3	1.0	1.3	4.5

Sources: ICRISAT and CGIAR Performance Measurement database; [1] UQ=Unqualified

As ICRISAT contends with a global economic turndown and change within the CGIAR itself, the combination of healthy reserves and sound financial policies should position it to weather the short and medium-term implications of changes to its operating environment. Because of very conservative investment policies and a prudent strategy with respect to currency risk, ICRISAT has not experienced short term problems with either the safety of its reserves or the loss of their underlying value. Its reserves are placed in highly liquid investments and with financial institutions that have government insured deposits.

The Center is preparing for potential reductions in support by reviewing its current spending and assessing operational plans. The increasing reliance on special project funding and support from non-traditional sources are presently ICRISAT's biggest risks. Economic uncertainty is likely to affect grants from governments linked to special projects as well as corporate philanthropy and the ability of businesses to participate in private partnerships with the Center. The Panel believes that ICRISAT is positioned to weather the initial consequences of these circumstances, and has the policies, practices and organizational resilience to negotiate the potential long-term consequences of a global recession and fundamental shifts in core funding.

[48] As of data for 2008, only the financial indicators for Reserves ad Cash Management Ratio are included in the PMS

6.4.2 Financial Management

The finance function is led by the director of finance. He is supported by a head of finance and three officers at the headquarters in Pantcheru. The regional programs in Africa each have regional administrators, who supervise the finance function in their respective regions and work closely with the main headquarters office.

Financial management functions at ICRISAT are driven by policies approved by the Board. The finance department and other units of ICRISAT adhere to these policies as part of planning and decision making. The Center has a planning and budgeting system, charge back system, investment management system, receivables management system and financial risk management system in place. In 2003, the Board approved policies for managing treasury operations. These policies, which the Center follows carefully, adequately address risks related to treasury operations, including credit risk, interest rate risk, liquidity and exchange rate risk.

ICRISAT, like a number of CGIAR Centers, uses Sun System software for accounting throughout the Center. It has been in operation for over ten years. Access to computing expertise in India has made it possible for ICRISAT to continuously adapt its financial software to meet its needs. For the Center, Sun System has been a reliable and adequate product around which integrated additive modules, such as procurement and personnel management work well. It has been a less effective system for grants management.

The CGIAR System is working to create greater alignment and economies of scale in the area of management information systems. Although the Center is currently investigating a move to a new system, it has not so far found it advantageous to adopt a system that would make it compatible with other Centers. The Center's finance director plays a leadership role in collective efforts to introduce system-wide financial practices. With this in mind, the Panel believes that the director's reservations about MIS systems in other Centers are prudent, particularly given the amount of attention that will need to be placed on more fundamental matters in the next year or two.

In the regions, staff are guided by a manual that addresses standard operating procedures for managing a full range of financial matters. The Panel used a questionnaire to assess the internal control environment at ICRISAT and considers it sound. ICRISAT's internal and external auditors were also asked to provide their assessment of the internal control environment and considered it strong.

6.4.3 Budgeting and Monitoring Systems

The finance director is a member of all senior management teams and committees, which helps to facilitate integrated and sound financial planning and budgeting and to align these with MTPs.

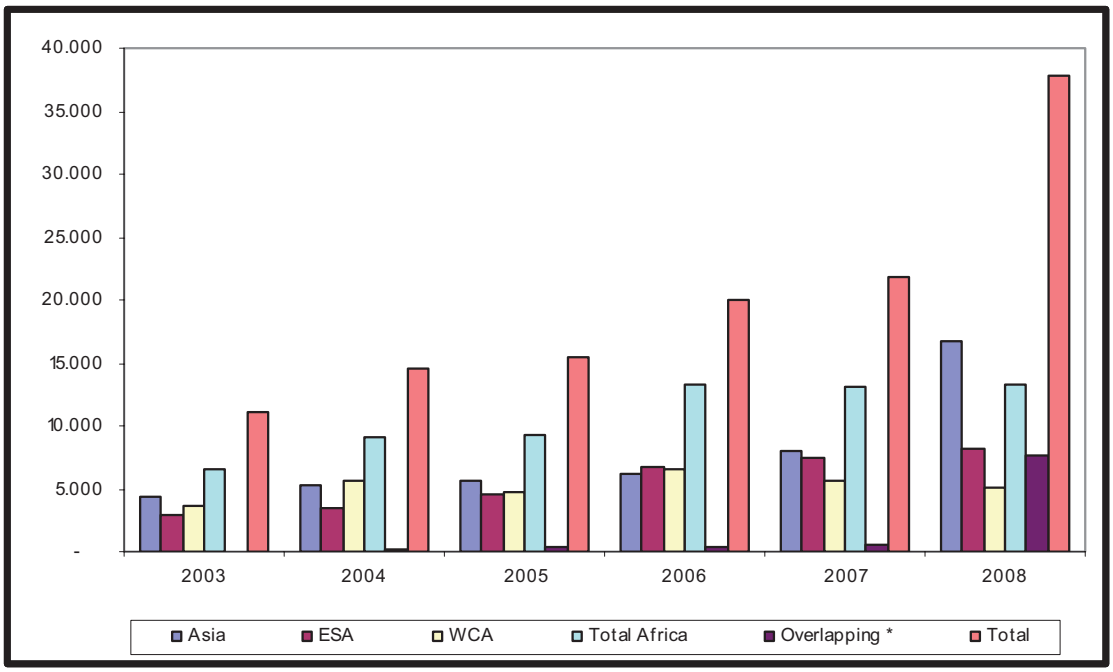
ICRISAT has a planning and budgeting system as well as a charge back system covering direct costs approved by the Board. The finance department works closely with research programs in developing annual and project budgets. ICRISAT has an on-line budget status reporting system (BSRS) that helps all budget holders in science and support services to monitor their actual expenses against their budgets. This helps them in timing actions and making decisions. Further,

the finance department has a reliable budget monitoring system that helps tracking budget utilization.

6.4.4 Indirect Cost Recovery

Grants for restricted projects grew from USD11 million in 2003 to USD21.8 million in 2007. Indirect cost recovery on restricted projects at ICRISAT during the review period has been in the range of 8 to 9 percent against the audited indirect cost rate of 23 percent (Figure 6.2). The low rate of cost recovery is partly explained by the fact that on pass through funds, which are an increasing percentage of ICRISAT's restricted support, indirect cost recovery ranges only from zero to 5 percent.

Figure 6.2 ICRISAT: Restricted projects by region 2003 – 2008 (USD 000)



The CCER on governance and support services recommended improving the recoveries. Beginning in 2008, ICRISAT has begun more systematically to achieve full cost recovery from restricted projects by identifying costs more precisely, improving budget development, and by pushing donors to cover a reasonable level of indirect expenses. Also beginning in 2008, ICRISAT began to systematically negotiate agreements with donors to incorporate as line items costs often covered by overhead, and to include a reasonable rate of overhead recovery on the portion of large grants that remains inside ICRISAT. These improvements are anticipated to increase indirect cost recovery to 14 percent in 2008.

6.4.5 Internal Audit

The CCER on governance and support services did a thorough review of ICRISAT's Internal Audit Unit but did not include recommendations with respect to it. ICRISAT is a member of the CGIAR internal audit unit, which enables it to benefit from economies of scale and consistently high levels of expertise in this area. The CCER included suggestions about the schedule of audits and the need to increase the frequency of audits in areas where risks to integrity or performance are high. The Board's Audit Committee and the full Board dedicated time to the careful oversight of internal audits. Because of the increased attention all Centers pay to this function,

the Audit Committee increased the frequency of its meetings to two each year in order to cover its agenda fully.

6.4.6 External Audit

ICRISAT uses the services of one of the big four audit firms for its external audit. The policy is to change audit firms every 4 years (check this). The Board appoints the external auditor based on the recommendation of the Audit Committee. During the review period, ICRISAT's auditors found no outstanding issues that needed to be addressed.

6.4.7 Conclusion

The 2003 EMR recommended that ICRISAT establish and maintain sound financial management and a balanced budget policy. Board and staff embraced these recommendations and introduced policies and practices in financial management that continue to serve the Center well. The executive committee of the Board provides good ongoing oversight of financial performance and the audit committee is active in both the external and internal audit functions. Recently, the audit committee increased its meetings to twice a year in order to accommodate a more demanding agenda.

The financial systems in place have enabled ICRISAT to manage a substantial growth in restricted support, including budget development and ongoing management of grant receivables and reports.

The CCER on governance and support services made a number of basic recommendations with respect to financial management, which the Center adopted and is in the process of implementing. The Panel endorses a recommendation in the CCER concerning the need for ICRISAT to develop a business plan. ICRISAT has deferred action on this item pending the completion of the EPMR and potential impact of system-wide changes on the Center's planning. While ICRISAT will inevitably revisit its strategic plan, it should not neglect the need to create a strategic business plan, which few Centers have in place. A business plan increases the ability of the Center to make adjustments in course based on priorities as well as resource availability and provides the Center with greater control over achieving its goals.

7 EMBRACING THE FUTURE

7.1 ICRISAT 2008

ICRISAT today is a thriving research institute with a unique capacity to address poverty alleviation, food security, and natural resource protection in the SAT. The 6th EPMR review Panel found a remarkable turnaround in the five years since the Center's 2003 EPMR. The budget grew by 70%, and current plans call for an increase from the current USD40 million in 2008 to USD58 million by 2015. Two regional programs have been established, one in WCA and the other in ESA, each with a regional Director and responsibility to plan, resource, and implement a research agenda to address region-specific constraints to food security and poverty. Overall funding for SSA programs rose to 60% of ICRISAT's total budget, and the Panel found substantial evidence of spillover from use of germplasm and other research outputs developed at ICRISAT's Patancheru, India, headquarters to the SSA programs and NARS.

Partnerships with NARS have been strengthened throughout the SAT, and new donors have been engaged. Of particular note is the strong support provided by the national and state governments of India to ICRISAT's research programs. New partnerships have been forged with the private sector. Most important, ICRISAT has a dedicated and highly motivated staff that is energized about the future and committed to the Center's mission.

The Panel commends the Center's leadership and staff for achieving this extraordinary turnaround and for laying the foundation for future growth.

But the purpose of an EPMR is not only to look backwards, but also to look forward at the challenges and opportunities ahead, and how ICRISAT can best meet them.

7.2 Navigating the Future

In the foreseeable future, poverty, hunger, land degradation, and water scarcity will continue to be the major constraints to economic development and improvement of human well being in the SAT for the foreseeable future. The Panel strongly believes that ICRISAT can and must play a catalytic role to marshal global agricultural research efforts focused on the SAT.

Recent trends in food prices have raised awareness among governments and donors about the pivotal role of agriculture as an engine of economic development and a foundation for political stability. In response, ICRISAT and other IARCs are enjoying a period of increased funding to support their programs. But history demonstrates that awareness and support can disappear rapidly should food prices fall or a different global crisis demand attention. In fact, the recent crash in prices for all commodities, including food, sends a cautionary signal that current funding levels are not assured. ICRISAT's currently strong position equips it with the resilience to embrace a highly uncertain future.

And it is an uncertain future indeed, not only with regard to funding resources, but also in terms of external forces such as globalization of trade, the uneven rate of economic development across the SAT, advances in science, climate change, and energy supply and cost. While navigating these forces ICRISAT must also remain responsive to a complex geography that includes a tremendous range in climate, water resources, soil degradation, and the productivity of its mandate crops. In this context, ICRISAT must work effectively with the variable capabilities and resources of its NARS partners, as well as the ebb and flow in the interests of donors.

Against this background, the Panel sees three strategic issues as most important for ICRISAT's future success. The first concerns the allocation of resources between Asia and SSA. The second is the balance of effort on the research-development continuum, and the third is to establish and maintain a critical mass of scientific capacity focused on agriculture in the SAT.

Differences in the intensity of poverty and NARS resources are the rationale for emphasis on the SAT in SSA than the Asian SAT. These differences are not likely to change and the polarity may actually intensify if economic development proceeds at a greater pace in Asia than in Africa. Given this trend the Panel expects that ICRISAT's work plan will continue to shift towards SSA. This shift, however, does not necessarily imply a move of headquarters. Instead, the Panel believes that strategic research at headquarters can explicitly target constraints in SSA and contribute directly to the two regional programs. But to do this well requires a concerted effort to better understand the reasons for spillover to SSA from technologies developed in Asia. It also requires use of this information to help guide prioritization of strategic research conducted at headquarters. The potential for spillover from Asia to SSA, and vice-versa, should be used as one of the explicit criteria employed in the Center-wide strategic planning process.

There is a disproportionate number of poor throughout the SAT, which means that ICRISAT will continue to be asked to move its research to end-users to validate donor investments. Hence, the need to properly balance the Center's efforts along the research—development continuum will remain a challenge. While the Panel believes that ICRISAT's comparative advantage is in strategic research that seeks to improve the water productivity of its mandate crops, we also recognize the need to remain strategically engaged in technology adaptation and adoption. We propose the potential to derive IPGs about the adoption process should be a guiding principle for deciding why, when, where, what, and how to engage in development-oriented projects. Selection of the most appropriate partners for such activities and an aggressive search for new partners in areas where there is little representation by NARS, NGOs, and the private sector are also important to avoid being spread too thin. Once involved with technology transfer and development-oriented projects, ICRISAT needs an exit strategy to withdraw or hand over to an appropriate governmental organization, NGO or commercial entity such as the ASP.

The Center's staff at headquarters will undergo a major transformation in the next five years as a significant number of senior IRS reach retirement age. Hundreds of years of experience in genetic improvement of mandate crops and in natural resource management research will leave the institute with these retirements. To address this issue, ICRISAT has a succession plan in place. But there remains the challenge of identifying the types of new skills and expertise that is needed, and also the recruitment and retention of world-class scientists. The Center's cutting-edge laboratories, gene bank, field facilities, and technical support staff provide the foundation for attracting top talent.

A critical mass of human resources must be established within the African SAT. To meet this need, ICRISAT must help develop a new generation of African scientists to run the NARS, facilitate growth of the private sector, and accelerate the transfer of knowledge and information to farmers at the field level. It will not be possible for ICRISAT to achieve its goals without greater scientific capacity in the NARS and private sector of the African SAT.

It will be agriculture, not manufacturing, services, or tourism, that drives economic growth in SSA because a majority of the population rely on agriculture for their livelihood. Therefore,

ICRISAT's core research offers the most direct pathway out of poverty. But given the huge tasks ahead and the limited possibilities for an individual organization to achieve widespread change, ICRISAT must leverage its resources to make an impact by expanding its partnerships with other CGIAR Centers, with African regional organizations and universities, and with a broad array of organizations that operate at the grassroots level..

Donors also recognize the magnitude of the challenges facing SSA and are pressing for better coordination of effort among the Centers, a wider range of collaborating organizations, and greater clarity with which research outputs and impact are defined. Taken together, these factors justify larger projects, often with multiple partners. The CGIAR's experience with challenge programs, the CGIAR change initiative, and the preferences of large donors support this trend. ICRISAT must respond by moving away from managing hundreds of small projects that are a by-product of the Center's financial turnaround to more focused and effective involvement as a participant and leader of large mega-projects. It will require that ICRISAT cultivate and strengthen its partnership skills and develop a clear vision of its core scientific strengths. Research quality must be allied with sophisticated management and financial skills if ICRISAT is to perform at the levels demanded by these funding trends.

ICRISAT will need strong and nimble strategic planning capability. It will require better information, greater insight, and the ability to discern priorities and make difficult choices. A clear and balanced understanding of organizational assets and the quality of its research outputs are essential components of this strategic planning process. A sound strategic plan provides the compass to make progress towards the Center's goals—in times when resources are plentiful and when they are scarce. The Center must therefore re-invigorate its strategic planning and research prioritization.

The most recent World Development Report (2008) depicts an uncertain future for SSA. Indicators such as life expectancy and poverty are stagnant even as they have improved elsewhere in the developing world. Agricultural indicators, such as input use, adoption of new varieties and yield increases also show little improvement in most areas. Yet agriculture holds the key to reversing these trends, and it also an important engine of growth in the harsh environments of the Asian SAT, which are home to hundreds of millions of extremely poor. Given this situation, much of the fight against poverty will occur in farmer's fields of the SAT, and it is not unreasonable for ICRISAT to envision an SAT free from poverty and hunger within the lifetime of the young scientists and scholars working at the Center today. ICRISAT can be proud of its achievements in the last five years, and the Panel believes it is poised for future success in building its programs to achieve its mission.

ANNEX 1
ICRISAT SIXTH EPMR PANEL COMPOSITION AND BIODATA

CHAIR **Kenneth G. Cassman** Professor University of Nebraska, Lincoln Nebraska 68583-0915 USA	 Tel: 402-472-3852 Email: kcassman1@unl.edu
MEMBERS **Eric Danquah** Professor Department of Crop Science College of Agriculture and Consumer Sciences University of Ghana P. O. Box LG44, Legon Ghana Tel./Fax +233 21 520609 e-mail: edanquah@wacci.edu.gh	 **Antonio J. Hall** Professor Emeritus Facultad de Agronomía Universidad de Buenos Aires Av. San Martín 4453 (1417) Buenos Aires Argentina Tel +54-11-4524-8000 ext. 8116 e-mail: hall@ifeva.edu.ar
Kenneth M. Menz Visiting fellow Crawford School of Economics and Governance Australian National Society 93 Sue Geh Circuit Nicholls ACT 2913 Australia e-mail: Ken.menz@anu.edu.au	**Maureen Robinson** Independent Governance and Management Consultant 8217 Hamilton Spring Court Bethesda, MD USA Tel: 1-301 365-7503 e-mail: Mkrobin500@aol.com
Prosper Biabo (Finance consultant)	
Senior Advisor / Freelance Consultant 9061 Manchester Rd, #103 Silver Spring, MD 20901 USA e-mail: pbiabo@gmail.com	
RESOURCE PERSONS	
SC Secretariat **Sirkka Immonen** (Panel Secretary) Senior Agricultural Research Officer SC Secretariat, FAO, NRDS, C634 Viale delle Terme di Caracalla 00153 Rome, Italy Tel.: +39 06 570 54861 E-mail: Sirkka.Immonen@fao.org	**CGIAR Secretariat** **Harry Palmier** Senior Liaison Officer The World Bank 1818 H Street NW, MSN G 6-601 Washington D.C. 20433, USA Tel.: +1 202 473-1053 E-mail: hpalmier@worldbank.org

CASSMAN, KENNETH (United States of America)
Position: Heuermann Professor of Agronomy and Director, Nebraska Center for Energy Sciences Research
Expertise: Agronomy and soil science
Education: Ph.D. in Agronomy and Soil Science from the University of Hawaii (1979); B.Sc. in Biology from the University of California, San Diego (1975).
Experience: 1991-95: Head of the Agronomy, Plant Physiology, and Agroecology Division at the International Rice Research Institute. 1984-90: Assistant and Associate Professor in the Department of Agronomy and Range Science at the University of California, Davis. 1982-84: Grain Legume Agronomist on the Egyptian Major Crop Improvement Project. 1980-82: Project Leader of the Jari Rice Project Research Group in Para, Brazil. Research interests include soil fertility and plant nutrition, nutrient cycling, root ecophysiology, crop yield potential, the sustainability of intensive cropping systems, and life-cycle analysis of biofuel systems. He is a Fellow of the American Society of Agronomy, Crop Science Society of America, the Soil Science Society of America, and the American Association for the Advancement of Science. Member of 4th EPMR (1997) of CIMMYT and Chair of 5th IITA EPMR (2001).

DANQUAH, ERIC YIRENKYI (Ghana)
Position: Director, West Africa Centre for Crop Improvement, University of Ghana; Dean, International Education Programs, University of Ghana
Expertise: Genetic diversity in crop plants and associated pests; Biotechnologies in crop improvement; Farmers' knowledge and plant breeding
Education: Ph.D., Genetics, (1993) and M.Phil., Plant Breeding (1987), University of Cambridge, England; B.Sc. (Agriculture), University of Ghana (1984).
Experience: 2005-2006: Head of Department of Crop Science, College of Agriculture and Consumer Sciences, University of Ghana; 2004-06: Associate Professor,; 2001-04: Senior Lecturer, Department of Crop Science, College of Agriculture and Consumer Sciences, University of Ghana; 2000-01: Visiting Scientist, Institute of Arable Crops Research, University of Bristol, Long Ashton, Bristol, England; 1994-01: Lecturer, Department of Crop Science, College of Agriculture and Consumer Sciences, University of Ghana; 1993-94: Research Scientist, Plant Breeding International, Cambridge, England; 1989-93: Demonstrator, Department of Genetics, University of Cambridge, England; 1987-89: Assistant Research Officer, Faculty of Agriculture, University of Ghana; 1986-87: National Service, Ghana Education Service, Ghana. He is a Fellow of the Cambridge Philosophical Society and the Cambridge Commonwealth Society,

HALL, ANTONIO JUAN (Argentina)
Position: Emeritus Professor of Plant and Crop Physiology, Facultad de Agronomía, Universidad de Buenos; Director, IFEVA (Institute for Agricultural Plant Physiology and Ecology); Member, National Academy of Agronomy and Veterinary Sciences, Argentina.
Expertise: Crop ecophysiology, with special reference to carbon balance and yield determination; Drought tolerance; Crop modeling; Environmental control of development, Lodging tolerance
Education: Ph.D., Biological Sciences, Macquarie University, Australia (1976); Ing. Agr., Universidad de Buenos Aires, Argentina (1966).
Experience: Successively, Tutor (1968), Assistant Professor, Associate Professor, Professor (1982) , Facultad de Agronomía, UBA. Principal Research Scientist, CONICET; Research Fellow, University of Melbourne (1985); Visiting Scholar, Dept. of Crop and Soil Sciences, Michigan State University. (1989 and 1990); Investigador visitante, ETS Ingenieros Agrónomos, Univ. de Córdoba, España (1991 and 1992); Coordinator, Plant Production M.Sc. Programme, Facultad de Agronomía, UBA (1986-1996); Director, Graduate School, Facultad de Agronomía, UBA, (1997-2004). Member, Evaluation and Promotion Committee, CONICET (2002-04). Member, Dean´s International Advisory Council, Ontario

Agricultural College, Univ. of Guelph, Canada (2005-2007). Has won a number of honors and fellowships and has published over 80 peer reviewed journal articles and 6 book chapters.

MENZ, KENNETH MILTON (Australia)
Position: Visiting Fellow, Crawford School of Economics and Governance, Australian National Society
Expertise: Agricultural Systems Economics and Management
Education: Ph.D., Agricultural and Applied Economics (1974) and M.Sc., Agronomy (1969), University of Minnesota; B.Sc. in Agronomy, Sydney University (1966).
Experience: 2003-07: Research Program Manager, Agricultural Systems Economics and Management, Australian Centre for International Agricultural Research (ACIAR). 1998-03: Head, Impact Assessment Unit and Research Program Manager, Agricultural Systems Economics and Management, ACIAR. 1994-97: Visiting fellow, Centre for Resource and Environmental Studies, The Australian National University. 1987-94: Research Program Coordinator, Economics and Farming Systems Program, ACIAR. 1982-97: Officer-in-charge and Principal Research Officer, Bureau of Agricultural Economics, Australia. 1981-82: Research Associate, Department of Agricultural and Applied Economics, University of Minnesota. 1979-1980: Principal Scientist and Head of Economics Unit, Farming Systems Program, IITA. Has authored some 70 scholarly articles.

ROBINSON, MAUREEN (USA)
Position: Independent Governance and Management Consultant
Expertise: Governance, management, board and organizational assessment and development, and strategic planning
Education: B.A., The George Washington University (1974)
Experience: 1990-98, founding Director of Education, National Center for Nonprofit Boards; 1987-90: Special Assistant, Office of the Assistant Secretary for Museums, Smithsonian Institution; 1979-85: Director of Government Affairs; 1975-79: Associate Editor of Publications, American Association of Museums. Publications: Nonprofit Boards that Work: The End of One-Size-Fits-All Governance; Developing the Nonprofit Board: Strategies for Educating and Motivating Board Members; The Chief Executive's Role in Developing the Nonprofit Board; , CGIAR Board Reference Guides, (7 booklets). Panel member of CIMMYT 5th EPMR (2005) and ILRI 2nd EPMR (2006). Co-author of EPMR meta-evaluation report for the CGIAR (2007).

BIABO, PROSPER (Cameroon)
Position: Financial Management Consultant to the World Bank and Senior Advisor / Freelance Consultant, Uracan Inc., Montreal, Canada
Expertise: Financial management, procurement and monitoring, Public/ Private sectors Reforms, Technical Assistance and Advisory Services to Institutions, Project Management, Statistics and Economics
Education: Executive Diploma in Public Financial Management, Harvard University, Kennedy School of government (2006); The European Association for Environmental Management Education, Italy (1997); M.Sc., Environmental Management, Swiss Federal Institute of Technology, (1997); MBA; Institute of Statistics, Planning and Applied Economics; Cameroon (1980); Ingénieur d'Application de la Statistique (M.A.), Institute of Statistics (1980).
Experience: 2003-06: Technical Assistant/Advisor to the Minister, Ministry of Finance, Kinshasa, DR Congo; 1997-2003: Consultancies with: The World Bank Group, UNDP, AfDB, The World Resources Institute, Fondation Universitaire Luxembourgeoise, Vriedge Universiteit, Monsanto-Europe, Harvard University; 1991-95: Technical Assistant/Comptroller, Livestock Development Project, Ministry of Livestock, Fisheries and Animal Production, Cameroon; 1987-91: Economic/Commercial Officer, The Canadian Embassy, Cameroon, 1980-85: Head Statistics and Economics Research Division, The National Electricity Corporation, Cameroon.

ANNEX 2
TERMS OF REFERENCE FOR EXTERNAL PROGRAM AND MANAGEMENT REVIEWS OF CGIAR CENTERS

BACKGROUND

CONTEXT

1. The Consultative Group on International Agricultural Research (CGIAR) is an informal association of over 50 members that supports a network of 16 international research centers in agriculture, forestry and fisheries. The CGIAR aims, through its support to the Centers, to contribute to promoting sustainable agriculture for food security in developing countries. Because the Centers constitute the core of the CGIAR, the effectiveness of each Center is crucial to the continued success of the CGIAR (as a System).
2. Each Center is an autonomous institution operating within the mandate assigned to it by the CGIAR, and is governed by a legally constituted Board that has full fiduciary responsibility for managing the Center. To ensure accountability in an essentially decentralized system, each Center is expected to be responsive to the CGIAR, which provides financial support for its work.
3. The CGIAR has established a tradition of External Program and Management Reviews (EPMRs) to provide a mechanism of transparency and accountability to the Members and other stakeholders of the CGIAR System. EPMRs are the joint responsibility of SC and the CGIAR Secretariat, and are conducted for each Center approximately every five years. As each Center is autonomous, EPMRs provide a measure of central oversight and serve as an essential component of the CGIAR's accountability system.

Integrated System of Reviews of Each Center

4. Besides the EPMRs, Center Commissioned External Reviews (CCERs) are undertaken at each Center. These CCERs are commissioned by the Center Boards to periodically assess the quality and effectiveness of particular aspects of a Center's work. The terms of reference (ToRs) for each CCER are determined by the Center, based on broad principles endorsed by the CGIAR at ICW95 (ref. document entitled *Improving the Quality and Consistency of CGIAR's External Center Reviews*, dated October 24, 1995).
5. EPMRs complement the CCERs by providing a CGIAR-commissioned and comprehensive external assessment of the Center's program and management, especially its future directions and the quality and relevance of its research. The ToRs for the EPMRs (which update the "standard ToRs" endorsed by the CGIAR at MTM95) are provided below. Guidelines for undertaking the reviews are issued separately.

TERMS OF REFERENCE

Objectives and Scope

6. EPMRs seek to inform CGIAR members that their investment is sound, or recommend measures to make it so. Members of the CGIAR and other stakeholders can be informed whether the Center is doing its work effectively and efficiently. EPMRs are both retrospective and prospective; and help ensure the Centers' excellence, relevance and continued viability, and the CGIAR System's coherence. Each review is expected to be strategic in orientation and as comprehensive as the situation warrants.
7. The broad objectives of EPMRs are to: a) provide CGIAR members with an independent and rigorous assessment of the institutional health and contribution of a Center they are supporting; and b) to provide the Center and its collaborators with assessment information that complements or validates their own evaluation efforts, including the CCERs.

8. The EPMR panel is specifically charged to assess the following:
   a) The Center 's mission, strategy and priorities in the context of the CGIAR's priorities and strategies;
   b) The quality and relevance of the science undertaken, including the effectiveness and potential impact of the Center's completed and ongoing research;
   c) The effectiveness and efficiency of management, including the mechanisms and processes for ensuring quality; and
   d) The accomplishments and impact of the Center's research and related activities.
9. The topics expected to be covered by the EPMRs are listed below.

TOPICS TO BE COVERED

A. Mission, Strategy and Priorities

- The continuing appropriateness of the Center's mission in light of important changes in the Center and its external environment since the previous external review.
- The policies, strategies, and priorities of the Center, their coherence with the CGIAR's goals (of poverty alleviation, natural resources management, and sustainable food security), and relevance to beneficiaries, especially rural women.
- The appropriateness of the roles of relevant partners in the formulation and implementation of the Center's strategy and priorities, considering alternative sources of supply and the benefits of partnerships with others.

B. Quality and Relevance

- The quality and relevance of the science practiced at the Center.
- The effectiveness of the Center's processes for planning, priority setting, quality management (e.g., CCERs, peer reviews and other quality and relevance assurance mechanisms), and impact assessment.

C. Effectiveness and Efficiency of Management

- The performance of the Center's Board in governing the Center, the effectiveness of leadership throughout the Center, and the suitability of the organization's culture to its mission.
- The adequacy of the Center's organizational structure and the mechanisms in place to manage, coordinate and ensure the excellence of the research programs and related activities.
- The adequacy of resources (financial, human, physical and information) available and the effectiveness and efficiency of their management.
- The effectiveness of the Center's relationships with relevant research partners and other stakeholders of the CGIAR System.

D. Accomplishments and Impact

- Recent achievements of the Center in research and other areas.
- The effectiveness of the Center's programs in terms of their impact and contribution to the achievement of the mission and goals of the CGIAR.

LIST OF STRATEGIC ISSUES IDENTIFIED BY THE SCIENCE COUNCIL TO BE ADDRESSED BY THE 6TH ICRISAT EPMR PANEL AS A SUPPLEMENT TO THE STANDARD EPMR TORs.

1. Following the 5th EPR, what are the major changes in ICRISAT's governance, management, research approach, resources and research agenda to tackle research for development challenges in sub-Saharan Africa in general and with respect to the current food crisis in particular? Does the Board have appropriate procedures and information to strategically decide on resource allocation between Asia and SSA?
2. Progress in improvement of dryland systems appears to be slow despite long-term efforts by ICRISAT among others. Has ICRISAT's research generated major IPGs for dryland agriculture? What evidence does ICRISAT now have on the gap in current yields relative to the potential of the available water supply in the target areas of research? Are the processes that ICRISAT perceives as the main limits to yield in dryland environments the key ones and how would improvement in them contribute to further narrowing the yield gap?
3. How have the priority targets for genetic improvement by ICRISAT changed over the last 10 years in response to the differential needs of the national programs in Asia and in Africa and to the progress in some traits? What crop/allele targets have been successfully passed on to the national systems in Asia in order to re focus on new targets?
4. How is ICRISAT addressing the emerging issues of climate change as they impact on farmers in the semi-arid tropics?
5. ICRISAT's research agenda sufficiently focused on the generation of international public goods (IPGs) specifically with regard to its socio-economic and NRM work? Is ICRISAT's involvement in some downstream activities sufficiently justified (for example proof-of concept)?
6. How should ICRISAT position its role in agricultural diversification and high value/ value-added agricultural products? Is ICRISAT's research on sweet sorghum for biofuel based on a compelling rationale for the work? Does ICRISAT perceive possible physiological and genetic trade-offs between the production of grain, fodder and biofuels and how does this influence the strategic targets for research in view of the important place grain and fodder hold for the poor?
7. To what extent has ICRISAT's activities in seed systems at the local level led to a better definition of a viable seed system for its mandate crops in Africa?
8. Should ICRISAT be involved in VASAT -Virtual Academy for the Semi-Arid Tropics?
9. ICRISAT (like some other centers) has embarked on a number of private based enterprises to off-set some of its fixed costs. What are the advantages and risks of these to the core mission of the center?
10. Does ICRISAT believe that it has in place a robust mechanism to run the core business of the Center on increasingly project based funding? To what extent are new and potential projects scrutinised for their contribution to the MTP of the Center? Do restricted projects recover full costs?
11. The financial accounts of ICRISAT are given a clean opinion by the auditors and the CGIAR peer review found the financial reporting in compliance with CGIAR FG2. However, does the Center sufficiently manage risk on treasury operations, given the trend in interest income and foreign exchange gains in the last five years?

ANNEX 3
ITINERARY OF THE EPMR PANEL

August 18-24, Initial Phase

The whole Panel visited ICRISAT Headquarters during the Initial Phase. During this time the ICRISAT Senior Management, Global Theme leaders, WCA and ESA Program directors and MTP Project coordinators gave presentations to the Panel on ICRISAT's strategy, mission, planning process and management, and briefing on the research programs, achievement, impacts and challenges. Panel members also met with staff in Finances and Human Resources. Prosper Biabo, finance consultant to the Panel, had several follow-up meetings with the relevant administrative staff. The Panel had an opportunity to see demonstration plots, heritage watershed and different field studies in a field visit at ICRISAT campus. It visited research and management service units, the genebank, laboratories, including the Center of Excellence in Genomics, other facilities, VASAT and the Agri-Science Park. The Panel also met students and young scientists. Outside the scheduled meetings the Panel had good opportunities to interact informally with ICRISAT research and management staff.

August 25-29, Meeting of the Governing Board

The whole Panel met with ICRISAT Governing Board in the initial day of the Board meeting. Subsequently Ken Cassman and Maureen Robinson observed the Board meetings, individually interviewed the Board Chair and members, and met separately with Board members representing ICRISAT's host-country, India. The Panel Chair also joined the Board to visit the Pioneer Seeds Overseas operations in Hyderabad

August 26-30, Visits with partners in India

August 26-28. Eric Danquah, Ken Menz and Antonio Hall accompanied by CLL Gowda visited partners in the Delhi area. At the National Research Center for Plant Biotechnology they had discussions with Drs. P. Ananda Kumar (Project Director), N. K. Singh (Principal Scientist, Indian Rice Genome Project) and Srinivasan (Principal Scientist); at the National Centre for Agricultural Economics and Policy Research they met with Drs. Joshi (Director), Suresh Pal and Bhuban Barahal (Principal Scientists on Economics).

In Jodhpur the Panel visited the Central Arid Zone Research Institute where they met with Drs. K.P.R. Vittal and O.P. Yadav and their colleagues. Dr O.P. Yadav also accompanied them to see the All India Coordinated Pearl Millet Improvement Project, which was presented by Dr. I.S. Khairwal (Project Coordinator) and his colleagues (Drs. Bhati, Kherwa, Rajpurohit, Beniwal, Deepak and Solangi).

August 29-30. Once more in Patancheru, the Panel visited the Central Research Institute for Dryland Agriculture (CRIDA) where they met Dr. Venkateswarlu (Director) and his colleagues, and were shown around BioSeeds Research India field operations and the firm's laboratories at the Agri-Science Park. Wrap-up meetings were organized with Senior Management prior to departure from ICRISAT.

September 29 – October 9, Field visits in SSA

September 29-October 1 Niger. Eric Danquah and Antonio Hall accompanied by Dave Hoisington and Farid Walyar visited the ICRISAT Sadore Research Station and field sites near Sadore where they saw field plots and demonstration and had discussions with ICRISAT staff. At the Institut Nationale de la Recherche Agronomique du Niger (INRAN) they met Dr. Hassane Moussa (Director General) and at the Institut de recherche pour le développement they had discussions with Dr. J-L. Rajot (Deputy Director). The team participated in a round-table

discussion held at the Fédération des Coopératives Maraîchères du Niger (market gardener cooperatives) (chaired by the president of the Fédération, M. Idrissa Bagnou) joining a large number of participants, including farmers, advisers, exporters, seed producers, NGO's and a representative of the world's largest onion seed producer. The team also visited the African Centre of Meteorological Application for Development and had discussion with the Secretary General and acting DG, M. M. Kadi, and some of the staff. At the Faculté d'Agronomie, Université Abdou Moumouni de Niamey (UAM) they met the Dean, Dr. Guero Yadji and his colleagues. The Panel later met with UAM research scholars and interns at the ICRISAT facility in Niamey. They also visited Farmers´ Field School at Dosso and participatory groundnut variety testing trial conducted by women at Tounga, experiments which are part of the BMGF funded Tropical Legume 2 program. Finally the team had discussions with the Head of the Integrated Rural Development Project, M. Roch Ajavon, overseeing integrated rural development projects, and some of his staff.

October 2-4 Mali. From Niger Eric Danquah and Antonio Hall, accompanied by Dave Hoisington and Farid Walyar, continued to Mali. There they visited ICRISAT's Samanko Research Station where they saw field plots and demonstrations and had discussions with ICRISAT staff. The Panel visited farmer participatory sorghum and groundnut variety selection trials and groundnut seed production fields at Gonsolo and Makanjana. They paid a visit to the Institut de Economie Rural and had discussions with Drs. Teme (DG) and Dr. A. Cissé (DG Admin.). They had a chance to visit some facilities at the IER Research Centre in Sotuba, namely the GIS Lab, the Animal Nutrition Lab, and the Sorghum Improvement Program. They visited the Biotechnology Laboratory (Laboratoire de Biologie ***Moléculaire Appliquée***) at the University of Bamako and were received by Dr. Ousmane Koita. At the Institut du Sahel (INSAH) they had discussion with the Dr. Amadou Moustapha (DG) and representatives of some other organizations. They later met Norbert Maroya and R. Hanchinal of West Africa Seed Alliance, and Ousmane Sidibé, president of the Socíete Semencíere du Malí . The team also met with Dr. Oumar Niangado of Syngenta Foundation and Dr. Karamoko Sako, the Regional Coordinator of European Cooperative for Rural Development. They had discussions with Cristophe Breyne, Technical Coordinator for Food Security of Action Contre la Faim, and they interviewed members of the COPROSEM seed producers' cooperative at Campement Kamadjana.

October 5-7, Kenya. Eric Danquah and Antonio Hall were joined by Ken Menz in Nairobi where they had extensive discussions, including presentations, with the ICRISAT staff. Dave Hoisington and Said Silim accompanied the Panel. At the College of Agriculture and Veterinary Sciences, Kabete Campus, University of Nairobi they were received by the Principal, Prof. Agnes Mwang´ombe, and Dr. Mary Mburu and they also visited the ICRISAT chickpea trials and seed production plots at the Kabete Campus. They visited the Biosciences Eastern and Central Africa (BecA) Laboratory at ILRI. At ILRI they also learned about the CGIAR Regional Plan for Collective Action in ESA (coordinated by Dr. Ravi Prabhu). The team had discussions with the Director of the Kenya Agricultural Research Institute (KARI), Dr. Ephraim Mukisira; and had a chance to interview several ICRISAT partners including: Fred Ogana (TechnoServe), George Odingo (Catholic Relief Services, CRS), Sam Gudu, sorghum breeder at Moi University, Stephen Lyimo, a pigeonpea breeder at the Selian Agricultural Research Institute (Tanzania), and James Onsando, the Technical Director for Programs of Africa Harvest Biotech Foundation, a Kenya NGO.

October 8-10, Malawi. Eric Danquah, Antonio Hall and Ken Menz, accompanied by Said Silim, met ICRISAT staff at the Chitedze Experiment station. They visited the Ministry of Agriculture and Food Security, and met with Dr. Geoffrey Lukanga (Comptroller of Extension and Research) and Dr. Andrew Daudi (Principal Secretary). They later met with Joshua Amon,

Mohamed Makda (Financial Controller), Dyborn Chibonga (CEO) and Joshua Varela (General Manager, NASFAM Commercial), all from the National Smallholder Farmer Association of Malawi. They interacted with a farmer group in a village nr. Mchinji, and visited a NASFAM groundnut seed and grain cleaning and storage facility close to the same village. Finally they had interviews with several ICRISAT partners including: Dr S.H. Shomari, Zonal Director, Naliendele Agricultural Research Institute, Tanzania; Kennedy Kanenga, Zambia Agriculture Research Institute; Dr Geoffery Kananji, Head of legume breeding, Malawi Ministry of Agriculture; and Aldwin Mtembezeka, Manager of the CARE Malawi.

January 25 – February 6, Main Phase

The Panel returned to ICRISAT Headquarters for the Main Phase. During this visit the Panel completed draft chapters of the report and shared them with ICRISAT senior management for checking of factual accuracy. During this process the Panel Chair had daily interaction with the DG and DDG-R to keep them informed of the Panel's progress and any additional needs. On the 6th of February the Panel gave a presentation about the key findings, conclusions and recommendations to ICRISAT's Senior Management Team and, in the afternoon, a further presentation to the Center's research staff. The final report was submitted to the Science Council Chair and CGIAR Director and shared with ICRISAT on Monday 16th February.

ANNEX 4

5th EPR AND EMR RECOMMENDATIONS, ICRISAT's RESPONSE AND 2008 UPDATE ON IMPLEMENTATION, AND THE 6th EPMR PANEL'S OBSERVATIONS.

EPR RECOMMENDATIONS

Recommendation No. 1:

The Panel recommends that ICRISAT continue to undertake strategic research on genomics and transgenic product development for SAT crops; and together with the other CGIAR Centers and relevant partners, address the pressing issues on intellectual property, biosafety and public acceptance of transgenic crops.

ICRISAT's response

ICRISAT accepts the recommendation, and will continue to ever more vigorously undertake strategic research on genomics and transgenic product development for SAT crops. At the same time, we will expand our research in the biosafety aspects of transgenic crops, and proactively address issues related to public acceptance and IPR of biotechnology products.

Implementation

Genome research active, GMC pipeline flowing, IP policy and biosafety guidelines in place and cooperation across CGIAR centers positive. 2005: Progress continued (See 2006-2008 MTP for full details). Implemented in 2004 and now on-going.

6th EPMR Panel's observations

ICRISAT has adequately addressed this recommendation.

Recommendation No. 2:

The panel strongly recommends that ICRISAT should maximize the synergy possible when GT 1 and GT 2 plus their partners work closely together to generate IPGs for the SAT. ICRISAT should rapidly re-build and re-engineer its crop improvement program and further enhance the evolution of the two pronged breeding strategy for Asia and Africa.

ICRISAT's response

We accept the recommendation. The process of integrating activities in GT 1 (Biotechnology) and GT 2 (Crop improvement, Management and Utilization) is already well underway. However, we accept the challenge to create a truly comprehensive genetic resources and enhancement paradigm through systemic multidisciplinary partnerships with NARS and private sector partners in the region. In this way we will fully capture the potential synergy between disciplines and sectors, and hope to serve the differential needs of Asia, Africa and the CGIAR as a whole

Implementation

GTs on biotechnology and crop improvement and their partners working in close harmony and synergies for the production of IPGs being exploited. GTLs of GT BT and GTCI discussed prioritization and a workshop planned for 05. Breeding programs in Africa being strengthened. Achieved 2004/5.

6th EPMR Panel's observations

ICRISAT has adequately addressed this recommendation. GT-BT and GT-CI are working closely together in a number IPG oriented research activities. Breeding activities in SSA have been strengthening.

Recommendation No. 3:

The panel recommends that ICRISAT phases out GT3 (Water, Soil and Agrodiversity management) research in Asia where it no longer has a comparative advantage, by devolving this research to NARS. These resources should be redeployed in Africa where they should be engaged in addressing some of the major challenges in land, water and agrodiversity research facing the SAT of the continent.

ICRISAT's response

We accept the recommendation and will re-deploy unrestricted funding to strengthen GT 3 activities in SAT Africa in a phased manner that will then better address the major challenges of land, water and agro-diversity research. However, given the availability of opportunities for restricted funding in the area of GT3 activities in Asia, ICRISAT will continue to pursue these simultaneously and create a self-supporting natural resource management team in Asia. In this way, GT3 scientists would continue to contribute to ICRISAT's IGNRM and new science strategies and draw lessons from long-term development programs in Asia to help translate these for impact in Africa.

Implementation

Core-funded GT Agroecosystems work in Asia being transferred fully to special project funding by 31/12/05 (minor exceptions: one on-station long term trial, Met station services and analytical laboratory costs). ICRISAT continuing, and will continue to play at NARES and donor request, vital coordinating role in Asian special project watershed improvement consortia. Started 2004, Achieved 2005 for the 2006 budget. Final savings will come on-stream in 2006-7 following payment of Asian staff retrenchment costs.

6th EPMR Panel's observations

This recommendation has not been fully addressed, partly due to conflicting guidance by the recent CCER. The 6th EPMR Panel endorses the 5th EPR recommendation.

Recommendation No. 4:

The Panel recommends ICRISAT prioritize its activities in IPM/IDM. Potential projects should be chosen with priority being given to projects that address constraints that are important in Africa and are potentially solvable through IPM and IDM approaches.

ICRISAT's response

ICRISAT agrees with the recommendation and will plan to undertake IPM/IDM research as an integral part of the IGNRM approach to meet the food security needs of smallholder farmers in SAT Africa.

Implementation

Consolidated IPM/IDM approach adopted and implemented e.g. 2004-2007 E. African String control project. Achieved 2004.

6th EPMR Panel's observations

ICRISAT has addressed this recommendation to a great extent, particularly regarding work on *String* in Africa and the Host Plant Resistance (HER) component of IPM/IDM in all regions. The 6th EPMR Panel was unable to evaluate changes in the non-HER components.

Recommendation No. 5:

The Panel recommends that ICRISAT rationalize the role, scope and objectives in terms of its comparative advantage in conducting research generating IPGs in GT4 (Seed systems). This includes addressing the anticipated problems related to marketing transgenic materials it will produce. The purposes and goals of GT4 will be best served if its activities are strongly anchored into appropriate global themes where interdisciplinarity can be enhanced and resources more efficiently and effectively utilized.

ICRISAT's response

We agree with the recommendation that the work on seed systems should generate further IPGs. ICRISAT agrees that inter-disciplinarity needs to be enhanced and would endeavor to integrate activities, wherever needed.

Implementation

Seed systems research rationalized and market chain research approach implemented to produce IPGs. Marketing issues for IPR and biosafety issues related to transgenic materials being addressed where possible and where appropriate. Harmonization of variety registration procedures in support of the commercialization agenda with strong backward links to GT Crop Improvement

and forward links to GT SAT futures. 2005: GT Seed Systems has now been fully subsumed into GT Crop Improvement and GT Markets, Policy and Impact. Achieved 2005.

6th EPMR Panel's observations

ICRISAT has adequately addressed the recommendation. The work has now been focused, prioritized, and is anchored in GT-IMPI and GT-CI.

Recommendation No. 6:

The Panel recommends that GT5 (Enhancing crop-livestock productivity and systems diversification) should transfer assessment of feed quality to GT2 (Crop Improvement, management and utilization) and cease its other activities in Asia. The level of staffing should be increased, and strategic research in Sub-Saharan Africa expanded, particularly in landscape level research on new systems. To ensure coherence in ICRISAT's programs this theme should be merged with GT3 (Water, soil and agro-biodiversity management).

ICRISAT's response

ICRISAT agrees with recommendation and will transfer the breeding for fodder quantity and quality to GT 2. Component design of IPM/IDM system will remain in GT 2, with system testing of integrated components in GT 3 as recommended. Crop-livestock systems and systems diversification will be subsumed in to an expanded GT 3-- Land, Water and Agro-diversity Management.

Implementation

GT3 and GT5 fully merged and activities focused on problems of SSA; breeding for higher fodder yield and quality transferred to GT2. Achieved in 2004.

6th EPMR Panel's observations

ICRISAT has adequately addressed the recommendation; it has initiated collaboration on fodder quality improvement with ILRI with an ILRI scientist posted at ICRISAT to work directly with ICRISAT scientists in the GT-BT program. However, the landscape level research in crop-livestock productivity awaits action.

Recommendation No. 7:

The Panel recommends more vigorous implementation of the recommendations of the CCER of Socio-economics and Policy Research Program at ICRISAT, 1996-2001. More social science resources should be re-allocated from GT6 (SAT Futures and Development Pathways) to the other themes under the leadership of non social scientists and the work program of social science should be more sharply focused on strategic assessments and activities that best inform macro and longer run priority setting in ICRISAT.

ICRISAT's response

We agree with the recommendation to more vigorously implement the CCER recommendations for socio-economics and policy research. We are in the process of establishing a critical mass of social scientists in all regions and global themes to undertake strategic research that will generate IPGs, as well as viable partnerships and policy recommendations of strategic importance to SAT agriculture. However, we believe that it is necessary to have some direct visibility for social science activities at ICRISAT. Thus we would seek to create an appropriate balance between those activities managed under GT6 and the remaining social science activities managed in other global themes under the leadership of non-social scientists.

Implementation

Implemented in 2004; but Social Science disciplines remaining essentially visible at institutional level. 2005: GT SAT Futures has been disbanded and refocused into a new global theme GT Markets, Policy and Impact for which the theme scope is closely in accordance with EPR recommendations. Achieved 2005

6th EPMR Panel's observations

ICRISAT has adequately addressed this recommendation.

Recommendation No. 8:

The Panel recommends that ICRISAT should rationalize the role, scope and objectives of the Institute in the distance learning for farmers initiative called the Virtual University for the SAT and provide management with clear guidance on where the limits of ICRISAT's interest lie consistent with its comparative advantage in IPG research. Further, the term University should be replaced with a more appropriate term such as "Virtual Learning Centre for the SAT".

ICRISAT's response

The recommendation is accepted in spirit. ICRISAT will further delineate the roles of ICRISAT and other members of the VUSAT coalition. Nevertheless, since VUSAT has been widely accepted and has captured the support of all partners, we shall work with the members of the coalition and the Board to find a suitable way to implement the recommendation**.**

Implementation

VASAT title changed. Role, scope and objectives rationalized consistent with IPG research. Achieved in 2004

6th EPMR Panel's observations

ICRISAT's response and progress to-date has been satisfactory, as there is now more information about the scope, need, and potential impact of the VASAT effort.

Recommendation No. 9:

The Panel recommends that ICRISAT should rapidly restructure its programs and transfer its headquarters, and all programs except its strategic plant genetic resources enhancement program to sub-Saharan Africa.

ICRISAT's response

ICRISAT accepts the spirit of the recommendation. It accepts the challenge to find a win-win scenario to enhance its impact in Africa and affirms its commitment to continue shifting core resources to address the needs of the farmers of sub-Saharan Africa as a high priority whilst yet dynamically responding to the ever-changing needs and profile of its stakeholders in Asia. ICRISAT will immediately establish a task force to comprehensively study the programmatic issues, costs (both human and financial), host country agreements, and donor support for various potential change scenarios. However, ICRISAT does not accept the view that the ICRISAT-Asia team should be devoid of INRM or social scientists as we see these as a necessary compliment to supporting well-targeted, upstream genetic enhancement activities. We would propose therefore to retain at least a minimum presence of such disciplines in Asia supported by special project funds.

Implementation

ICRISAT Task Force recommendations awaiting Governing Board response. ICRISAT management proposals to achieve Governing Board approved recommendations (as reported at AGM04) have been implemented. Financial targets indicating ICRISAT's commitment to Africa of at least 60% has been achieved. Achieved in 2005.

6th EPMR Panel's observations

ICRISAT's response has been appropriate; ICRISAT headquarters should remain at Patancheru for the foreseeable future. The Center should continue to enhance investments and infrastructure in SSA and seek increased spillover to SSA from research done in Asia.

EMR RECOMMENDATIONS

Recommendation No. 1:

The Panel recommends that the Center consult with the host country to reduce the number of host country positions on the Board and to ensure that host country nominees can serve full Board terms of appointment.

ICRISAT's response

We agree with the spirit and intent of the recommendation. We will work hard to ensure that host country nominees can serve at least one full Board term. We also recognize that the number of host country positions is stated in the ICRISAT's constitution and is agreed to in the Memorandum of Understanding with the Government of India (GOI). The process and implications of implementing this recommendation will therefore require common understanding between ICRISAT and the GOI.

Implementation

Report on practices in CG Centers discussed in GB in April 04. ICRISAT is not unique in its practice. The contributions of host country nominees in their different capacities, including their role in enhancing South-South collaboration for SSA, are important outcomes of their membership. The GB decided to maintain the status quo. There are 13 GB members presently.

6th EPMR Panel's observations

ICRISAT's response to this recommendation has been appropriate; improvements to Board practices have helped to balance the interests of multiple stakeholders.

Recommendation No. 2:

The Panel recommends that neither the Chair nor Vice-Chair position on the Governing Board be held by a host country member.

ICRISAT's response

We agree with the recommendation especially in the case of the Board Chair. The current Vice-Chair arrangement is but a convention that is not unique to ICRISAT. We remain vigilant to ensure that whatever process is followed does not weaken ICRISAT's partnership and relations with the GOI.

Implementation

GB did not accept the recommendation for the Vice Chair. GB Chair is not from the host country. Action completed in September 2003.

6th EPMR Panel's observations

ICRISAT's response to this recommendation has been appropriate. The vice chair is not a successor to the chair, and the chair is selected only from Board members other than host country representatives..

Recommendation No. 3:

The Panel recommends that the Board continue to meet twice a year, one meeting at the headquarters site and the other at the African regional sites on a rotational basis.

ICRISAT's response

We agree with the recommendation.

Implementation

GB agreed to meet as recommended from the 2004 meetings. Action completed in September 2003.

6th EPMR Panel's observations

The recommendation has been implemented

Recommendation No. 4:

The Panel recommends that the new Board members receive a comprehensive indoctrination on Board governance responsibilities in addition to their orientation to the Center's programs.

ICRISAT's response

We agree. A comprehensive process of orienting the Board members is currently in place. We will make sure that this process is further enhanced. The understanding of the governance responsibilities among Board members will be strengthened.

Implementation

New members joining since Sep. 2003 have all received a comprehensive induction with specific

reference to governance responsibilities. Implemented since then and ongoing activity.

6th EPMR Panel's observations

The recommendation has been implemented.

Recommendation No. 5:

The Panel recommends that the entire Board regularly and systematically review and document its own performance (including the Chair's), set performance objectives based on that assessment, and intentionally address ongoing Board development, based on the assessment. Committees should be encouraged to do likewise.

ICRISAT's response

We agree. We will work to improve the existing process.

Implementation

Evaluation system introduced into the GB meeting since Sep. 2003. Ongoing activity since then.

6th EPMR Panel's observations

With respect to Board self-assessment the current practice does not fully address this recommendation, which the 6th EPMR Panel reinforces.

Recommendation No. 6:

The Panel recommends that the Center adopt the practice of an annual "in camera" session to discuss the overall organization performance, without the Director General present.

ICRISAT's response

We accept the recommendation. This is already being done in the context of the DG's performance evaluation.

Implementation

The system is already in place. Ongoing activity.

6th EPMR Panel's observations

The recommendation has been implemented. The 6th EPMR recommends strengthening the DG's annual performance review.

Recommendation No. 7:

The Panel recommends that the ICRISAT Board adopt the "model" grievance and appeal process as proposed by the Committee of Board Chairs, including as a final step for IRS staff the right to appeal to the International Labour Organization Administrative Tribunal in Switzerland (which can be done at minimal cost).

ICRISAT's response

The model grievance and appeal process proposed by the CBC will be studied and relevant provisions will be adopted. We will study the financial feasibility of adopting the ILO's Administrative Tribunal as an appeal mechanism at the Institute.

Implementation

A review undertaken by the management and findings discussed in April 04 GB meeting. GB adopted the model grievance & appeal process proposed by CBC. Implemented in April 2004.

6th EPMR Panel's observations

The recommendation has been implemented.

Recommendation No. 8:

The Panel recommends that the Finance Committee be disbanded and that its responsibilities for financial planning and oversight be assumed by the Executive Committee and that the oversight of both the external and internal audit functions be assumed by the Audit Committee.

ICRISAT's response

We agree with the recommendation.

Implementation

Implemented as of 22 September 2003.

6th EPMR Panel's observations

The recommendation has been implemented.

Recommendation No. 9:

The Panel recommends that the Technology Exchange Committee be disbanded and its responsibilities be added to the Program Committee. This addition will also ensure that the major programmatic items that should be discussed by the full Board will be taken up at that level.

ICRISAT's response

We accept the recommendation.

Implementation

Implemented as of 22 Sep. 2003.

6th EPMR Panel's observations

The recommendation has been implemented.

Recommendation No. 10:

The Panel recommends that, keeping with existing Board policy, the Board and management commit to a break-even or better budget in the Center's annual financial planning and operations.

ICRISAT's response

We agree to the need for a balanced budget policy as a guiding principle. Despite the continuing uncertain financial circumstances prevailing in the CGIAR system, the Institute will strive to do its best to achieve this position.

Implementation

A Balanced Budget Policy is always the guiding principle for the Board and it strives its best to achieve this position. Surplus budget had been achieved for two successive years (2003 and 2004). Ongoing activity.

6th EPMR Panel's observations

The recommendation has been implemented.

Recommendation No. 11:

The Panel recommends the introduction of an improved system of performance evaluation for all IRS and SMG, which incorporates elements of the 360-degree system.

ICRISAT's response

The recommendation is accepted. A review of the Performance Management System has already been started and the 360-degree system is being studied to enrich the performance evaluation process.

Implementation

A study was conducted by the management and proposal discussed in GB in April 2004. The strengthening of the performance evaluation system is ongoing.

6th EPMR Panel's observations

ICRISAT's response to the recommendation has been appropriate. The 6th EPMR suggests strengthening the criteria to emphasize the divergent requirements from different staff, including high quality research publications, other outputs and trainee mentorship.

Recommendation No. 12:

The Panel recommends that benchmarking against *best practice* norms be undertaken for the Facilities and Support Service units.

ICRISAT's response

The recommendation is accepted.

Implementation

Benchmarking done periodically. Continuous improvements done based on the Benchmark findings. Ongoing activity.

6th EPMR Panel's observations

ICRISAT's response to the recommendation has been appropriate. CCER on Governance and Support Services (2008) thoroughly assessed performance in these areas.

Recommendation No. 13:

The Panel recommends that the competencies of the PDMO be reviewed in the light of the Terms of Reference for the Office, and that missing experience and skill sets be added.

ICRISAT's response

We will undertake a review of PDMO competencies, including the skills required by the contemporary task environment of this office.

Implementation

PDMO competencies reviewed. Reconfigured PDMO and Communication Office in place since Jan 2004. Have hired two marketing experts with MBAs to strengthen day-to-day operations and a third to do a marketing strategy/plan for targeting private sector financial resources in Asia.

Re-skilling is ongoing.

6th EPMR Panel's observations

ICRISAT's response to the recommendation has been appropriate. The 6th EPMR recommends clarification of the role of PDMO in priority setting.

ANNEX 5
LIST OF DOCUMENTS REVIEWED BY THE PANEL

BACKGROUND DOCUMENTS

1. Terms of Reference and Guidelines for External Program and Management Reviews of CGIAR Centers
2. Report of the Sixth External Program and Management Review of ICRISAT
3. Summary of actions taken in response to the last EPMR
4. CGIAR Research Priorities 2005-2015
5. The latest Board-approved Strategic Plan of the Center: Vision and Strategy to 2015
6. Medium-Term Plans of the Center for the period of the review
7. SC commentaries of the Center's Medium-Term Plans
8. Center Commissioned External Review Reports and Status:
   - Global Theme – Land, Water, and Agrodiversity Management(Agroecosystems), 2006 (M. Wilson, L. Harrington, M. Wopereis)
   - Global Theme – Land, Water, and Agrodiversity Management(Agroecosystems) CCER Status 2007
   - Global Themes: Crop Improvement and Management, and Harnessing Biotechnology for the Poor (CI and BT), 2007 (S.S. Sundaram, C.J. Coyne, J.A. Thomson, O. Niangado)
   - Global Themes: Crop Improvement and Management, and Harnessing Biotechnology for the Poor (CI and BT) CCER Status 2007
   - Global Theme on Institutions, Markets, Policy and Impacts And Knowledge Management and Sharing, 2007 (S. Ehui, A. Whyte, J. Behrman)
   - Global Theme on Institutions, Markets, Policy and Impacts And Knowledge Management and Sharing CCER Status 2007
   - Government, Management and Support Services Report: Supporting ICRISAT Research: Moving to the Next Level and Beyond, 2008 (M.J. Williams, S.K. Maheshwari, S.R. Obien, E.W. Sulzberger)
   - Government, Management and Support Services CCER Status 2007
9. Donor commissioned external review reports:
   - Desert Margins Program - Phase I, 2004 (M.J. Nicholson, Z. Ogutu)
   - Desert Margins Program - Phase II, 2007 (W. Critchley)
   - Monitoring of CGIAR Projects Co-funded by the European Commission in 2004 in A.C.P., Asia, Latin America and the Mediterranean regions, 2005 (J.C. Streibig, E.F. Tollens)
10. List of Achievements/Outputs from each Global Theme: 2003-2008
11. ICRISAT Issues of Concern and Vision
12. ICRISAT Organizational Structure and Committees
13. New Vision and Strategy for the CGIAR
14. Monitoring and Evaluation System for CGIAR Centers
15. EPMR reports of CGIAR Centers
16. Latest CGIAR Stripe Studies involving ICRISAT
17. CGIAR Charter
18. Latest ICRISAT Annual Reports (2003-2007)
19. Latest ICRISAT annual funding request: funding request for 2008.
20. ICRISAT Staff CVs. List of professional staff with short CVs including standard set of information as instructed by the SC Secretariat (publications, key memberships, invited lectures, prizes/awards; students supervised)
21. ICRISAT Conferences, reviews, meetings and workshops (2003-june 2008). List of reports of major planning conferences, internal reviews, expert meetings, etc. which have had a major influence on the direction of specific Center programs.
22. List of the agreements for cooperative activities with other Centers and institutions

23. List of ongoing and recently completed contracted projects
24. Most recent CGIAR financial guidelines and manual:
    - Financial Management
    - CGIAR Accounting Policies and Reporting Practices Manual
    - Audit Policies
    - Guidelines for Preparing the 2009-2011 Medium-Term Plans and the 2009 Financing Plans
    - CGIAR Indirect Cost Allocation Guidelines
    - CGIAR Procurement of Goods, Works and Services Guidelines
25. Reference Guides for CGIAR International Agricultural Research Centers and their Boards of Trustees
26. ICRISAT Charter and other basic documents establishing the Center:
    - ICRISAT-India government agreement
    - Gazette of India notification
    - The constitution of ICRISAT
    - Agreements with Kenya, Malawi, Mali, Niger and UNDP, Zimbabwe, Zimbabwe and USA, Nigeria.
27. Table showing composition of the Board over the last five years, along with an indication of the Term of Office of current Members and their roles on the Board.
28. Board handbook and rules of procedure
29. Table showing allowances, benefits, and salary ranges for each category of staff
30. Table showing personal data on professional staff by program, including job title, incumbent's location, IRS/NRS/LRS status, period of tenure, gender, nationality, age, salary over the last three years, funding source.
31. Table summarizing turnover of staff over the last five years by staff category
32. List of international staff vacancies and how long positions have been vacant
33. Set of minutes covering Board and Board committee meetings since the last External Review
34. Local compensation surveys used by the Center
35. Reports of external auditors, including management letters, and financial officer's reports to the Board since the last external Review
36. Latests internal audit reports
37. Summative List of Publications from each Global Theme: 2003-2008
38. Five Best Publications from each global theme 2003-2008
39. Citation analysis for research publications of the Center: 2003-2007
40. Comprehensive list of other outputs than publications by Center and Global Theme
41. Five most relevant and significant outputs from each Global Theme: 2003-2008
42. Comprehensive list of Impact Assessment studies on Center research
43. ICRISAT Research Project Structure: 2003-2007
44. Annual allocation of funding and scientific staff time by each Global theme/Discipline area
45. MDG trends in each region where the Center operates
46. Yield trends. Production and productivity trends of ICRISAT mandate crops.
47. ICRISAT Grants 2003-2008

REFERENCE OVERVIEWS

1. ICRISAT and Partners: Champions of the Poor of the Semi-Arid Tropics
2. Harvesting the Seeds of Success of ICRISAT's Research
3. Governance, Management and Support Services at ICRISAT
4. ICRISAT in Sub-Saharan Africa

SUPPLEMENTARY DOCUMENTS

1. List of additional documents provided at EPMR Panel's request (80 documents)
2. CCER of GT CI&BT Vol.1 to 4 - Background
3. CCER of GT IMPI Vol.1 Part A and B&C - Background

4. CCER of KMS – Background
5. GT CI - Exchange of germplasm and breeding materials from ICRISAT (2003-2007)
6. GT AE – Abstracts of students' research projects (2000-2008)
7. Operational Research Strategy
    - BioPower
    - Climate change
    - Health and nutrition
    - High Value Crops
    - Land degradation
    - Water scarcity
8. Performance Measurement Summary Report (2005 to 2007)

ANNEX 6
RESULTS OF ICRISAT STAKEHOLDER SURVEY

The EPMR Panel conducted a stakeholder survey to collect perceptions from partners and other stakeholders on ICRISAT's performance, past contributions and future role. The survey questionnaire was sent to about 350 people included in ICRISAT's own partner database supplemented and other relevant databases. The survey was conducted through SurveyMonkey, an on-line tool, and through e-mail. The questionnaire was prepared in English and French.

The response rate was 28% (98 responses) The respondents represented 25 NARIs, 14 NGOs, 13 private sector organizations, 31 universities or advanced institutions (5 of them in developing countries), 8 government departments, and miscellaneous other types of organizations. Half of the respondents were based in a developing country, and the other half came from organizations operating in a developed country or internationally. Seventy percent were current partners. Only 10 respondents had been employed by ICRISAT recently (less than 5 years ago) and 73% never.

The responses showed little divergence in perception between the different groups. The Panel therefore considered the perceptions at a general level in most cases. The responses to each question are presented in the tables and figures below. The Panel used these results to complement its own observations and perceptions collected during field visits and e-mail interviews.

1. What is your assessment of IRISAT's performance and reputation in the 5 areas listed below?

	excellent	good	quite good	fair	quite poor	n[1]
Quality of research	40%	41%	11%	6%	1%	87
Relevance to poverty alleviation	31%	47%	12%	9%	1%	86
Provider of seed based technologies	40%	36%	12%	12%	0%	77
Provider of knowledge on crop, soil and water management	27%	45%	18%	6%	4%	78
Provider of capacity and training	17%	48%	19%	11%	5%	81

[1] = number of respondents

Respondents that were not current partners tended to have a slightly less favourable perception on ICRISAT's performance in these areas.

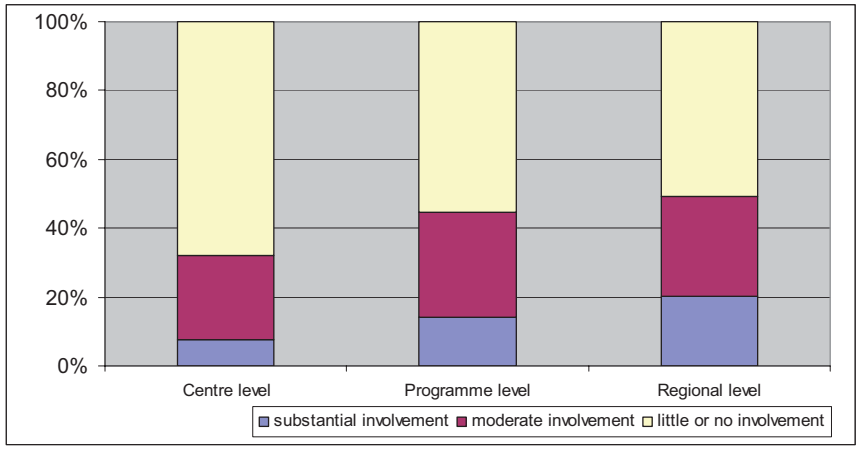
2. What are the two most important ways in which you or your organization benefits from ICRISAT's activities?

Of the 158 items stated by the respondents, the following generic categories of benefits were the most common: access to germplasm (41), research partnerships (35), technology and knowledge provider (33) and capacity building (20).

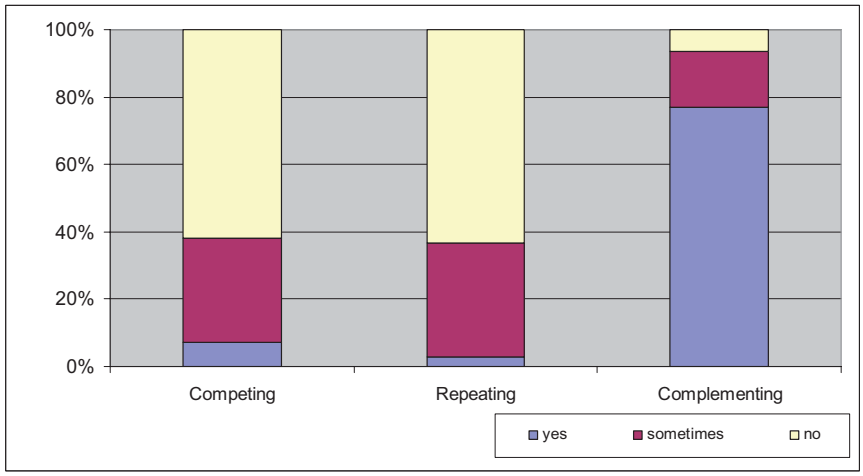
3. Have you or your organisation been able to contribute to ICRISAT's priority setting at Center, program and regional levels?

There was clear divergence in perception. Half of the respondents who were either current partners or working in a developing country organization (or both) reported some involvement in ICRISAT's priority setting at some level, while of those were neither current partners nor working for a developing country organization only about 13 % reported any involvement in priority setting.

Respondents who are either current partners or are from developing country organizations

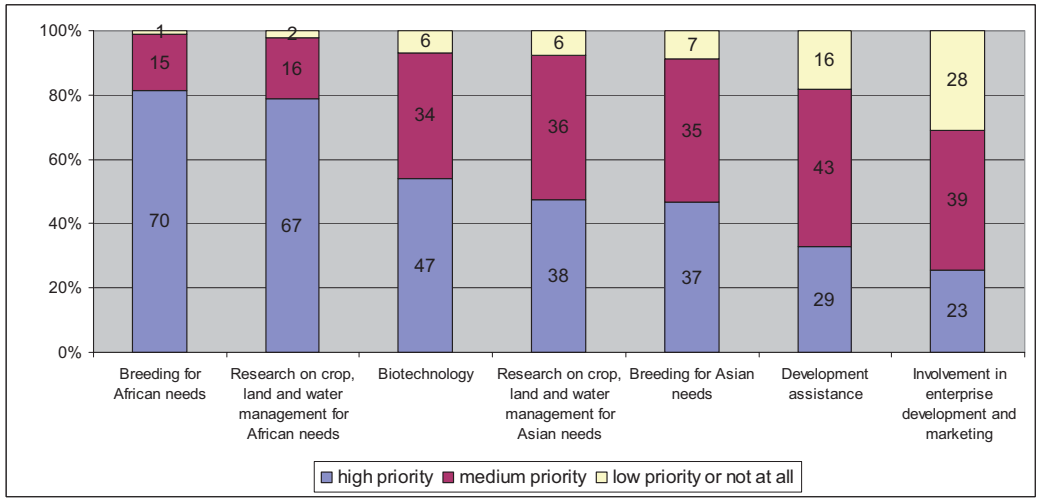


4. Please assess ICRISAT's role in relation with that of your organisation. Is ICRISAT competing, repeating or complementing the work of your organisation?



Respondents from developing countries tended to see ICRISAT less often as competitor or repeating their activities. Current partners perceived more competition and repetition than others.

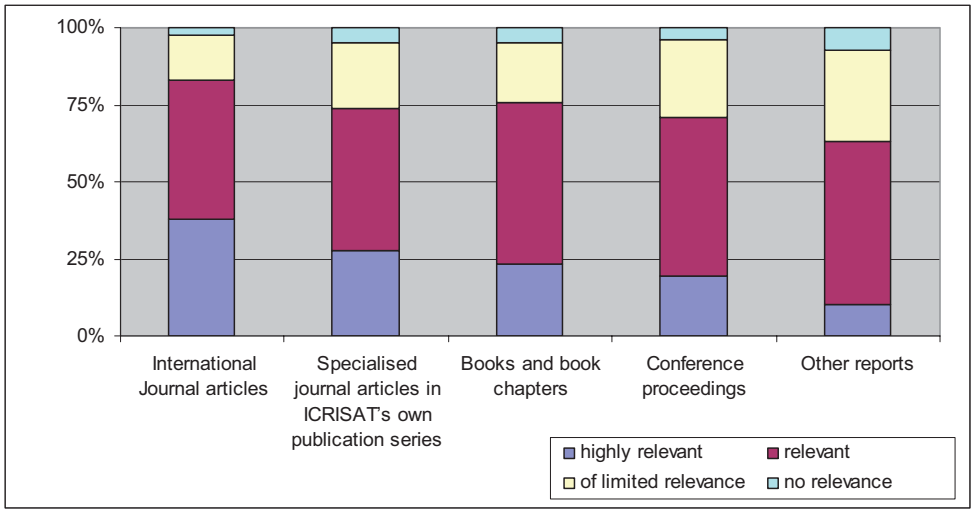
5. Regarding the balance of ICRISAT's work, how much priority should ICRISAT put in the areas listed below. Please tick the appropriate option for each activity



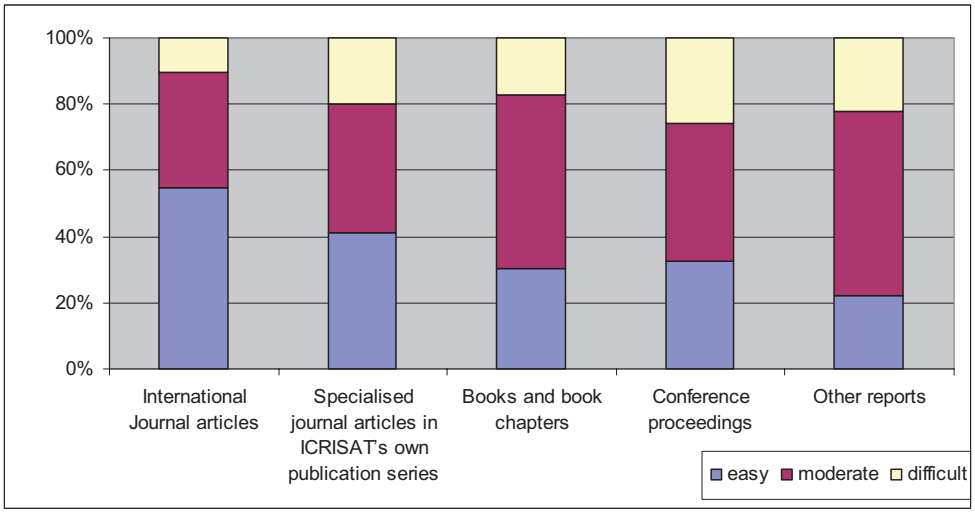
There was slight difference regarding biotechnology that the persons from developing country organizations perceived somewhat less important than those from international or developed country organizations.

6. How relevant are ICRISAT's publications to your organization and how well can you access them. Please choose appropriate option for relevance and accessibility for the different types of publications

Relevance of publications (all respondents)



Access to publications (all respondents)



The overall responses reflect the perceptions of persons who come from international of developed country organizations. Those from developing country organizations considered all publications nearly equal for both relevance and accessibility.

Nineteen respondents (13 from developing country organizations) gave comments for why they perceive access to ICRISAT's publications as difficult. Five of them (2 from developing countries) specified the high cost of accessing articles in international journals as a problem and 15 identified difficulties such as: not knowing what is being published if lists of publications are in the Web/ commonly used databases; having access to in-house publications (conference publications, books/book chapters and reports; not receiving hard copies or information without specific request.

ANNEX 7
LIST OF THE MOST CITED DOCUMENTS (2003-2007)[49]

1. Ellis F and HA Freeman, 2004. Rural livelihoods and poverty reduction strategies in four African countries. Journal of Development Studies 40:1-30 (64)
2. Varshney RK, A Graner and ME Sorrells, 2005. Genomics-assisted breeding for crop improvement. Trends in Plant Science 10: 621-630 (64)
3. Ferguson, ME, MD Burow, SR Schulze, PJ Bramel, AH Paterson, S Kresovich and S Mitchell 2004. Microsatellite identification and characterization in peanut (*A. hypogaea* L.). Theoretical and Applied Genetics 108:1064–1070 (63)
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ANNEX 8
ACRONYMS

ABI	Agri-Business Incubator
ACIAR	Australian Centre for International Agricultural Research
AGROCURI	Agricultural Open Curriculum and Learning Initiative
AIC	Ag-biotech Innovation Center
AMG	African Market Garden
APSIM	Agricultural Production Systems Simulator
ARI	Advanced Research Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASP	Agri-Science Park
AVRDC	The World Vegetable Center
BecA	Biosciences for Eastern and Central Africa
BMGF	Bill and Melinda Gates Foundation
BSRS	Budget Status Reporting System
CAZRI	Central Arid Zone Research Institute
CCER	Center Commissioned External Review
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CMIE	Center of Monitoring Indian Economy
CMS	Cytoplasmic Male Sterility
CP	Challenge Program
CRA	Collaborative Research Agreement
CV	Curriculum Vitae
DDG-R	Deputy Director General of Research
DG	Director General
DMP	Desert Margin Program
DNA	Deoxyribonucleic Acid
DSSAT	Decision Support System for Agrotechnology Transfer
EMR	External Management Review
EPMR	External Program and Management Review
EPR	External Program Review
ESA	East and South Africa
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FTE	Full-Time Equivalent
GCP	Generation Challenge Program
GIS	Geographical Information System
GoAP	Government of Andhra Pradesh
GoI	Government of India
GSL	Genotyping Services Laboratory
GT	Global Theme
GT-AE	Global Theme - Agroecosystem Development
GT-BT	Global Theme - Biotechnology
GT-CI	Global Theme - Crop Improvement

GT-IMPI	Global Theme - Institutions, Markets, Policy and Impact
GxE	Genotype x Environment
H+ CP	HarvestPlus Challenge Program
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HPR	Host Plant Resistance
HPRC	Hybrid Parent Research Consortium
HR	Human Resources
IARC	International Agricultural Research Center
ICAR	Indian Council of Agricultural Research
ICARDA	Internationa Center for Agricultural Research in the Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IGNRM	Integrated Germplasm and Natural Resource Management
ILRI	International Livestock Research Institute
iMAS	Integrated Marker-Assisted Selection System
INRM	Integrated Natural Resource Management
IPR	Intellectual Property Rights
IPG	International Public Good
IDM	Integrated Disease Management
IPM	Integrated Pest Management
IPR	Intellectual Property Rights
IRRI	International Rice Research Institute
IRS	Internationally Recruited Staff
KMS	Knowledge Management and Sharing
LGP	Length of Growing Period
LSU	Learning Systems Unit
M&E	Monitoring and Evaluation
MDG	Millennium Development Goal
MTP	Medium-Term Plan
NARS	National Agricultural Research Systems
NCAP	National Center for Agricultural Policy
NGO	Non-Governmental Organisation
NRCPB	National Research Centre on Plant Biotechnology
NRM	Natural Resource Management
PCR	Polymerase Chain Reaction
PDMO	Project Development and Marketing Office
PMI	Performance Measurement Indicators
RRS	Regionally Recruited Staff
SAT	Semi-Arid Tropics
SBU	Strategic Business Unit
SC	Science Council
SCI	Science Citation Index
SEF	Sahelian Eco-Farm
SOC	Soil Organic Carbon
SSA	Sub-Saharan Africa
SSR	Simple Sequence Repeat
SWEP	Systemwide and Ecoregional Program

SWNnet	Soil Water Management Network
TOR	Terms Of Reference
USA	United States of America
VASAT	Virtual Academy for Semi-Arid Tropics
WASA	West African Seed Alliance
WCA	West and Central Africa
WFCP	Water and Food Challenge Program

Science Council Secretariat
c/o FAO
Viale delle Terme di Caracalla, snc
00153 Rome, Italy
www.sciencecouncil.cgiar.org

t +39 06 57056782
f +39 06 57053298
e sc-secretariat@fao.org

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