ICRISAT Medium-Term Plan

2008-2010

Nourishing the productivity and livelihoods of success in the semi-arid tropics

International Crops Research Institute for the Semi-Arid Tropics

MTP 2008-2010

Nourishing the Productivity and Livelihoods of Success in the SAT

ICRISAT's Medium Term Plan: 2008-2010

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Overview

Retrospective: How the context in 2006/7 has changed plans for 2008
ICRISAT is now approaching its next EPMR (2008) and is two-thirds through its precursor CCER cycle in 2006/7. It had a most constructive year in 2006. The budget performance was strong and the scientific output was high.

Adjustment to the Science Priorities: 2006 was also a year in which radical change in the presentation of ICRISAT's work and beyond was precipitated by its new adherence to the System's Priorities and in the current MTP ICRISAT attempts to retain the 2006 project structure as far as is possible in order to allow the structure (which was new in the previous MTP) to be "bedded in" and to achieve the ownership and support of these changes by the ICRISAT staff globally. ICRISAT has linked its logframe outputs to the Science Priorities and, where possible, also to individual specific goals within priorities (see Project Narratives). Work under 1B, 2B, 2C, 2D, 3B, 3D and 4C have all achieved greater institutional prominence and/or investment. The accordance of the work proposed with the respective priorities is described in the project narratives. The CCERs performed in 2006/7 have not recommended any change in ICRISAT's new project structure.

ICRISAT has also phased out some research (particularly where these were no longer in accordance with the SPs) on completion of projects and by freeing human resources to take advantage of new opportunities. This includes the completion of our socio-economic work on *Stylosanthes* as a potential forage and completion of the study on the Global Outlook for Crop-Livestock products which is now published (Project 1). The work on disaster rehabilitation in Zimbabwe is essentially completed until of course the next drought emergency arises in ESA and we expect the IPG knowledge that we have now created can then be put to immediate good use (Project 9). The institute has frozen work on insect pest resistance and some associated virus breeding work in groundnut due to lack of special project funding (Project 6). Similarly, research efforts on chickpea viruses and nematodes have also been stopped to more effectively prioritize our efforts within the key systems priorities (Project 6). In the agro-ecosystems area funding from the large multiple-year ADB watersheds project in China, Vietnam and Thailand has now ceased and this work will be reported finally against a 2007 output target (Project 9). The work may be continued subject to the availability of new special project funds in 2008 onwards. Work sponsored under IWMI's Comprehensive Assessment of Water has also been completed and additional funding is being sought to put into practice research in accordance with one of the principal recommendations from the study which has stressed the importance of research to develop improved rainfed, rather than irrigated, agricultural systems (Projects 7 and 9). In west and central Africa the major CFC funded groundnut improvement and seed systems project has also been completed and this area is now being evaluated for impact over the next couple of years (Projects 1 and 3). Population improvement and development of open-pollinated varieties (done in partnerships with NARS) in pearl millet for the Asia region has now been shelved to emphasize specifically hybrid parents research (Project 6).

ICRISAT's funding picture for 2008-2010 is positive and we expect the current $33 million budgeted for 2007 to exceed $35 million in the MTP period (See Table 1). The semi-arid tropics are the home of two-thirds of the world's poor that are concentrated in south Asia and sub-Saharan Africa (SSA) *ca*. 800 million people. Thus, ICRISAT has an extremely difficult and challenging mandate. This MTP shows that the institute is vigorously addressing this pressing responsibility. Yet, if additional resources are forthcoming, these will be translated by ICRISAT into further substantive additional output and development impacts.

What has changed at ICRISAT over the last year is that the institute is receiving considerably more funding from the Union Government of India (GOI) and from the Indian State Governments than previously. For example, it is expected that ICRISAT's efforts on genomics will be further enhanced in the MTP period as the GOI Department of Biotechnology has awarded the ICRISAT Genomics Laboratory the accolade of being a "National Center of Excellence" and has awarded new funds exceeding $1 million. This is to help the laboratory upgrade its equipment to include the new DART platform to allow enhancement of our tilling and ecotilling activities and to allow ICRISAT to run additional capacity building courses in subjects such as the use of molecular markers in breeding. By implication, this allows us to accord immediately greater emphasis particularly to Science Priorities 1A-B and 2A-B (through Projects 2-6). Additionally, we have implemented a program of re-tooling our senior human resources with young talented counterparts so that when these senior staff reach retirement in the MTP period that they have replacements with shared hands-on experience, to whom

their programs can be made over, without loss of knowledge or momentum. Replacements for the senior pearl millet breeder, the senior sorghum breeder, the senior pathologist, the senior pigeonpea breeder, and the senior groundnut breeder are now on the staff and working.

With the rapidly growing interest in biofuels in the last 12 months, has come increased demand for collaboration with ICRISAT from donors such as the Bill and Melinda Gates Foundation and from the Government of India, the Government of the Philippines, the Japanese Public and Private Sectors and likewise from Nigeria and Indonesia. Consequently our research efforts in ethanol production from sweet sorghum and our biodiesel systems research designed for very poor quality land with highly disadvantaged communities and without compromising food security has expanded. This is likely to expand further in the immediate future as more funding becomes available. The greater breeding effort for sweet sorghum (see Project 5) has been classified under system priority 2 D (Breeding for High Value Crops) and for the development of pro-poor biodiesel systems for disadvantaged communities is mostly applicable to priority 3 D (sustainable income generation from forests and trees and it is encapsulated as part of the center's watershed improvement program [Projects 7/9]).

Given funds from the Generation Challenge Program (GCP), ICRISAT's long, patient and unrewarded stewardship of the World Minor Millets germplasm collection has finally born fruit. The GCP has stimulated work on the identification of a biodiverse subset of finger millet lines. This new effort is expected to grow in the next 3 years as this crop is regarded as important for East Africa owing to its popularity for nutritional purposes and is the basic staple cereal extending over nearly 1 million ha in the drought prone areas of Maharastra State alone in India. This will be reported under Science Priority 1 B (Project 2).

Development activities are largely restricted to ICRISAT's continuing support to its Agri-Science Park and there is a minor effort on free standing training which is self-funded. ICRISAT's Project 10 is still deemed to be Blue Skies research and beyond the 80% required under the Science Priorities.

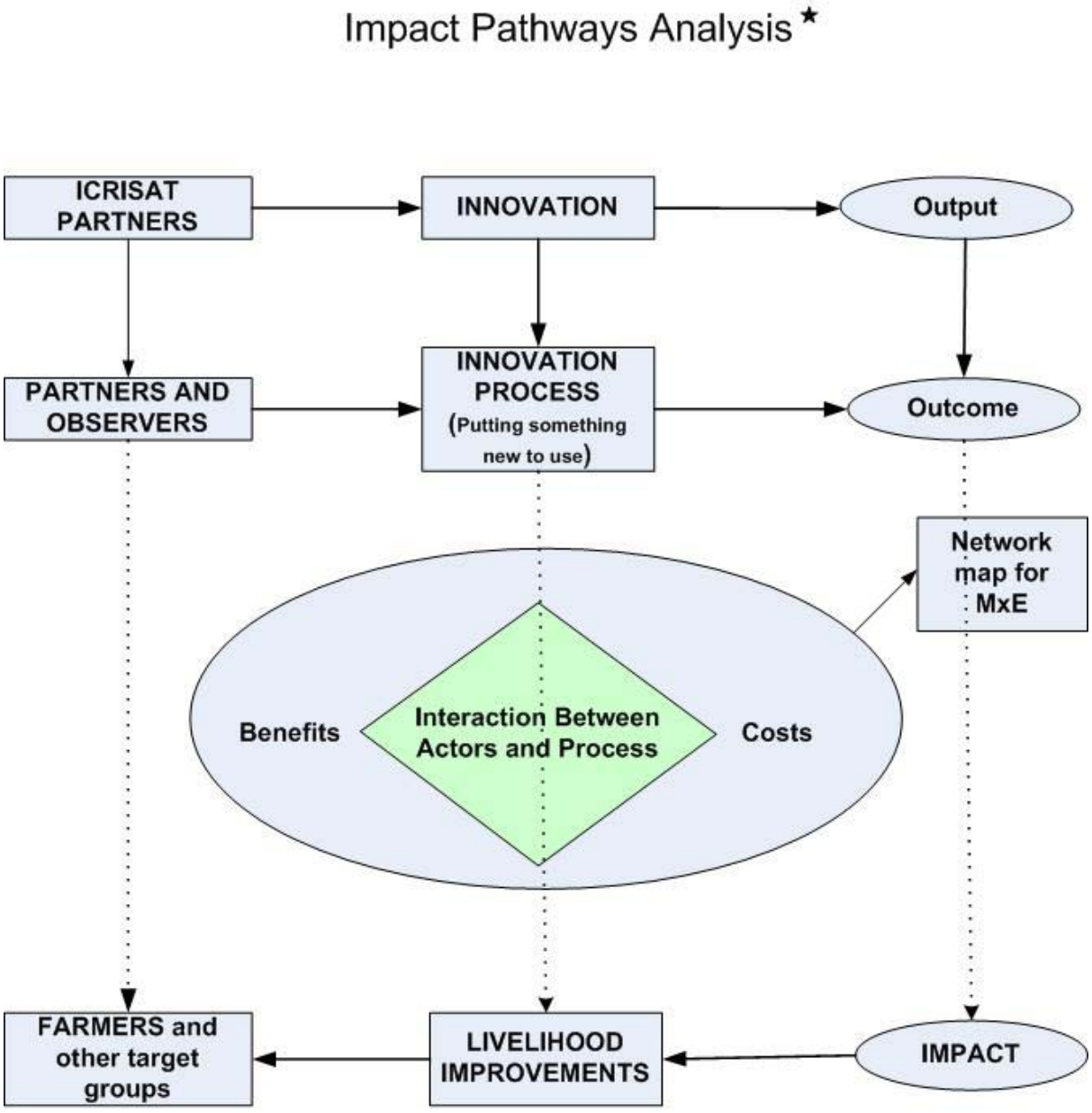
Impact Pathway Analysis
ICRISAT as part of its monitoring and evaluation process and for the purposes of clarifying the impact pathways for its "generic" projects has experimented during its planning meetings with the creation of problem trees and network diagrams (for specific projects only). This is not a simple task and it is as yet unclear what might be the most suitable model for each project. An attempt has been made to at least follow the logic being promulgated by Dr. B. Douthwaite and his colleagues at CIAT http://impactpathways.pbwiki.com and in its most generic form this includes the logic displayed in Figure 1. This is still work in progress and we are looking to match visual impact pathway problem trees and network diagrams with their suitability for specific projects. The Impact Pathway Analysis sections of the project narratives and those of the IPGs and the elaboration of partners' roles have been extensively re-cast for the current document.

We remain concerned that increasing levels of capacity development are required from ICRISAT by our NARS partners and their continuing decline in performance ability is a factor that may influence the likelihood of successful research outcomes and impact. As a result we are paying increasing attention to our collaboration with a wider range of potentially useful partners such as NGOs, CSOs and the private sector. For example, through our Hybrid Parents Seed Consortium (Project 5), issues of hybrid seed creation and marketing are being increasingly devolved to the private sector in India. Likewise, our establishment and running of an aflatoxin testing laboratory in Malawi has now been taken on board by the NASFAM (National Small Farmers Marketing Cooperative in Malawi). Further demand of this type is being registered from other eastern and southern African countries and this specific area is now generating IPGs.

New strategic plan
ICRISAT's new strategic plan based on the System Priorities format was approved by the ICRISAT Governing Board in 2006 and can be accessed at www.icrisat.org/vision/visionnew.htm. The current MTP is in close accordance with the Strategic Plan Research Strategy which is summarized below:-
"ICRISAT adopts integrated genetic and natural resource management (IGNRM) as its overarching research strategy to attain scientific excellence and relevance in agriculture in the semi-arid tropics, focusing on key livelihood and income opportunities to improve the well-being of the poor with equity, multidisciplinarity, sustainability and community participation as core principles. IGNRM is a powerful integrative strategy of agricultural research that seeks to maximize the synergies among the disciplines of biotechnology, plant breeding, agronomy, agro-ecosystems and social sciences with people empowerment at its core. In pursuing IGNR/M as its overall strategy, ICRISAT recognizes the need for greater focus, thematic-regional integration, multi-stakeholdership and multi-level partnerships in mobilizing science and technology for the poor. Through

the synergies catalyzed from IGNRM, ICRISAT will be strategically positioned to act regionally and yet produce international public goods (IPGs) with potential development impact.

Fig.1



★ Logic Compliments of B.Douthwaite (CIAT)

To pursue the foregoing, ICRISAT's four global research themes and three regional strategies have been integrated to help ICRISAT refocus its efforts to the needs of poor households and development partners in sub-Saharan Africa (SSA) and Asia. Similarly, ICRISAT recognizes that its vision and strategy must be anchored on concrete action. This will be achieved through the adoption of the five new CGIAR Systemwide priorities as the 'ribs' around which the 'flesh' of ICRISAT's global research and regional strategies will be attached. Consistent with the position of the CGIAR Alliance, ICRISAT's vision and strategy straddles the research to development continuum, generating IPGs globally and doing downstream research as a bridge, broker and catalyst to attain more impact. ICRISAT will provide custodianship to six mandate crops and improve germplasm and provide cutting edge options in diversifying SAT farming systems. These will be done to help national, sub-regional and regional institutions, private sector, civil society, advance research institutions and donors in achieving the MDGs.

During the past several years, the environment in which ICRISAT operates has significantly changed. The MDGs have tremendously broadened the agricultural research agenda from increasing food supply to embrace poverty and hunger reduction, environmental sustainability and social issues such as gender equality, health and nutrition. Publicly-funded agricultural research has declined by more than 50%. At the same time, the private sector has assumed an increasing share of agricultural research and ownership of new technologies. The emergence of global markets, biotechnology and information and communication technologies (ICTs) have a strong influence in changing the strategic direction of ICRISAT's research.

These changes are happening at a time when international agricultural research is seeing the emergence of a new set of institutional arrangements where public-private partnerships are mainstreamed towards a new vision of agriculture and rural development. We are witnessing a gradual convergence of the public sector's pro-poor development goals and the private sector's commercial interests. Similarly, new patterns of accountability and governance are changing the role of public agricultural research institutions and their relationships with the private sector and civil society. In harmony with this trend, ICRISAT will further intensify linkages with a wide range of strategic partners which include the Alliance of CGIAR centers, advanced research institutes, regional and sub-regional organizations, NARES, the private sector and civil society organizations. In SSA, our strategy has been synchronized with those of regional and sub-regional organizations, NEPAD, the Comprehensive African Agricultural Development Program (CAADP) and the SSA Challenge Program. In addition, ICRISAT will integrate its research with other fields of development such as education, human health, nutrition, energy supply and water quality. ICRISAT will also intensify innovative public-private partnerships through its Agri-Science Park (ASP).

Towards 2015, ICRISAT's strategy for knowledge sharing will be fully in gear along with the CGIAR's new priority on facilitating institutional innovations to support sustainable reduction of poverty and hunger. Towards this, the ICRISAT-led Virtual Academy for the Semi-Arid Tropics (VASAT) will be upscaled with partners to enable dynamic linkages among diverse, distributed human and information resources in the SAT. Linkages are being cemented with partners such as the Global Open Food and Agriculture University (GOFAU), advanced learning institutions and national open universities to develop courses in distance mode and other innovative learning opportunities.

Starting in 2006, ICRISAT has sought to effectively allocate $30 million towards the fulfillment of its vision and strategy and this budget figure may be approaching $50 million by 2015. Since this is a large annual investment, ICRISAT recognizes the importance of rigorous research prioritization."

Changes in structure and project composition due to alignment with the CGIAR System Priorities
ICRISAT has maintained its four Global Themes and a Knowledge Management and Sharing Office (KMS) as a sub-structure that retained the responsibility for ensuring science quality, avoiding disciplinary duplication and encouraging spillovers between regions for the full exploitation of the IPG nature of ICRISAT's research. These themes remain in being and continue their previous roles. They are, in short, entitled GT Institutions, Markets, Policy and Impact (IMPI), GT Biotechnology (Biotech), GT Crop improvement (CI), and GT Agro-ecosystems (AE). ICRISAT's project structure, created in 2006, is fully aligned with the System priorities with Projects 1-6 being 100% aligned, with projects 7-9 being at least 80% aligned and with project 10 being non-aligned blue skies and the remaining activities assembled in "project 11" being unaligned. ICRISAT thus estimates that at least 80% of its effort accords with the System Priorities (See Tables 1 and 2).

Additional research and training which is not covered under CGIAR System Priorities.
One of ICRISAT's continuing projects (Project 10) is The Virtual Academy for the African and Asian SAT and its linkages with the Global Open Food and Agriculture University (GOFAU). This is a vital institutional tool in ensuring that ICRISAT's IPG technologies attain the broad exposure that they deserve. ICRISAT prefers in the current plan to give this effort Blue Skies Project status within the context of the CGIAR Systems Priorities. Yet it is to be noted that this project could be subsumed as an element in all the other projects and may be treated in this fashion in future unless ICT/KM research is granted suitable priority recognition in the meanwhile. ICRISAT will therefore continue to lobby the Science Council (SC) to adopt this area as a forthcoming priority.

ICRISAT also receives income from the Government of Andhra Pradesh in support of it's Agri-Science Park development activities which are declared under Project 11 as "Development". The Institute has also re-categorized money which it had previously allocated to stand-alone training to become within-project training leaving a small residue of funds from true stand-alone, self-financed training. This amounts to around $60,000.

ICRISAT's Project Structure

Table 1: **ICRISAT Projects 2008-2010**	**Expenditure Estimate $**	**System Priority Area**
1. Improving policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT	$ 4.86M	5 (A-D)
2. Sustaining biodiversity of Sorghum, Pearl Millet, Small Millets, Groundnut, Pigeonpea and Chickpea for current and future generations	$ 4.21M	1 (A-B)
3. Producing more and better food at lower cost of the staple cereals and legumes of the WCA SAT (Sorghum, Pearl Millet and Groundnut) through genetic imp.	$ 3.10M	2 (A-C)
4. Producing more and better food at lower cost of the staple cereals and legumes of the ESA SAT (Sorghum, Millets, Groundnut, Pigeonpea and Chickpea) through genetic improvement	$ 2.80M	2 (A-C)
5. Producing more and better food at lower cost of staple cereal and legume hybrids in the Asian SAT (Sorghum, Pearl Millet and Pigeonpea) through genetic improvement.	$ 1.95M	2 (A-C)
6. Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (Sorghum, Millets, Pigeonpea, Chickpea and Groundnut through genetic improvement	$ 2.87M	2 (A-C)
7. Reducing Rural poverty through Agricultural Diversification and Emerging Opportunities for High-Value Commodities (HVCs) and products	$ 3.08M	3 (A, B, D)
8. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources, particularly at the Desert Margins of the Sahel and the drylands of ESA	$ 1.84M	4 (A, D)
9. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources through sustainable agro-ecological intensification in low- and high-potential environments	$ 5.04M	4 (A, C, D)
10. The Virtual Academy for the African and Asian SAT	$ 1.35M	Blue Sky
Development activities	$ 1.29M	Development
Stand-alone training	$ 0.06M	Training
New research area	$ 0.18M	New research
	Total$ 32.6M	

Table 2
ICRISAT –Budget Cost Allocation by Priority
Amount in US $ Million

Priorities	Grand Total
Priority 1A	2.875
Priority 1B	1.026
Priority 2A	4.956
Priority 2B	3.448
Priority 2C	2.577
Priority 2D	0.042
Priority 3A	2.120
Priority 3B	0.635
Priority 3D	0.329
Priority 4A	2.577
Priority 4C	1.521
Priority 4D	2.777
Priority 5A	2.139
Priority 5B	1.434
Priority 5C	0.573
Priority 5D	0.712
Development Activities	1.287
Stand-alone Training	0.057
Blue Sky New Research	1.525
Total	**32.610**

Major changes in existing collaborations including changes in participation in SWEPs & CPs
ICRISAT continues to participate broadly in all the current System Challenge Programs (particularly in Generation, Harvest Plus and Water and Food) and it coordinates the SSA Desert Margins Program SWEP (See Project 8). It contributes to several of the other SWEPs, the principal ones being those on Genetic Resources, Livestock, IPM and Rice-Wheat in the Indo-Gangetic Plain. ICRISAT continues to be the facilitator for the forthcoming CGIAR Centers Alliance --- Southern Sudan Consortium and, jointly with ICARDA is expecting the Oasis Consortium to make additional progress in solving the problems of land degradation and biodiversity loss in the disadvantaged desert margin areas of the world in 2007. ICRISAT (through Oasis) is one of the principals in the current preparation of a CP pre-proposal in the area of the mitigation of desertification.

ICRISAT cemented its strategic alliance with AVRDC --- the World Vegetable Center by having their South Asian regional office within ICRISAT's headquarters at Patancheru and having two shared appointments in west and central Africa (one each in Niamey and Bamako). ICRISAT has also been a principal collaborator in the preparation of the proposal with the WVC for the establishment of a new challenge program to coordinate fruit and vegetable research. ICRISAT is also a leading institute in the mega-consortium on marketing and market chain development (SMART). It also will participate in the pre-proposal writing for the proto-Challenge program on climate change.

EPMR 2003 recommendations progress summary
EPMR Report Presentation and Discussion to:

- Science Council: EPR to Interim SC (ISC/TAC 85) 30 August 2003
- Executive Council: EPR and EMR to 5th ExCo September 19th 2003
- AGM: 28-31st October 2003 in Nairobi

Complete details of recommendations and responses were provided in Appendix 1 of MTP 2007-2009 and required action has been completed in 2006. ICRISAT has completed two Center Commissioned External Reviews in 2007 the first covering the area of Global Theme Agro-Ecosystems (GTAE, Projects 7, 8 and 9) which made 23 recommendations and the second covering the area of the Global Theme Institutions, Markets,

Policy and Impact (GT IMPI Project 1) and the Knowledge Management and Sharing Office (KMS, Project 10) which made 20 recommendations. A third CCER covering the areas of Global Themes Biotechnology and Crop Improvement (Project 2-6) has been completed at the time of submission of this MTP but the formal report is not yet available.

Summary Remarks from the AE CCER Report
"The GTAE is the conduit for applying ICRISAT's high science and best practice to the problems of poor farmers and for feedback from them. It is successful in this and in forging productive relationships with a multiplicity of agencies involved in the world of Development. And it is the more effective in addressing the CGIAR's priorities because of its fit into the total poverty effort.

All in all, the team has been most favorably impressed with the work of the GTAE, with the morale and dedication of the GTAE team and by its achievements in an intrinsically difficult agricultural environment and against a not uncomplicated and challenging set of goals and priorities set by the CGIAR.

There have been some outstanding successes; to name some; the consortium approach to watershed development in Asia and the policy influence that watershed work is now making: The meteorological prediction work and the analysis of farmers' acceptance of it; the management and monitoring of aflatoxin contamination in maize and groundnuts; fertilizer micro-dosing and the identification and remediation of micro-nutrient deficiencies; and in promising work on desertification in WCA which is gradually becoming a flagship for ICRISAT and its partners in the region.

These and others are important International Public Goods in which Governments and Donors are interested and which, as well as a potential to benefit very large numbers of the poor, would seem to have potential to achieve major environmental benefits in terms of carbon sequestration, reduced land degradation and replenished water resources.

As a general rule, the design of GTAE research activities was found to be suitably shaped and guided by development objectives, which of course vary across and within regions. The team was impressed by the emphasis on "big targets" like watersheds, and wastelands and mono-crop rice systems, of which the latter two account for about 30m ha across southern Asia. Extensive areas in ESA are suited to market-led agro-ecosystem intensification featuring legumes and crop-livestock systems. In WCA, sustainable use of drylands, and loss of land and biodiversity to desertification are the major target for GTAE research."

Summary remarks from the GT IMPI and KMS Report
"The Panel has overall positive findings about the two programs it reviewed. Both GT-IMPI and KMS were found to be producing generally high quality outputs and are functioning well, especially given the resource constraints under which they are operating. The high staff morale in difficult times is testament to good leadership from both the senior management of ICRISAT and at the level of the heads of GT-IMPI and KMS. The Panel was also impressed with the strong team spirit of staff in GT-IMPI and KMS and the willingness to collaborate across Global Themes and be supportive to the needs of other parts of the Institution."

The declining unrestricted core budget has negatively affected both GT-IMPI and KMS in some important respects, while possibly opening up new opportunities in others. For GT-IMPI in particular, increasing success in obtaining external project funding has increased the resources available for certain types of research, such as social impact studies, but at the risk of stretching the scientific and support staff resources too thinly and of shifting attention too much from longer-run strategic activities to shorter-run externally-funded project-focused activities. For KMS, the reduced core budget has meant that critical IT systems for the whole Institution have to depend on not only project-funded staff but a revolving door system of short-term interns, presenting some risk to the future functioning of ICRISAT.

Like other Centers, ICRISAT must produce cutting edge research/IPGs upstream while maximizing impact downstream through giving increasing attention to effective transfers of knowledge to intermediaries and end users. This challenge is well understood by senior management and the staff of GT-IMPI and KMS and there are some outstanding examples of success in creating IPGs that have impact. These include the VLS, methodologies for NRM impact assessment, strategic assessments of SAT and institutional analysis, seed policy reforms and harmonization and synthesis and inter-regional knowledge exchange (spillovers) in GT-IMPI and VASAT in KMS as well as capacity building of Partners (including NARS) and farmers.

ICRISAT has been, and should continue to consider how to leverage its unique advantages stemming from its location near Hyderabad with respect to ICT and its application to development to play a leadership role within the CGIAR system.

MTP changes in response to the MTP 2007-2009 Commentary

The major requirement of the SC commentary on the 2007-2009 MTP was for the center to provide output targets for all projects rather than to declare annual outputs. This was undertaken later in 2006 and is further refined in the current MTP. The center had attempted, and continues to try further, to highlight those areas of research which had achieved new prominence in ICRISAT's research portfolio under the segregation of the system priorities such as 2b, 2c, 2d, 3b, 3d and 4c (see for example Project 5 priority 2d). It is evident from Table 2 that distinct budget allocations have now been made to these priority areas. In the previous MTP no distinct financial allocation was made to areas 2d, 3b, 3d and 4c (the latter only partially). ICRISAT in its response to the SC commentary has indicated the center's view that the concept of delegation of responsibility to large NARS of crop breeding activities of parental materials is not in harmony with the requests of the concerned NARS themselves (specifically confirmed by CAAS and ICAR representatives). In the case of hybrids, ICRISAT is happy to note that it's private and public sector partners have assumed responsibility for hybrid creation, seed distribution and marketing in sorghum and pearl millet (Project 5) and yet similar opportunities for such successful delegation for open pollinated crop varieties remain much more difficult to attain. It is to be hoped that ICRISAT's additional efforts to define its impact pathways and partnerships are now better defined in the current MTP and this will better clarify our role in upstream research and in facilitating partnerships further downstream. The Center never acts alone in downstream development and wherever possible we seek both a science research role and that of a promulgator of IPGs in our relationship with locally based research and development organizations. The issue of the balance of our work between Africa and Asia in Project 9 (EPMR recommendation to phase out such work in Asia, 2003) has been addressed by the 2006 Agro-ecosystems CCER whose 15th recommendation stated:

"We recommend that financial support for this [watersheds-based] work [in Asia] be maintained at a level that enables the GTAE to engage in "highly-relevant, well-focused cutting-edge research". The GTAE should strive to maximize the use of partner co-funding and special project funds without, however, completely prohibiting the use of unrestricted funds in this region when these can be used to leverage other resources."

This recommendation is thoroughly welcomed by the institute as it allows the ICRISAT management a greater degree of flexibility in the generation of IPGs and impact with respect to MDG 1 which previously was seriously inhibited by the earlier 2003 EPR recommendation 3. ICRISAT continues to aim for, and has achieved in the last 3 years, a distribution of relative budget expenditure between Africa and Asia of approximately 60:40. Other commentary issues such as on partnerships and IPGs include the issue of helping NASFAM establish a Mycotoxin testing facility in Malawi. This unit is now fully operated by NASFAM and the outcome is that groundnut exports to the EU have been restarted after many years as a result of the use of this facility. This local public good has now been transmuted into an international public good as the lessons learned from its establishment and start-up are now being applied in several other Eastern and southern African countries (Kenya, Mozambique, Tanzania). No NGO or private consulting firm has the capacity, expertise or experience to transfer this knowledge as effectively as ICRISAT at this time. Similarly, lessons learned from ICRISAT and its partners experiences with the microdosing of fertilizer in Zimbabwe and Niger which goes well beyond simple fertilizer trials to include, new delivery systems, nutrient release timing issues, micro-credit and farmer investment needs have now reached a phase of rapid outscaling and is becoming a major international public good. NGOs in a range of SSA countries are now involved in this process (eg. EUCORD in Mali) and proposals for much broader expansion have been solicited from major donors (eg. AGRA). Other issues are dealt with at specific project level.

Financial Indicators

In 2006 ICRISAT's short-term solvency (Liquidity) was 171 days; Long-term financial stability (adequacy of reserves was 114 days; Indirect cost ratio was 23% and the cash management ratio on restricted operations was 0.37.

Project Portfolio

Project 1 Narrative:
Improving policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center
The research proposed in this project is in specific accordance with System Priority 5 --- Improving policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT. It specifically covers priorities 5A, 5B, 5C and 5D. ICRISAT claims that 100% of this project's activities are encapsulated within the CGIAR System Priorities. This project provides the essential social science context for ICRISAT research. The strategic assessments for agricultural and economic growth in the SAT region - the dynamics of rural livelihoods, nature and the determinants of poverty, as well as commodity and market trends in increasingly global markets, and input supply and access constraints - are vital to inform and direct future investments in the SAT. This project will also focus on mapping the complex development pathways and alternative livelihood options to help make critical interventions to address poverty, vulnerability, marginalization and social exclusion. The project has the following four specific objectives:

a. Evaluate and develop alternative institutional arrangements and policy options for expanding access and utilization of new technologies and services for smallholder producers for greater impact of agricultural innovations on poverty and sustainable management of agro-ecosystems (links to Science Priority 5A)
b. Develop and promote strategies that enhance market access and competitiveness of dryland commodities for smallholder farmers and agro-enterprises and food safety for consumers (links to Science Priority 5B)
c. Examine, develop and promote strategies for strengthening rural institutions and pro-poor institutional change to improve access of smallholders to markets and technologies and reducing vulnerability of livelihoods (links to Science Priority 5C)
d. Analyze the effectiveness of agricultural and rural development strategies and identify development pathways and policies that facilitate poverty reduction and livelihood protection under chronic and transitory emergencies (links to Science Priority 5D)

The target ecoregion, the beneficiaries and end users
The target ecoregion is the semi-arid tropics of sub-Saharan Africa and Asia. The remainder is unchanged from MTP 2007-2009.

Is the center the primary or secondary research provider?
The Center in this project is both a primary and secondary research provider.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact
ICRISAT plays a bridge-broker-catalyst role in this project articulating a vision for the future of dryland agriculture that will make a difference to the livelihoods of people in the SAT.

Comparative and complementary advantage of the project activities
ICRISAT is a leader in this research area and is well poised as a major player in developing strategies, policies and innovations in the semi-arid tropics. It works in an interdisciplinary and partnership mode and produces international public goods by using micro- and macro-level analysis to inform policy development. For more detail please see MTP 2007-2009.

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs
Ultimately ICRISAT and its partners hope to achieve enhanced policy and institutional arrangements for accelerated investment in SAT agriculture globally. This project addresses the complex challenges and emerging constraints facing agriculture in the semi-arid tropics which require a multi-faceted approach that encompasses innovations in policy, institutions and new technologies. Strategic assessments require a systematic analysis of the future outlook for dryland agriculture, targeted research priorities and impact evaluation methodologies which are developed and shared with national and sub-regional research systems.

Participatory, monitoring and evaluation models (to measure impact on the poor) will be developed and a coalition approach applying principles of innovation systems (including institutional arrangements) for better coordination and marketing will be documented and implemented as specific exemplars for IPG formulation.

Rationale for mid-course corrections should be explained. **Linkages between old and new project structure. Changes in output targets for 2007 influencing the PM reporting in 2008**
The project structure for ICRISAT was re-worked newly in 2006 and has not changed in 2007. This applies to all subsequent projects 1-10.

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

Priority 5 A: Science and Technology Policies and Institutions

Priority 5A, Specific goal 3: Improving incentives for technology generation, access and use
A key intervention point is in developing strategic options and best practices for seed systems development in the SAT and supportive policies that facilitate trading and marketing of seeds across national boundaries, including harmonization of seed regulations and policies, especially variety registration, seed quality and certification procedures. This has the advantage of creating new incentives in terms of better economies of scale and scope for the emergence and participation of the private seed industry in seed supply and marketing. This will complement the weaker public sector seed enterprises in the region and create opportunities for farmer entrepreneurs and small rural agro-enterprises to participate in the seed production and marketing in rural areas.

ICRISAT and its partners can hope to achieve an enhanced policy and institutional environment for accelerated investment in SAT agriculture that would contribute towards generation and adoption of better suited technologies and increase in farm incomes and nutritional security for the poor. This may be achieved through a strategy that focuses on the following output target for 2010 1.1.1:

"Best practices for harmonization of seed-related regulations and policies suitable for the specific conditions of the SADC and ASARECA regions promoted"

This research area is closely linked to that of Projects 3-6 but as a global generic policy issue it is felt to be better to address it as a whole in Project 1 rather than to disarticulate it between 4 other projects.

Priority 5A, Specific goal 5:Enhancing the structure, conduct and performance of knowledge-intensive institutions
An output will be produced from this initiative including intensive capacity building through collaboration with SAT Asia and Africa national and international researchers. Policy dialogues with governments on research priorities, institutional innovations and policy will be catalyzed. These efforts are summarized in two output targets namely:

By 2009 a pilot study based on a coalition approach applying principles and methodologies of institutional learning and change in a selected SAT country will be completed with global and national partners.
By 2010 Future outlooks for dryland agriculture, targeted research priorities and impact evaluation methodologies will be developed and shared with national and sub-regional agricultural systems.

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

Priority 5B, Specific goal 1: Enhanced livelihoods and competitiveness for smallholder producers and food safety for consumers influenced by changes in national and international markets

Priority 5B Specific goal 2: Improved marketing environment for smallholders by improving the efficiency of domestic markets

Under its institutional innovation research ICRISAT is experimenting with innovative institutional arrangements to link small-scale sorghum and pearl millet producers with poultry feed manufacturers in India, China and Thailand. The activities under this component include bulking, grading and storage of produce for sale directly to feed manufacturers. The models would link not only producers and processors but also input suppliers, credit agencies and transport providers and market agents. Based on experimentation at the field level appropriate models of market linkages will be identified. The model will be generic in nature *i.e.*, applicable to many

commodities in several regions with only minor adaptive changes needed to meet local requirements. As an exemplar of specific, rather than the generic, partner inter-relationships described in this MTP, the linkages in this "component" project are displayed in the figure on the following page.

In the coming decade, whether smallholder producers in the SAT would be able to benefit from domestic and/or international markets would depend on their ability to access these markets, make the necessary adjustments to meet growing quality standards and improve efficiency in production and marketing. Efficiency in production would depend on their ability to access and exploit the best available technology and inputs. Market access requires access to price information in different markets, seasonal patterns of supply and price changes, credit, and availability of essential services. Given the complex factors that limit the functioning and efficiency of markets in rural areas, diverse policies and institutional arrangements can be employed to make markets work for the poor. Vertical coordination of production and marketing arrangements to improve economies of scale and reduce transaction costs will be critical. This is already evident in the region through cooperatives, producer organizations, and contract farming, whose role is likely to increase in the coming years. Linking producers directly to the upper part of the value of chain can shorten the supply chain, reduce the role of intermediaries (and transaction costs), and raise farm-gate prices while prices to poor consumers remain low.

As demand for a consistent supply of homogenous and quality products increases, there will be growing demand for private sector participation in agriculture through contract farming and other arrangements. This may also pose new threats and opportunities for small farmers in the SAT. While it may create monopolistic behavior and further marginalize less-competitive and unorganized poor farmers in low potential areas, it may provide reliable market outlets and access to inputs, skills and technologies for some producers that will improve production efficiency. Future research will need to identify efficient strategies and equitable mechanisms for linking producers to markets and enforcing such contracts, while also protecting the livelihoods of marginal farmers under transitory and chronic poverty.

It is expected that a new mechanism through a Challenge Program or Systemwide Initiative for better integrating this project's multiple-partner contributions to IPGs will be established in the CGIAR prior to the start of the current planning period (2008).

ICRISAT efforts will focus on the following elements:

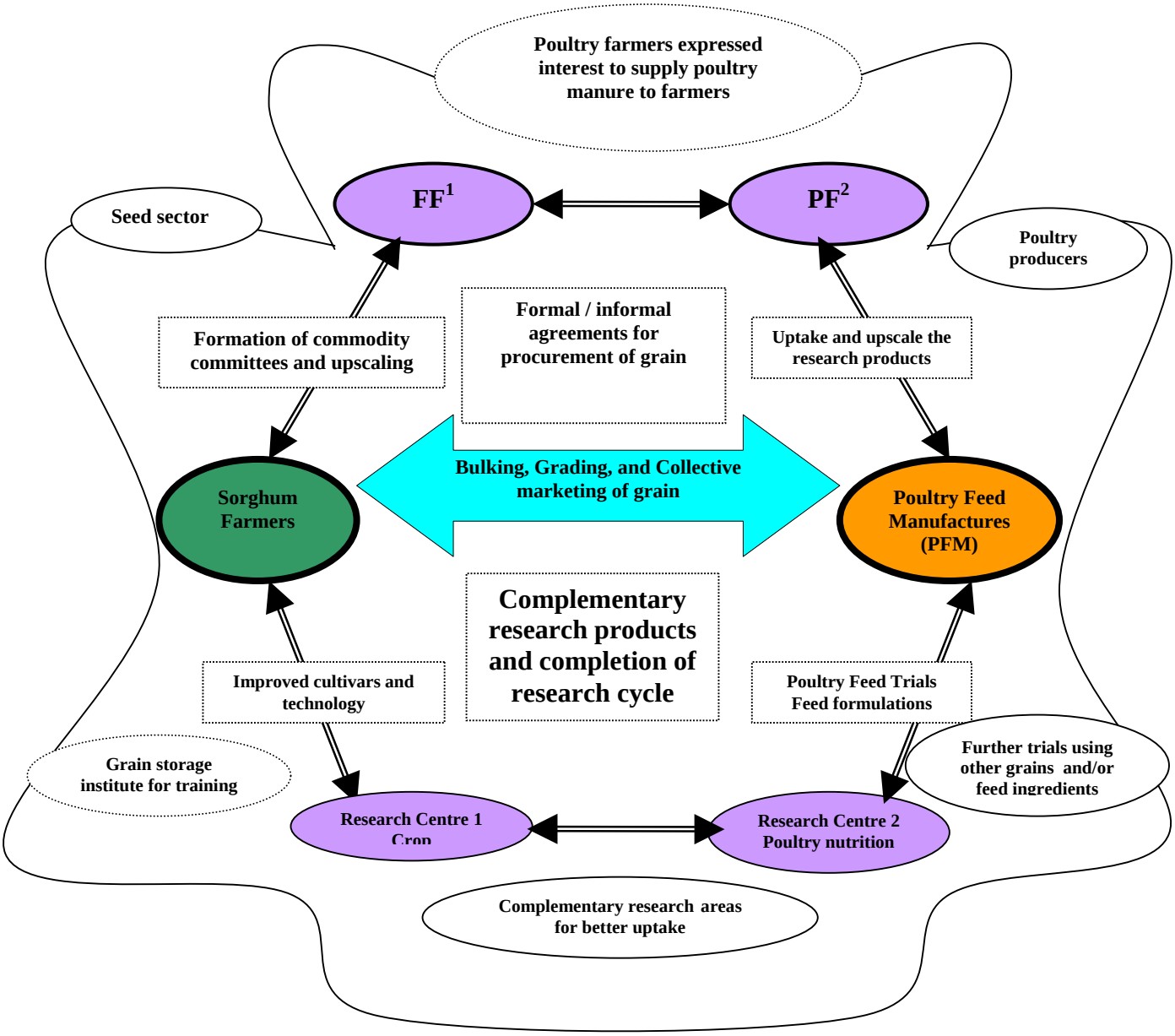
- Future markets and commodity outlook studies
- Good agricultural practices that meet social, food safety and environmental standards
- Strategies that enhance farmer access to new technologies and services
- Institutional arrangements for better coordination of production and marketing
- Grading and quality control systems
- Profitable marketing channels and outlets in domestic and international markets
- Policies that enhance and encourage contract formation and enforcement
- Policies that support industry competitiveness and intra-regional trade

The research strategy focuses on the following output target for 2010:
"Policies and strategies that encourage private sector investment in dryland agriculture through futures contract markets that provide more reliable markets for the poor and support contract enforcement developed".

Coalition approach for promoting sorghum for poultry feed

The need for global information on mandate crops and associated livestock and the place of the SAT in the WTO arena. World market price information of mandate crops & associated livestock and supply–demand projections would help in more informed decision making on research resource allocation and their implications for small-scale farmers in relation to global market trends. An output will be produced from this initiative including intensive capacity building through collaboration with SAT Asia and Africa regional and international researchers. Dialogues with governments on policy options and suitable interventions will be catalyzed.

This research effort is summarized by a 2008 1.4.2 output target:
"Forecasting models and analytical tools in collaboration with other CGIAR Centers and partners for situational analysis and outlook in commodities including phytosanitary standards and technical specifications for international trade developed". This collaboration is with IFPRI, ILRI and other Alliance centers.



1. FF – Farmers Federation 2. PF –Poultry Federation.

Priority 5C. Rural institutions and their governance

Priority 5C, Specific goal 1: Identify mechanisms for the strengthening of producers' organizations and for modes of participatory research

Priority 5C, Specific goal 2: Identify new forms of partnerships with NARS, the private sector, public extension agencies, NGOs and producers' organizations, and public agencies from other sectors, such as environment and health to enhance the conduct and impact from agricultural research

ICRISAT is faced with the challenge to identify broad lessons and strategies that facilitate the emergence of viable farmer organizations and institutions that facilitate access to essential services, namely markets and agricultural innovations, and help mitigate vulnerability to shocks or support local agricultural recovery efforts. ICRISAT is working closely with different kinds of farmer organizations in various countries. ICRISAT has also taken initial steps in understanding how such rural organizations evolve and function and how they can

provide effective services especially in relation to marketing groups, farmer cooperatives and other commercially-oriented farmer enterprises. This research is carried out in harmony with the SWIHA SWEP.

This research will involve the following areas:

- Characterization of selected rural institutional arrangements in selected countries including their potentials for improving farmer access to markets and agricultural technologies for income growth and reducing vulnerability to shocks (HIV/AIDS, drought, etc)
- Institutional options for targeting technology and market interventions for poor and HIV/AIDS affected households.

The output target for 2010 1.5.1 is:
"Policy recommendations for formal and informal social networks to address vulnerability, gender and social exclusion in SAT farming systems developed and shared".

ICRISAT hopes that the proposed re-kindling of the SWIHA SWEP in 2007 by WARDA will enable this output target to accord with other Alliance and related activities in SSA and S. Asia.

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

Almost a billion people in SAT Asia and Africa are still engaged in small-scale agriculture. The past years have seen an increasing focus on the diversity of livelihood strategies employed by rural households. Farming remains important but rural people are looking for diverse opportunities to improve food security, livelihood resilience, and stabilize their incomes. Farmer's vulnerability and their adaptation through coping mechanisms depend on their assets (physical, natural, financial, human, and social), and are influenced by institutions, the external environment and broader economic trends such as market prices and shocks including drought.

ICRISAT and its partners aim to maximize the impact of agricultural research by improving research and development options to reduce rural poverty and vulnerability in Asia and sub-Saharan Africa. To achieve this, ICRISAT will focus on mapping complex development pathways and alternative livelihood options to help make critical interventions to address poverty, vulnerability, marginalization and social exclusion. In particular, this will involve:

- Understanding the dynamics of poverty in the SAT and monitoring changes; identify options for the rural poor to access, acquire, protect (in the case of shocks) and use assets to improve their livelihoods and use the information to inform future R&D strategies
- Improving characterization of the rural poor (assets, context, depth and duration of poverty, vulnerability, basic needs, and choice of livelihood strategies) in relation to SAT agriculture.
- Analyzing uptake pathways of improved technologies and natural resource management practices and participation in higher-value product markets
- Determining specific opportunities or niches for ICRISAT to make a difference to the welfare of the SAT poor to include trade-offs underlying investments in crops and livestock, farm and non-farm rural employment and enterprise, migration and remittances, labor efficiency and greater human disease burden including HIV/AIDS, market interventions and policy changes.
- Assessment of returns to alternative livelihood and resource management strategies, and evaluation of approaches to improve ex-ante risk management through livelihood diversification, formal and informal insurance mechanisms, financial and in-kind savings, futures and forward markets, and improved market information systems.
- Analysis of the effectiveness of public sector assistance programs and rural development strategies to improve livelihood resilience and reduce poverty

Outputs produced from this initiative includes intensive capacity building through collaboration with SAT Asia and Africa regional and international researchers. Policy dialogues with governments on improving rural livelihoods and social protection interventions will be catalyzed.

The proposed work is highly innovative, since it will link vulnerability, distress and risk behavior to the stability/instability of sources of livelihoods including financial, human and social capital, and the natural resource base and its management. In addition, the dynamics of economic, social, and health issues underlying poverty will be addressed by adapting both economic and social lenses whereby the consequences of rural distress are discussed from the angle of sources of livelihoods including farm and non-farm income, off-farm options, migration and risky behavior, especially considering gender dimensions. More importantly, the links

between farm-household initiatives to stabilize sources of livelihoods or reduce rural distress and their risk behavior will be established by scrutinizing evidence of individual household and collective action in the management of financial and human capital as well as the community's natural resource base. Ultimately, this work combines micro (VLS) and macro studies to best inform long-run priority setting at ICRISAT and design policy and technological interventions. Insights into the livelihood and coping strategies of the poor and vulnerable would support policy formulation in improving rural livelihoods. This improved understanding of sources of risk and vulnerability for the poor provides a basis for informing policy development. Innovative, long-term, durable multi-stakeholder partnerships will be established for fostering dialogue, enhancing the use of participatory methodologies and learning processes focusing on the actors and the sectors involved.

A linked pair of output targets summarizing this work for 2009 1.6.2 and 2010 1.6.2 are:
"Policy package elements on risk management strategies (both ex-ante and ex-post) for mitigating the impact of risks inherent in rainfed agriculture developed and shared with partners by 2009 and participatory capacity building activities on development of a risk management policy for policy makers in SAT Asia completed by 2010".

Description of Impact Pathway: Project 1

The impact pathway developed for ICRISAT MTP Project 1 is an essential part of project monitoring and evaluation which enables a learning process throughout the Project 1cycle. This impact pathway systematically outlines a hierarchy of outcomes that contributes to attaining Project 1's ultimate development goal, that is, improved livelihoods of the people in the semi-arid tropics. The pathway shows a hierarchy of "outcomes" and how these "outcomes" at different levels ---outputs/activities, outcomes, impacts --- are expected to contribute to the Project 1 sub-goals and ultimate development goal. Getting all research partners and stakeholders to be aware and to agree to this impact pathway facilitates the learning process and will ensure a common understanding of what the project is trying to achieve. This understanding is crucial for an effective delivery of project outputs to the target users and beneficiaries of ICRISAT research products.

Impact from improving incentives for technology generation, access and use, **we assume**, will come through enhanced commercial investment in, for example, seed production and marketing as a result of reduced transactions costs faced by the private sector as a result of seed trade harmonization. Our efforts in the creation and capacity development, for example, of the West African Seed Association are designed **to mitigate this risk.** For crops that are less commercially attractive – including groundnut that is bulky, perishable and has a low seed multiplication rate – the development of independent foundation seed enterprises set up as units of public utility with the authority to take business decisions, the financial autonomy that will allow the full recuperation and use of proceeds from seed sales, and provide the necessary accountability to whatever governance mechanism is decided upon, **we assume**, will improve access to publicly developed germplasm and **we provide capacity development to help ensure this**. These units will support community-based seed production, and the development of seed entrepreneurs both of which are expected to improve impact from public-breeding efforts.

The ICRISAT Project 1 Impact Pathway articulates the essential phases in achieving the overarching development goal of improved livelihoods for the SAT poor. Six sub-goals are identified: food security, income augmentation, reduced vulnerability, improved quality of life, market-led transformation, inclusiveness and gender equity. The outputs-outcomes-impacts phases are systematically outlined and illustrated in the Figure 1.1 below. For the research outputs to have an effective influence on the achievement of higher level purposes and goals, a holistic inclusive network of partners/actors/participants is conceptualized and illustrated by a "network pathway" for Project 1 (Figure 1.2). This is developed to identify the players and their interactions throughout the research and development process. This instrument, along with the pathway in Figure 1 (see introduction), provides a visual perspective of the "transformation of knowledge into action through effective evaluation and reflective learning, the key to successful implementation of a project, and to generating significant impact through project activities and dissemination of results."

Methodologies, tools and other IPGs that have applicability beyond one nation's borders:

The project's outputs are often globally derived, building on ICRISAT's strengths throughout the SAT and it delivers clear examples of international public goods (IPGs). These are:

- Village Level Studies (VLS): overall methodology, risk preferences, estimation of time preference, research and policy findings. The VLS database which has been historically a vital IPG used by international partners from the broadest spectrum.
- Research evaluation and impact assessment (REIA): methodology, training modules

- Strategic assessments of SAT environments and institutional analysis
- Ways to linking markets and technology design
- Strategic trade analysis for decision making in applied development work
- Bioeconomic models; database development and dissemination
- Recognition of consumer preferences in intermediate and end user markets and implications for technology dissemination
- Policy guidelines on the types of institutional arrangements needed to establish non-profit private entities of public utility and the conditions under which such institutions succeed will be developed
- Seed policy reform

Elaboration of partners' roles and capacity development

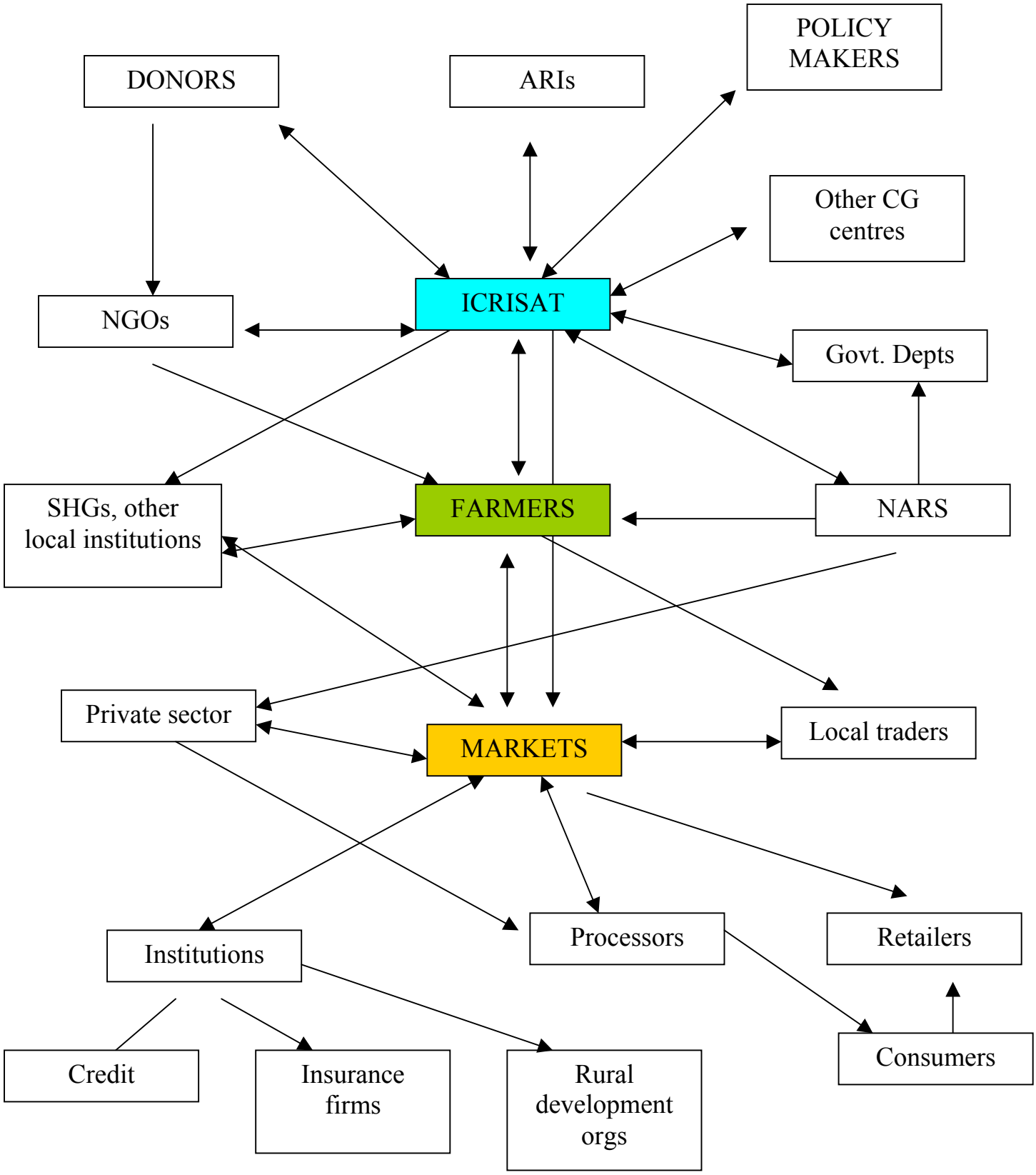
The national program partners participate in project planning and implementation as well as in training and capacity building. The evolving network of social scientists adapts methods promulgated by ICRISAT while policy makers use alternative development pathways particularly for pro-poor policies and risk management strategies. Higher degree students will be associated with most aspects of this project. Economists, policy makers, and think-tanks for development policy analysis in Mali, Burkina Faso, Niger, Senegal, Nigeria, Kenya, Ethiopia, Malawi, India, and Bangladesh are part of the evolving network of social scientists working on the SAT. They take decisions informed by studies on impacts, trade prospects and outlooks. Advanced research institutes are closely involved in addressing methodological and empirical issues as well as cutting edge analytical methods for both macro and micro level assessments. Scientists from other disciplines within and outside ICRISAT obtain feedback information on insights on village economies to aid in the design and development of SAT technologies. The above partners are also directly collaborating to improve priority setting and resource allocation. Our new initiative on innovation systems involve close partnerships with the private sector, NGOs and farmers' organizations who assist in identifying profitable marketing channels among alternative options that reduce transaction costs for seeds systems and dryland tradable coarse grains. Ultimately as policy makers better understand the consequences of policy and institutional constraints, they more effectively identify appropriate interventions and formulate pro-poor policy for farmers in the SAT.

In terms of ICRISAT's most strategic alliances:- IFPRI helps ICRISAT through its global expertise on marketing and is one of the lead agencies in the development of the SMART (Stimulating Market-Led Agricultural and Rural Transformation) consortium which includes a further wide range of Alliance and non-Alliance consortium partners. Iowa State (a world leader in international seed science issues) and the SCOSA Consortium (Seed systems to support commercialization of small scale agriculture in SSA) and NASFAM (Malawi) are critical to work under Priority 5A in Africa and NCAP (Indian National Center for Agricultural Policy is the key partner in Asian and VLS activities owing to its extensive domestic reach in India and long experience of collaboration with ICRISAT (Priority 5D).

Figure 1.1 MTP Project 1 problem tree/impact pathway.

Goal	Level 1 **Purpose/sub-goals**	Level 2 **Impacts**	Level 3 **Outcomes**	Level 4 **Outputs/Activities**
IMPROVED LIVELIHOODS FOR SAT ASIA AND AFRICA	**Food security** with better foresight knowledge on opportunities and constraints in the SAT	Sustainable increase in food production through more informed research allocation decisions	Research partners & policy makers take informed science-based decisions using analysis of macro trends, micro studies & situation & outlook reports	Scanning macro environment linked with micro-level realities: macro trends micro studies
	Income augmentation through improved linkages with input and output markets and supply chain management (including seed systems)	Better price realization/better quality standards for SAT crops and improved profitability	Policy makers and planners show informed decision making concerning SAT agriculture using decision support tools and databases	Priority setting, IMPACT models and database developed
	Reduced vulnerability due to effective interventions and strengthened rural institutions (formal and informal)	Risk management strategies for mitigating the impact of risks inherent in SAT agriculture effective	Planners use recommended strategies and policy options for unlocking the potential of markets and institutions to accelerate income generation and upward socio-economic mobility	Market innovations and social networks to facilitate and enhance technology uptake Multi-sectoral alliances to address impacts of HIV/AIDS on household food security
	Improved quality of life (development pathways of rural poor realized)	Increased investments by the public and private sector	Producer groups and policy makers implement policies that enhance competitiveness	Pilot and case studies undertaken with consortium approach
	Market-led agricultural rural **transformation**	Agricultural performance in SAT countries transformed through harmonized market industry	Planners and market agencies realize the potential of institutional options and market innovations	Income and consumption studies
	Inclusiveness and **gender equity**	Platforms for capacity building, learning and informing policy decisions effective	NARS social scientists adapt methods promulgated by ICRISAT	Viability of crops and livestock enterprises; Studies on adoption of improved SAT crops/livestock and management technologies
			Researchers, students and other partners harness new development theories on inter-generational investments and development pathways to support evidence based decision making	Labor market studies; migration; investments in education, health, nutrition; investments in NRM (water exploration and land management)
		Effective policy advocacy	Policy makers are better informed on alternative development pathways for rural SAT economies	Documentation on changes in livelihood 1975-2007
			Agencies for social protection adopt principles of innovations tapping social networks	Architecture of social networks documented
			Development investors and policy makers implement principles developed in packaging management strategies to deal with risk	Mitigation of risks faced in production and marketing (prices) through formal insurance mechanisms and credit
			Policy makers sensitized to deal with equity issues confronting rainfed agriculture in the SAT	Policies for input subsidy procurement, PD policies and support prices
			NARS social scientists capacity enhanced	Social scientists training - 3 NARS countries per region
				NARS capacity building through collaboration/ partnership

Figure 1.2. MTP Project 1 Network Map.



Project 1 Logframe: Improving policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT

Output	Output Target	Intended Users	Outcome	Impact
Systems Priority 5A				
1.1 Best innovative practices and mechanisms for harmonization and utilization of seed-related and biosafety regulations and policies suitable for the specific conditions of the SAT piloted, promoted and adopted with new knowledge shared with partners	2007 1.1.1 Mechanisms for enhancing the utilization and market and non-market based exchange of germplasm through harmonization of seed policies developed and piloted in Africa; 2007 1.1.2 Innovative public-private partnerships and foundation seed enterprises to strengthen seed supply systems developed and piloted in Africa	Public, private seed industry, partners, policy makers, farmer and regional seed organizations in the SAT, Iowa State University	Partners and policy makers internalize in 2008 and take initial steps to harmonize in 2009 seed related, biosafety and seed system protocols in the SAT (particularly at regional level) which enhances the utilization and market and non-market based exchange of germplasm to promote agriculture	The regulation of the seed industry, particularly when harmonized at a regional level has a very great influence on farmer's access to improved genetic material which should be substantively beneficial
	2008 1.1.1 Critical gaps in understanding in safety standards and food safety regulations identified and new knowledge shared with partners for capacity development.			
	2009			
	2010 1.1.1 Best practices for harmonization of seed-related regulations and policies suitable for the specific conditions of the SADC and ASARECA regions promoted.			
1.2 SAT agricultural research database, impact evaluation methods, participatory, pro-poor monitoring and evaluation and institutional learning and change models generated, shared and capacity developed	2007	Research partners, policy makers, NARES and SAT farmers	Research partners and policy makers take better informed, innovative, science-based, decisions on alternative investment opportunities for improving agricultural productivity, incomes and employment and sustainability in the semi-arid regions	NARES demonstrate much enhanced research efficiency and knowledge is more freely available from their securely preserved databases.
	2008			
	2009 1.2.1 Pilot study based on a coalition approach applying principles and methodologies of institutional learning and change (ILAC) in a selected SAT country and associated capacity development with global and national partners completed			

with national and sub-regional agricultural research systems with new knowledge shared with partners	2010 1.2.1 Future outlooks for dryland agriculture, targeted research priorities and impact evaluation methodologies developed and shared for capacity development with national and sub-regional agricultural research systems			
Systems Priority 5B				
1.3 Strategies that encourage investment in dryland agriculture, that enhance the competitiveness and quality standards of farmer products, that facilitate innovative methods to improve coordination in market chains, that ensure profitable marketing channels and outlets for ICRISAT mandate crops in domestic and international markets identified and promulgated throughout the SAT with new knowledge shared with partners	2007 1.3.1 Strategies that enhance farmer access and utilization of productive inputs and linked services that enhance competitiveness promoted 2008 1.3.1 Trade prospects and outlooks for major commodities assessed and communicated to major producing countries in the region Grading and quality control systems for selected tradable cereals and legumes promoted for capacity development in three major growing countries 2009 1.3.1 Innovative arrangements for better coordination of production and marketing along the value chain for reducing transaction costs promoted and capacity developed 2010 1.3.1 Policies and strategies that encourage private sector investment in dryland agriculture through futures contract markets that provide more reliable markets for the poor and support contract enforcement developed	Policy makers, farmer organizations, traders, small-scale producers, agro-enterprises, market agents, processor and the private sector.	Farmer organizations and policy makers and planners take innovative and scientifically-informed decisions and implement policies that enhance the competitiveness, product quality and profitability of farmers, agro-enterprises, market agents and processors and facilitate enhanced national, intra-regional and global trade	The marketing industry harmonized at a regional level contributes greatly to the transformation of agricultural performance in SAT countries.
1.4 Forecasting models, market linkage models and analytical tools developed and promulgated in collaboration with other CG centers and partners	2008 1.4.1 Knowledge on how informal markets function, how small-scale livestock owners from the SAT can engage in these markets and how it would benefit them developed and shared with partners 2008 1.4.2 Development of forecasting models and analytical tools in	NARES partners, traders, processors, market agents, small-scale crop and livestock producers	Partners show informed decision making for SAT regions and commodities and assist small-scale producers of both crops and livestock to	Effective supply and demand projections for SAT mandate crops and associated livestock based on more scientific information have led

for situational analysis and outlook in commodities & livestock including phyto-sanitary standards (SPS) and	collaboration with other CG centers and partners for situational analysis and outlook in commodities including phyto-sanitary standards (SPS) and technical specifications for international trade and associated capacity development		demonstrate enhanced technical know-how, reduced-risk production strategies, institutional linkages, bargaining power; access to niche markets, reduced transaction costs and reduced market risk.	to more informed research resource allocation and research priority setting by commodities and regions. ICRISAT mandate crops have been tailored to meet international quality.
Technical specifications for international trade and new knowledge shared with partners	2010 1.4.1 Documentation of formal markets to show how small scale farmers from the SAT can participate in the mainstream economy developed and shared with partners			standards for the benefit of small scale farmers
Systems Priority 5C				
1.5 Alternative institutional innovations and topologies to strengthen rural institutions that facilitate and enhance adoption of technological and market innovations and policy recommendations for formal and informal social networks to address vulnerability, gender and social exclusion in SAT farming systems developed and shared with partners.	2007	Policy makers, planners, extension and market agents and agencies for social protection, SHIHA SWEP partners	Policy makers, planners, extension and market agents realize the potentials of alternative institutional options and use these for delivering technological and market innovations to smallholder farmers Agencies for social protection and agricultural rehabilitation adopt and implement principles of institutional innovations that strengthen local institutions that facilitate recovery and mitigate the impacts of HIV/AIDS on household food security and incomes	Development has occurred within a context in which rural institutions are newly strong and functional in the SAT resulting in improved rural livelihoods.
	2008 1.5.1 **Multi-stakeholder alliances to address vulnerability for mitigating the impacts of HIV/AIDS on household food security piloted at experimental scale (associated with the SWIHA SWEP)**			
	2009 1.5.1 Capacity building measures to strengthen rural institutions that facilitate and enhance adoption of technological and market innovations and policy recommendations for formal and informal social networks undertaken in at least 3 SAT countries			
	2010 1.5.1 Policy recommendations for formal and informal social networks to address vulnerability, gender and social exclusion in SAT farming systems developed and shared.			

Systems Priority 5D				
1.6 Policy package of management strategies (both ex-ante and ex-post) for mitigating the impact of risks inherent in rainfed agriculture developed with associated capacity building for partners and policy makers in SAT Asia	2007 1.6.1 Comparative study contrasting current with past VLS key findings drafted	NARES social scientists, policy makers and development planners	NARS social scientists adapt methods promulgated by ICRISAT and policy makers are better informed on alternative development pathways for rural SAT economies in the development of pro-poor agricultural policies.	Hard factual information from the VLS and lessons learned from past success and failures have had a major impact on ensuring more science-based decision making in matters concerning agricultural development throughout the SAT which has contribute to more effective development activities.
	2008			
	2009 1.6.1 Documentation completed of 'Changes in household economies on SAT Asia' based on the analysis of panel data from 1975-2007. 2009 1.6.2 Policy package elements on risk management strategies (both ex-ante and ex-post) for mitigating the impact of risks inherent in rainfed agriculture developed and shared with partners			
	2010 1.6.1 Uptake pathways of SAT technologies documented based on case studies shared with national program partners 2010 1.6.2 Participatory capacity building activities on development of risk management policy package for policy makers in SAT Asia completed			

Project 2 Narrative:
Sustaining Biodiversity of Sorghum, Pearl Millet, Small Millets, Groundnut, Pigeonpea and Chickpea for Current and Future Generations

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center (A fuller treatment of the first sections of this narrative may be found in the 2007-2009 MTP)
The research proposed in this project is in accordance with System Priority 1A -- Specific goals 1 to 5 and Priority 1B -- Specific goals 1 to 3. This research, through its active custodianship of a large proportion of the world's germplasm, is delivering IPGs annually as its responsibility to the world community has been defined by FAO to be "in perpetuity". ICRISAT claims that 100% of this project's activities are encapsulated within the CGIAR System Priorities. ICRISAT is involved with the System-wide Genetic Resources Programme (SGRP) in developing policies and practices for managing, acquiring and making available genetic resources that are consistent with international agreements. Knowledge, technologies and information on genetic resources is shared with other partners for sustainable use of biodiversity.

The target ecoregion, the beneficiaries and end users
The project has a global responsibility within ICRISAT's MTP for effective conservation and utilization of the biodiversity of mandate SAT staple crops and small millets. The immediate beneficiaries of this research are the institute's own researchers, varied research and development partners: including NARS and private sector scientists involved in genetic resources conservation and crop improvement. The end users are farmers; village communities, and consumers benefiting from enhanced yields, nutritious diets and more secure annual incomes.

Is the center the primary or secondary research provider?
The center is a primary research provider in this project. It has been a major contributor to the **Generation Challenge Program and is continuing to play this role.** Amongst much other work, for example, in 2006 three thousand accessions of a chickpea composite collection were genotyped using SSR markers in collaboration with ICARDA.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to ensure outcomes and impact
The germplasm conserved in the genebank is the primary source of basic germplasm for the scientists at ICRISAT and many NARS and private sector companies worldwide. ICRISAT also plays the role of enabler and facilitator – the international status of this collection is guaranteed by the in-trust agreement between FAO and ICRISAT. Our obligations to FAO and the International Treaty on Plant Genetic Resources for Food and Agriculture require that we set the highest standards for conservation of staple and under-utilized species and assist in the conservation of, and access to, the germplasm and provide related information to the global R&D community.

A brief description of the comparative and complimentary advantage of the project activities
ICRISAT is well placed to organize information and legal germplasm exchanges between partners from different countries. It has excellent germplasm conservation facilities at Patancheru, India and improved infrastructure for managing the genetic resources at its regional genebanks. Also, ICRISAT has a comparative advantage of working on system-wide projects with other CG centers on genetic resources management and information sharing.

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs
Computerized documentation systems enable rapid dissemination of information to users as well as assist curators to manage collections more efficiently. ICRISAT has been an active participant in the System-wide Information Network on Genetic Resources (SINGER), and a participating member in the other regional networks and contributes to CG sponsored activities related to development and implementation of genetic resources exchange protocols. Thus, we ensure our knowledge is made freely available worldwide.

Problem analysis, identification of specific problems that can be tackled by research focused on specific objectives

Systems Priority 1 A & B: Sustaining Biodiversity of Sorghum, Pearl millet, Small millets, Groundnut, Pigeonpea and Chickpea for current and future generations (all outputs are associated with the SGRP SWEP)

Supporting exploration, exchange, and conservation of plant genetic resources (PGRs) is one of the main objectives of ICRISAT so that the germplasm accessions are easily accessible to research workers, worldwide. Currently, the ICRISAT genebank holds 114,870 germplasm accessions of its mandate crops and small millets representing contributions from 130 countries of the world.

Development of a 'composite set' of germplasm in research has been conceptualized in recent years mainly due to the initiatives of the Generation Challenge Program. The composite set (about 3000 accessions) represents the entire collection by geographic origin, mini-core sets, main germplasm diversities, and other economic traits. At ICRISAT such composite collections of sorghum, chickpea, groundnut, pigeonpea, and finger millet have been and are being developed. The composite sets will be analyzed using molecular markers to assess the molecular diversity in the composite collection and devise strategies for exploiting it for crop improvement, especially for traits such as drought tolerance and other economic traits.

Besides germplasm of sorghum, pearl millet, chickpea, pigeonpea, and groundnut (staple crops), ICRISAT also conserves, characterizes, and promotes the utilization of six small millets (finger-, foxtail-, barnyard-, kodo-, little-, and proso- millet) that have regional and location-specific importance and as such classified as under-utilized crops. ICRISAT genebank is holding 10,193 accessions (5,949 finger millet, 1,535 foxtail millet, 842 proso millet, 743 barnyard millet, 658 kodo millet, and 466 little millet) of these crops. These small millets are characterized as underutilized crops and fall under Systems Priority 1B.

Description of impact pathways and capacity development

Newly acquired germplasm and germplasm with incomplete data are characterized and data is recorded on morpho-agronomic traits, facilitating greater use by researchers. Data is transferred to the SINGER database facilitating greater access by the global community. Evaluation of core and mini core collections of staple crops and finger millet for agronomic traits and various biotic and abiotic stresses to identify trait specific germplasm will result, **we assume**, in enhanced use of germplasm by the breeders to develop high yielding cultivars with a broad genetic base. Population structure and extent of linkage disequilibria are studied in the core/mini core and composite collections using SSR markers. Devising strategies *e.g.* association mapping for utilizing the existing allelic diversity in plant breeding programs and sharing this with partners is an important activity. A reference collection for each crop would be selected, and conserved for future use in crop improvement by partner breeders. Molecular characterization of trait specific germplasm will help in identifying genetically diverse parents for use in mapping and in breeding programs to develop cultivars with a broad genetic base. The mini core and reference collections are shared with the global scientific community, particularly with the partners specified below and **we offer capacity development where appropriate in all these areas especially for higher degree students in biotechnological issues to mitigate possible risk of under, or inappropriate, use.**

Expected IPGs that have applicability beyond one nation's borders in the MTP period

- Safely conserved germplasm and DNA collections of staple ICRISAT mandate crops and small millets.
- Knowledge base shared on characterization and evaluation of conserved germplasm.
- Improved methods and practices for enhanced utilization of existing collections.
- Improved facilities and operational procedures on managing collections.
- Improved knowledge and techniques on germplasm access, manipulation and utilization for partners.
- Sub sets of germplasm and improved methods for research and crop breeding to reduce risks to food security.

Elaboration of partners' roles

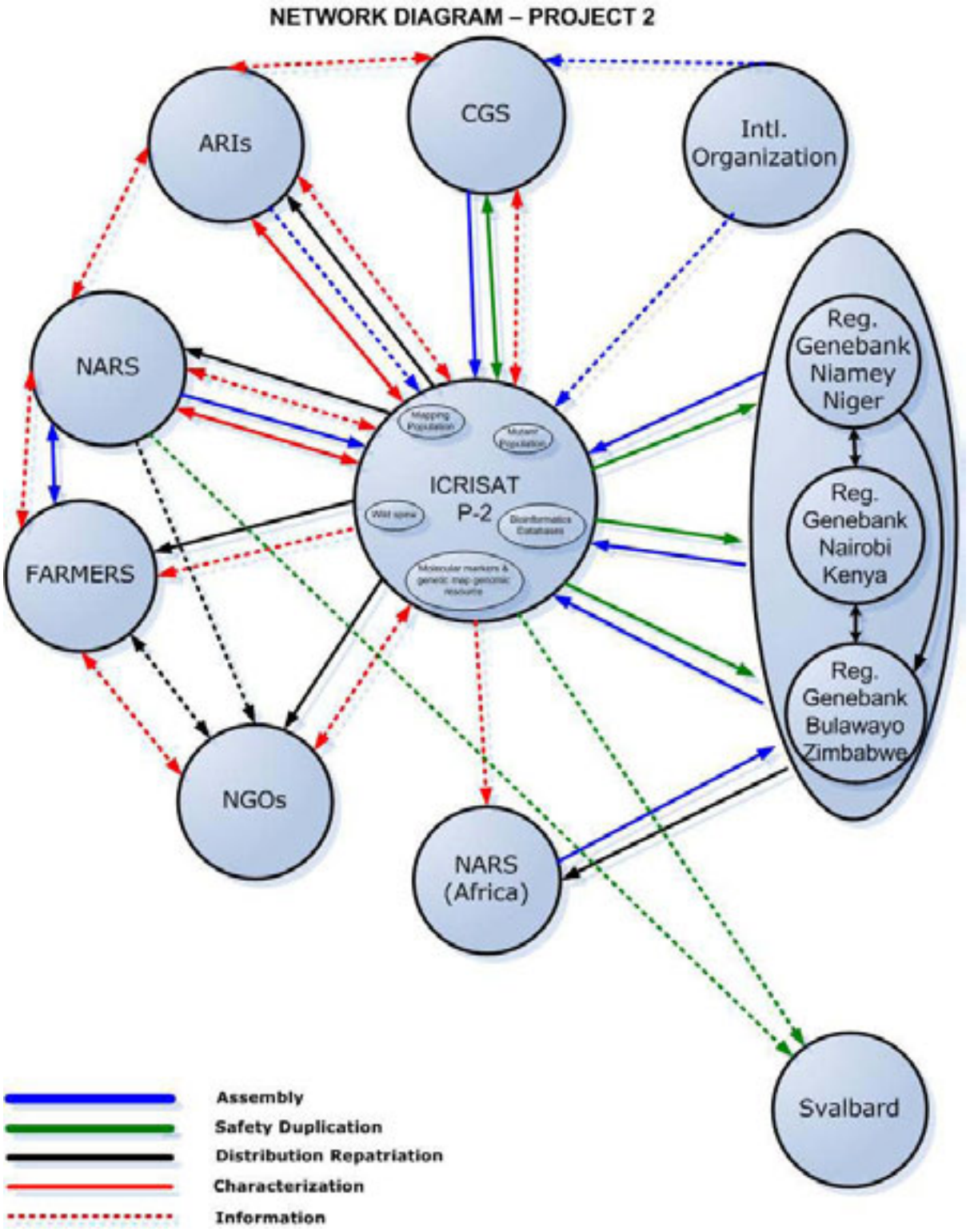
The principal partners in the project are: National Germplasm Repositories, **SGRP Partners**, NARS and State Departments for assembling unique germplasm and Parties to the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture (IT- PGRFA), IPGRI, Local governments in different countries, Collaborating NARS and Universities in collecting endangered germplasm.

For preservation, safety duplication and knowledge dissemination of germplasm partners **include ICARDA, the partners in the SWEP - System-wide Genetic Resources Program (SGRP) SINGER and ICIS, the Generation CP** and the Svalbard repository. Partners for multi-location evaluation of germplasm include collaborating NARS in Asia (India, China, Vietnam, Thailand, Japan) and Africa (Kenya, Malawi) and universities for staple crops; and the MS Swaminathan Research Foundation (MSSRF) for small millets in India. For genotyping and molecular characterization – Other CG centers (ICARDA, IRRI), **Generation CP Partners** (EMBRAPA, CAAS) Advanced Research Institutions (CIRAD), The Indian Department of Biotechnology and universities (Texas A & M University, USA) (see accompanying network diagram). Population structure and extent of linkage disequilibria are studied in the germplasm collection. Devising strategies *e.g.* association mapping for utilizing the existing allelic diversity in plant breeding programs is an important activity. Newly acquired germplasm and germplasm with incomplete data are characterized and data is recorded on morpho-agronomic traits, facilitating greater use by researchers. Data is transferred to the SINGER database facilitating greater access by the global community. Evaluation of chickpea and groundnut core and/or mini-core collections for biotic and abiotic stresses and for agronomic traits is carried out to enable identification of trait specific diverse and agronomically superior germplasm for use in crop improvement by partner breeders. Core collections of sorghum, pigeonpea and finger millet are being evaluated for morpho-agronomic traits, data is analyzed and representative mini core collections are developed for sharing with partner breeders. Composite collections of five mandate crops will be genotyped using micro- satellite markers. The diversity of the composite collections will be assessed and a representative reference collection for each crop selected, and conserved for future use in crop improvement by partner breeders. Reference collections will be made available for research to the global scientific community, particularly to the partners specified below.

Key Strategic Alliances: Specifically with the SGRP for its long collaboration on conservation, the Generation CP partners by providing early access to germplasm, information and cutting edge biotechnological techniques and the Indian Department of Biotechnology for exploitation of germplasm through its network of associated research institutions and generous funding support.

Figure 2.1 MTP Project 2 problem tree/impact pathway.

Goal	Level 1 **Impact**	Level 2 **Outcomes**	Level 3 **Outputs/Activities**	Level 4 **Basic Activities**
Sustaining biodiversity of ICRISAT mandate crops and small millets for current and future generations	Enhanced utilization of germplasm	Unrestricted access to germplasm databases	i. Gap analysis ii. Identify secure/ collect unique germplasm	Assembly and Conservation
	Genetic base broadened	Germplasm subsets for enhanced utilization (wild species/core/ minicore/reference/trait specific)	i. Regenerating healthy seeds ii. Medium and long term conservation and safety duplication (phytosanitary and seed health)	Characterization and Evaluation
	NARS capacity for germplasm utilization enhanced	Molecular markers, genetic maps, QTLs, superior alleles	Developing genomic and bioinformatics tools	Utilization (Distribution)
		Globally accessible databases (genetic resource information, genotypic and phenotypic information)	Establishing, evaluating core/ mini core/reference sets of germplasm	
		Broadened genetic diversity through wide crosses etc.	i. Phenotypic and genotypic characterization of germplasm sets (core/mini core/reference/ trait specific germplasm) ii. Characterizing/evaluating wild genepool for desirable traits	
			Assembly of mapping population (RIL) and mutant populations. Conservation and distribution of DNA from core/minicore/ reference/trait specific germplasm/mapping and mutant populations/transgenics/microbes	


NETWORK DIAGRAM – PROJECT 2
ARIs
CGS
Intl. Organization
NARS
FARMERS
NGOs
NARS (Africa)
ICRISAT P-2
Reg. Genebank Niamey Niger
Reg. Genebank Nairobi Kenya
Reg. Genebank Bulawayo Zimbabwe
Svalbard
Assembly
Safety Duplication
Distribution Repatriation
Characterization
Information

Project 2 Logframe: Sustaining biodiversity of Sorghum, Pearl Millet, Small Millets, Groundnut, Pigeonpea and Chickpea for current and future generations

Output	Output target	Partners	Outcomes	Impact
Output 2.1: Germplasm of staple crops assembled and conserved and germplasm characterized and documented for utilization and knowledge shared with partners	2007 2.1.1 Global database of chickpea and pigeonpea compared to identify unique germplasm 2007 2.1.2 500 chickpea accessions (ICARDA) and 600 groundnut accessions (Japan) assembled and characterized	SGRP, Other CG centers, Generation CP partners, Parties to CBD and IT, NARS, Crop Diversity Trust, Universities, ARIs and the Svalbard repository	i) Germplasm safely conserved for present and future use, and ii) Partners have the most up-to-date knowledge and secure access to the largest collection of well-characterized genetic diversity of five SAT staple crops in the world and use this internationally to improve the efficiency and effectiveness of their breeding programs.	Risks to food security in the SAT are strongly reduced as crop researchers have had access to diverse germplasm to develop improved broad genetic based cultivars; and ii) Biodiversity is sustained for current and future generations.
	2008 2.1.1 Priorities areas identified for chickpea and pigeonpea for collection/assembly in collaboration with NARS 2008 2.1.2 Sorghum germplasm from USDA (500 no's), pearl millet from Niger (400 accessions) and pigeonpea collections from Tanzania, Uganda and Mozambique (200 accessions) assembled 2008 2.1.3 Sorghum germplasm from Niger (450 accessions), chickpea germplasm from ICARDA (500 accessions) and groundnut germplasm from Japan assembled and characterized for morpho-agronomic traits 2008 2.1.4 Global databases of sorghum and groundnut compared to identify unique germplasm and to identify gaps for collection			
	2009 2.1.1 Priority areas for sorghum/groundnut for collection and assembly determined in collaboration with NARS and with associated capacity development 2009 2.1.2 **Staple crops germplasm databases updated and uploaded to SINGER database**			
	2010 2.1.1 Germplasm of staple crops assembled and conserved for utilization at regional genebanks in Africa (Bulawayo, Kiboko and Niamey)			

Output 2.2: Germplasm of six small millets assembled and conserved germplasm characterized/ evaluated and documented for utilization and knowledge shared with partners	2007 2.2.1 Global database of finger millet compared to identify unique germplasm and to determine gaps for future collection 2007 2.2.2 Priority areas identified with associated capacity development for finger millet collection/assembly in collaboration with NARS	Parties to CBD and IT, Crop Diversity Trust, SGRP, Bioversity International, Generation CP partners, NARS, Universities, ARIs and the Svalbard Repository	i) Germplasm safely conserved for present and future use, ii) Partners have the most up-to-date knowledge and secure access to the largest collection of well-characterized genetic diversity of six small millet crops of SAT in the world and use this internationally to improve the efficiency and effectiveness of their breeding programs, and iii) Small millets germplasm with desirable traits including high grain quality known.	i) Risks to food security in the SAT are strongly reduced as crop researchers have had access to diverse germplasm to develop improved broad genetic based cultivars, and ii) Biodiversity of six small millets is sustained for current and future generations
	2008 2.2.1 Global database of foxtail, little, kodo, proso and barnyard millet compared to identify unique germplasm 2008 2.2.2 Priority areas identified with associated capacity development for foxtail, little, kodo, proso and barnyard millet finger millet collection/assembly in collaboration with NARS 2008 2.2.3 Passport, characterization and evaluation data of small millets germplasm documented			
	2009 2.2.1 Gaps in finger millet collection identified and potentially filled in at least two countries in ESA 2009 2.2.2 Germplasm databases of small millets updated to SINGER format			
	2010 2.2.1 Databases of small millets germplasm updated for utilization 2010 2.2.2 Germplasm of six small millets assembled and conserved with 50% of germplasm characterized/ evaluated for desirable traits and documented for utilization			
Output 2.3: Core, and mini-core collections and trait specific germplasm identified and evaluated and composite sets and reference collections developed and	2007 2.3.1 Composite sets of germplasm established for utilization (groundnut, pearl millet and pigeon pea 1000 accessions each) 2007 2.3.2 Diversity of sorghum composite collection analyzed and reference set (300 accessions) established	Other CG centers, Generation CP Partners, ARIs, NARS and Universities	i) Partners have the most up-to-date knowledge on diversity of germplasm available in core and mini core collections, trait-specific germplasm and representative reference collections and use this to improve the efficiency of their	i) Precision of germplasm evaluation has been enhanced. ii) Risks to food security in the SAT have been strongly reduced by robust, informed, efficient trait-based

genotyped for utilization and new knowledge shared with partners	2008 2.3.1 Mini-core subsets of sorghum germplasm established for utilization (sorghum, finger millet) 2008 2.3.2 Diversity of groundnut and pigeonpea composite collections analyzed and reference sets (300 accessions each) established Mini core collections of chickpea, groundnut, and pigeonpea evaluated in multilocations in Asia 2008 2.3.3 Core subset of foxtail millet germplasm established for utilization		breeding programs	breeding programs
	2009 2.3.1 Core and mini-core subsets of germplasm evaluated and trait specificity identified			
	2010 2.3.1 85% of germplasm characterized and documented for utilization 2010 2.3.2 New reference collections of germplasm established and evaluated for utilization for all 5 mandate crops (300 accessions each)			
Output 2.4: Genetic diversity and population structure of staple crops and small millets assessed and mapping populations, RILs developed and DNA extracts assembled, conserved and distributed and new knowledge shared with partners	2007 2.4.1 Genetic diversity and population structure assessed for staple crops using composite collections	Other CG centers, GCP Partners, NARS, Universities and ARIs	Partners use the most up-to-date knowledge on available genetic diversity, population structure, mapping populations and reference collections of staple and small millet crops to improve the efficiency and effectiveness of their breeding programs	Enhancement of breeding efficiencies after assessing and exploiting allelic diversity, maintenance of usable germplasm, and use of mapping populations, mini core and reference collections has resulted in an enhancement of the productivity and quality of ICRISAT mandate crops in the SAT
	2008 2.4.1 Trait specific mapping population/RILs of staple crops assembled			
	2009 2.4.1 Diversity assessment of composite collections of finger millet and foxtail millet made available globally via the internet			
	2010 2.4.1 DNA extracts of minicore subsets of germplasm conserved for utilization 2010 2.4.2 Datasets for groundnut, pigeonpea, pearl millet and small millets genetic diversity made available globally via the internet Agriculturally beneficial micro-organisms assembled for utilization with associated capacity development			

Project 3 Narrative:
Producing more and better food of the staple cereals and legumes of the west and central African (WCA) SAT (sorghum, pearl millet and groundnut) through genetic improvement

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center
The research proposed in this project is in accordance with System Priority 2 A (yield) with both its specific goals 1 and 2, priority 2B (selected abiotic stress: drought) and priority 2C (nutritional quality and safety). This project will also address tangentially Priority area 3B as for all three crops the crop residues are an economically important component, primarily used for animal production. ICRISAT claims that 100% of this project's activities are encapsulated within the CGIAR System Priorities. ICRISAT sees its research as a positive contribution which its research is making to the MDGs in a region where food and nutritional security is regularly threatened. The research from this project is regionally oriented towards the large number of Sahelian countries from Senegal to Chad and owing to the consistency of environments across a broad swathe of west Africa the results from this project are used widely as IPGs and there is the strong likelihood of future spillover from this research from Sahelian country to Sahelian country and into comparable environments in Sudan, Ethiopia and the Horn of Africa.

The target ecoregion, the beneficiaries and end users
The target ecoregion is the semi-arid tropics of west and central Africa, specifically the Sahelian, Sudanian and northern Guinea savannah zones of agricultural production. The immediate beneficiaries of this research are our varied research and development partners from the NARES, the NGO and CBO communities. We are also trying to assist the few private sector marketing and seed enterprises. The end users are village communities benefiting from more secure and nutritious staple food production and more secure annual incomes, as well as more and better quality crop residues for increased animal production.

Is the center the primary or secondary research provider?
The Center in this project is often the primary research provider especially in the area of hybrid cereals but can also adopt a secondary role especially when farmer participatory breeding and seed systems development is employed as a research mechanism. However funding of most NARS has been decreasing, thus numbers of staff have been leaving, and only few national breeding programs remain fully operational in WCA. Higher degree student support is one way in which ICRISAT is trying to redress this problem.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact
ICRISAT, in this project under System Priority 2 plays multiple roles. It has recently re-oriented its crop improvement research to focus on photoperiod-specific agro-ecological zones with the key issue being the need to develop photoperiod sensitivity in varieties so that they are specifically adapted to specific rainfall zones in the WCA –SAT. Some other examples for such regionally zone specific problems are the abundant presence of the parasitic weed S*triga*, or low levels of soil phosphorus availability in the drier Sahelian/ Northern Sudanian zones. Thus collaboration with NARES which share similar agro-ecozones is natural and efficient and enables progress from joint selection, which no partner alone could achieve, under the present conditions of resource availability and scientific research capacity. Farmers of the WCA-SAT are increasingly organizing themselves into associations for increased economic benefits, enhanced political representation, and for improving information exchange. ICRISAT will thus play both catalytic and facilitating roles amongst these very different partners as appropriate.

A brief description of the comparative and complementary advantage of the project activities
ICRISAT plays a leading role in the West and Central African region for the genetic enhancement of pearl millet, sorghum and groundnut. One key advantage of ICRISAT's regional approach in WCA is the capacity to undertake priority setting and implementation of research and technology development on an agro-ecological basis by targeting the predominant production systems that cut across the entire West-and Central African region. ICRISAT plays a key role in fostering regional collaboration to achieve the critical mass required for effectively addressing specific production zone research issues that exceed the capacity of individual NARS, as well as ICRISAT. The ICRISAT team in WCA is well placed to organize information and legal germplasm exchanges between partners from different countries. ICRISAT's pro-poor stance is also highly valued for its

work on participatory approaches to plant breeding, enabling ICRISAT and their partners to address priority needs and specific pro-poor opportunities for genetic enhancement.

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs

ICRISAT will play research, catalytic, facilitating and enabling roles amongst a wide range of very diverse partners as appropriate. These roles are necessary to ensure that public goods can be created and scaled up to fully international public goods. It should be recognized that there is little incentive for NARS partners at a local or national level to either consider the regional or international implications arising from research projects. Nor are they willing necessarily to share their knowledge outputs were ICRISAT not playing this role and ensuring that such knowledge reaches the public domain in easily accessible form.

Problem analysis, identification of specific problems that can be tackled by research focused on specific objectives

Farmers and consumers in the semi-arid tropics of West and Central Africa, depending on sorghum and pearl millet as their staples face a number of basic issues that limit production, productivity increases, food security as well as nutrition and health.

1. **Increasing demands on the natural resource base:** A number of abiotic, biotic and socio-economic constraints limits pearl millet, sorghum and groundnut production and marketing in WCA.
2. **Increasing intensification of sorghum production systems:** Sorghum, and to a lesser extent pearl millet production systems are intensifying. Sorghum begins to benefit from inputs such as fertilizers, either as residuals from cash crops such as cotton or with direct application. Farmers are also increasingly harvesting stover for controlled feeding of livestock.
3. **SAT the home of the poor -- Food security, nutritional and health status remain low:** High child mortality, low life expectancy and poor women's health are distressingly common issues throughout the region. Farming in WCA is primarily labor limited and thus the poor health status of the potential workforce seriously compromises agricultural productivity.
4. **Emerging markets for cereal grain:** Increasingly sorghum and pearl millet grain are important as an income source as well as for food sufficiency, while groundnut is a key source of income, primarily for women farmers. Poor infrastructure, institutional framework, price variability, and farmer cash flow problems however represent significant challenges. Farmer organizations are undertaking collective marketing of grain and seeing increased opportunities for animal and poultry feed (These issues are linked to research in Project 1).

Overall, it must be noted that there is a strong need for integrated solutions towards production intensification and marketing, focusing on the opportunities and constraints of specific agro-ecological regions and farming systems. The strategy to increase groundnut, pearl millet and sorghum production and marketing in WCA is based on integrated genetic and natural resource management (IGNRM). Breeders and geneticists cooperate with systems agronomists, animal scientists and socio-economists to develop sustainable, integrated solutions and to profit from positive genotype x management interactions.

The pearl millet breeding research as a component of the IGNRM approach will focus on the Sahelian and northern Sudanian zones, sorghum improvement research focuses on the Sudanian and to a lesser extent on the northern Guinea savannah zones. Groundnut improvement is focusing on areas with sandy soils in both the Sahelian and Sudanian zones. The research will pursue the following three focal areas of research that encompass many of the ongoing and emerging activities largely in accordance with the System priorities.

- Exploitation of heterotic relationships between different germplasm pools of sorghum and pearl millet.
- Development of tools and methodologies for effective implementation of genetic enhancement research within an INGRM approach across the region.
- Addressing specific nutrition and health concerns through targeted crop improvement

1. Exploitation of heterotic relationships between different germplasm pools of sorghum and pearl millet

Priority 2A, Specific goal 1: Enhance capacity and efficiency of genetic improvement programs through approaches linking characterization and use

Priority 2A, Specific goal 2: Identification of pro-poor traits
Identification of heterotic pools among locally adapted, nutrient-efficient, photoperiod-sensitive genetic materials of sorghum and pearl millet landraces and available improved materials is the main target of this research. It is expected that the use of genetically distinct heterotic pools in both population and hybrid breeding will enhance heterozygosity and therefore hybrid vigour in the new cultivars. This in turn is expected to result in higher yield and stability due to enhanced individual buffering. The heterotic grouping comprises a detailed phenotypic and genotypic (using molecular markers) characterization of pearl millet and sorghum genetic resources and breeding materials from all over WCA and combining ability studies of selected, genetically diverse materials.

The research looks towards a 2010 output target of: 2010 3.1.1 "New pearl millet and sorghum inbred lines with good combining ability and quantitative trait characterisation made available to partners for developing hybrid cultivars."

2. Develop tools and methodologies for effective implementation of genetic enhancement research within an INGRM approach across the region.

Priority 2A, Specific goal 1: Enhance capacity and efficiency of genetic improvement programs through approaches linking characterization and use

Priority 2A, Specific goal 2: Identification of pro-poor traits

Priority 2B: Tolerance to abiotic stresses

The development and initial implementation of a regionally coordinated strategy for population improvement and participatory variety development for groundnut, pearl millet and sorghum will be based on improved understanding of the specific requirements for crop adaptation to production systems. Regional integration is expected to enhance breeding efficiency, since the target countries share the same ecological zones.

Environmental characterization, GIS-based adaptation mapping (modelling of genotype x environment interactions) and development of a mega-environment concept will be a key activity of this project. The advantages of such regional targeting are

- The use of spill-over effects by transferring gain from selection made at one site to other target sites that belong to the same mega-environment
- Information for choosing, artificially creating and weighting of selection environments for improvements of selection efficiency
- The development of maps and eventually a handbook of varietal adaptation for sorghum, pearl millet and groundnut varieties in WCA.

Given the highly variable beginning of the rainy season, photoperiod sensitivity is a key adaptation trait for both sorghum and pearl millet in WCA, as it assures flowering at the more predictable end of the rainy season, independent of the highly variable date of planting. Improving our understanding of the physiology of photoperiodicity in West-African sorghum and pearl millet will help to identify tools for improving selection efficiency for combining zone-appropriate photoperiod response with higher yielding ability, specifically an increased sink size. Development of allele-specific markers for photoperiodic sensitivity of flowering time of pearl millet and sorghum will be one approach we shall pursue. Marker-assisted selection (MAS) for appropriate photoperiod response in each adaptation zone may assure a more efficient exploitation of the full range of available pearl millet and sorghum genetic diversity in WCA for each adaptation zone.

Similarly we will be testing the efficiency of dynamic genepool management for linking *in-situ* conservation of pearl millet and sorghum genetic resources with the development of pearl millet and sorghum populations and open-pollinated varieties with specific adaptation to predominant production constraints. In this approach, sub-samples of adapted, but highly diversified populations are grown in contrasting sites within each adaptation zone. Natural, farmer and breeders selection for specific adaptation will act on the subpopulations. One focal

point will be adaptation to poor soil fertility. In addition, each sub-population is also a potential cultivar and source of variation for specific characters or adaptation traits.

Research efforts towards these specific goals are encapsulated in the output targets for 2009 and 2010 namely:

2009 3.2.1 "First availability of allele-specific molecular markers for genes controlling photoperiod sensitivity of flowering time in pearl millet and sorghum by 2009"

2009 3.2.2 "New Striga resistant genepool of pearl millet available for testing in WCA breeding programs by 2009"

2010 3.2.2 "Three NARS empowered to breed groundnut varieties with multiple attributes especially drought tolerance by 2010".

3. Address specific nutrition and health concerns through targeted crop improvement

Priority 2C, specific goal 1: Increase the content of micronutrients in the edible parts of crop plants through improved biotechnologies and breeding

Priority 2C, specific goal 2: Evaluation of bio-fortification strategies and introduction of the best means to enhance the diets of nutritionally disadvantaged populations in developing countries

Priority 2C, specific goal 3: To reduce the content of constitutive or microbial toxins in selected staples that affect quality, food safety and human health

Many West-and Central African countries, especially the land-locked ones rank among the lowest in the Human Development Index. Sorghum and pearl millet provide the main staple foods for over 100 million people living in this region. These crops also are an important source of micronutrients in this region, providing one third to one half of Fe needs/person/day but malnutrition remains a serious problem. An additional dietary challenge of growing concern is the widespread presence of mycotoxins in a wide variety of foods. *Aspergillus flavus* that produces aflatoxin in groundnut is widely distributed in nature. Therefore, aflatoxin contamination in staple diets is another major cause for malnutrition and can directly and indirectly affect food security, health and livelihoods of people in WCA. ICRISAT focuses its research on developing technologies to improve nutrient and vitamin uptake and providing safety measures to decrease risk of food and feed contamination by aflatoxins. This can be achieved through an Integrated Genetic and Natural Resource Management (IGNRM) approach by developing vitamin (betacarotene) and micronutrient (iron and zinc) rich, aflatoxin tolerant cultivars, and implementing appropriate pre- and post-harvest technologies that reduce the risk of aflatoxin contamination in food/feed, and increase the bioavailability of key minerals and vitamins. SC Commentary concern with reference to projects 3 and 4 "Nowhere is the conflict between breeding for low nutrient status (*soils?- ICRISAT addition*) properly reconciled with the desire to biofortify crops" was being addressed in specific trials at ICRISAT, Patancheru (Project 5) and no obvious correlation was found in replicated trials between low grain Zn and Fe content in sorghum with low soil nutrient status (ICRISAT Archival Report for 2005).

Research addressing these particular specific goals is summarized through two output targets for 2010 namely: For groundnut, "Effectiveness of seed bulking of new preferred varieties resistant to aflatoxin contamination through village seed banks assessed and knowledge shared with partners". For sorghum and pearl millet we shall work towards "the diffusion of knowledge and skills about cereal processing tools assessed for improving bioavailability of iron and zinc in young children"

Description of impact pathways and capacity development

The key to achieving anticipated impact from the outputs from the identification of heterotic groupings for more efficient hybrid development in WCA is close collaboration with, and thus strengthening the capacity of, NARS researchers to identify superior hybrids and releasing them. Seed production techniques for these photosensitive materials will also be jointly developed with NARS scientists, and interested private sector investors, including farmer managed seed cooperatives and enterprises. We expect that the release of superior hybrids will increase private investment in the seed sector in key sorghum growing countries in West and Central Africa. Farmers will benefit from the purchase of these seeds with higher grain yields, and with higher incomes as a surplus over household needs is more likely to be produced. **We assume** that cereal prices in WCA will actually become less volatile in the near future, due to rises in world market prices for coarse cereals, as well as due to increasing demand in regional markets, and lastly due to increasing demand specifically for food processing for specific uses in specific countries. **We further assume** that socio-economics research collaboration with development

projects to improve farmers negotiating powers through enhanced group/cooperative marketing skills will also be successful, so that farmers will able to generate income from surplus cereal production**. Capacity development is provided to help ensure such assumptions are realized.**

The impact pathway for groundnut varieties and open pollinated varieties of sorghum is similar, except that the involvement of the private sector in seed production and dissemination will not be as high. Seed diffusion will also be possible through organized farmer group efforts, through targeted NGO or development projects, or through the local seed systems per se, however at a slower rate. For millet this is unlikely to be successful, unless a serious and continuous investment is made into production of pure seed stocks, due to the outcrossing nature of pearl millet.

The speed and rate of impact will depend on innovations in the seed systems that farmers can use. Progress from selection depends on successful multi-location trails. Thus, the partnerships with NARS working in the same agro-ecology, as well as with farmer organizations interested in testing varieties are necessary. **We further assume** that the research stations remain managed in a manner that allows quality trials to be conducted. **Capacity development on breeding techniques etc. are provided where appropriate**. An unpredictable risk could come from serious droughts, or atypical invasions of insects, like locusts. We expect that our work on tools and methods for breeding new varieties will have similar pathways to impact.

Impact on improved yields, and increased resilience, for poor farming households will also come from involvement in Farmer Field Schools geared towards experiential learning about *Striga* management, and improved marketing skills. We expect that farmers will be able to use the FFS results to increase productivity in their fields, and improve their capacity for group marketing. We expect that NGO partners and collaboration with large development projects will facilitate large scale impacts.

The nutrition impacts, both reduced aflatoxin contamination, as well as increased iron and zinc status will be achieved in part through adoption of more appropriate varieties, and thus follow the pattern described. However, the new varieties alone will probably not achieve this impact. Farmers, specifically women farmers will have to also learn about the advantages of these varieties in human, and especially in children's consumption. In addition the women will have to learn about improved crop management techniques (post-harvest treatments for groundnuts) or specific processing techniques to improve the bioavailability of existing micronutrients. To achieve these impacts collaboration with development partners is essential. For the micronutrient work the partners have to have the capacity to successfully address child nutrition issues. We expect that the use of local radios will be very supportive in generating impact from bio-fortification, and introducing new techniques to reduce aflatoxin contamination.

All the outputs have important components of new knowledge sharing as targeted outputs. In all cases the impact will only be possible if this knowledge is understood and applied by relevant partners, especially the NARS, NGOs, development personnel and Farmer Organizations. We thus place particular importance on ensuring that knowledge is created jointly, and owned by all our key partners, who contribute to its creation and testing.

This principle of shared ownership also applies to the new germplasm, varieties or hybrids, whenever possible. However the key impact pathway for new seeds needs to be a commercial seed system but this is very far from being established in all West-Africa countries, except Nigeria. This project thus collaborates closely with Project 1 to identify interventions, policy and market changes that could facilitate private investments in seed supply, as well as low cost options for enhancing the traditional seed system with respect to its capacity to access and disseminate new germplasm.

Expected IPGs that have applicability beyond one nation's borders

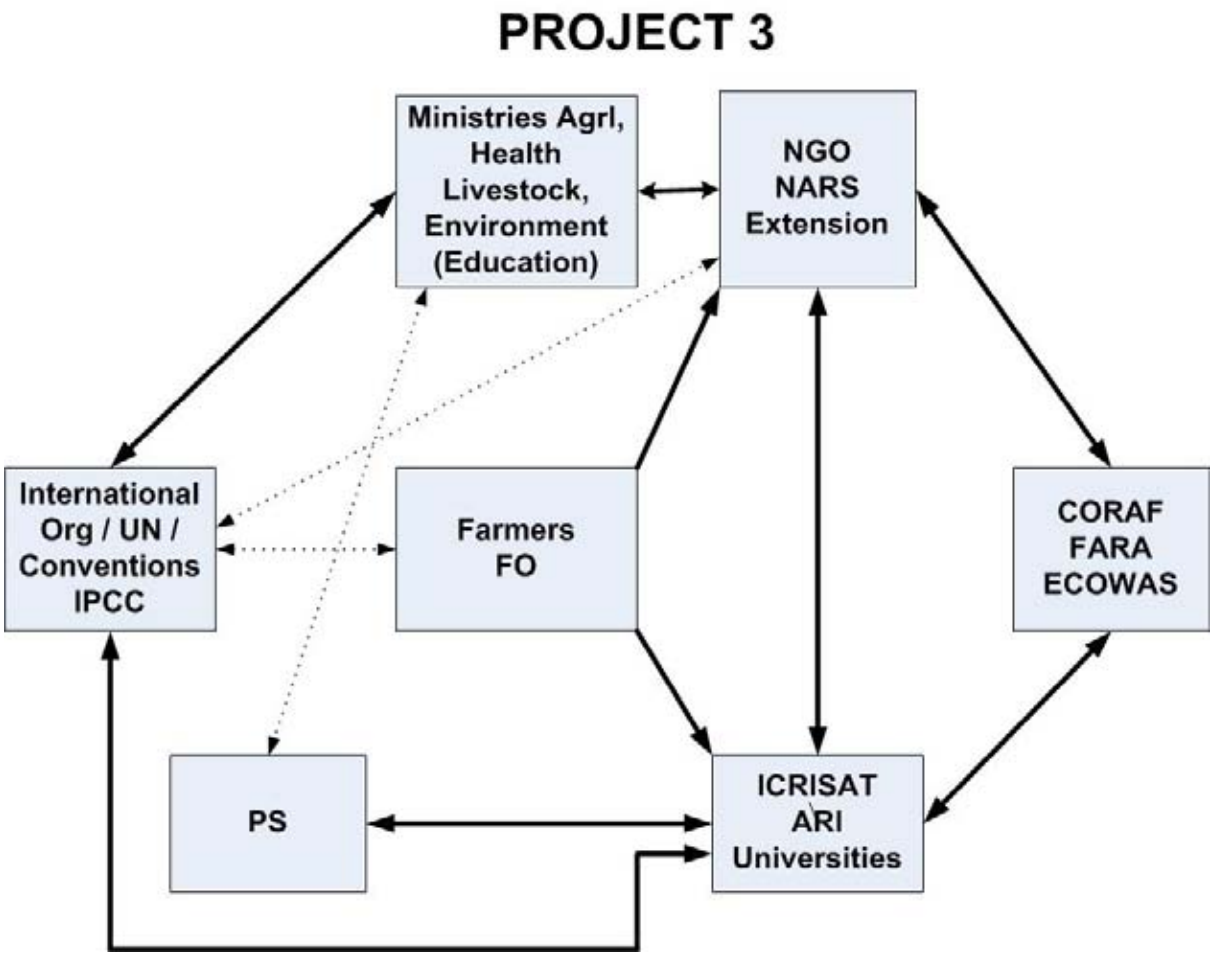
- Tools methods and institutional arrangements for effective farmer participatory variety development for sorghum, pearl millet and groundnut.
- Information and knowledge about characteristics of previously underutilized germplasm of sorghum and pearl millet.
- Broad based breeding populations improved for specific traits and adaptations to major agro-ecological zones of WCA.

- Breeding methods (molecular and phenotype based) methods for improving *Striga* resistance in pearl millet and sorghum
- Tools for effective participatory technology adaptation and diffusion for specific production conditions in pearl millet and sorghum systems, e.g. FFS for integrated *Striga* management.
- Information on structure of variability in regional sorghum and pearl millet germplasm on different levels of differentiation: regions, countries, villages, and intra-varietal (in collaboration with projects 2 and 9).
- Knowledge on improving grain yield potential of photoperiod sensitive sorghum and pearl millet hybrids and varieties.
- Seed production techniques established for photoperiod sensitive sorghum hybrids.
- Training manuals for breeders, technicians, development workers on hybrid breeding, seed production, integrated *Striga* management options, participatory recurrent selection, and for control of aflatoxin contamination in groundnuts.

Elaboration of Partners' roles (see also Project 3 network map below)
For the research on heterotic patterns the key partners are IER (Mali, sorghum , pearl millet and groundnut); INRAN (Niger, pearl millet, groundnut); INERA (Burkina Faso, sorghum and pearl millet); IAR, Nigeria (sorghum, groundnut); LCRI , Nigeria (pearl millet) and Senegal (ISRA, sorghum, pearl millet and groundnut). The NARS partners provide much of the genetic material, testing facilities, inputs into planning, and developing joint strategies. The key ARI partners who are primarily responsible for the development genetic marker techniques and analyses are the University of Hohenheim, CIRAD, Cornell University, and IRD, each with specific expertise for specific crop and methodological issues. CIRAD is a key partner for research on adaptation, and photoperiod response in sorghum and pearl millet, as well as biosafety issues.

A number of farmer organizations are investing in this research by joining in selection and variety testing activities for a wide range of traits, and conditions. Their inputs are the key to adapting breeding targets to meet primary farmer needs. The collaboration with large investment development projects funded through IFAD, as well as other development projects, are central to the effort of reaching more farmers more quickly.
The Helen Keller Foundation is a key partner in the nutrition research, and we expect to work intensely with the University of Wageningen, and other Harvest-Plus Challenge program partners. The Systems Wide Livestock program (with ILRI) is a partner in addressing specific issues related to improving feed value of crops residues, and generally crop livestock integration in Sahelian and Sudanian zone agro-ecologies. The mycotoxin research involves the same NARS partners in all the countries, for testing components of integrated management of *Aspergillus flavus* and synergies between them. The University of Georgia supports these efforts. The Water and Food Challenge program (Volta consortium) are partners and in future the African CP is likely to play a role. The VASAT consortium (Project 10) is lead e-learning efforts. This project also contributes to the **Participatory Research and Gender Analysis SWEP** though its participatory breeding and farmer-centric research approach. It is also linked to the **SLP SWEP** through its work on forage quality in cereals.

Key Strategic Alliances: CIRAD (expertise in crop physiology), Hohenheim University (expertise to support breeding methods) and Wageningen University (expertise to support efforts on human nutrition).



Network Map: Project 3 West and Central Africa

Project 3 Logframe: Producing more and better food of the staple cereals and legumes of the west and central African (WCA) SAT (sorghum, pearl millet and groundnut) through genetic improvement

Output	**Output Target**	**Intended Users**	**Outcome**	**Impact**
3.1 Heterotic relationships identified within sorghum and pearl millet germplasm adapted to WCA conditions and appropriate broad-based breeding populations and hybrid parents and knowledge made available to NARS and other partners in order to maximise genetic gain from selection	2007 3.1.1 SSR genotyping of 250 pearl millet and 210 sorghum accessions assessed for heterotic grouping	NARES, ARIs and private sector breeders and seed producers	Strengthened partners (NARES, private sector) change their breeding strategy, and make productive hybrids regionally available in WCA	Farmer staple cereal production has increased, and stabilized, contributing to increased annual incomes, and system resilience though adoption of new hybrids. Commercial seed and breeding enterprises have been established successfully
	2008 3.1.1 Enhanced access and capacity development of NARS to new, characterised diversity of sorghum and millet germplasm in adapted backgrounds 2008 3.1.2 Guinea race sorghum hybrid parents made available to NARS and PS breeders for developing hybrid cultivars			
	2009 3.1.1 Initial heterotic groupings for sorghum and pearl millet hybrid breeding for WCA established			
	2010 3.1.1 New pearl millet and sorghum inbred lines with good combining ability and quantitative trait characterization made available to partners with associated capacity development for developing hybrid cultivars			
3.2 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 making them available with new	2007 3.2.1 **Partners from WCA trained in the use of participatory recurrent selection and hybrid breeding techniques (associated with the PGRA SWEP).**	NARES and private sector breeders and NGO/CBOs, Alliance, PGRA, SLP, Generation CP, Africa CP partners and VASAT Consortium partners (project 10) in the WCA SAT	NARES in WCA work together, involving farmer associations, private sector, and NGOs whenever appropriate to identify and release superior varieties using modern tools as appropriate	Increasing and stabilized productivity of staple crops in a range of eco-systems, and production contexts has been achieved through the availability of well-adapted, genetic diverse varieties and participatory methodologies which have helped farmers to

knowledge to partners	2008 3.2.1 **Diversified dwarf Guinea-race sorghum population and broad based pearl millet populations with farmer – preferred traits made available with associated capacity development to partners for the first time for different SAT agro-ecologies in WCA (partly associated with SLP SWEP).** 2008 3.2.2 Tools for effective integrated Striga management for different agro-ecologies made available to partners. 2008 3.2.3 Survey on the adoption and impact assessment of groundnut improvement research in WCA completed			identify their most promising options.
	2009 3.2.1 First availability of allele-specific molecular markers for genes controlling photoperiod sensitivity of flowering time in pearl millet and sorghum 2009 3.2.2 New Striga-resistant genepool of pearl millet available for testing in west African breeding programs 2009 3.2.3 Knowledge of adaptation and validated regional adaptation maps for sorghum and pearl millet made available and disseminated with associated capacity development to WCA partners			
	2010 3.2.1 **Tools for farmer participatory recurrent selection tested for pearl millet and sorghum with partners with associated capacity development in different agro-ecologies. (associated with PRGA SWEP)** 2010 3.2.2 Three NARS empowered to breed groundnut varieties with multiple attributes especially drought tolerance.			

3.3 Crop management, *Aspergillus flavus* resistant groundnut varieties and post-harvest technologies to reduce aflatoxin contamination in food and feed products, as well as micronutrient rich cereal varieties and processing techniques to improve bio-availability developed, tested and made available to partners with new knowledge in the SAT of WCA	2007 3.3.1 Integrated aflatoxin management practice knowledge distilled and disseminated to partners 2007 3.3.2 Human mineral nutrition (Fe, Zn) and role of sorghum and pearl millet assessed in Mali	NARES breeders, Harvest + CP partners, agronomists, animal scientists and private sector processors and the VASAT Consortium for dissemination (Project 10).	Partners adopt new breeding, agronomic and processing practices which improve food and feed quality	Improved nutrition of rural and urban populations has been brought about through consumption of new nutrient dense staples, and mycotoxin free groundnuts and secondary products.
	2008 3.3.1 Technology adoption studies on uptake of aflatoxin contamination avoidance completed			
	2009 3.3.1 2-3 farmer-and market preferred varieties resistant to aflatoxin contamination recommended for release with associated capacity development by NARS in WCA 2009 3.3.2 Cereal processing tools assessed for improving bioavailability of iron and zinc in young childrens'diets			
	2010 3.3.1 Effectiveness of integrated management techniques , including new preferred varieties resistant to aflatoxin contamination, assessed and knowledge shared with associated capacity development with partners			

Project 4 Narrative:
Producing more and better food from staple cereals (sorghum and millets) and legumes (groundnuts, chickpea and pigeonpea) at lower cost in the eastern and southern African (ESA) SAT through genetic improvement

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center

The research proposed in this project addresses System Priority Area 2 in the Eastern and Southern Africa (ESA) semi-arid tropics (SAT) through genetic improvement. Within this priority area, focus will be on (i) system priority 2A to increase yield and also considering pro- poor traits (pests, diseases and *Striga*), (ii) system priority 2B abiotic stresses (drought) and (iii) 2C for improvement in the nutritional quality of sorghum, pearl and finger millet through bio-fortification; and on safety issues associated with aflatoxins in groundnut. ICRISAT claims that 100% of this project's activities are encapsulated within the CGIAR System Priorities. This project therefore places an emphasis on improving and strengthening the efficiency of breeding and cultivar evaluation for ICRISAT crops across the ESA region while conserving and making maximum use of the natural genetic resource base. This will be achieved through new regionally-based institutional networking arrangements which integrate traditional crop breeding, biotechnology and farmer participation. To facilitate adoption and impact from technological changes, scientific inputs and technical support will be provided to public and private sector institutions spearheading the harmonization of seed regulations and policies in ESA. The project outputs are regionally oriented and their IPG nature also spills over into ICRISAT's west and central African and Asian projects (Projects 3 and 6)

The target ecoregion, the beneficiaries and end users

The target ecoregion is the SAT of ESA. The immediate beneficiaries are NARS breeders from both public and private sectors, agronomists and social scientists, our partners in the Alliance centers, the Water and Food CP, Harvest Plus and African CPs, the NGO and CBOs involved in agricultural research, extension and small scale, private sector marketing and seed entrepreneurs. The end users are small scale farmers and village communities.

Is the center the primary or secondary research provider?

The Center in this project can be either the primary or secondary research provider depending on circumstances. NARES crop improvement programs in ESA are becoming increasingly weak in terms of financial and human resource commitments with varying strengths among the NARES to carry out breeding activities. The weaker NARES will therefore rely on the Center for semi-completed and finished breeding products while the stronger NARES may be able develop the products independently. In most cases the center becomes the primary source and provider of materials.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact

ICRISAT is a **catalyser** in the field of plant breeding and genetic engineering (GE) in the ESA region, north of the Republic of South Africa. As a **facilitator**, ICRISAT is working with NARS scientists in crop improvement and management of genetic resources to develop improved varieties for its mandate crops in ESA. ICRISAT ESA is also an **enabler and/or advocate** in that it assists the SADC-FANR and ASARECA based public and private partners e.g. ECARSAM to establish and pursue efficient regionalized breeding programs that integrate biotechnology, farmers' participation and use of local germplasm of ICRISAT mandate crops.

A brief description of the comparative and complementary advantage of the project activities

ICRISAT is well placed to organize information and legal germplasm exchanges between partners from different countries. It has highly trained interdisciplinary research teams at several locations across the SAT that are well positioned to implement regionally coordinated projects in partnership with NARS. In the field of biotechnology, ICRISAT has developed many markers linked to important traits related to enhanced performance under biotic and abiotic stresses in the SAT for all its mandate crops (Project 2). These are to be applied in ESA to introgress beneficial traits into locally adapted varieties through marker-assisted backcrossing (MAB). It has also developed efficient genetic transformation systems for all its mandate legume crops which provide a unique comparative advantage to develop and introduce improved genetically modified crops and technologies to the region.

W here centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs
ICRISAT, in this project under System Priority 2, recognized that crop breeding and variety release systems remain largely focused on national markets while seed markets are becoming increasingly globalized. However, breeding programs are poorly staffed and under-funded in relation to the number of each country's crop breeding challenges. Geographic Information System (GIS) analyses are used to delineate the region into recommendation domains based on lengths of growing periods (LGPs). Multiple variety releases demonstrate the potential adaptability of these varieties across country borders. Using grain yield data from Multi-Environment Trials (METs) conducted over a span of 15 years, allowed stratification of 39 SADC test sites into 6 groups according to their similarity of line- yield differentiation. This provided an objective basis (IPG) for selection of a few representative benchmark test sites for efficient regionalized variety testing through the "Lead NARS" approach targeting regional variety registration, especially for sorghum and millet in ESA. The center has demonstrated a *modus operandi* for enhancing efficiency in crop improvement by engaging stronger NARES in product development and providing a platform for sharing products and information across the region to facilitate farmers' fast access to new improved varieties and address constraints of small seed markets. Products from ICRISAT for genetic improvement remain largely in the public domain and no exclusivity is given to any individual partner even where partnerships involve the private sector. Products can therefore be easily accessed for exploitation, resulting in measurable impact.

Problem analyses and issues identification*:* The use of improved varieties with inbuilt mechanisms to tolerate and resist many of the biotic and abiotic stresses faced by farmers in the ESA SAT is often cited as the easiest and most cost effective form of technology change in smallholder production systems. Yet, in ESA, gains from crop improvements have not been fully exploited to date. Development, dissemination and adoption of improved varieties are hindered by a number of key constraints. Firstly, the focus of crop improvement is still national, rather than regional yet most national research institutes do not have adequate resources to pursue a full range of strategic, applied and adaptive research for each priority problem associated with ICRISAT's mandate crops. Secondly, breeders have not adequately tapped traits of economic importance available in local germplasm to develop market - and end user-preferred quality and nutritious cultivars that provide good yields under biotic and abiotic stresses. This is in part due to limited germplasm characterization and use of biotechnology tools and methods that can increase efficiency and effectiveness in crop improvement. In addition, for new varieties to impact at the farm level, viable seed systems are a prerequisite and should be linked to Integrated Genetic and Natural Resource Management (IGNRM) approaches to enhance productivity, and translate these into profitability through product market linkages and partnerships to encourage farmers to sustainably invest in productivity enhancing technologies and inputs.

Within System Priority 2, the focus will be on 2A- to increase yield and pro- poor traits through tolerance to biotic (pests, diseases and also striga for the cereals); 2B-for abiotic stresses (drought) and 2C -for enhancing the nutritional quality of sorghum, pearl and finger millet through bio-fortification; and on nutritional health issues associated with aflatoxin contamination in groundnuts. Important also are preparations for an enabling environment for the eventual deployment of transgenic crops in ESA, for both cereals and legumes.

a) Priority 2A: Maintaining and enhancing yield and yield potential of food staples
Outputs: 4.1 *Sustainable regional breeding networks that integrate conventional and biotechnology tools established and associated capacity building implemented*

4.2 Improved germplasm and parental lines of adaptable sorghum, pearl millet, pigeon pea, chickpea and groundnut that are resistant to chronic biotic stresses and meet end user preferences developed and disseminated with new knowledge to partners

Priority 2B: Tolerance to selected abiotic stresses
Output: : 4.3 *New knowledge of the QTLs for the stay green and drought tolerance traits confirmed, and marker assisted selection efficiency improved, and specific abiotic stress tolerant varieties and associated knowledge for sorghum, pearl millet and groundnuts developed and disseminated in ESA with associated capacity development*

Priority 2C: Enhancing nutritional quality and safety
Output: 4.4 *Progress in knowledge and/or improved germplasm of nutritionally enhanced transgenic sorghum and biofortified transgenic events and non-transgenic germplasm with enhanced micronutrient levels available for evaluation*

Output: 4.5 *Technological options and knowledge to reduce aflatoxin contamination at different stages of the groundnut crop cycle developed and disseminated to partner NARES, traders and processors in ESA with associated capacity building for enhanced food and feed quality*

Intended users and Outcomes: Public breeders will experience improved efficiency in their crop improvement programs, and by pooling resources, be able to address an increased number of breeding targets across the region. In ESA there are at least 5 breeding networks that are operational in ASARECA with one NARS providing leadership and facilitating sharing of germplasm products. NARES and private sector breeders are collaborating in breeding and screening for pests, striga and disease resistance, drought, adaptation traits e.g. photoperiodism and are looking into the potential of hybrids. Partner breeders can use the available germplasm for further selection and testing for adaptability and acceptability. The BECA facility is being strengthened and used by NARS scientists to enhance capacity for biotechnology. NARES agronomists, breeders, pathologists, traders, food processors and health experts access and promote germplasm of nutritionally enhanced and safe to use crops. Regulatory bodies in SADC and ASARECA make informed bio-safety policy decisions based on knowledge of environment risks and safety analyses from gene flow studies. Partner breeders accept proof of concept of the feasibility of conventional breeding aided by MAS and transgenics and incorporate higher nutritional standards into their breeding goals**. It is assumed** that funds for breeding activities within the NARES continue to be forthcoming. **It is also assumed** that the new role of the Bill and Melinda Gates Foundation in agriculture will help assure the promotion of such activities (See Problem Tree Figure on following page). The recent approval (May 2007) of the major multi-year project for legume research by the Gates Foundation through the Generation CP, of which ICRISAT is a substantive beneficiary, is **evidence that this assumption will be achieved.**

Impact: Public and Private sector breeders through capacity development in the region will improve their efficiency and cost effectiveness in development and release of improved cultivars. Breeders will also be more willing to take on a broader regional mandate; share regional breeding responsibilities, germplasm products, knowledge and low cost diagnostic tools with traders and processors to ensure food safety. Improved germplasm that combine high yields, resistance to biotic and abiotic stresses and with enhanced micronutrient contents will be available to seed producers for marketing across the region. A vital assumption is that the new International Treaty on plant genetic resources enables rather than hinders the regional flow of improved germplasm. This does not look particularly encouraging at present and makes the role of ICRISAT as a broker of more importance than previously. Informed policy decisions will be made on the deployment of transgenics in the ESA region based on results from environmental risk assessments. Farmers will integrate improved crop cultivars with on farm water management and soil fertility enhancing technologies to improve crop productivity and links to product markets to improve profitability and hence contributing to achieving the CGIAR, NEPAD and MDG goals.

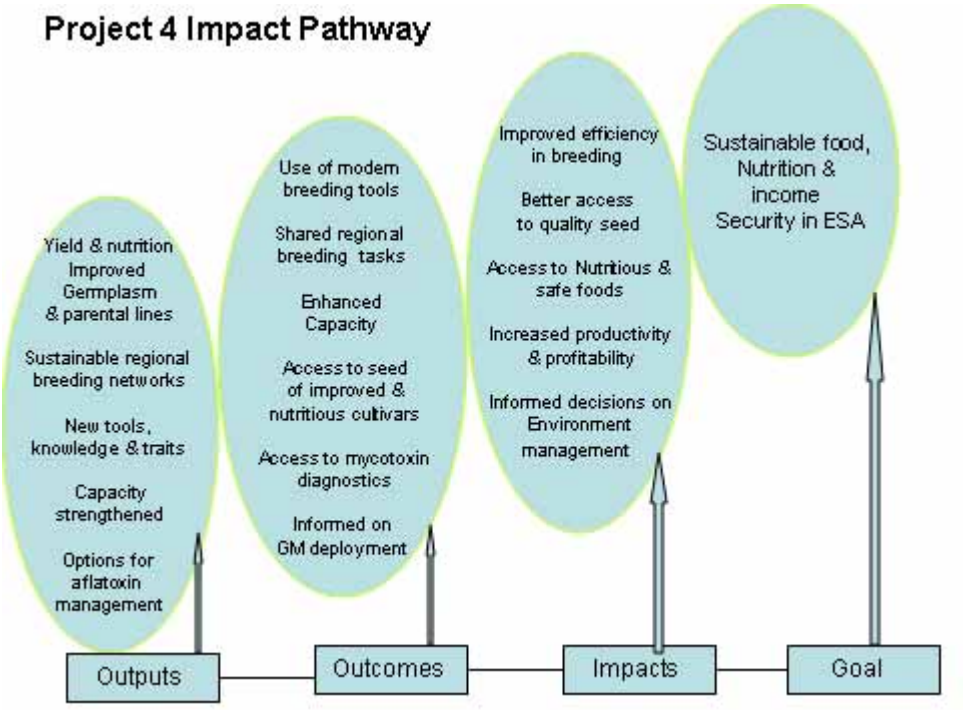
The IPGs that have applicability beyond one nation's borders produced by the project include:

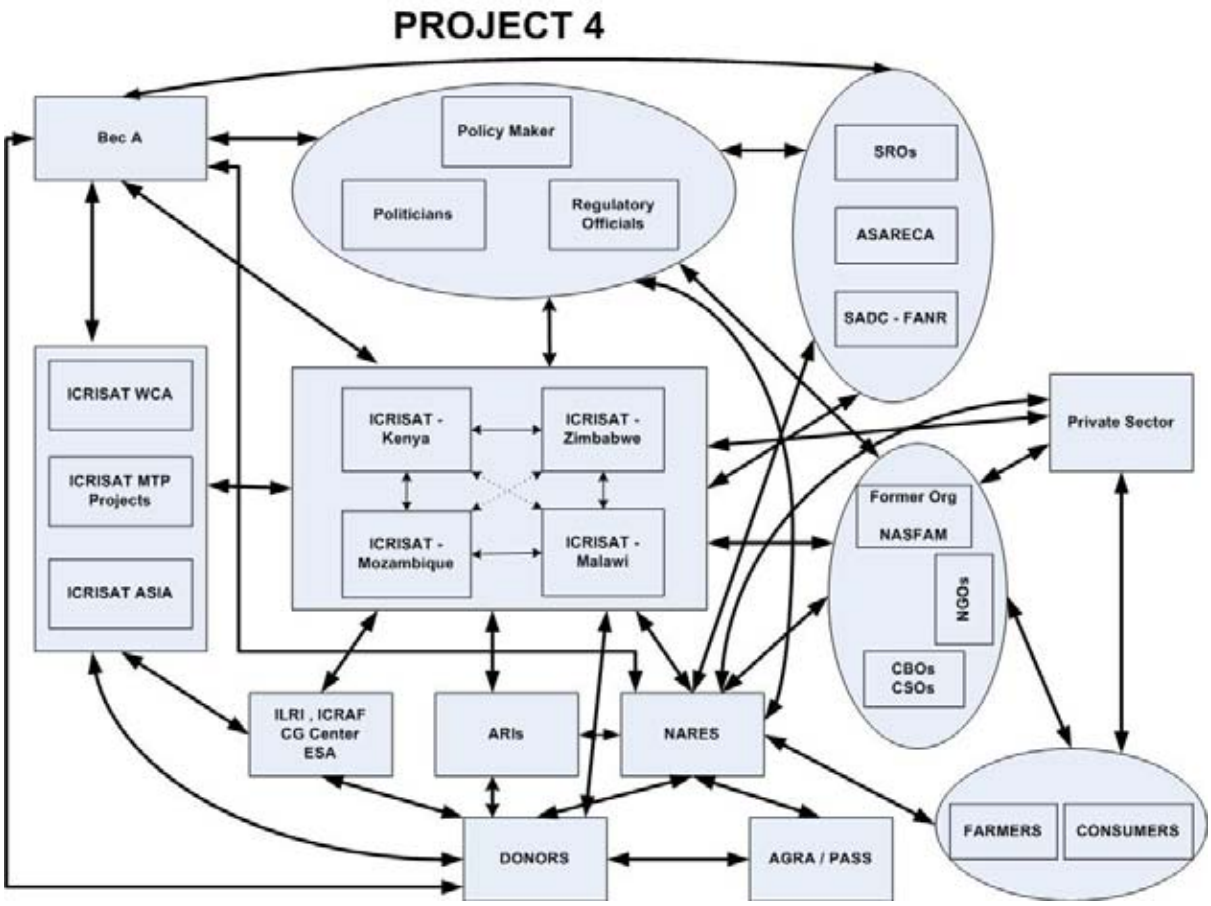
- Improved germplasm products - finished and semi finished for open pollinated varieties and hybrids (parents and hybrids) for the major production systems in ESA;
- New tools and methods for improving efficiency in crop breeding, molecular markers and transgenic events;
- Low cost diagnostic tools and data to inform institutional and policy changes (linked to Project 2).

The IPGs are in the public domain and no exclusivity is given to any individual partner even where partnerships involve the private sector. **The target eco-region** is the SAT of ESA including other agro ecologies where the ICRISAT mandate crops are important. ICRISAT has unmatched experience in this eco-region where the majority of the poor and undernourished reside. The **partnerships** and intended users are NARES, Alliance and CP partners, sub Regional Organizations (SROs) such as ASARECA and SADC FANR and networks e.g. ECARSAM as well as private sector breeders and seed production companies and alliances e.g. AFSTA, NGOs such as Africa Harvest and CBOs who leverage resources for crop improvement and also use the materials to deliver finished products. **Capacity development** will be provided in all areas where appropriate including support of higher degree student research. Partnership is also extended to other Centers especially in circumstances where a system approach is imperative in addressing cross cutting issues such as striga, seed and biosafety policy issues. **The end users** of this project range from breeders in private and public institutions in the ESA, but the ultimate end users are small scale farmers and village communities who need to use the technologies to increase productivity and enhance their income. The project will deliver outcomes and impact through the following outputs.

Elaboration of Partners' roles
The major partners who are also beneficiaries are governments and NARES in Sub Regional Organization in SADC and ASARECA; particularly the networks e.g. ECARSAM partners from eight countries in Eastern and Central Africa for sorghum and millets crop improvement. Others include consortium members of the African Biofortified Sorghum [ABS] project with partners from institutions in the north e.g. Dupont/Pioneer, University of California Berkley and others in the south like FARA, CSIR and ARC South Africa and AATF. Others include partners in the Generation Challenge Program and Harvest Plus CP. There are close collaborations with NGOs such as CRS and also private sector organizations e.g. seed and food processing industries. The IGNRM work targeting improved crop water productivity and linked to markets for profitability through the Challenge Program Water for Food include CGIAR partners such as CIMMYT, CIAT and IWMI; the NARES of Mozambique, Zimbabwe and Republic of South Africa as well as ARC and private organizations like Progress Mills in RSA to facilitate market linkages. For marker assisted selection approaches to crop improvement, ICRISAT is providing the technical guidance and facilities through the BecA platform for all genotyping activities, whilst the NARS partners in participating countries do the back-crossing into their farmer preferred varieties. The NARS research partners consist of KARI (Kenya), ARTC (Sudan) and breeders in the national breeding programs of Mali, Eritrea, Ethiopia, Tanzania, Rwanda, Burundi and DR Congo. Partners outside the region include the University of Hohenheim and CIRAD. Financial support is also provided by BMZ (Germany), ASARECA, GCP, Rockefeller Foundation and BecA. For genetic engineering, the most important partner is KARI in Kenya, which will initially provide the facilities for the research, which will later be moved to the BecA platform (See Network Figure on the following page).

Key Strategic Alliances: ECARSAM (for local collaboration in cereal breeding) and members of the BecA consortium (eg. KARI and ILRI for infrastructure to support biotechnology research).




PROJECT 4
Bec A
Policy Maker
Politicians
Regulatory Officials
SROs
ASARECA
SADC - FANR
ICRISAT WCA
ICRISAT MTP Projects
ICRISAT ASIA
ICRISAT - Kenya
ICRISAT - Zimbabwe
ICRISAT - Mozambique
ICRISAT - Malawi
Private Sector
Former Org
NASFAM
NGOs
CBOs
CSOs
ILRI , ICRAF
CG Center
ESA
ARIs
NARES
FARMERS
CONSUMERS
DONORS
AGRA / PASS

Project 4 Logframe: Producing more and better food from staple cereals (sorghum and millets) and legumes (groundnuts, chickpea and pigeonpea) at lower cost in the ESA-SAT through genetic improvement

Output	Output target	Intended Users	Outcomes	Impact
Systems Priority 2A				
4.1: Sustainable regional breeding networks that integrate conventional and biotechnology tools established and associated capacity building implemented	2006	NARES and private sector breeders and seed production companies, NGOs, CBOs and Alliance partners	Private and public sector partners throughout ESA gain access to materials with diversified genetic bases and use these for further evaluation under targeted agro environments and improved efficiency of their biotechnology and breeding programs and to release improved varieties with resistance to diseases and integrated in the production systems for improved productivity and profitability for small-holder farmers. The BECA facility is strengthened and is used by NARS scientists to build their capacity in modern breeding methods	Farmers growing ICRISAT mandate crops have experienced increased productivity and enterprise profitability. Food quality has been improved due to enhanced nutritional value and reduced aflatoxin contamination in groundnuts and there growing acceptance for the use of GMOs throughout the ESA region
	2007 4.1.1 Regional sorghum hybrid trials with brown/red and white seeds evaluated in short/ medium season environments in ESA 2007 4.1.2 At least one multi-disciplinary pearl millet cultivar improvement team operational amongst regional NARS in ESA 2007 4.1.3 Training NARS partners on use of GIS tools for varietal recommendation domains completed			
	2008 4.1.1 A regional highland sorghum improvement program initiated with at least two NARS in ESA 2008 4.1.2 Completion of regional field trial evaluation of 30 high yielding advanced chickpea lines for potential release in ESA			
	2009 4.1.1 At least 3 high-yielding medium duration pigeon pea cultivars adapted to southern African cropping systems developed and available with associated capacity development to NARS partners			
	2010 4.1.1 Three groups of task networks addressing the key constraints of drought and photoperiod response active in sharing improved germplasm regionally			

Output	Output target	Intended Users	Outcomes	Impact
4.2: Improved germplasm and parental lines of adaptable sorghum, pearl millet, finger millet, pigeon pea, chickpea and groundnut that are resistant to chronic biotic stresses and meet end user preferences developed and disseminated with new knowledge to partners	2007 4.2.1 SSR derived markers more tightly linked to *Striga* resistance in sorghum identified and mapped 2007 4.2.2 Markers segregating with traits associated with resistance to sorghum midge identified and linkage map of the F2 population derived from AF28 and Seredo generated 2008 4.2.1 Pigeonpea landraces from Tanzania and Mozambique fully screened for Fusarium wilt resistance 2008 4.2.2 At least one improved sorghum or pearl millet cultivar released in an ESA country 2008 4.2.3 Training of trainers for local seed production techniques for improved groundnuts completed 2008 4.2.4 Infector row technique for screening of GRD resistance in groundnut operational in at least one ESA NARS 2009 4.2.1 6 newly improved pigeonpea cultivars disseminated through participatory methods in ESA 2009 4.2.2 Bt transgenic pigeonpea events from locally adapted germplasm ready for testing in containment glass houses 2009 4.2.3 Capacity building for transgenic transformation protocols held at BecA 2010 4.2.1 Performance and adaptability of "bristled" pearl millet ICMV221 evaluated for the first time in ESA to reduce chronic bird damage 2010 4.2.2	NARES and private sector breeders and seed production companies, NGOs, CBOs, Africa CP and Alliance partners	Private and public sector partners throughout ESA gain access to materials with diversified genetic bases and use these for further evaluation under targeted agro environments and improved efficiency of their biotechnology and breeding programs and to release improved varieties with resistance to diseases and integrated in the production systems for improved productivity and profitability for small-holder farmers. The BECA facility is strengthened and is used by NARS scientists to build their capacity in modern breeding methods	Farmers growing ICRISAT mandate crops have experienced increased productivity and enterprise profitability. Food quality has been improved due to enhanced nutritional value and reduced aflatoxin contamination in groundnuts and there growing acceptance for the use of GMOs throughout the ESA region

Output	Output target	Intended Users	Outcomes	Impact
	Fine mapping of sorghum midge resistance QTL completed 2010 4.2.3 Striga resistance transferred to farmer-preferred sorghum varieties using MAS 2010 4.2.4 Best sources of groundnut rosette virus resistance and vector resistance introgressed in preferred varieties using molecular markers			
Systems Priority 2B				
4.3: New knowledge of the QTLs for the stay green and drought tolerance traits confirmed, and marker assisted selection efficiency improved, and specific abiotic stress tolerant varieties and associated knowledge for sorghum, pearl millet and groundnuts developed and disseminated in ESA with associated capacity development	2007 4.3.1 Drought tolerant varieties of sorghum for evaluation with water management technologies identified 2008 4.3.1 Efficiency and effectiveness of MAS for stay-green in sorghum determined 2009 4.3.1 Segregating populations of sorghum for both photoperiod sensitivity and stay green evaluated using molecular markers 2009 4.3.2 Increased crop water productivity demonstrated with appropriate capacity development for sorghum and pearl millet lines 2009 4.3.3 Field evaluations of drought tolerance of stay-green sorghum lines evaluated using a farmer-participatory approach in Kenya 2010 4.3.1 Multiple groundnut events with improved drought tolerance available for potential contained field testing	NARES and private sector breeders, Alliance and Generation/Water CP partners, NGOs and CBOs	From 2009, partner breeders are able to use germplasm developed with ICRISAT and increase their efficiency and cost effectiveness in breeding for drought and photosensitivity in sorghum, pearl millet, chickpea and groundnut. The BECA facility is strengthened and is used by NARS scientists to build their capacity in modern breeding methods	Improved speed and cost effectiveness has been achieved in the release of abiotic stress trait-specific varieties throughout ESA which has improved productivity and profitability of small-scale dryland cropping enterprises.

Systems Priority 2C				
4.4 Progress in knowledge and/or improved germplasm of nutritionally enhanced transgenic sorghum and biofortified transgenic events and non-transgenic germplasm with enhanced micronutrient levels available for evaluation	2007 4.4.1 10 molecular markers identified for geneflow studies in sorghum identified 2008 4.4.1 Farmers' knowledge on wild and weedy sorghum and implications for cultivated sorghum documented with associated capacity development for at least 2 ESA countries 2009 4.4.1 Heritability and correlations among important micronutrient traits determined in sorghum 2009 4.4.2 Nurseries of biofortified groundnut lines under evaluation in at least 2 NARS in ESA 2009 4.4.3 Knowledge from geneflow studies of non-transgenic sorghum generated and provided with associated capacity development to national regulators 2010 4.4.1 Documentation for risk/safety assessment for GM regulatory needs drafted	NARES agronomists and breeders; NGO/CBO; GM regulatory bodies Harvest + and Africa CP partners	Partners accept proof of concept of the feasibility of conventional breeding and transgenic approaches for crop improvement using biofortification of mandate crops. NARS breeding programs incorporate improved nutritional standards as desirable goals	Improved varieties and breeding materials that combine high yield potential with enhanced micronutrient contents and resistance to biotic and abiotic stresses as well as adaptation to environment have become available to farmers thus resulting in the improved health of malnourished SAT communities.

2C:				
4.5 Technological options and knowledge to reduce aflatoxin contamination at different stages of the groundnut crop cycle developed and disseminated to partner NARES, traders and processors in ESA with associated capacity building for enhanced food and feed quality	2007 4.5.1 Mycotoxin testing facilities and protocols developed in Kenya, Malawi and Mozambique 2008 4.5.1 Protocol for isolation of atoxigenic strains of A. flavus developed in ESA 2008 4.5.2 IPG knowledge on the extent of mycotoxin contamination of groundnut in Malawi and Kenya with appropriate capacity development disseminated regionally	NARES agronomists, breeders and pathologists; Policy makers, traders, processors and health professionals	Partners use low-cost diagnostic tools and make these available widely to NARES, traders and processors for monitoring human exposure to aflatoxins, and mycotoxin contamination in foods and feeds. Partners promulgate the risks of aflatoxin contaminated food and feed throughout ESA and subsequent action is taken to promote adoption of low cost technologies for reducing aflatoxin contamination in groundnut and other staple and high value crops grown in diverse farming systems	Human and animal health has been improved and enhanced market opportunities have occurred through increased production of high quality food and feed free of aflatoxin or with low aflatoxin content.
	2009 4.5.1 Atoxigenic strains of A. flavus isolated from ESA soils 2009 4.5.2 Trainers trained in quality on-farm seed production with pre- and post harvest aflatoxin control measures available in at least 2 ESA NARS 2010 4.5.1 Role of variety/genotype contribution to aflatoxin control documented in Sorghum and groundnut in ESA			

Project 5 Narrative:
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

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center

Sorghum and pearl millet are important cereal sources of dietary energy, and pigeon pea is an important source of dietary protein in much of the Asian SAT. Sorghum and pearl millet are also valuable as fodder crops (both green forage and stover). Pigeonpea is also now recognized for its potential as a valuable forage crop. Asia is a major region for these crops, growing sorghum on about 12 M ha, which is 28% of the global area under this crop. Pearl millet is cultivated on 12 M ha (42% of the global area). Pigeonpea, though cultivated on only 4 M ha, accounts for 90% of the global area under this crop. Productivity of all these crops is low (700-900 kg ha^{-1}) in the SAT Asian region (as well as in other SAT regions) due to the low yield potential of farmer cultivars and numerous biotic and abiotic constraints. Synthesis of research results over the years has shown that both in sorghum and pearl millet, hybrids have 25-30% grain yield advantage over improved open-pollinated varieties of comparable maturity. There have been continuing productivity gains both in sorghum and pearl millet, largely due to the adoption of high-yielding hybrids. In pigeon pea, improved varieties have been developed and released, but the productivity has remained stagnant so far, either due to lack of their significant and repeatable yield advantage over locals, or due to lack of adoption. Pigeonpea hybrids have shown at least similar grain yield advantage over improved open-pollinated varieties as observed in sorghum and pearl millet. Development of commercially exploitable cytoplasmic-nuclear male-sterility (CMS) in pigeonpea now offers the promise of enhancing its yield potential through hybrid technology.

ICRISAT's research on these crops in Asia is oriented to complement those of the NARS and the private sector by restricting its role to the development of advanced breeding lines and hybrid parents, leaving the hybrid development, testing and release to NARS and the private sector. There is limited research collaboration with NARS in key strategic research area as well. This approach has proved highly productive as reflected in the rapid and extensive uptake of ICRISAT-bred improved germplasm and potential hybrid parents of both sorghum and pearl millet by NARS and the private sector for hybrid development. The research proposed in this project falls under System Priority 2 in four specific research areas: These include: Maintaining and enhancing yield potential (2A), Tolerance to selected abiotic stresses (2B), Enhancing nutritional quality and safety (2C) and Genetic enhancement of selected high-value species (2D namely sweet sorghum for ethanol production). It also has components falling under priority 3B as all these crops are essentially dual purpose food/feed. The outputs and output targets from this project are firstly regionally based but owing to the upstream nature of its breeding methods, such as its innovative use of new systems of male sterility, it has substantive IPG spillover potential at global level. 100% of the research in the project accords with Systems Priorities.

The target eco-region, the beneficiaries and end users

The target eco-region is SAT Asia, which also comprises the arid zone of India and Pakistan with large areas under pearl millet. The immediate beneficiaries of this research will be researchers in NARS and the private sector in Asia, Alliance and Generation/Harvest + CP partners. The end users will be farming communities and seed agencies engaged in seed and grain production, urban consumers and traders, feed and food manufacturers and dairies.

Is the center the primary or secondary research provider?

ICRISAT-Patancheru has evolved into a center of excellence for hybrid parental research in all three crops (sorghum, pearl millet and pigeonpea). Thus, it is a primary supplier of strategic research outputs and intermediate breeding products that are pertinent to the target region in Asia and are having significant spillover effects worldwide.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact

ICRISAT plays multiple roles depending on the issues it addresses and the stage of its own and partner research. For instance, in pigeonpea hybrid research, it is currently playing a direct active role in developing high-yielding hybrids with farmer-acceptable traits, and coordinating their field evaluation and release through NARS and private sector. At the same time, ICRISAT is playing a catalytic role with NARS and the private sector through capacity building (including visits to their programs) to enhance the pace of hybrid development and release.

Another example of a direct active role ICRISAT is playing at present is to develop parental lines with high levels of salinity tolerance and high grain iron and zinc content in sorghum and pearl millet, and demonstrate the potential of such lines in hybrid development. ICRISAT conducts scientist field days, bringing scientists from various research centers to enable them select breeding materials and discuss on-going and emerging research issues, thus playing facilitator and enabler roles. The scientist field days also provide opportunities to ICRISAT to seek feedback on the usefulness of ICRISAT's research products, and the prevailing and emerging preferences of farmers. This knowledge helps ICRISAT to reorient its research programs to align with emerging regional priorities.

A brief description of the comparative and complementary advantage of the project activities
ICRISAT has numerous comparative advantages over other institutions in the region, in terms of well-informed and rapid access to genetic resource in its genebanks. ICRISAT's Patancheru location imparts a natural advantage over many organizations due to the favorable climatic conditions that allow 2-3 crops per year and hence rapid generation turn over. In an era of tightly defined Intellectual Property Rights, the exchange of germplasm and breeding lines is highly restricted across countries. ICRISAT has a real and demonstrable comparative advantage in the area of facilitation of germplasm exchange.

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs
ICRISAT's direct and active role in hybrid research generates a broad range of IPGs, in terms of efficient breeding and screening techniques and transformation protocols, and strategic research information; molecular markers and QTLs; genetic and cytoplasmic stocks; and improved breeding lines and hybrid parents.

Problem analysis, identification of specific problems that can be tackled by research focused on specific objectives

These are defined under each priority as below:

2A: Enhancing and maintaining grain and fodder yield
While improving yield potential, key farmer-preferred adaptation and quality traits, mostly related to maturity, and grain size and colour (cooking quality as an additional trait in pigeon pea) are taken into account. Genetic improvement of resistance to major diseases and insect pests is an integral part of yield improvement as it enhances the stability of production, and reduces the cost of production by reducing/avoiding pesticides to control diseases and insect pests. Grain mold, stem borer and shoot fly in sorghum; downy mildew in pearl millet; and wilt, sterility mosaic and pod borer in pigeonpea are the major biotic constraints that will be addressed through genetic improvement. Resistance to downy mildew in pearl millet, and to wilt and sterility mosaic in pigeon pea are mandatory, since hybrids lacking these traits can not be successfully cultivated in most regions. Transgenics offer the greatest promise for genetic improvement of pod borer and stem borer resistance, while marker-assisted selection (MAS) appears promising for the genetic improvement of shoot fly resistance.

Output: 5.1 *Hybrid parents and breeding lines of sorghum, pearl millet and pigeonpea with high yield potential and pro-poor traits in diverse and elite genetic backgrounds made available to defined partners with associated knowledge and capacity building in the Asian SAT*

2B. Tolerance to selected abiotic stresses
Sorghum, pearl millet and pigeonpea are among the most drought tolerant crops because of their evolution in moisture-deficient environment. Drought and salinity are the two most serious abiotic stress factors, causing significant yield losses in all three crops. Phosphorus (P), after nitrogen, is the most critical nutrient deficiency stress factor, causing yield losses and appears to be implicated closely in drought tolerance issues. Pearl millet is being increasingly grown as an irrigated summer season crop in parts of Gujarat and Rajasthan states of India, where air temperatures during flowering time in some areas can go as high as 48^0C. Most of the hybrids fail to set seed under such conditions and ways to circumvent this constraint are being examined.

Output: 5.2 *Enhanced molecular genetic and phenotyping platforms for drought and salinity screening and parental lines of hybrid sorghum, pearl millet and pigeon pea with improved tolerance to abiotic stresses, made available to partners with associated knowledge and capacity building in SAT Asia*

2C. Enhancing nutritional quality and safety

While 800 million people are classified as undernourished worldwide, the number of people affected by "hidden hunger" is two-and-a-half times that size. Three micronutrients, Fe, Zn and beta-carotene, are widely recognized as limiting by the World Health Organization (WHO). SAT Asia is a major region suffering from the deficiency of these micronutrients. Biofortification research efforts on staple food crops have been is initiated and it is expected to further expand in the coming years.

Output: 5.3 *Germplasm and improved breeding lines with high and stable grain Fe and Zn content in sorghum and pearl millet hybrid parents made available to specific partners with associated knowledge and capacity building*

2D. Genetic Enhancement of selected high-value species

In recent years, juice from sweet sorghum (*Sorghum bicolor*) stalks is emerging as a viable source for bioethanol production. Sweet sorghum is similar in appearance and agronomic performance to grain sorghum. It grows rapidly, is photosynthetically efficient due to its C4 metabolism, and is widely adaptable. The difference is that sweet sorghum stores much of its photosynthate as sugar in the stalks, although it also gives reasonable grain yields. Normal grain sorghum is already grown on 11.7 million hectares in dryland Asia (28% of global sorghum area) and on 23.4 million hectares in Africa (55% of global sorghum area), and sweet sorghum could fit into these areas, producing more biomass and grain if yield-enhancing technologies were stimulated by biofuel market incentives.

A crop of sweet sorghum takes about 4.5 months, and can be followed by a ratoon crop (natural second re-growth from stubble after the first crop is harvested). Together the main and ratoon crops require about 8,000 cubic meters (m^3) of water, whether from rainfall or irrigation. This is four times less than required by one crop of sugarcane (12−16 months duration and 36,000 m^3 of water per crop). Sweet sorghum can also be planted from seed, which is less laborious than the stem cuttings used to plant sugarcane, and can be more easily mechanized. Because of this major water saving, less fertilizer, labor, and other inputs, the cost of one hectare of sweet sorghum cultivation (main + ratoon crop in 9 months) is 60% lower than for sugarcane (one crop in 9-12 months). Since poor farmers are less likely to have access to irrigation water and the capital needed to bear the cultivation costs of sugarcane, this means that sweet sorghum is more accessible to poor farmers in less water-endowed areas. Even though the ethanol yield per unit weight of feedstock is lower for sweet sorghum, the much lower production cost for this crop more than compensates, so that on the bottom line sweet sorghum still ends up with a competitive cost advantage (US$0.29 cost to produce one liter of ethanol from sweet sorghum, versus US$0.33 for ethanol from sugarcane). These costs of course will vary somewhat depending on a range of local production factors. Sorghum exhibits ‘hybrid vigor’ and, in addition to higher biomass, good hybrids also express early maturity and photoperiod insensitivity, which means they mature over roughly the same number of months regardless of the time of year they are planted. This valuable trait allows them to be planted over a wider range of planting dates as long as irrigation water is available, providing a steadier supply of feedstock to ethanol processing facilities.

Because of these strong advantages, sweet sorghum hybrids parents and hybrids are receiving high priority to help produce more feedstock per drop of water and unit of energy invested. Sorghum has an added advantage for hybrid breeding: a high ratio of seeds produced per seed planted. This makes hybrid seed production highly cost- and labor-efficient, which are especially important considerations for regions like Africa. The juice and sugar productivity from sweet stalks and grain productivity potential of some of the sweet sorghum hybrids developed at ICRISAT are high. Selected hybrids were on average superior by 55% in per-day ethanol productivity and 109% superior for grain yield productivity compared to the check variety SSV 84. These results indicate the feasibility of improving stalk sugar yield (and hence ethanol yield) through plant breeding.

Output: 5.4 *Sweet sorghum improved breeding lines with high and stable sugar and biomass made available to specific partners as hybrid parents with associated knowledge and capacity building*

Description of impact pathways and capacity development
While the uptake of sorghum and pearl millet breeding lines and parental lines of hybrids with high yield potential (both grain and stover) and resistance to key biotic constraints continues to be high, and newer hybrids based on these continue to be produced, released and marketed for rainy season cultivation, lack of high levels of resistance to grain mold, stem borer and shoot fly in sorghum, and frequent breakdown of resistance to downy mildew in pearl millet, **we assume**, will remain some of the greatest challenges. In the case of post-rainy season sorghum, **we assume,** development of productive hybrid parents and breeding lines for the post rainy season in sorghum and for the arid zone of north-western India, will be a slower process than for the rainy season ecology because (i) there is less genetic variability in the germplasm having specific adaptation to these agro-ecologies, and (ii) NARS and the private sector have placed less emphasis, in terms of resource allocation, for hybrid development and testing. **It is also assumed** that world petroleum prices and/or interest of Governments in the SAT in ethanol as a petroleum substitute derived from sweet sorghum remain high enough for this technology to remain economically or politically viable.

With a pioneering role in developing parental lines of hybrids with more stable cytoplasmic-nuclear male sterility, **ICRISAT continues to have the leading edge and provides capacity development** (including in the support of higher degree student research) in demonstrating the yield advantages of hybrids over varieties in pigeonpea, and have also developed a fully economic seed production technology for this crop. With the hybrid yield advantage over varieties being at least as much as much as in sorghum and pearl millet, rapid adoption of pigeonpea hybrids is expected (especially in the early and medium-maturity groups), the more so considering the growing shortage and rising prices of pigeonpea in India. **We assume** the large Indian national deficit in pulse production will continue in the short term. **However, ICRISAT and its partners are making a large effort to ensure that this assumption is eventually invalidated**. The Indian Council of Agricultural Research (ICAR) Institutes, State Agricultural Universities (SAUs), and private seed companies (PSCs) in India, are major partners in, and major beneficiaries of, the research products and scientific information. In recent years, forage quality and quantity research (done in partnership with NARS and ILRI) has received relatively greater attention than in the past. Drought and salinity in sorghum and pearl millet; P-acquisition and high temperatures during flowering in pearl millet, and micronutrient malnutrition in sorghum and pearl millet (grain iron and zinc), groundnut (beta-carotene), and pigeonpea (beta-carotene and methionine), are additional issues which are being addressed. With the development of screening protocols and effective selection criteria, and increasing use of marker-assisted breeding in cereals; and transgenic technology in legumes, NARS and the private sector partners visualize clear benefits from drought, salinity and high temperatures tolerance and forage research, but they only play limited role in the current partnership. In other research areas, their interest, capacity and partnership have yet to develop. This provides the logic for ICRISAT to lead the way through technology development and dissemination, and capacity building in these new research areas. Scientist Field Days to promote dissemination of breeding products and new/refined technologies, and consultation meetings to invite partners views and feedback on new challenges and opportunities, and ways to strengthen the partnerships, including capacity building for their participation in impact assessment, are held in alternate years. Research information and products are also disseminated through presentation of paper/posters in conference, symposia and workshops; research articles in peer-reviewed journals and in ICRISAT reports. The impact of ICRISAT research is measured in terms of the existing on-farm diversity of hybrids based on ICRISAT-bred materials, increased capacity of NARS and the private sector (reflected in wider and more productive germplasm base of the programs and enhanced skills), and increase in productivity of these crops and the associated livestock.

Expected IPGs that have applicability beyond one nation's borders

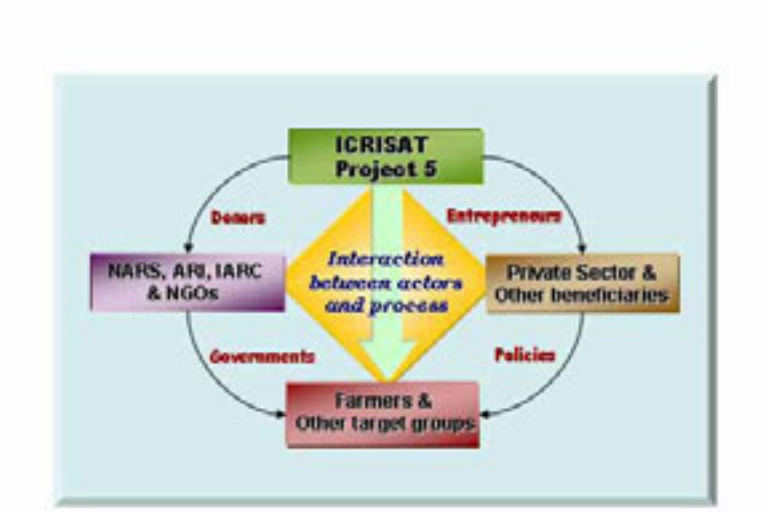
- Breeding products of all three crops**,** tested in and released for specific eco-regions in India and for agro-ecologies with parallel adaptation worldwide.
- Sorghum breeding products and research information related to hybrid parents and hybrid development
- Pearl millet and pigeonpea hybrid technology start-up support in Asia (eg. in India, China and the Philippines).
- Hybrids with high seed yield in pigeonpea, high sugar yield in sorghum, and high forage yield both in sorghum and pearl millet for potential technology testing rather than product development.

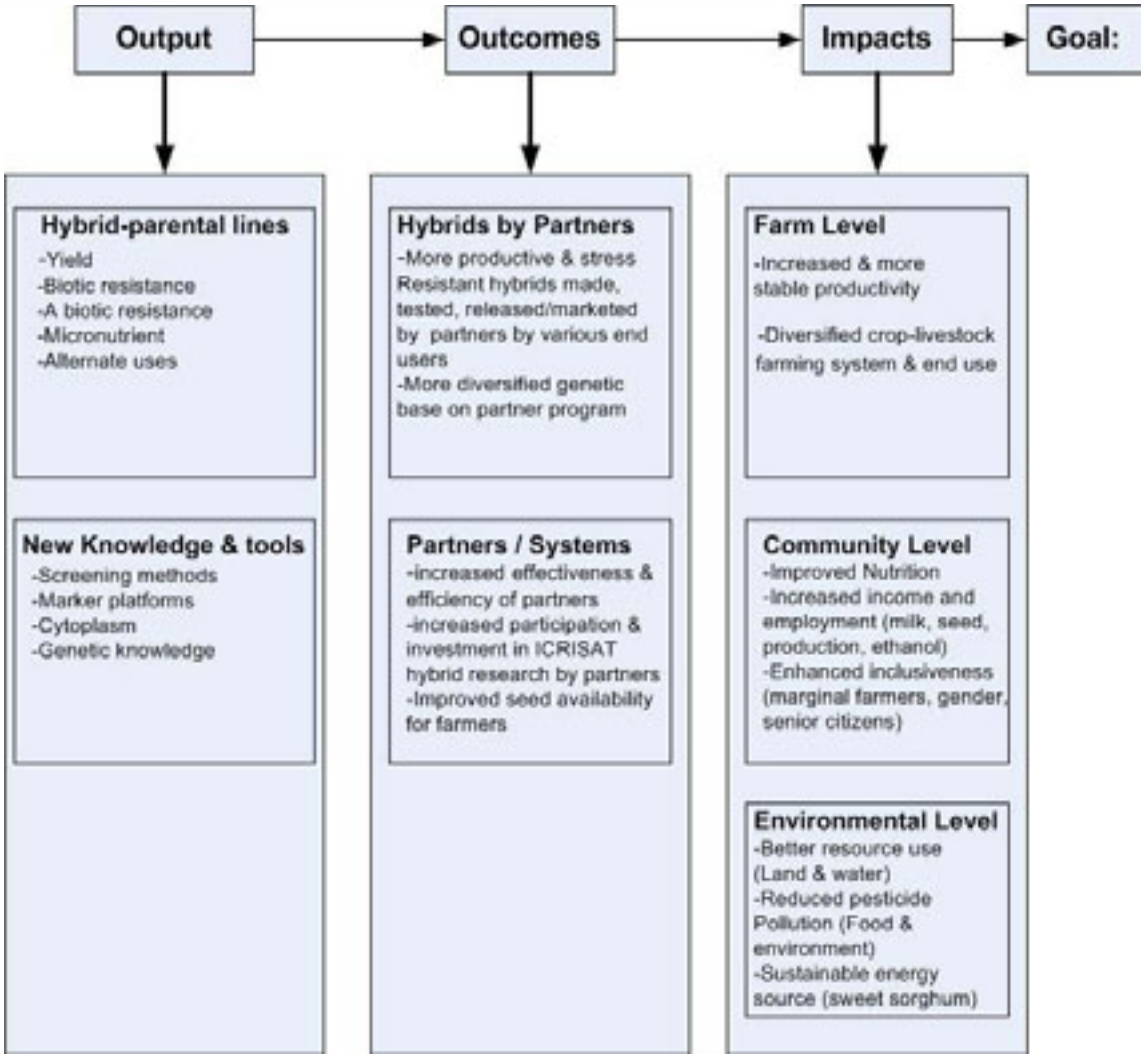
- The parental lines of potential hybrids and improved breeding lines with high yield potential and resistance to biotic stresses (grain mold, stem borer, and shoot fly in sorghum; downy mildew in pearl millet; and wilt and sterility mosaic in pigeonpea) and apparent grain quality traits.
- Breeding lines, hybrid parents, improved populations and gemplasm with high forage yield, and high levels of salinity tolerance and grain iron and zinc contents in sorghum and pearl millet; high-temperature tolerance and P-uptake efficiency in pearl millet; seed parents and restorers of diverse CMS systems in all three crops;
- Mapping populations and QTLs for drought and salinity tolerance (with project 2), grain Fe and Zn in sorghum and pearl millet; transgenic groundnut with high beta-carotene and pigeonpea with high beta-carotene and methionine;
- Information on the efficiency and effects of QTLs pyramided for drought tolerance in sorghum, and drought tolerance and downy mildew resistance in pearl millet, and genetics of CMS systems and trait-associations in all three crops.

Elaboration of Partners' roles
In hybrid parents research under this project, partner roles are very well defined with little overlap. ICRISAT will largely undertake targeted germplasm evaluation and introgression into elite genetic backgrounds, generate improved breeding lines and hybrid parents using multiple research tools, and undertake strategic research in the areas of screening techniques and breeding methodologies to enhance breeding efficiencies. ICAR and SAU partners collaborate in evaluating trait-based nurseries (also pigeonpea hybrids and forage hybrids of sorghum and pearl millet) annually constituted at the partners' requests under the umbrella of the ICAR-ICRISAT Partnership Research Projects. NARS and the PSC partners (including National and State Seed Corporations) will make use of ICRISAT-bred materials either directly in hybrid development, or in breeding their own parental lines of hybrids, which they will test, release and market. It is assumed that in creating their own hybrids from a single ICRISAT parent that the seed company will be creating a novel product and thus gaining their own IPRs. These partners will also provide technical inputs in terms of the emerging new challenges and opportunities with respect to changing agricultural systems and farmers/consumers preferences. They are now becoming increasingly involved in impact assessment, resource mobilization, and capacity building (both as partners and as resource persons). For example, 35 PSCs now support hybrid parents research of these crops in a consortium framework through financial contributions under a 5-year (renewable) agreement to address the core research agenda of the institute and place all the breeding products and research information in the domain of IPGs. Our other partners include ARIs (e.g. National Institute of Nutrition, India, sharing project resources; and University of Georgia, USA, using their own resources) who provide basic research components or provide services in the areas requiring specialized expertise and/or expensive capital items.

Our international research centers, such as ILRI partner with us in forage quality analysis and research, **and ICBA partners with us in salinity tolerance** testing of lines both in pot culture and in saline locations. These partners are also involved in resource mobilization through joint project proposal development to support these research activities. Partnerships have recently expanded beyond SAT Asia, into China (pigeonpea) and Central Asia (sorghum and pearl millet), who will initially be recipients of crop technologies, with the prospects being favorable of them developing into active partners for resource mobilization and resource-sharing in the medium term. This project is linked to the SLP SWEP.

Key Strategic Alliances: Hybrid Parents Research Consortium for access to their information and marketing networks, ICAR for partnership and support with a large range of Indian research institutions, ILRI/SLP and ICBA (for support on livestock feed and salinity issues respectively).





Objective Tree for Project 5 to meet the goal of producing more and better quality food at lower cost of staple cereals and pigeon pea using hybrids whilst protecting the environment and human health in the Asian SA

Project 5 Logframe: 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

5.1 Hybrid parents and breeding lines of sorghum, pearl millet and pigeonpea with high yield potential and pro-poor traits in diverse and elite genetic backgrounds made available to defined partners with associated knowledge and capacity building in the Asian SAT	**Sorghum** 2007	NARS breeders, private seed companies and ARI, Generation CP, SLP SWEP, and Alliance partners	NARS and private sector partners use hybrid parents in the development of their own hybrids and these are successfully evaluated in multi-location yield trials. Breeding lines are utilized to diversify the genetic base of partner breeding programs.	Higher-yielding and more genetically diverse hybrids have been bred and released for specific target niches. Sustained annual growth in productivity in sorghum and pearl millet has occurred and pigeon pea hybrids are grown on at least 100,000 ha in Asia by 2015.
	2008 5.1.1 Comparison of A1, A2, A3 and A4 CMS systems in hybrid combinations for key constraints in sorghum completed			
	2009 5.1.1 SO **Insect-host genotype-natural enemy interactions and mechanisms of resistance and inheritance clarified** **(associated with the SP-IPM SWEP)** 2009 5.1.2 SO **Dual-purpose foliar disease resistant forage/sweet sorghum hybrid parents developed (associated with the SLP SWEP)**			
	2010 5.1.1 SO Genetically diverse new male-sterile lines for high yield and large grain size with resistance to shoot fly and grain mold made available with associated capacity development to partners			
	Pearl Millet 2007 5.1.1 PM More than 150 potential hybrid parents characterized for morphological diversity			
	2008 5.1.1 PM QTL mapping of downy mildew resistance in five F6 RIL populations completed 2008 5.1.2 PM Additional hybrid parents (9 each of male-sterile and restorer lines) and more than 500 trait-specific and DM resistant improved breeding lines developed and disseminated with associated capacity development			

	Knowledge on relative efficiency of 3 diverse CMS systems documented 2009 5.1.1PM Two improved populations of pearl millet with high forage yield potential developed 2009 5.1.2PM Virulence change in Indian pearl millet downy mildew populations characterized 2009 5.1.3PM 20 major QTLs imparting resistance to DM pathotypes identified			
	2010 5.1.1 PM At least 5 each of pearl millet seed and restorer parents adapted to arid conditions developed 2010 5.1.2 PM Genetics of four diverse CMS systems documented			
	Pigeonpea 2007 5.1.1 PP Cytology and genetics of the A4 CMS system and its fertility restorers characterized 2007 5.1.2 PP 6 A4 male-sterile lines and 15 restorer lines with resistance to wilt and sterility mosaic disease developed			
	2008			
	2009 5.1.1 PP 15 widely adapted high-yielding pigeonpea hybrids are available to partners with associated capacity development for diverse environments in Asia 2009 5.1.2 PP Elite pigeonpea hybrid parents characterized for important agronomic traits and molecular diversity			
	2010 5.1.1 PP Consensus molecular marker and genetic linkage maps developed and shared with partners			

Output 2B				
5.2 Enhanced molecular genetic and phenotyping platforms for drought and salinity screening and parental lines of hybrid sorghum, pearl millet and pigeon pea with improved tolerance to abiotic stresses, made available to partners with associated knowledge and capacity building in SAT Asia	**Sorghum and Pearl Millet** 2007 5.2.1 SOPM Protocol for consistent and reliable P-acquisition data applicable to large numbers of entries developed for proto-drought tolerance screening in pearl millet 2007 5.2.2 SOPM Protocol for consistent and reliable estimation of ABA content of drought-stressed tissues developed as an aide to drought tolerance screening in pearl millet	NARS breeders, private seed companies, ARI, ICBA, ILRI, Generation CP and Alliance partners	NARS and private sector consortium partners make initial use of improved breeding lines with tolerance to abiotic stress factors in breeding programs	Adoption by farmers of high-yielding hybrids with improved abiotic stress tolerance by 2015 has improved productivity and profitability substantially in dry and salt affected areas in Asia
	2008 5.2.1 SOPM QTLs for salinity tolerance in pearl millet mapped and transferred to three diverse elite A/B-pair backgrounds. 2008 5.2.2 SOPM Pearl millet hybrids screened for P-acquisition under conditions of low available soil P for proto-drought tolerance screening			
	2009 5.2.1 SOPM New F6 RIL mapping populations for salinity tolerance in pearl millet available for phenotyping and genotyping 2009 5.2.2 SOPM **Dual-purpose stay-green and foliar disease resistant forage/sweet sorghum hybrid parents developed (partly associated with the SLP SWEP)**			
	2010 5.2.1 SOPM Marker-assisted backcrossing and phenotyping of product lines to assess pair-wise interactions and breeding value of six stay-green QTLs in two sorghum genetic backgrounds completed 2010 5.2.2 SOPM Relationship between the parental lines and their hybrids for seed set under ultra high air temperature conditions in the reproductive phase established			

2C				
5.3. Germplasm and improved breeding lines with high and stable grain Fe and Zn content in sorghum and pearl millet hybrid parents made available to specific partners with associated knowledge and capacity building	2007 5.3.1 Correlations of high grain Fe (40-50 ppm) and Zn (30-40 ppm) contents with grain yield and agronomic traits estimated for sorghum hybrid parents 2008 5.3.1 Variability of Fe and Zn in commercial hybrids and core collection of the germplasm assessed in pearl millet 2009 5.3.1 Sorghum germplasm hybrid parental lines with extra-high (>50ppm) and Zn (>40ppm) identified and made available to partners with associated capacity development 2010 5.3.1 Flanking markers of QTLs for grain Fe and Zn content in pearl millet identified for MAS for hybrid parents	NARS breeders, private sector partners, ARIs, ILRI, Harvest + and Alliance partners	High grain Fe and Zn content lines used by partners in breeding programs	Farmers have increased product quality and nutritional value of pearl millet and sorghum in SAT Asia by 2015, thus reducing malnutrition amongst disadvantaged SAT communities
2D				
5.4Sweet sorghum improved breeding lines with high and stable sugar and biomass made available to specific partners as hybrid parents with associated knowledge and capacity building	2010 5.4.1 **First generation of improved hybrid parents available to consortium partners for testing with associated capacity development (associated with the SLP SWEP)**	NARS breeders, private sector partners, ARIs, and Alliance partners including ILRI and the SLP SWEP	Highly sweet hybrid parental lines used by partners in breeding programs	Sweet sorghum has become an economically viable, pro-poor biofuel

Project 6 Narrative:
Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (sorghum, pearl millet, pigeonpea, chickpea and groundnut) through genetic improvements

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center

This project is in accordance with System Priority 2A- Specific Goal 2 (pro-poor traits), Priority 2B (selected abiotic traits), and Priority 2C (nutritional quality and safety). It focuses on open-pollinated varieties of staple cereals (sorghum and pearl millet) and legumes (self-pollinated varieties of pigeonpea, chickpea, and groundnut), and nutritional quality and safety as international public goods. It also involves work under system priority 3B (income increase from livestock) as all these crops are essentially dual purpose food/feed. This project is extremely relevant and pro-poor for the semi-arid tropics (SAT) region in Asia, where many farmers either cannot afford to buy hybrids/improved cultivar seed or have no access to them. There also is little possibility of developing hybrids for commercial exploitation in chickpea and groundnut in the near future. Even in the case of sorghum and pearl millet, where commercial hybrids are available, nearly 30 to 40% area will continue to be under open-pollinated varieties as there may be no clear advantage of growing hybrids under harsh environmental conditions or varieties will continue to be popular with farmers because of their fodder value or specific adaptation requirements (nearly 4.5 million ha in pearl millet and 5.5 million ha in sorghum). All five ICRISAT mandate crops, even when non-hybrids, are important for food and nutritional security under rainfed subsistence farming conditions in Asia, which provide sustenance to the largest number of poor people in the world. Globally, Asia accounts for nearly 80% of the area in chickpea (~10 m ha), 90% in pigeonpea (~4 m ha), 55% in groundnut (~13 m ha), 35% in pearl millet (~12 m ha), and 25% in sorghum (~11 m ha). The pro-poor outputs of this project, although regionally oriented, have the potential to have a major impact on the MDGs in Africa and other regions as Asian bred chickpea and pigeonpea are well adapted in eastern and southern Africa (links to Project 4), and thus, are seen by ICRISAT as producing both Substantive Public Goods (SPGs) and IPGs for food and nutritional security in the SAT.

The target eco-region, the beneficiaries, and end users

The main target is the SAT in Asia. However, the other regions in Asia, where these crops are grown or have potential to be grown, will also benefit from the outputs of this project. Some of the outputs from this project will also have spill over effects in Africa (sorghum, pearl millet, and groundnut in East, southern and West Africa (links to Project 3 and 4), and chickpea and pigeonpea in East and southern Africa). The immediate beneficiaries of the outputs of this project are crop improvement scientists in NARES, public and private seed companies and Alliance and CP partners, the SLP SWEP, NGOs and CBOs. The end users and ultimate beneficiaries of the products of the project are the small-scale farmers of Asia (also SSA), the food processing industries, the dairy and livestock industry, and the poor rural and urban consumers.

Is the center the primary or secondary research provider?

ICRISAT is the primary or co-primary research provider, depending upon the strength of the NARES, the seed industry, and the NGOs.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact?

ICRISAT plays all of these roles for sustaining the chain of developing technologies for crop improvement, high yielding pest and drought resistant cultivars, and seed production and distribution. It plays both a catalytic and enabling role by supplying nucleus and breeder seed to public/private sector seed agencies. ICRISAT also plays a strategic role through capacity building and by making available improved techniques in crop improvement and biotechnology, germplasm, and breeding materials to public and private institutions in the SAT. ICRISAT also plays a facilitator role by managing and coordinating networks that bring NARES breeders and other scientists together on a common platform. By demonstrating the benefits of participatory research and development, ICRISAT is able to influence the policies and practices in agricultural research and development at the local, national, and regional levels. ICRISAT also "keeps" the momentum going for research in these crops (particularly with respect to host plant resistance to biotic and abiotic stresses) which usually require a long term regional effort that only a stable international institution can provide,

A brief description of the comparative and complementary advantage of the project activities

ICRISAT's comparative advantage lies in its well-established competence in genetic enhancement involving conventional breeding, marker-assisted selection, and genetic engineering; phenotyping for resistance to insect pests, and disease, tolerance to abiotic stresses, and development of diagnostic tools for mycotoxins and viruses, bioinformatics supported by multidisciplinary teams of experienced scientists having informed access to world collection of germplasm, excellent laboratory, greenhouse, and field facilities; and the necessary infrastructure supported by competent staff to carryout high quality research. Further, ICRISAT has excellent rapport with all the

NARES in the region, and complements the stronger NARES such as India and China in carrying out joint research and development, and also helps in bringing together the stronger and the less developed NARES. ICRISAT-ILRI's collaboration in developing dual-purpose varieties of sorghum, pearl millet, groundnut, and pigeonpea is trend-setting as they complement each other in their respective areas. The international public good (IPG) nature of ICRISAT's products gives it an added advantage to collaborate with public and private sector institutions, NGOs, CBOs, village self help groups, and is seen to be politically neutral, and acceptable to all in the SAT. The Institute has noted the SC's desire (2006 Commentary) for ICRISAT to delegate its strategic constraint breeding of non-hybrid crops to strong national programs in Asia such as India and China. ICRISAT believes this is an unsafe rationalization and does not accord with the reality on the ground which is experienced by ICRISAT and clearly articulated to the institution by its NARS partners. Suffice to say that the transfer of improved genetic material (in both hybrids and non-hybrids) does not occur easily across national boundaries from the strong to the weak NARS without the impetus and active involvement of ICRISAT. India and China evidently are strong NARS capable of fully independent breeding programs in crops such as rice and wheat. However, this position is less demonstrably clear for the more minor crops and in providing resistance to the extremely virulent and fast mutating pathogens capable of causing chronic epidemics (downy mildew in millet, ascochyta blight in chickpea etc.) against which ICRISAT provides a continuing bulwark for resource-poor farmers. There remains a continuing demand for ICRISAT's strategic trait-specific and pest and disease resistant breeding material from both large and small NARS partners and we believe this remains a vital strategic role for ICRISAT.

Problem analysis, identification of specific problems that can be tackled by research focused on specific objectives

Priority 2A, Specific Goal 2: Identification and development of pro-poor traits
Crop (and system) productivity in the SAT remains low due to several biotic and abiotic stress factors. The major constraints to increase crop productivity for sustainable crop production in different crops are discussed below, along with research interventions to alleviate these stresses.

Sorghum: Need to develop varieties with resistance to grain molds, shoot fly, stem borer, aphids, and terminal drought. In addition, there is need to develop dual-purpose cultivars with pearly white grain and adaptation to different agro-ecosystems. Introgression of genes for resistance to different stresses/quality traits from the cultivated germplasm and wild relatives, marker-assisted selection for resistance to shoot fly, stem borer, and grain molds, and genetic engineering for resistance to stem borer are the major areas of research focus to alleviate these stresses. It is also necessary to identify sorghum lines which are able to thrive under low fertility conditions, in particular low P soils.
Pearl millet: There is a need to develop varieties with resistance to downy mildew and dual-purpose varieties for use as fodder and/or with enhanced levels of Fe and Zn, and adaptation to different agro-ecosystems. Introgression of genes from the cultivated germplasm through conventional breeding and marker-assisted selection are being employed to alleviate these stresses. It is also necessary to identify pearl millet lines which are able to thrive under low fertility conditions, in particular low P soils.

Groundnut: Need to have varieties with resistance to late leaf spot (LLS), rust, aflatoxin, peanut bud necrosis, peanut stem necrosis, leaf miner, and thrips; combined with high oil content, confectionery traits, and local adaptation to diverse agroclimatic conditions. Exploitation of cultivated germplasm and wild relatives for resistance genes/quality traits, and marker-assisted selection for resistance to leaf diseases, and genetic engineering for resistance to leaf diseases, viruses, and aflatoxins are the major interventions to alleviate these stresses.

Chickpea: Need to develop varieties with resistance to Fusarium wilt (mandatory), Ascochyta blight, Botrytis gray mold, and *Helicoverpa*,. In addition, there is a need to develop extra-bold Kabuli types responsive to inputs and adaptation to a wide range of environments. Major emphasis has been placed on exploitation of cultivated germplasm and wild relatives for resistance to diseases and *Helicoverpa*, and marker-assisted selection for resistance to Ascochyta blight, wilt, and *Helicoverpa*, and genetic engineering for resistance to *Helicoverpa* and improved tolerance to drought.

Pigeonpea: Need to develop varieties with resistance to Fusarium wilt, sterility mosaic virus, and *Helicoverpa* in medium-, short-, and extra-short maturity, and with adaptation to a wide range of environments. Exploitation of cultivated germplasm for resistance to diseases, and wild relatives for resistance to *Helicoverpa,* and genetic engineering for resistance *Helicoverpa* are the major focus of research to alleviate these stresses.

Output: 6.1 *Improved germplasm and varieties of sorghum, pigeonpea, chickpea and groundnut with pro-poor traits and associated advanced knowledge of breeding methods and capacity building made available to partners internationally*

Priority 2B: Tolerance to selected abiotic stresses
Among the abiotic stresses, drought is the most significant constraint due to limited and unpredictable nature of rainfall in the SAT. Drought and salinity are among the most severe abiotic stresses in Asia.

Drought: Drought avoidance is the major trait that needs to be addressed to stabilize and improve the production of varieties in sorghum, millet, groundnut ,and chickpea in Asia. The major emphasis has been placed on marker-assisted selection for tolerance to drought, using a trait-based approach where both water capture and water use efficiency are the main targets. To improve these traits, a transgenic approach is also used in groundnut and chickpea, where the use of a transcription factor involved in drought response is showing promising results.

Salinity: Soil salinity is another limiting factor for improving crop productivity. Legumes, in general, are very sensitive to soil salinity, usually more than cereals. The salinity problem is increasing, in many areas where poorly-managed irrigation is a common practice. Exploration of a large set of representative germplasm in all mandate crops of ICRISAT has indicated a large variation for salinity tolerance, and that breeding for salt tolerance is possible. Being a complex trait, the breeding of salt tolerant varieties would benefit from marker-assisted selection.

Output: 6.2 *Knowledge of the improvements of the biotechnological and conventional tools designed to facilitate drought and salinity tolerance breeding and germplasm of legume mandate crops and associated capacity building made available to partners internationally*

Priority 2C: Enhancing nutritional quality and safety

Food security and malnutrition are a serious problem amongst a large number of the poor in the SAT. ICRISAT is focusing its research on developing technologies that improve the nutritional quality and vitamin status of its mandate crops. Introduction of crop varieties with high Fe, Zn, and ß-carotene concentrations will complement existing approaches to combat micronutrient/vitamin deficiency among the poor in Asia SAT. To reduce mycotoxin contamination, ICRISAT emphasizes integrated management involving resistant cultivars, biological control, appropriate pre- and post-harvest technologies that reduce the risk of contamination by mycotoxins, and genetic engineering for resistance to aflatoxin; and development of low-cost diagnostic tools for monitoring food and feed.

Output: 6.3 *Knowledge of the improvements of the biotechnological and conventional tools designed to facilitate biofortification and biodetoxification breeding, improved germplasm of pearl millet, sorghum, groundnut and pigeon pea crops and associated capacity building made available to partners internationally*

Description of impact pathways and capacity development

We assume that high-yielding cultivars (often dual purpose food/feed) with resistance/tolerance to biotic/abiotic stresses, adaptation to diverse agro-ecosystems, technologies, knowledge, and capacity building of the NARES and the private sector delivered through networks will help translate research outputs into outcomes. Scientists field days, training programs for germplasm, breeding materials, mapping populations, and transgenic plants for resistance to insects, diseases, and drought; tissue culture and transformation, marker-assisted selection, mycotoxin and pathogen detection and support of higher degree students will help **in capacity building to overcome this risk** and improve NARS abilities in accelerated crop improvement in SAT Asia. **We also assume** that the NARES, public and private seed industry, and NGOs will select the improved material/technologies developed by ICRISAT, and test and release/use the varieties/technologies for adoption by the farmers. Others recipients of technologies, germplasm include partners in the Generation and Harvest Plus Challenge Programs, ILRI, ICBA and the ARIs. This will further help in the development and transfer of technology to the poor farmers growing these crops under rainfed, subsistence farming conditions globally and help improve crop productivity, food security, and nutrition, and increase farm incomes in Asia and other regions in the SAT. The VASAT Consortium will be a major player in information dissemination (Project 10).

Expected IPGs that have applicability beyond one nation's borders

- Cultivars with resistance to biotic and abiotic stresses, improved yield, and adaptation to diverse agro-ecosystems,
- Protocols for evaluation of germplasm, breeding materials, mapping populations and transgenic crops for resistance to insect pests, diseases, and drought,
- Protocols for genetic transformation of chickpea, pigeonpea, sorghum, and groundnut,

- Genetically modified plants with resistance to *Helicoverpa* in chickpea and pigeonpea, drought in groundnut and chickpea, and aflatoxin and viruses in groundnut,
- Mapping populations for major insect pests, diseases, and drought in sorghum, chickpea, pigeonpea, and groundnut,
- Molecular markers and QTLs for resistance to insect pests, diseases, and drought in sorghum, chickpea, pigeonpea and groundnut,
- Knowledge of mechanisms and inheritance of resistance to biotic and abiotic stresses,
- Diagnostic tools for mycotoxins and viruses,
- Technologies for IPM and detection and management of Aflatoxin contamination,
- Knowledge of the usefulness of transgenic crops for pest management,
- Genetic engineering protocols and systems for ICRISAT mandate crops.

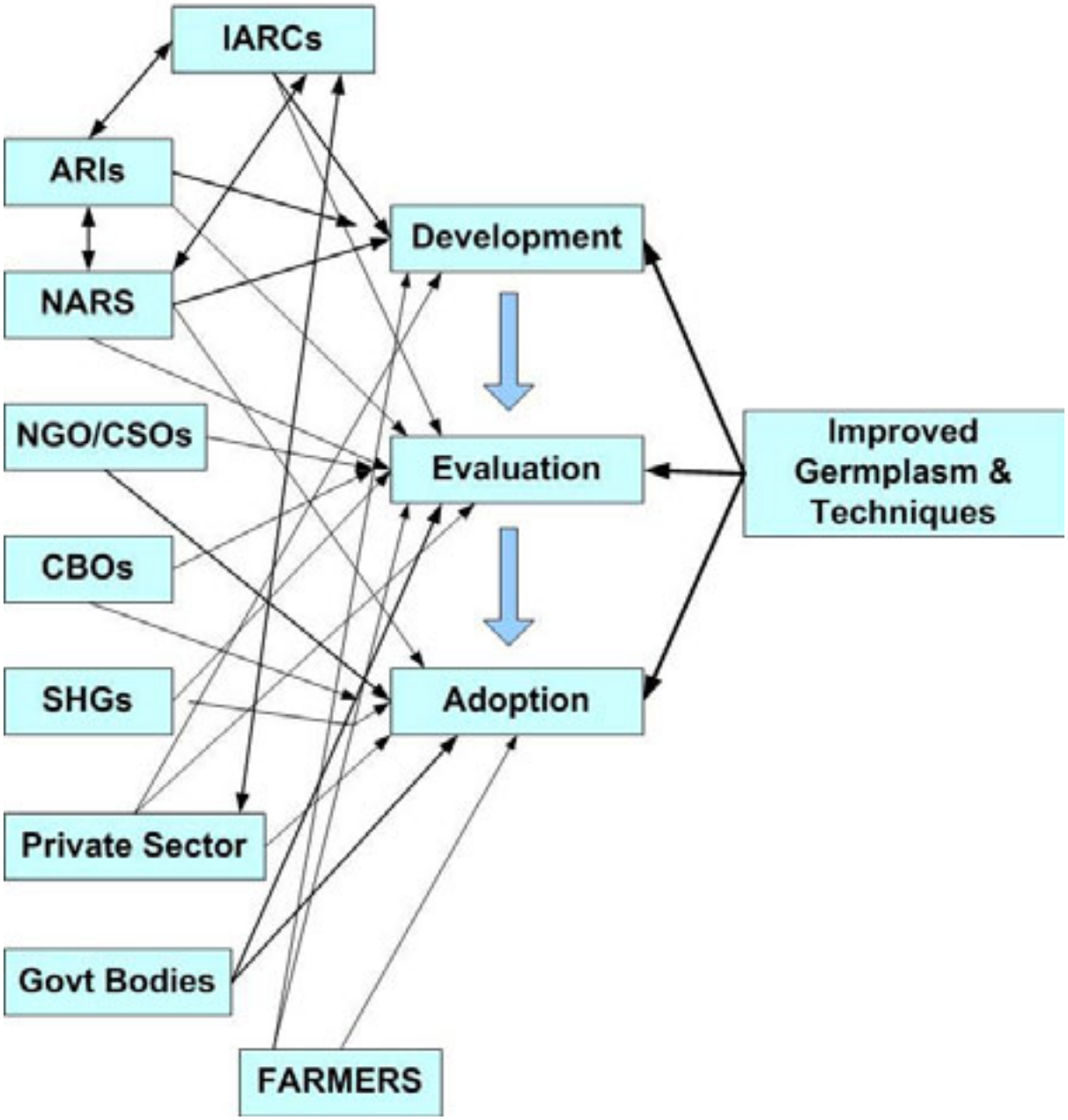
Elaboration of partners' roles

The role and responsibilities of partners will vary depending up on the nature of collaborative activities. In the case of Priority 2 B and 2 C, ARIs would provide their products and technologies e.g., JIRCAS has provided the DREB gene construct, Michigan State University will provide a gene for aflatoxin resistance and the National Institute for Nutrition will analyze samples for ß-carotene and methionine contents. ARIs would also take up researchable issues of mutual interest where we lack infrastructure and facilities. Our principal ARI partners in the Generation Challenge Program are CIRAD (France) and EMBRAPA (Brazil) and our principal partners in the Harvest Plus Challenge Program are a range of Indian Council for Agricultural Research institutes and universities. ILRI will assist in feed quality assessment (priority area 3B) and ICBA in salinity testing. The World Vegetable Center will assist in comparator studies on indigenous legume vegetables (eg. Mung bean).

In the case of conventional breeding products (Priority 2 A), NARS from SAT Asia would facilitate evaluation for local adaptation including diseases and pest resistance screening in hotspot locations and provide feedback on the performance of materials and interface with farmers. They will take the lead in getting the promising materials released through their national/ provincial systems and produce Breeder and other categories of seed for formal/informal seed production chain to enable farmers to cultivate improved varieties. They will also assist in technology dissemination and product diversification. The rice-wheat consortium SWEP is a partner for the introduction of legumes into cereal monocrops in the Indo-Gangetic plain. The SP-IPM is associated with insect resistance studies and VASAT will help in information dissemination (Project 10).

Key Strategic Alliances: ICAR for partnership and support with a large range of Indian research institutions, ILRI/SLP and ICBA (for support on livestock feed and salinity issues respectively). The Harvest Plus and Mycotoxin consortium for their expertise and techniques in biofortification and biodetoxification.

Project 6 : Network map



Project 6 Logframe: Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (sorghum, pearl millet, pigeonpea, chickpea and groundnut) through genetic improvements

Output	Output target	Intended Users	Outcome	Impact
System Priority 2A				
6.1 Improved germplasm and varieties of sorghum, finger millet, pigeonpea, chickpea and groundnut with pro-poor traits and associated advanced knowledge of breeding methods and capacity building made available to partners internationally	**Groundnut** 2007 6.1.1 GN 100 transgenic events with *TSVcp* gene developed and screened in the greenhouse for resistance to TSV	NARS and IARC biotechnologists, breeders and crop improvement scientists, ARIs and Generation and Water CP partners, the RWC SWEP, ILRI and the World Vegetable Center	Partners worldwide are strengthened and have access to the most up-to date knowledge, germplasm and varieties of five SAT staple crops (non-hybrids) and use this to enhance their crop improvement activities for the benefit of poor people in Asia and globally.	Risks to food/feed security from chronic biotic stresses throughout SAT Asia have been reduced
	2008 6.1.1 GN 8 - 10 elite breeding lines evaluated and selected for resistance to stem necrosis and bud necrosis virus diseases 2008 6.1.2 GN 50 lines of advanced generation interspecific derivatives of groundnut evaluated for LLS disease and promising lines identified			
	2009			
	2010 6.1.1 GN 6-8 high yielding dual-purpose groundnut varieties in a range of maturity groups with resistance to chronic biotic constraints available for release and commercialization 2010 6.1.2 GN Two best transgenic events with resistance to TSV used for introgression into locally adapted groundnut genotypes and evaluated 2010 6.1.3 GN Five promising PBNV cp or alternative gene transgenic events identified and disease resistance characterized under contained field conditions			
	Chickpea 2007 6.1.1 CP 50 transgenic events of chickpea with *Bt* genes developed and screened in the greenhouse			

	15-20 new high yielding Fusarium wilt resistant desi and kabuli chickpea breeding lines made available to NARS. 2007 6.1.2 CP Novel set of chickpea SSR markers developed 2008 6.1.1 CP Markers for Ascochyta Blight and Botrytis Grey Mold resistance QTLs validated in new populations 2008 6.1.2 CP Strategies to cross cultivated species with species of secondary and tertiary genepools developed and shared with partners			
	2009 6.1.1 CP 10 kabuli chickpea breeding lines with extra large seed and high resistance to wilt developed and made available to partners			
	2010 6.1.1 CP Breeding lines with combined resistance to Fusarium wilt and Helicoverpa identified and made available to partners 2010 6.1.2 CP 3 promising *Bt* transgenic events identified and characterization for insect resistance continuing under contained field conditions 2010 6.1.3 CP Interspecific derivatives with enhanced resistance to AB, BGM and Helicoverpa identified and made available to partners			
	Non-Hybrid Pigeonpea 2007			
	2008 6.1.1 PP New knowledge on vegetable pigeonpea production synthesized, published and disseminated to partners			

	2009 6.1.1 PP Molecular characterization of pigeonpea germplasm and breeding lines to generate mapping populations with diverse genetic background 2009 6.1.2 PP 15 new sources of resistance to wilt and sterility mosaic virus identified and made available to partners			
	2010 6.1.1 PP 1-2 Bt- transgenic events used for introgression Biosafety of transgenic products assessed 2010 6.1.2 PP At least 5 new varieties of PP with multiple disease and insect resistances made available to partners			
	Sorghum 2007 6.1.1 SO 10 high biomass forage sorghum lines with tolerance to stem borer and foliar diseases developed 2007 6.1.2 SO Major grain mold pathogens in sorghum growing states in India identified and their distribution in relation to weather factors characterized			
	2008 6.1.1 SO Lines with large grain size and high grain yield (5) with resistance to shoot fly developed for adaptation to post-rainy season conditions in S. Asia			
	2009 6.1.1 SO Two F6 sorghum RIL mapping populations (300 each) available for genotyping and multi-locational phenotypic assessment of yield and quality considerations with sugar and sugar extraction characteristics phenotyped			
	2010 6.1.1 SO Genetically diverse sorghum breeding lines for high yield and large grain size with resistance to shoot fly and grain mold available to partners			

System Priority 2B 6.2 Knowledge of the improvements of the biotechnological and conventional tools designed to facilitate drought and salinity tolerance breeding and germplasm of legume mandate crops and associated capacity building made available to partners internationally	**Groundnut** 2007 6.2.1 GN 3 mapping populations between contrasting parents to identify QTLs for salinity tolerance and component traits of drought tolerance developed 2007 6.2.2 GN At least 10 genotypes with superior salinity tolerance identified.	NARS and IARC biotechnologists, crop physiologists, breeders and agronomists, Generation and Water CP and Alliance partners, The World Vegetable Center	Partners worldwide are strengthened and have access to the most up-to date knowledge and germplasm of five SAT staple crops (non-hybrids) and use this to enhance their crop improvement activities for the benefit of poor people in Asia and globally that suffer from abiotic stress problems.	Risks to food security from abiotic stresses have been somewhat reduced throughout SAT Asia
	2008 6.2.1 GN New breeding strategies for drought tolerance in groundnut using surrogate traits developed and knowledge shared with partners 2008 6.2.2 GN Molecular markers ready for validation in introgression studies for abiotic stresses			
	2009 6.2.1 GN 6-8 dual purpose groundnut varieties with high biomass and improved haulm digestibility identified and promoted for drought prone areas in Asia (Collaboration with ILRI) 2009 6.2.2 GN 8-10 new advanced lines with resistance to drought tested in south Asian locations			
	2010 6.2.1 GN 1-2 Transgenic DREB events available for introgression into locally adapted germplasm in India			

	Chickpea 2007 6.2 1 CP Phenotyping of a mapping population for salinity tolerance completed and marker data available for QTL mapping			
	2008			
	2009 6.2.1 CP QTLs for salinity tolerance identified and QTLs for drought avoidance root traits validated			
	2010 6.2.1 CP MABC-derived drought tolerant lines available from 2-3 locally adapted cultivars 2010 6.2.2 CP Transgenic *DREB/P5CSF* events available for introgression into locally adapted germplasm in India			
	Pigeonpea 2007			
	2008			
	2009 6.2.1 PP At least two mapping populations developed to map QTLs for salinity tolerance			
	2010 6.2.1 PP Pigeonpea genotypes selected for salinity tolerance breeding			

System Priority 2C				
6.3 Knowledge of the improvements of the biotechnological and conventional tools designed to facilitate biofortification and biodetoxification breeding, improved germplasm of pearl millet, sorghum, groundnut and pigeon pea crops and associated capacity building made available to partners internationally	**Biofortification** 2007 6.3.1 FORT 75 transgenic events of groundnut with maize *psyl* gene developed and screened for high beta carotene production in the greenhouse 2007 6.3.2 FORT 50 transgenic events of pigeonpea with maize *psyl* gene developed and screened for high beta carotene production in the greenhouse	NARS, private sector and FHA biotechnologists, breeders, pathologists, virologists, agronomists and medical and health professionals, Harvest +/Africa CP and Alliance partners	Partners worldwide are informed of the risks of malnutrition are strengthened in their capacity to cope with such problems and have access to the most up-to date knowledge and germplasm of the SAT staple cereals and use this to enhance their crop improvement activities for the benefit of the health of poor people	Risks of malnourishment compromising food security have a greater potential to be substantially reduced throughout SAT Asia and globally in the medium term
	2008 6.3.1 FORT At least 8 groundnut candidate *psyl* events selected for contained field screening for beta carotene content			
	2009 6.3.1 FORT At least 8 pigeonpea candidate *psyl* events selected for contained field condition screening for beta carotene content			
	2010 6.3.1 FORT 1-2 transgenic events of groundnut and pigeonpea with high beta-carotene content available for introgression into locally adapted germplasm in India			
	Biodetoxification 2007 6.3.1 DTOX Enzyme linked immunosorbent assay (ELISA) developed for estimation of aflatoxin adducts in human serum 2007 6.3.2 DTOX Performance of 9 promising groundnut transgenic events expressing the *RChi* gene for A. flavus resistance tested in contained field trials			
	2008			

	2009 6.3.1 DTOX Multiplex filter paper immuno assay developed for the rapid estimation of aflatoxins and fumonisins 2009 6.3.2 DTOX 8 - 10 elite aflatoxin resistant breeding lines evaluated for *A. flavus* resistance under artificial inoculation condition in the field and at least 5 resistant varieties identified for commercialization			
	2010 6.3.1 DTOX Transgenic events with enhanced resistance to *A. flavus* and aflatoxin production identified and available for introgression into regionally adapted germplasm 2010 6.3.2 DTOX 5 *A. flavus* resistant lines of groundnut available for potential release			

Project 7 Narrative:
Reducing Rural Poverty through Agricultural Diversification and Emerging Opportunities for High-Value Commodities and Products

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center
The proposed research is in specific accordance with System Priority 3A, Specific goals 1 and 2. The project will develop and disseminate technologies to increase production of high-value commodities such as fruit and vegetables, livestock and trees for biodiesel. ICRISAT claims that >80% of this project's activities are encapsulated within the CGIAR System Priorities.

Target ecoregion, beneficiaries and end users
The target ecoregions are the semi-arid tropics in west and central Africa, eastern and southern Africa, and Asia. The immediate beneficiaries are our various partners: NARS; NGOs and CBOs involved in rural development and small-scale private marketing enterprises. The end users of technologies developed by the project are farming communities, who will benefit from more diverse, nutritious diets and higher and more stable incomes.

Is the center the primary or secondary research provider?
ICRISAT with its partners such as AVRDC is often the primary research provider.

Is it a catalyzer, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact
ICRISAT aims to catalyze broadly based consortia for watershed development in Asia and elsewhere. The research is proof-of-concept at the end of the first stage which is imminent with two major output targets are due for achievement in 2007: "Sahelian Eco-farm. First proof of concept tested and validated in Sahelian countries and report published" and "Exemplar watershed studies completed in four Asian countries and reports published". Strategies for outcomes and impact will be re-assessed (MTP 2009-2011) in the light of these critical reports.

Comparative and complementary advantages of project activities
ICRISAT is well placed to facilitate information flows and legal germplasm exchanges between partners from different countries. Partnership in **a new strategic alliance** with the World Vegetable Center is expanding rapidly with jointly-based staff now at three ICRISAT locations. ICRISAT's pro-poor research orientation is also highly apposite for its work on biodiesel, which is often well suited to the most marginal land that often supports a large number of the poor. The concept therefore of a high value crop is therefore deemed to be relative to the remaining options in the environment.

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs
A decade of research is expected to produce a generic strategy for watershed development and management. These strategies are key IPGs and have the potential to benefit nearly one billion poor people in the SAT. Our efforts will ensure that local and national public goods can be scaled up to regional and fully international public goods. It should be recognized that partners at local or national level have little incentive to consider the regional/international implications arising from the research. Nor are they necessarily willing (or able) to share knowledge and outputs, without the strong support and facilitation role played by ICRISAT.

Problem analysis, identification of specific problems that can be tackled by research focused on specific objectives

These are described by specific goal as below:

<u>Priority 2A, Specific goal 1: Identify key species for research and assess their factor and product markets</u>
<u>Priority 2A, Specific goal 2: Enhance production of selected fruit and vegetables through improvement of farming systems</u>

<u>West and Central Africa</u>
Water availability – due to low and variable rainfall, high temperatures and evaporation – is a key limiting factor to rainfed agriculture in the Sahel. Water retention technologies and more efficient water use are necessary for increasing productivity. Farm enterprises are generally limited to a few staple crops; opportunities clearly exist for introducing new crops and production systems. Food security and poverty can be addressed by increasing farming system efficiency, diversifying into higher value crops, opening new markets and adding value to farm products. Traditional food plants such as fruit and oil seed trees, pulses and leafy vegetables have the potential, but technical and scientific support (e.g. for domestication) is needed.

Development of more efficient farming systems
The African Market Garden (AMG) is a low-pressure drip irrigation system particularly suitable for small farmers. It has all the advantages of conventional drip irrigation systems at a fraction of their cost. The Sahelian Eco-Farm (SEF) is an integrated dryland tree-crop-livestock system for millet-based production systems. Three versions of the SEF are being tested, in partnership with the NARES of Burkina Faso (INERA) and Ghana and with pilot farmers in Niger.

Crop diversification
Improvement of traditional crops and native plants and identification of new income-generating crops includes *Acacia Senegal,* traditional leafy vegetables, *Hibiscus sabdifara,* watermelons, *Ziziphus mauritiana,* dates, fruit trees and heat tolerant vegetable varieties.

Output: 7.1 A*frican Market Garden technology strategy and knowledge database, developed, tested and promulgated with associated capacity development regionally in the SAT of the Sahel in collaboration with AVRDC and ICRAF and assessed in comparison with existing and new potential dryland alternatives*

Asia
Diversification in Asia
Rural welfare in South Asia remains highly dependent on agriculture. However, there is also a trend away from the traditional SAT crops like sorghum and pearl millet, towards high-value and tradable commodities. When technological options exist, small farmers through diversification move into new products and can often capture market opportunities. ICRISAT-Asia is using an integrated genetic and natural resource management approach at catchment scale, and has been able to sustainably enhance livelihoods through the introduction of high-value, fruit, vegetables and value-added plant products. ICRISAT also has growing expertise in the area of agriculture and energy, particularly in the provision of substitutes or blending agents for petroleum. Potential proof of concept for use of environment-friendly alternative sources of energy using ethanol from sweet sorghum to use as energy source will be undertaken.

Development of sustainable and efficient farming systems
ICRISAT is involved in the following research areas associated with specific goal 2:
a) Sweet sorghum for ethanol production (See Project 5)
b) Systems diversification through vegetables and fruits
c) Systems diversification with medicinal and aromatic plants

Output: 7.2 *New approaches and technological options to create a strategy to diversify SAT systems using available water resources efficiently to grow high-value commodities that increase incomes for disadvantaged households identified and promoted with associated capacity building by consortium partners to Government agencies, donors, NGOs, and CBOs***.**

Priority 3B, Specific goal 2: Management of the intensification in livestock production is improved to limit the negative impacts on the poor and the environment

The impact of livestock on natural resources will be described within different policy environments and agro-ecosystems, with reference to biodiversity and primary and secondary productivity. The need for dry season feed and fodder will be quantified and prioritized based on its potential impact within agro-ecological zones using participatory selection of alternative feeding strategies with poor farmers. Improved land use strategies are to be developed with stakeholders to reduce risk and vulnerability and recommendations on policy reform will be formulated

Output: 7.3 *Environmental impacts of livestock intensification reduced during droughts and the dry season by developing and promoting alternative feed and fodder strategies in crop-livestock systems with associated capacity building*

Priority 3D, Specific goal 1: Improve the opportunities for the market exploitation of a range of tree products by the poor

Determining the options of very poor people (including the landless) to exploit the growth of biodiesel tree species and their agronomy on common or low quality land resources. The SC Commentary on the 2007-2009 MTP has queried the IPG nature of this highly pro-poor research activity (point d). ICRISAT believes that it is well placed to generate IPGs from this activity not only from the critically needed information on the genetic potential and likely

economic agronomy of biodiesel trees but also on how the landless and other highly disadvantaged population groups can have a policy-friendly environment created for them to ensure that they can benefit from the usufruct rights from tress planted on low quality "common land". Demand for such quantitative and policy information appears to be widespread in S. Asian countries at present and ICRISAT is seen as an honest broker from which such knowledge can be accessed with confidence.

Output: 7.4. *Opportunities for the market exploitation of biodiesel tree products by the poor promoted with associated capacity building*

Description of impact pathways and capacity development
The two stated outputs of this project have similar impact pathways. Rural poverty, exacerbated by lack of agricultural diversity, is endemic throughout large areas of the SAT. **It is our assumption** that on station and on-farm site specific research are the first necessary steps towards finding solutions to farmers caught in the poverty trap. Much of the testing and institutional development associated with proof-of-concept of the African Market Garden and Watershed Consortia, has been completed. Research papers have been, and will continue to be, published as source material from which effective articulation of generic strategies and their refinement for upscaling and advocacy can be achieved. Research and capacity development in this subject area has been conducted for nearly 10 years, in partnership with NARES, NGOs, CBOs and the private sector, specifically in west Africa and south Asia. ICRISAT will encourage partners to now adopt a stronger advocacy role both nationally and with regional political organizations, to ensure policy support for these development strategies, leading to international and MDG scale impact. **We assume** this will occur as success in this area is already apparent in the policies of the Indian Government. **Efforts under Projects 1 and 10 help to mitigate risks associated with this assumption**. ICRISAT will continue to play a vital role in this process, as a technology Product Champion, capacity developer and knowledge disseminator. Collaboration with ICRISAT's VASAT initiative will accelerate dissemination and multiply the IPG benefits in order to reach the expected very large number of potential beneficiaries.

Expected IPGs that have applicability beyond one nation's borders
- Farmer options for attaining further crop and livestock diversification products expanded
- Vegetable/fruit varietal selections with adaptation to harsh Sahelian environments
- Proof of concept that date/vegetable or vegetable/fruit systems are profitable and sustainable at small farmer level where access is possible to water for trickle irrigation
- Economic demonstration of diversified, water harvesting based, dryland crop systems on station with sufficient replicability to warrant regional upscaling.
- Improved land use strategies developed for dryland, animal-based systems to reduce risk and vulnerability, with recommendations on policy reform

Elaboration of partners' roles
In WCA our principal research partners are Ben Gurion University, The World Vegetable Center (will be responsible for vegetable breeding and cultivar selection), ICRAF (collaboration on "Pomme de Sahel"), and the NARS of Ghana, Senegal, Niger, Mali and Burkina Faso. All provide services in kind that substantially contribute to project outputs and success. OASIS and the DMP SWEP are also dissemination partners for this technology and likewise the VASAT Consortium (Project 10).

In Asia a range of partners contribute in kind: CRIDA (India), BAIF (Indian NGO that helps with livestock issues), several State Governments in south and central India, the NARS of Thailand, Vietnam, the Philippines and China. IWMI has been a supporter though the Comprehensive Assessment and ILRI through the Systems-wide Livestock program. In addition, the government of India provides financial support for the Agri-Business incubator, through which Rusni Distilleries became a close partner; and a range of federal and state governments are, or are proposing to, support biodiesel and bioethanol research.

Key Strategic Alliances: The World Vegetable Center for expertise in vegetable breeding, ICAR (CRIDA) for techniques and experience in dryland agriculture in south Asia, ILRI for expertise in crop-livestock interactions and Rusni Distilleries for expertise in the industrial dimensions of ethanol production from crops.

Project 7 Logframe: Reducing Rural Poverty through Agricultural Diversification and Emerging Opportunities for High-Value Commodities and Products

Output	Output target	Intended Users	Outcome	Impact
7.1. African Market Garden technology strategy and knowledge database, developed, tested and promulgated with associated capacity development regionally in the SAT of the Sahel in collaboration with AVRDC and ICRAF and assessed in comparison with existing and new potential dryland alternatives			Strengthened partners (NARES, CBOs and private sector) diffuse AMG and Sahelian Eco-farm technology and improved vegetable seeds regionally in WCA and the strategy is adopted by farmer enterprises with access to water	Farmer annual income, system resilience and food production has been increased though adoption of new technologies and crop diversification systems. Improved nutrition of rural and urban populations through greater consumption of fruit and vegetables has occurred. Traders and exporters have benefited from greater competitiveness in local, regional and international markets.
	2007 7.1.1 African Market Garden: 1st proof of concept tested and validated in Sahelian countries and report drafted	NARES and NGO/CBO agronomists and breeders, the World Vegetable Center, VASAT consortium, Oasis, the DMP SWEP, Alliance and Africa CP partners		
	2009 7.1.1 **Authoritative AMG strategy published and advocacy campaign for policy amendment completed (associated with the DMP SWEP).**			
7.2. New approaches and technological options to create a strategy to diversify SAT systems using available water resources efficiently to grow high-value commodities that increase incomes for disadvantaged households identified and promoted with associated capacity	2007 7.2.1 Exemplar watershed studies completed in four Asian countries and reports published	NARES, NGO and CBO agricultural communities, local governments and the private sector, IARCs, WVC, OASIS, DMP-SWEP	Approaches and technological strategies to increase incomes through diversifying SAT systems using high-value commodities incorporated in policies and implementation guidelines by government agencies, NARES, and donor agencies in India,	Participatory research and development (PR&D) approaches to improve the livelihoods of the landless and small farmers through rehabilitating degraded lands and diversifying SAT systems have been developed and promoted in the SAT areas of India, Thailand, Vietnam, China and the Philippines.
	2008 7.2.1 Inventory of alternative watershed practices for 4 Asian countries documented and made available globally			

building by consortium partners to Government agencies, donors, NGOs, and CBOs.	2010 7.2.1 Potential proof of concept for use of environment-friendly alternative sources of energy using biodiesel and ethanol from sweet sorghum to use as energy source		Thailand, Vietnam, Southern China, and Philippines for strengthening their sustainable research and development programs.	Incomes of the farmers in target rainfed areas using available water to grow high-value commodities has been shown to have the potential to be increased by 50%.	
7.3. Environmental impacts of livestock intensification reduced during droughts and the dry season by developing and promoting alternative feed and fodder strategies in crop-livestock systems with associated capacity building	2008 7.3.1 Impact of livestock on natural resources described within different policy environments and agro-ecosystems, with reference to biodiversity and primary and secondary productivity. 2009 7.3.1 Need for dry season feed and fodder quantified and prioritized based on potential impact within agro-ecological zones, through participatory selection of alternative feeding strategies 2009 7.3.2 Improved land use strategies developed with all stakeholders to reduce risk and vulnerability, with recommendations on policy reform 2010 7.3.1 Capacity building of stakeholders (farmers, NGOs, NARS scientists) to implement improved NRM practices for intensifying and diversifying existing livestock and crop-livestock systems undertaken	NARES, NGOs, CBOs and policy makers, Alliance and Water CP, ILRI and SLP SWEP partners	Reduced impact on natural rangeland degradation understood by government extension services, private sector, NGOs and CBOs. More sustainable policies developed that acknowledge the tradeoffs within livestock and mixed crop-livestock systems.	Partners have helped small-scale farmers throughout the SAT, to adopt new sustainable feeding strategies to reduce livestock mortality during droughts, improve animal condition and increase both livestock and crop production
7.4. Opportunities for the market exploitation of biodiesel tree products by the poor promoted with associated capacity building	2010 7.4.1 Proof of concept that biodiesel trees are an economically and socially viable product for very poor and landless communities when granted usufruct rights on low quality non-titled land	NGOs and government policy makers, ICRAF	Degraded wastelands are shown to be an economic asset for the poor and government policy is amended accordingly	The very poor have seen a potential way out of poverty that is economically and politically highly desirable	

Project 8 Narrative:
Poverty alleviation and sustainable management of water, land, livestock and forest resources, particularly at the desert margins of the Sahel and the drylands of ESA
(SSA Desert Margins Program SWEP)

The DMP is a collaborative initiative among nine African countries: Burkina Faso, Botswana, Mali, Namibia, Niger, Senegal, Kenya, South Africa, and Zimbabwe assisted by five CGIAR Centers (ICRAF, ICRISAT, IFDC, ILRI, TSBF-CIAT) and three Advanced Research Institutes (CEH, CIRAD, IRD). ICRISAT amongst other roles acts as the coordinating agency.

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the center
The research proposed in this project is in accordance System Priority 1, goal 1b, promoting conservation and characterization of underutilized genetic resources to increase the income of the poor; under System Priority 4, goal 4b, integrated land, water and forest management at landscape level and goal 4d, sustainable agro-ecological intensification in low-and high- potential areas; System Priority 5, goal 5a, science and technology policies and institutions. ICRISAT claims that >80% of this project's activities are encapsulated within the CGIAR System Priorities. The proposed project, the Desert Margins Program SWEP (DMP), aims at arresting land degradation in sub-Saharan Africa's desert margins and at addressing issues of global environmental importance as well as issues of national economic and environmental importance; and in particular the loss of biological diversity, reduced sequestration of carbon, and increased soil erosion and sedimentation, associated with land degradation in these arid and semi-arid ecological zones. The overall objective of the DMP is to arrest land degradation in SSA's desert margins through demonstration and capacity building activities. ICRISAT is the Executing Agency while the GEF Implementing Agency is the United Nations Environment Program (UNEP) with support by the United Nations Development Program (UNDP). This project fits within ICRISAT's mandate to enhance the livelihoods of the poor in semi-arid farming systems through integrated genetic and natural resource management strategies.

The target ecoregion, the beneficiaries and end users.
The target ecoregion is the desert margins of SSA. The immediate beneficiaries of this research are the participating countries' institutions as the program will strengthen their capacity to design and plan interventions to mitigate land degradation and establish sustainable land use and management practices.

Is the center the primary or secondary research provider?
The Center in this project is both a primary and secondary research provider. On one hand, by being chosen to coordinate and lead this integrated research program, aimed at increasing our understanding of the physical, biological, and socioeconomic processes associated with this crucial environmental problem, ICRISAT plays a secondary role in the DMP: On the other hand, ICRISAT as a research partner is developing technological packages such as the Sahelian Eco-farm (SEF) and the African Market Gardens (AMG), thus playing a primary role in research.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact
ICRISAT is playing many of these roles in its research in this project. At the national level, ICRISAT, through the Scientific and Technical Advisory Team (STAT), is assisting NARS to develop a common framework for site stratification and to characterize specific benchmark sites. It also provides support to NARS for the development of standardized data collection methodologies, storage and management systems for an understanding of ecosystems status and dynamics with regards to the loss of biodiversity.

A brief description of the comparative and complementary advantage of the project activities
ICRISAT is well placed to catalyze and facilitate work done at the national level. It has a highly trained interdisciplinary research team working on climate change and prediction models, has offices located both in the desert margins of West Africa (Sadore), East Africa (Nairobi) and Southern Africa (Bulawayo) and thus has a comparative advantage in coordinating work in those areas and to observe the bigger continental picture as a whole.

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs
ICRISAT is providing an oversight role in the DMP while also contributing to its research agenda. The DMP supported by the Global Environment Facility (GEF) recognizes two important public goods, namely domestic benefits, i.e. benefits realized at the local level or country level and global benefits or benefits of a global nature for which IPGs are a component.

Problem analysis, identification of specific problems that can be tackled by research focused on specific objectives

These are defined by priority as below:

Priority 1b: Promoting conservation and characterization of under-utilized plant genetic resources to increase the income of the poor

Improved understanding of ecosystem and dynamics with regard to loss of biodiversity in the desert margins of SSA
Activities to complete inventories of biodiversity and ecosystem functions in each of the project sites; identify temporal and spatial changes and trends in baseline data and their causes, including the development and application of indicators; and regional synthesis and interpretation of data sets; and provide necessary data for an adaptive management approach to project implementation have been undertaken and are now being reported.

Priority 4a: Integrated land, water and forest management at landscape level

Strategies for conservation, restoration and sustainable use of degraded agro-ecosystems, developed and implemented in the desert margins of SSA
The DMP will take the latest lessons from the field, indigenous knowledge and scientific research from across the region to update and rationalize approaches to water and soil management at project sites. Rural development initiatives have been undertaken to help local communities build the capacity to organize themselves into collectives and co-operatives, increase their levels of productivity and add value to farm gate prices. The DMP will build on the foundations laid by the community development and rehabilitation activities, building on this broad base of experience in the proposed Phase 3 2008-2009.

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

Alternative livelihood systems tested and promoted in the desert margins of SSA
Initiatives are underway at project sites to encourage the development of new rural enterprise and livelihood ventures.

Priority 5a: Science and technology policies and institutions
Sound policy intervention/guidelines for sustainable resource use in desert margins of SSA formulated, adopted and implemented
Further initiatives are planned in Phase 3 to promulgate a policy and regulatory environment to encourage sustainable use of natural resources.

Priority 1 and 4
Building Partner Power
a) Capacity of stakeholders and target populations in the nine DMP countries for SSA desert margins research enhanced
Natural resource management initiatives are planned to help communities organize, plan and manage the use of their own natural resources, especially community lands.

b) Capacity of stakeholders and target populations in the nine DMP countries for SSA desert margins research upscaling enhanced
A scaling-up strategy with participating governments, including a broad consultation process; assist in setting-up government implementation units and build the capacity of implementation units to implement a scaling up strategy is envisaged in Phase 3.

Rationale for mid-course corrections should be explained. **Linkages between old and new project structure. Changes in output targets for 2007 influencing the PM reporting in 2008**
The DMP Phase 2 is nominally complete but is being extended into 2007 following a successful external review and the granting of a no-cost extension to complete the use of remaining funds. Funds for Phase 3 2008-2009 are in process of application.

Description of impact pathways and capacity building
The DMP is a complex consortium effort and is largely dependent on NARES activity in the nine collaborating countries to achieve progress. The CGIAR center and ARI partners act as research facilitators, coordinators, capacity developers and as research partners. Technologies, strategies, knowledge and capacity building are shared at least annually amongst all consortium members and guidance is provided by the program steering committee. This

knowledge has specifically to be scaled out and up as part of the DMP Phase III program requirements as specified by the funding agency support document and by the steering committee. Action at a national level is the responsibility of the specific NARES agencies and internationally it is the responsibility of the other consortium members including ICRISAT. ICRISAT will use all its knowledge management and sharing opportunities to assist in this process (as detailed in Project 10) and support graduate students where feasible. **We assume** that Phase 3 funding will be achieved but this is now unlikely until at least 2008**. Intensive lobbying by ICRISAT and its partners continues in mid 2007 to ensure that this assumption has the highest probability of being realized.**

Global benefits or IPGs that have applicability beyond one nation's borders being developed under the DMP include:

- Full inventory of threatened and endangered species and habitats and monitoring of changes in biodiversity of global significance. This will include assessments of the genetic diversity losses that may result from the expansion of cropped land, the fragmentation of rangelands associated to increasing grazing pressure and wood harvesting, harvesting of medicinal plants etc
- Scientific base to establish relationships between biodiversity status and loss in productivity and stability of the ecosystem
- Development and implementation of sustainable harvesting regimes, validation and adoption of sustainable ecosystem rehabilitation techniques
- In-situ conservation of endangered crop, forage and medicinal plant species
- Conserving habitats rich in wild relatives of crops
- Use of community-based participatory approaches to enhancing the return of natural resource assets
- Technologies aimed at lifting barriers to the sustainability and replicability of appropriate harvesting techniques
- Developing, testing and demonstrating sustainable biodiversity management and conservation technologies and models in selected project sites in each of the nine countries.
- Up-scaling of sustainable use of biodiversity

Elaboration of Partners' roles

The SSA Desert Margins Program (DMP) is a collaborative research initiative among nine African countries: Burkina Faso, Botswana, Mali, Namibia, Niger, Senegal, Kenya, South Africa, and Zimbabwe assisted by five CGIAR Centres (ICRAF, ICRISAT, IFDC, ILRI, TSBF-CIAT) and three Advanced Research Institutes (CEH, CIRAD, IRD Strong complementary expertise amongst partners exists:

- ICRISAT in crop biodiversity and natural resource management
- ILRI in pasture land restoration
- ICRAF in agroforestry systems
- TSBF for soil fertility management
- IFDC for integrated soil nutrient management
- ARIs in models for development and up-scaling
- Specialized NGOs in medicinal plants
- NARS in local expertise on all relevant subjects

Key Strategic Alliances: The NARS of the DMP Consortium for local access/expertise and ILRI (crop-livestock interaction experience) and ICRAF (Use of trees to enhance agricultural productivity and sustainability).

Project 8 Logframe: Poverty alleviation and sustainable management of water, land, livestock and forest resources, particularly at the desert margins of the Sahel and the drylands of ESA (SSA Desert Margins Program SWEP)

Outputs	Output targets	Intended users	Outcomes	Impact
8.1. Nine benchmark site characterization on the improved understanding of ecosystem dynamics with regard to loss of biodiversity completed and synthesized	2007 8.1.1 Synthesis of soil fertility research in the Sudano-Sahelian zone completed 2008 8.1.1 **(Assuming Phase 3 funding is received)** Biogeochemical process studies completed and reported 2009 8.1.1 Carbon sequestration model developed for WCA desert margins and made available to partners	NARES, NGOs and development agencies working at the desert margins in SSA on biodiversity issues, partner IARCs and OASIS partners, Africa CP, ASARECA, CORAF, SADC, and ARIs NARES and ARI scientists working on climate change amelioration	Partners have access to advanced knowledge to the status of biodiversity, causes, dynamics and indicators of land degradation and use this in their R & D activities Partners have effective tool for assessing the likely C absorption capacity of drylands	The problems of desertification and loss of biodiversity in the desert margins of SSA have a greater likelihood of being solved effectively in the medium term Opportunities within drylands for additional C sequestration can be examined to contribute to amelioration of global climate change
8.2. Crop, tree and livestock integration strategies incorporating enhanced water and nutrient use techniques with appropriate capacity building measures developed and promoted for agro-diversity management, commercialization of agricultural enterprises and improved human and livestock health. Knowledge shared and strategies formalized	2007 8.2.1 Training on biodiversity management strategies and assessment monitoring to 50 NGO and CSO groups in SSA completed 2007 8.2.2 Training on LLM, and FIRM given to partners in ESA. 2008 8.2.1 **(Assuming Phase 3 funding is received)** Upscaled best bet restoration technologies reach approximately 100,000 farmers in SSA 2008 8.2.2 Additional training on prevention of land degradation to a further 50 NGO and CSO groups in SSA completed	NARES, NGOs and development agencies working at the desert margins in SSA on systems improvement issues, policy makers Africa CP and OASIS partners, IARCs and ARIs	Partners are strengthened in research efficiency and adopt and use new strategies for system improvement More effective knowledge and information transfer between partners and improved decision making by land users and policy makers	Enhanced income generation has been achieved amongst desert margin small-scale farmers and there is potential for at least 100,000 ha of land to be under improved management for biodiversity conservation

	2008 8.2.3 **(Assuming Phase 3 funding is received)** Sound policy for the conservation of biodiversity and reducing land degradation adopted by policy makers in at least 4 DMP countries at either local, regional or national levels 2008 8.2.4 **(FROM ILRI MTP)** **Information and wider policy implications available on long-term stress, resilience and adaptive capacity in a Sahelian agro-pastoral system in Niger** 2009 8.2.1 **Authoritative AMG strategy published and advocacy campaign for policy amendment completed (associated output with Project 7).**			

Project 9 Narrative:
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

Rationale for the research within the context of the CGIAR SPs and the mandate, goals and objectives of the centre

The proposed research is in accordance with Priority 4A – Integrated land, water and forest management at landscape level, specific goal 1; Priority 4C – Improving water productivity, specific goal 1; and Priority 4D – Sustainable agro-ecological intensification in low- and high-potential areas, specific goals 1-6 and 8. ICRISAT claims that >80% of this project's activities are encapsulated within the CGIAR System Priorities. The project builds on ICRISAT's existing NRM portfolio of land, water and crop-livestock management options; supported by the development and use of new tools such as systems simulation and climate forecasting; and use of farmer-participatory approaches that integrate genetic and non-genetic solutions.

Target ecoregion, beneficiaries and end-users

The target ecoregions are the SAT of sub-Saharan Africa and Asia, covering parts of 55 developing countries. These regions are home to some 1.4 billion people, 45% of the world's hungry and 70% of the world's malnourished children. The immediate beneficiaries of this research are our R&D partners: NARES breeders, agronomists, socio-economists, climatologists and water management specialists; NGOs and CBOs involved in rural development; and private sector input suppliers. The end users are rural communities benefiting from better food and nutritional security and higher, more stable incomes. The SC commentary on the MTP 2007-2009 quotes an ICRISAT 2003 EPMR recommendation concerning the devolving of INRM activities to NARS in Asia. However, it does not take into account the fact that ICRISAT only accepted that this support should no longer be provided from core funds. Yet, ICRISAT has maintained that if special project funding for this research area were available in Asia, then it would continue its efforts in this field. It transpires that ICRISAT is now able to demonstrate substantive IPGs in this area after some years of proof of concept research. Moreover, ICRISAT's recent CCER in this area strongly recommends continued and even expanded effort in this field of research in Asia as it has now a unique opportunity to show impact with its partners and to make a substantive contribution to the MDGs.

Is the center the primary or secondary research provider?

ICRISAT will be the primary research provider in the development and use of new tools such as systems simulation and climate forecasting, and farmer-participatory approaches that integrate genetic and non-genetic solutions. It plays a secondary role in the support and coordination of the Soil and Water Management Network (SWMnet) for Eastern Africa, the Watersheds Consortia in India, and the emerging consortia of national, regional and international organizations that will evaluate the agricultural implications of climatic variability and climate change.

Is it a catalyzer, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact

ICRISAT acts as a catalyzer/facilitator and enabler of the consortium to examine the agricultural implications of current climate variability and future climate change. At national levels, ICRISAT plays the role of enabler and facilitator in the development and evaluation of IGNRM interventions that help rural households improve food security and cope with climate variability. These interventions are implemented through a range of donor-funded projects and two NRM-focused Global Challenge Programs, 'Water and Food' and 'Sub-Saharan Africa'.

Comparative and complementary advantages of project activities

Strong networks (SWMnet and the Water and Food CP with ICRISAT) are in place. ICRISAT has considerable expertise in linking participatory research with simulation modeling, and in IGNRM work, including collaborations with leading modeling teams. These experiences form the basis of ICRISAT's current work on climate risk. ICRISAT and ASARECA coordinate a consortium of 15 national, regional and international organizations with a program on "Investing in rainfed farming systems of sub-Saharan Africa: evaluating the agricultural implications of current climatic variability and planning for future climate change".

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs

ICRISAT's approach is to use local test sites to develop proof-of-concept. Results are then scaled out, often to a selection of target countries. Ultimately, generic models are developed from this experience, combining local-scale results and insights into research-for-development strategies with regional, continental and even global applicability.

Problem analysis, identification of specific problems that can be tackled by research focused on specific objectives

Agriculture and livelihoods in the SAT evolved under the influence of biotic (pest and disease incidence) and abiotic constraints. The most binding abiotic constraints are related to water scarcity and poor soil fertility (macro-nutrient

deficiencies in sub-Saharan Africa, micro-nutrient deficiencies in Asia where N and P fertilizers are widely used). SAT agriculture is inherently risky, due to limited water availability and seasonal variation and unreliability of rainfall.

Development of new tools and methods for the management of multiple use landscapes and climatic variability
Priority 4A, Specific goal 1: Develop analytical methods and tools for the management of multiple use landscapes with a focus on sustainable productivity enhancement
Priority 4D, Specific goal 8: Identify social, economic, policy and institutional factors that determine decision-making about managing natural resources in intensive production systems and target interventions accordingly

This research will involve the following areas:

Development of predictive, spatially distributed models for tradeoffs analysis and decision support.
Monitoring and evaluation protocols for ecosystem services.
Studies on land use and land cover, baseline and changes.
Management of climatic risk and uncertainty

Output: 9.1 *New tools and methods for management of multiple use landscapes and climatic variability with a focus on sustainable productivity enhancement, developed and promoted with associated capacity building in collaboration with NARES partners in Africa and Asia*

This is a rapidly growing area which ICRISAT is playing a leading role in promulgating. New 'Climate variability and change projects' that ICRISAT staff in Africa and Asia are currently involved in, or have developed over the last 2 years and will be funded in 2007 the initiation of 6 pilot climate risk management/carbon sequestration projects in Africa which covered the countries, Cape Verde, Ethiopia, Gambia, Ghana, Kenya, Madagascar, Mali, Mozambique, Niger and Senegal. Furthermore, during 2006, ICRISAT and partners were successful with the submission of 5 competitive grant concept notes and have been invited to develop full proposals. One is to be funded by the African Development Bank through ASARECA and covers Sudan, Eritrea and Uganda with capacity building activities throughout East and Central Africa. Three are to be funded by IDRC / DFID through their 'Climate Change Adaptation in Africa (CCAA) grants scheme and cover Zimbabwe, Zambia, Ghana, Mali, Niger, Tanzania, Kenya, Ethiopia Eritrea and Sudan. The fifth will be funded by IDRC through their Research in Tobacco Control (RITC) Program and will focus on Malawi. In Asia over the same period six concept notes have been developed and two have move forward to full proposal development. ICRISAT also projects that it will play a major role in the development of the forthcoming challenge program on climate change.

Development and promotion of affordable and sustainable crop management options (nutrients, water management, crop-livestock, integrated weed management, IPM, cultivar, rotations)
Priority 4C, Specific goal 1: Improved management practices that enhance the productivity of water
Priority 4D, Specific goal 1: Improve understanding of degradation thresholds and irreversibility, and the conditions necessary for success in low productivity areas
Priority 4D, Specific goal 3: Identify domains of potential adoption and improvement of technologies for improving soil productivity, preventing degradation and for rehabilitating degraded lands
Priority 4D, Specific goal 5: Improve soil quality to sustain increases in productivity, stability and environmental services through greater understanding of processes that govern soil quality and trends in soil quality in intensive systems
Priority 4D, Specific goal 6: Design methods to manage and enhance biodiversity to increase income, reduce risk and vulnerability through IPM, crop diversification and rotations, and genetic diversity within crop species

This research will involve the following areas:

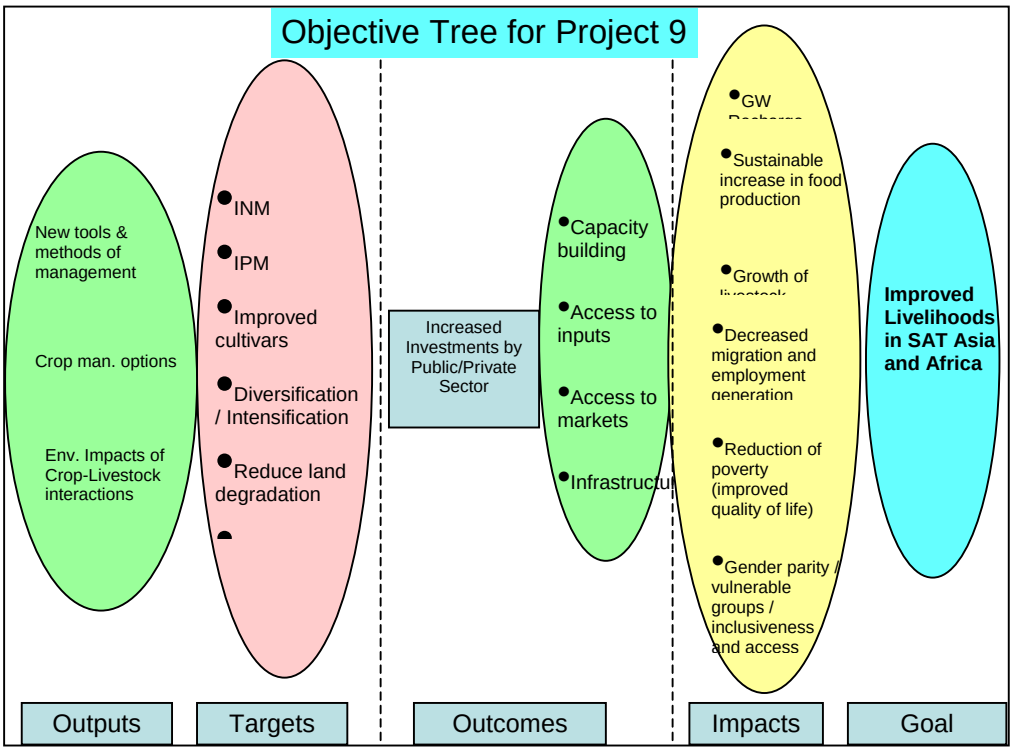
- Land degradation
- Simulation modeling
- Improving productivity
- Pests and diseases through IPM
- Enhancing soil nutrients

In the latter case our research in micro-dosing has evolved from simple fertilizer application research to the complex area of finding ways in which it is possible to scale-up these recommendations to regional level and to overcome the present constraints to farmer adoption that are currently articulated. ICRISAT's collaboration with Project Intrants (FAO) and the "Warrantage" schemes are developing important IPGs in this area which are showing their transferability across national boundaries.

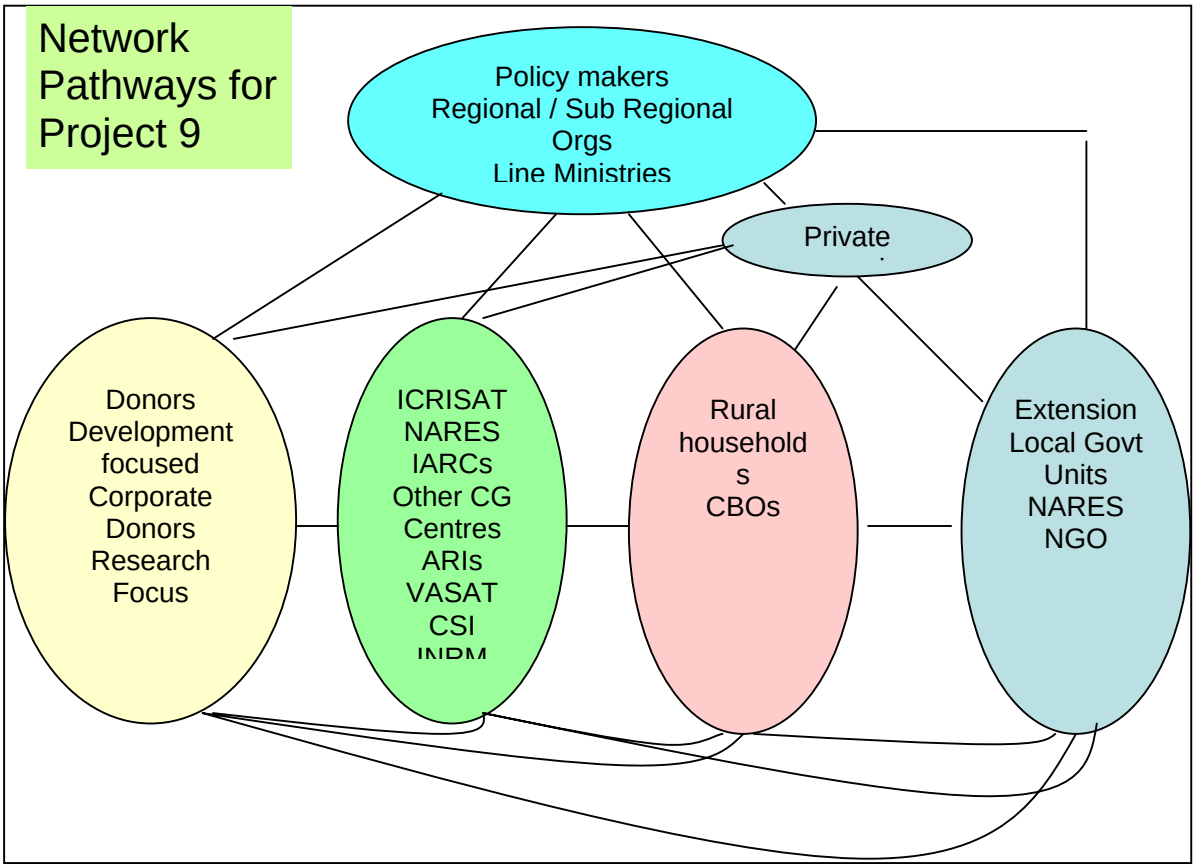
Output: 9.2 *Affordable and sustainable crop management options (nutrients, water management, crop-livestock, IPM, cultivar, rotations) developed and promoted with associated capacity building in collaboration with NARES partners in Africa and Asia*

Description of impact pathways

The development of impact pathways within ICRISAT's IGNRM focused Centre Project 9 is crucial part of delivering the projects outputs to the right people in the semi-arid tropics at the right time in ways which improve utilization of what is produced (associated with the INRM SWEP and the Consortium for Spatial Information [CSI] and the VASAT consortium). Unlike traditional crop improvement research, where there is considerable documented evidence of impacts, there is a dearth of evidence of both overall and specific outcomes, and intermediate impacts of Integrated Natural Resource Management (INRM) research. However, **we assume** that a lack of documented evidence does not necessarily mean a lack of impact; rather it is often difficult in the short term to attribute the direct impacts/benefits. A major problem with the majority of INRM technologies/interventions is the inadequate understanding of performance in locations outside where they were originally developed. Many proven technologies and approaches have not been widely spread, and only small bright spots have been achieved. A limited understanding of best-bet options for different eco-regions, opportunities and circumstances facing local people increase the risk to investments and highly reduce overall productivity and productivity of IGNRM technologies and interventions. A generic/global objective tree for project 9 is outlined in the figure below.



For interventions to have a positive effect we have concluded that a holistic systems approach is required that includes all stakeholders in the INRM process being developed in Project 9, rather than only the poor farmers, and facilitates a learning process, treating both large and small farmers, as informed clients to whom the research and development organizations are accountable, rather than only to the donors. Consequently, the key guiding principle to Centre Project 9's impact pathway approach is 'turning knowledge into action' through effective evaluation and reflective learning, the key to successful implementation of a project, and to generating significant impact through project activities and dissemination of results. An attempt has been made to develop a generic/global network pathway that is summarized in the Figure below.



Evaluation procedures have been formalized for different types of agricultural research and different groups of stakeholders. While they may be partly adequate for some types of research, such as genetic enhancement, the evaluation approaches commonly used are far from adequate – and often entirely inappropriate – for measuring the impact of INRM research. Unlike germplasm technologies, the impact of INRM technology occurs only indirectly. These benefits are often multi-faceted, encompassing economic, environmental and social gains across space and time – usually extending far beyond the project cycle, and therefore "outside the scope" of a conventional evaluation that looks at a specific time frame linked to the project life cycle in a linear fashion. Thus, to measure the full impact of Project 9's outputs, ICRISAT and its partners (See Network Pathway) are developing a more itterative and participatory process that considers social and natural resource endowments and well-being, in addition to traditional economic indicators. To do this we have to resolve a host of methodological issues: the techniques and tools used, discount rates to be applied, how to apportion impact among different (planned and unplanned) outcomes and factors external to the project. Such a process involves the full range of stakeholders as evaluators. It involves a conscious effort to reflect, share ideas and perspectives during (not after) the evaluation, and re-orient the evaluation process to better reflect the different perspectives of stakeholders.

Four factors contribute to this reflective learning process and are the corner stones of ICRISATs IGNRM impact pathways – these are stakeholder participation, systems approach to evaluation, timing of the evaluation and an iterative approach to investigation.

Elaboration of partners' roles and capacity building
The governments and NARES in Bangladesh, Botswana, Burkina Faso, Ethiopia, Ghana, India, Kenya, Malawi, Madagascar, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Thailand, Uganda, Vietnam and Zimbabwe are our principal research partners in the development of sustainable land, water and crop management interventions (FAO, the Alliance Centers, CSI, OASIS, DMP and INRM SWEPs), and will continue to benefit from active participation in this project. Graduate students will continue to be a focus area for capacity building. Research benefits that accrue and the skill of the project members will help develop the future IGNRM agricultural research strategies of sub-regional organizations such as ASARECA, SADC, INSAH, CORAF, FARA and APAARI.

The national program partners participate in project planning and implementation as well as in training and capacity building. The evolving network of IGNRM scientists adapt methods promulgated by ICRISAT while policy makers use alternative development pathways particularly for pro-poor policies and risk management strategies. **We assume that** research benefits also accrue to universities, NGOs, the private sector and many farmer organizations. For example, collaboration with research managers, scientists and development specialists on

improved priority setting, will improve research efficiency, resource allocation, the effectiveness of development interventions, and our understanding of policy and institutional constraints. **Related capacity building under Project 1 should help to ensure the achievement of this assumption**. The SLP SWEP (ILRI et al.) and The Water and Food CP consortia provide a range of additional partners and it is expected that the African CP will do likewise in 2008.

Tools, methods for research and other IPGs that have applicability beyond one nation's borders:

- Simulation models
- Climate information products
- Participatory approaches for crop and natural resource management
- Decision support systems
- Ways to link farmer-participatory research with biophysical simulation and predictive models
- Participatory approaches and decision support systems
- Ways to improve public-private sector linkages
- An exemplar model for watersheds consortium development
- Alternative feed and forage strategies
- Promotion of better practices in using macro and micro nutrients, low-input precision agriculture (micro-dosing), genetic resources, particularly legumes, and IPM/IDM strategies (*Striga* management) in sustaining productivity in rainfed and irrigated areas
- Improved strategies of crop rotation involving legumes to ensure system diversification
- Scaling up methods used by NARES partners, NGOs and development agencies to widely disseminate improved soil fertility and water management technologies e.g. conservation agriculture

Key Strategic Alliances: FAO/Warrantage Project Partners (for expertise in warehousing and micro-credit), Water and Food CP Consortia (Limpopo and Volta basins) for expertise in improving water use efficiency in dryland environments, CRIDA (India) for watershed management expertise and AREX (Zimbabwe) for local support in fertilizer trials as part of disaster relief processes.

Project 9 Logframe: Poverty alleviation and sustainable management of land, water, livestock and forest resources through sustainable agro-ecological intensification in low- and high-potential environments in the semi-arid tropics of Africa and Asia

Output	Output Target	Intended user	Outcomes	Impact
9.1. New tools and methods for management of multiple use landscapes and climatic variability with a focus on sustainable productivity enhancement, developed and promoted with associated capacity building in collaboration with NARES partners in Africa and Asia	2007 9.1.1 Mechanistic model adapted for spatial simulation of African sorghum/millet phenology and biomass partitioning. Model released, along with updated genotype databases and simplified framework for extrapolating variety performance to larger recommendation domains	NARES agronomists and breeders, Alliance and CSI partners	New tools, approaches and technology options for sustainable development and improved livelihoods incorporated into the policy and implementation guidelines used by NARES partners	In rainfed areas, greater resilience to climate variability through integrated land and watershed management. Agricultural productivity and incomes has been increased in target countries
	2008 9.1.1 At least one farm-level response option to reduce the impacts of climate variability verified and developed with stakeholders	NARES, NGOs, Africa and Water CP, climatologists and policy makers	End users (farmers and their support agents) are better able to adapt to climate variability and change, with improved management of seasonal and annual climate risks.	Communities have experienced reduced vulnerability to climate variability and are more resilient and better prepared through the implementation of the improved risk management strategies.
	2009 9.1.1 One predictive toolset based on assimilation of in-situ measurements and satellite observations with models released for evaluating soil C sequestration options at farm and cropping system scales, including the role of livestock on C and nutrient balances	NARES, NGOs, climatologists and policy makers, ICWG-CC, Alliance partners		
	2010 9.1.1 At least one decision aide that support strategic and tactical decision making in selecting appropriate responses to manage risks and capitalize on opportunities created by variable climate, developed and availed to stakeholders	NARES, NGOs, climatologists and policy makers	Decision makers identify and promote new strategies that exploit climate niches, through the use of tools that match commercial opportunities.	New strategies that exploit climate niches, through the use of tools that match commercial opportunities have brought improved livelihoods for the SAT poor

9.2. Affordable and sustainable crop management options (nutrients, water management, crop-livestock, IPM, cultivar, rotations) developed and promoted with associated capacity building in collaboration with NARES partners in Africa and Asia	2007 9.2.1 Precision application of low doses of N or P fertilizer on their own, or in combination with manure, widely disseminated in WCA and ESA regions 2007 9.2.2 Sahelian Eco-farm. 1st proof of concept tested and validated and report drafted.	NARES, NGOs, CBOs and policy makers, Alliance and CP partners, private sector	Partners (NARES, CBOs, private sector) promote better practice in using macro and micro nutrients, fertilizer microdosing, genetic resources, particularly legumes, and IPM strategies in rainfed and irrigated areas	Larger and better targeted investment in rainfed agriculture by a range of stakeholders (district policy makers, private sector, micro-finance institutions, extension services, meteorological departments, NGOs) has occurred
	2008 9.2.1 At least 2 technical options (nutrients, water management, crop-livestock, IPM, cultivar) provided for intensifying and diversifying production systems in low and high potential environments	NARES, NGOs and policy makers, Alliance SWEP and CP partners, the input and output private sector	NARES research capabilities enhanced through collaborative activities, use of new tools (simulation models and GIS) and training	Income and food production of smallholders has increased without further degradation of natural resource base
	2009 9.2.1 Capacity building of NARES partners to implement improved NRM approaches, including use of simulation models, for intensifying and diversifying cropping systems in low and high potential environments undertaken	NARES, NGOs and policy makers, Alliance, SWEP and Water CP partners	SWMnet and WFCP partners improve research efficiency, adopt improved practices/policies for enhancing water productivity and actively scale these out across the SAT	Pressure on the supply of water for irrigated land is reduced as rainfed agriculture has increased its contribution to food/feed production. NARES research capacity this area has been enhanced

Project 10 Narrative:
Virtual Academy for the Semi Arid Tropics (VASAT) in Asia and West and Central Africa

Rationale for the research within the context of SP' and the mandate, goals and objectives of the center
To improve agriculture and to mitigate the effects of drought, desertification and the other major constraints of SAT environments, there is an urgent need for a sustained information, communication, capacity building and social mobilization effort to link strategic sectors, especially most vulnerable rural communities, researchers, extension workers and policy-makers. The dictum "information is the backbone of drought preparedness" advocated by the UN accurately captures this need. Likewise, the UN Convention to Combat Desertification and Drought (UNCCD) has laid high importance on implementing a communication strategy, a blend of both top-down as well as bottom-up approaches, to support initiatives in combating drought and desertification. This project uses ICT-mediated methods to build the research and human resources capacity of our partners and helps ICRISAT to scale-out and scale-up its research results and technologies. We are harnessing recent advances in ICT and open-distance learning, as an innovative and cost-effective medium to inform, educate, and mobilize a critical mass of our partners and clients spread across big geographical areas in Asia. We are building partner power in West and Central Africa through a variety of participatory knowledge management methods to understand information needs and requirements and meet these with information IPG's and value-added products derived from them. We seek to enhance organizational information flows (internal as well as external) and make agricultural knowledge more accessible in the semi-arid tropics. This will eventually empower vulnerable rural communities to collectively identify problems, articulate their needs and take up informed action especially in times of drought and emergencies. This project will make a contribution to the achievement of MDG 8 on building global partnerships.

The target ecoregion, the beneficiaries and end users
The target ecoregion for this project is the SAT of Asia and West and Central Africa. The immediate beneficiaries of this research are our diverse and varied partners in these regions: the NARES communicators, educators, extensionists, NGO's, CBO's and the Open Learning agencies. The end users are the rural communities, especially the women and youth, who would benefit from improved levels of preparedness to drought and desertification events. The results are immediately IPGs as they will be available and applicable to any web enabled scientist, agricultural professional or farmer throughout the SAT.

Is the center a primary or secondary research provider?
The Center started as a primary research provider in this project. An example is the design of a pilot repository of learning objects. However, as partners build capacities in association with the Center, the task of building such repositories will be moved to them. There will be a change in focus, on making available more and newer IPG's to the partners from Center's research, using ICT-mediated methods.

Is it a catalyser, facilitator, enabler and/or advocate to influence the impact pathway and thus to help ensure outcomes and impact
The Center will play all these roles in this research project, but its primary role is to catalyse the development of new technology blends and to enable partners to access information IPG's. The Center will not be a core-technology developer, but will develop strategies for appropriate blend of technologies that the partners need to enhance preparedness levels among the end users. An example is the blended use of community radio with the digital satellite radio in Niger in the Kahe community. A large quantity of ICRISAT-generated IPG's are partially in digital format, and this project will design novel methods to render them fully in digital format consistent with global specifications. This will enable significantly improved access to IPG's by the partners, and will contribute to easy value addition by partners for delivery to the end users. Advocacy is needed on occasions to enable national policy makers to extend support to the NARES partners for inclusion of new technology blends in capacity strengthening and in extension.

A brief description of the comparative and complementary advantages of the project activities
ICRISAT is in an advantageous position to develop new prototypes in information and knowledge sharing with partners and end users. A number of software tools have been developed during 2004-05 which were peer reviewed for cost-effectiveness and suitability, and can now be used to develop novel content repositories. ICRISAT is also well placed in terms of human resources and capacity to adopt new methods (such as Web 2.0) to augment internal knowledge flows such that external partners can access internally generated information products. The Center also has considerable expertise in the use of participatory appraisal methods. Over the last three years, we have also developed capability to sustain a coalition of partners using online methods. Our

biggest comparative advantage is our internationality and global presence, which permits viable partnerships with partners from varied disciplines and countries to work together in sharing knowledge.

Where centers play a catalytic, facilitating, enabling or advocacy role complementary to the center's research role and their contribution to IPGs
During the last three years, the Center activities in capacity strengthening were cast in multiple roles, with its research focused on building a generic repository of learning materials. The catalyst role was and will be needed in the future to bring together core-technology development partners to build more flexible software tools that will be NARES-oriented. There is also a need to make core-software developments conform to global specifications. This will allow ICRISAT IPG's to be accessible in novel ways to an even wider, larger audience of NARES, NGO and CBO partners. Thus, the online system for accessing validated agricultural knowledge will itself be an IPG built on global specifications. The strategy for ICT-mediated information dissemination will be generic, combining participation with technology mediation, and thus will be an IPG in the area of extension communication. An example: over the year 2005, ICRISAT catalysed the offering of mass instruction (30000 learners) in India on drought-coping. The partner used a technology for one-way video and two-way audio with success. To expand it to other regions, even in India, a strategy for technology blending is needed and that will be generated on this project.

Problem Analysis, identification of specific problems that can be tackled by research focused on specific objectives
Drought preparedness on a mass scale in SAT Asia and WCA is an unprecedented process. It can be achieved through a combination of emerging methods of open learning, participatory rural information appraisal, and ICT-enabled rural information dissemination. There is a need to develop a common strategy based on a blend of these technologies which can be adopted for partners in the specific regions. The Center has created well-regarded instructional materials that need to be transformed into granules and objects consistent with the open learning approach. These can be used by partners to design information modules of their own, based on a participatory assessment of local information needs.

In order to achieve this, there is a need to develop two groups of activities:

1. Design of a Technology Blend and its Testing

Under this group of activities, we will focus on identification of partner information needs (including end user needs, through the partners), technology assessment, local capacities and resources, in order to develop a comprehensive knowledge sharing strategy that is tech-mediated (NOT tech-driven). This would be a contribution to the ongoing global search for novel knowledge sharing models that take research results to mass audience. Specific variants of this generic strategy will be tested with partners in two locations, one in Asia and another in WCA.

An integral component of activities on this group will be the design and development of a comprehensive repository of learning granules and objects derived from ICRISAT IPG's (instructional modules). There are no global procedures and protocols available for conversion of generic agricultural information and instruction into locally viable information materials. We will use this repository to develop a protocol for conversion of globally generated learning granules into local materials by partners. This will be anchored in a distributed grid of learning materials and in a training grid for partners.

2. Strengthening Knowledge Flows to Facilitate Ease of Access to the IPG's by Partners

Learning and instructional module IPG's need to be supplemented with the availability of a host of other information IPG's from the center. There is a need to develop systems, software and online tools to facilitate validation and rapid publication of information IPG's for easy access by partners and for co-creation where necessary. A blend of tools and methods from the emerging paradigm of Web 2.0, Open Access/e-prints and online communities of practice will be developed for use by ICRISAT staff and partners. A detailed report on their development, deployment and use by partners will be prepared.

Description of impact pathways and capacity building
We assume that to improve SAT agriculture and to mitigate the effects of drought, there is a need to develop an integrated knowledge sharing process that links the vulnerable rural families with researchers, policy makers

and extension workers (linked to Projects 3,5,6,7,8 and 9 + CSI and OASIS). The institutional strategy is to blend the recent developments in open and distance learning sector, (namely the granulation of learning and information materials and their re-combination to suit pedagogic and information management standards), and the hub-and-spokes model of ICT for development (combining the use of mobile phones, satellite and community radio and PC-based platforms) to launch and sustain this process with multiple partners in SAT Asia and WCA. This effort is linked to the GO FA University Consortium and supports graduate student research at local universities. A supporting strategic activity and capacity development will be to facilitate production and validation research information using highly accessible Web 2.0 methods that, **we assume** will enable NARES partners to collaborate in content generation and **we offer capacity development to help ensure this**.

Regional:
In SAT Asia, the KMS along with GT-AE, GT-CI and GT-IMPI will design an online repository of learning granules and objects that conform to global specifications and standards. In one rural cluster, ICRISAT and partners will test the process of knowledge sharing on a large scale with the repository-derived information and will use internet-connected rural access centers.

In WCA, the online repository will be used while the KMS and the DMP will conduct tests on mass dissemination using a blend of satellite digital radio and community radio.

Impact Pathway Assessment and IPG Activities:

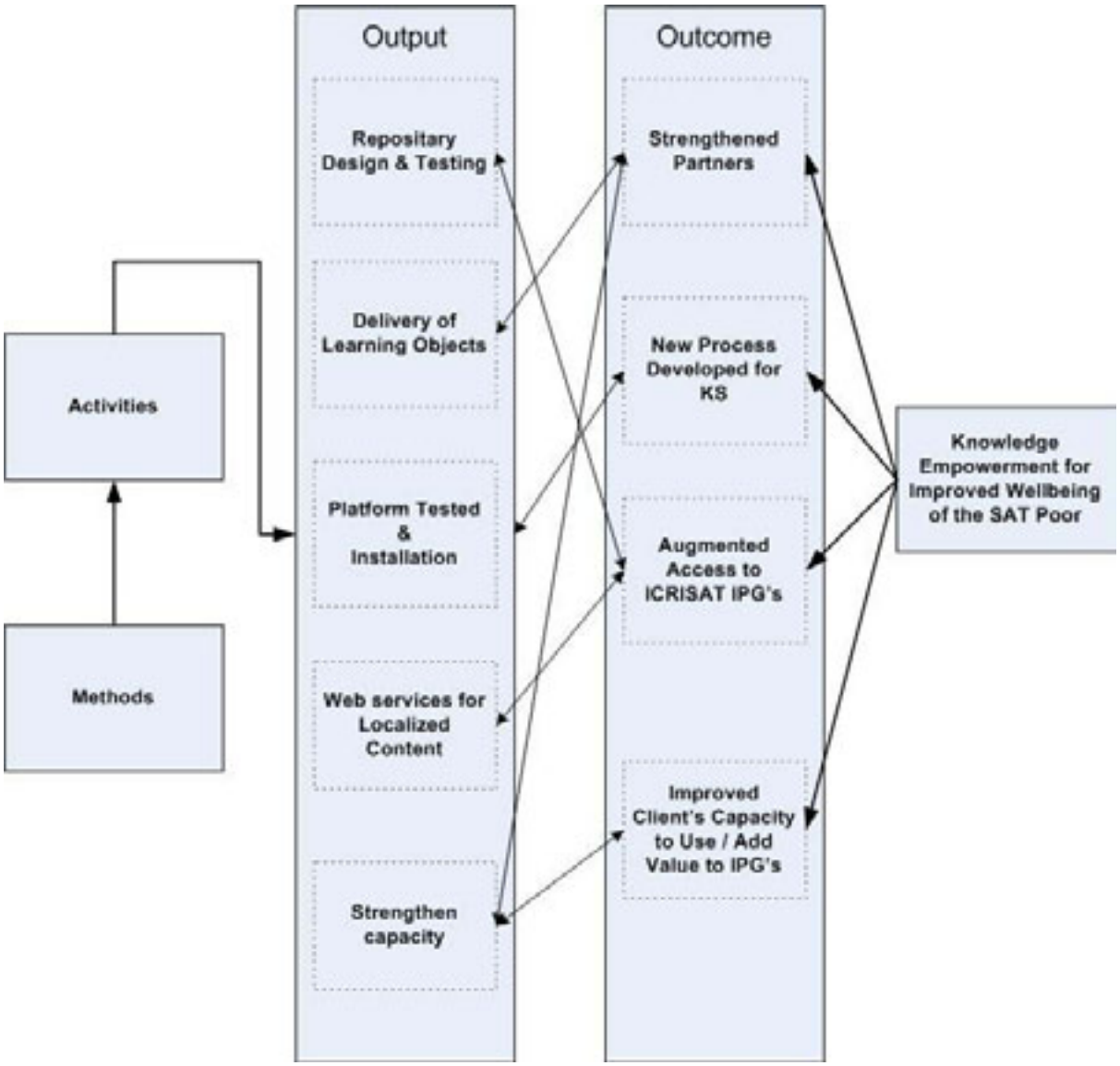
- Baseline information needs in one location in SAT Asia and another in WCA assessed using ethnographic action research (UNESCO) and the FAO's Participatory Rural Communication Appraisal methods will be gathered.
- User surveys to assess changes in information demand and in use patterns will be conducted
- Number of learning modules created in the LO repository in granular, re-useable form will be assessed
- Number of granules used or localized by the partners as evident in their web sites or radio scripts will be measured
- Number of learners passing through the partners' channels will be quantified
- Number of Blogs, Wiki articles and entries in E-print server of ICRISAT will be monitored

Identification of Partner Roles:

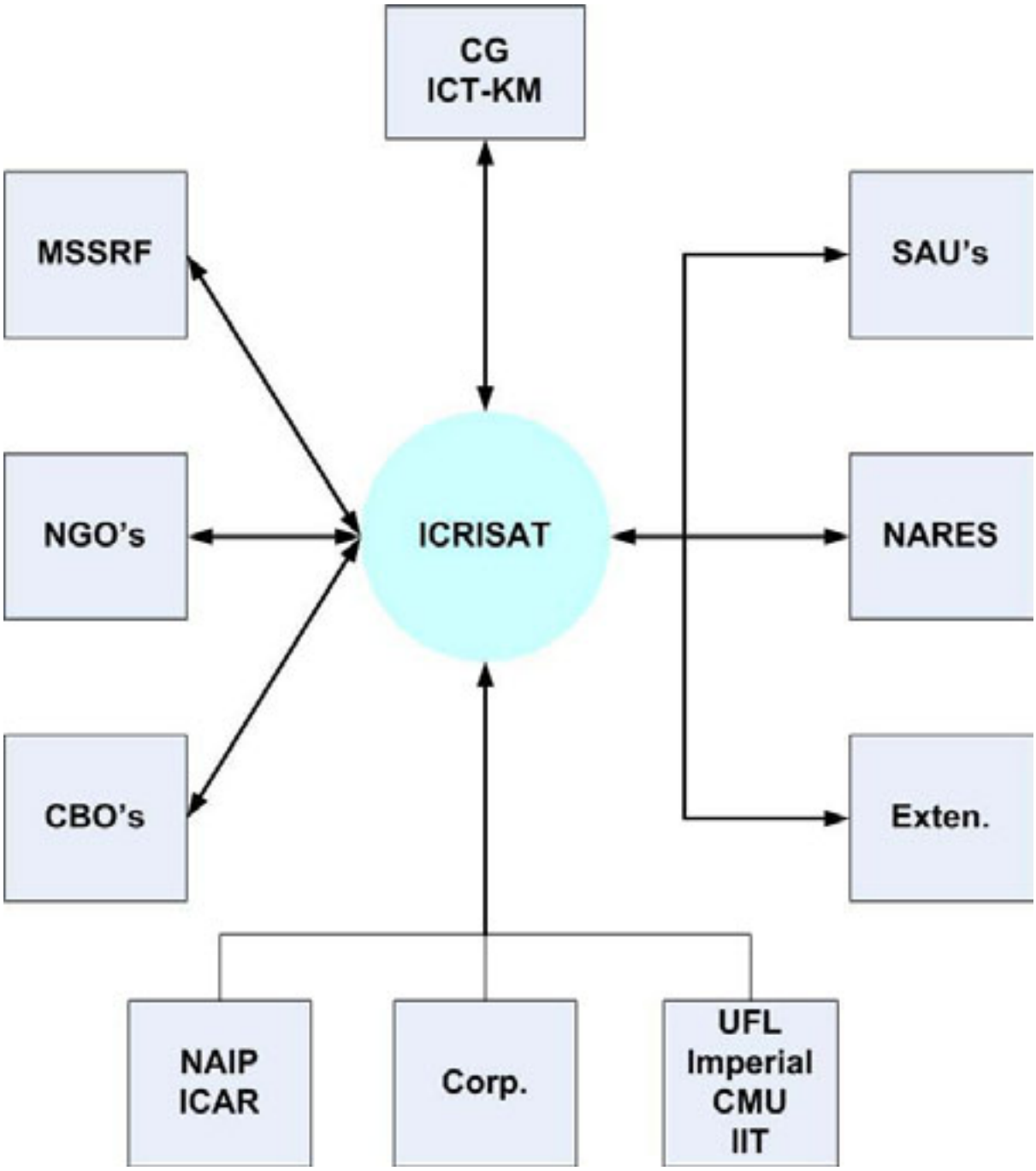
- LO repository:
    - Platform design and management: ICRISAT KMS
    - Nuclear content and validation: ICRISAT GT's AE and CI
    - Assessment of sample LO's for suitability in pedagogy: the COL (Commonwealth of Learning)
    - Ontology design: ICRISAT KMS with FAO
    - Rural users' localization and assessment: GT-IMPI with CSO partners (AMS in India)

- Strengthening Knowledge Flows and capacity building:
    - User tests on the platform: One OU (YCMOU) and one SAU (ANGRAU) in SAT Asia and RANET in WCA
    - Collaborative content creation on the platform with one NARES partner in SAT Asia (CRIDA-ICAR) and the DMP. See also the network map below.

Key Strategic Partners: VASAT Consortium (expertise in on-line educational techniques), FAO (expertise in ontological study issues).



Objective tree for Project 10 to meet the goal of knowledge empowerment for the improved wellbeing of the poor in the SAT



Network Diagram for Project 10

Logframe Project 10: The Virtual Academy for the African and Asian SAT

Outputs	Output targets	Intended users	Outcomes	Impact
10.1. ICT-mediated knowledge sharing strategy developed and implemented with partners and online, web-based repository of learning materials designed and developed in the public domain with appropriate capacity building	2007 10.1.1 Repository design with one group of objects completed and tested and report shared with partners	NARES, University and extension organizations, CBOs and NGOs, ICT/KM IARC partners, private sector	Strengthening of both real-time as well as virtual partnerships in content creation, validation, delivery and impact assessment.	NARES capacity to foster drought preparedness has been enhanced in Asia; and partner capacity has been augmented in WCA to combat desertification and drought-induced stresses.
	2008 10.1.1 Prototype for delivery of learning objects for partner transformation tested with two partners 2008 10.1.2 Repository design finalized (for large scale use) and documented for publication			
	2009 10.1.1 Platform installed in 3 partner organizations			
	2010 10.1.1 Joint evaluation with partners completed and document on effectiveness of new delivery service developed and shared with all partners			
10.2. New approaches for enhanced access to ICRISAT IPG's developed, tested and shared with partners	2007 10.2.1 Two capacity strengthening workshops on localization undertaken with two partners and reports published	NARES and global technology partners, ICT/KM, SWEP and Alliance members.	Augmented access to IPG's by NARES and CBO partners brings enhanced capacity to add value to IPG's for more localized use.	Improved adoption of ICRISAT materials and technologies by partners has led to better conservation, and more sustainable and integrated use of genetic and natural resources.
	2008 10.2.1 Editable web-based documentation on LO creation and localization developed and tested with three partners			
	2009 10.2.1 New approach based on web services tested for localization with two partners			
	2010 10.2.1 Document on the new LO approach and effectiveness developed and published			

Appendix 1: Desert Margins Program (DMP)

For the text associated with the DMP, please see Project 8

DMP : Budget by Outputs and Activities (US $) Phases 1 to 3

Activities	Project Phase	Baseline	Alternative	Co-funding	GEF
Output A. Nine benchmark site characterization on the improved understanding of ecosystem dynamics with regard to loss of biodiversity completed and synthesized by 2008					
A.1. Inventory of endemic species	1	2,093,863	3,634,370	906,161	634,346
A.2. Ecosystems stability	2	2,415,909	3,740,909	657,143	667,857
A.3. Document IK	1	404,500	581,720	151,850	25,370
A.4. Inventory of endangered species	1	12,400	124,460	106,225	5,835
A.5. Biodiversity degradation	2	497,000	1,132,000	335,000	300,000
A.6. Regeneration	2	12,180	173,960	121,780	40,000
A.7. Restoration of biodiversity	2	717,175	930,175	111,000	102,000
A.8. Characterization of benchmarks	1	276,000	1,313,000	801,000	236,000
A.9. Standardized data collection	1	1,256,133	2,736,133	895,000	585,000
A.10. Identify social skills	2	625,000	1,115,000	310,000	180,000
A.11. Develop packages	3	500,000	1,315,000	580,000	235,000
A.12. Scaling up methodologies	3	1,534,857	4,336,785	1,669,071	1,132,857
A.13. Modeling	3	590,000	1,252,000	340,000	322,000
Total A		***10,935,017***	***22,385,512***	***6,984,230***	***4,466,265***
Output B. Crop, tree and livestock integration strategies incorporating enhanced water and nutrient use techniques with appropriate capacity building measures developed and promoted for agro-diversity management, commercialization of agricultural enterprises and improved human and livestock health. Knowledge shared annually and strategies formalized by the end of the DMP Phase II in 2009					
B.1. Document best-bet practices	1	813,043	1,850,727	803,290	235,738
B.2. Pilot technologies	1	401,658	1,738,393	932,400	404,335
B.3. Adoption and implementation	2	1,014,176	2,461,938	1,009,665	438,097
B.4. Conservation and restoration	3	647,371	1,991,716	939,131	405,214
B.5. Enhance IK	3	203,200	1,235,200	792,880	239,120
B.6. Overall synthesis	3	485,000	1,548,640	608,640	455,000
B.7. Assess Training needs	1	946,904	2,600,970	912,554	741,512
B.8 Develop training programs	1	929,029	2,976,617	1,378,469	669,119
B.9 Planning and implementation	2	813,333	2,788,333	1,202,000	773,000
B10. Sensitize partners	2	1,214,272	2,871,272	1,398,600	258,400
B11. Organize training courses	2	654,500	3,255,150	2,132,960	467,690
B12. Information packages	3	338,100	1,104,330	416,250	349,980
B13. Training packages	3	317,125	2,335,425	1,528,300	490,000
B14. Livelihoods options	1	1,047,500	2,500,650	1,008,150	445,000
B15. Empower communities	1	58,100	670,800	543,100	69,600
B16. Implement best-bet options	3	826,462	2,687,862	1,408,900	452,500
Total B		***10,709,773***	***34,618,023***	***17,015,289***	***6,894,305***

Activities	Project Phase	Baseline	Alternative	Co-funding	GEF
Output C . Policy briefs and policies facilitating the uptake and upscaling of NRM and intensification/ diversification technology options and enhancing the conservation of biodiversity and reducing land degradation with associated capacity building measures devised and promoted in SSA by the end of the DMP Phase II in 2009 and knowledge shared annually					
C1. Document existing policies	1	757,219	1,838,834	461,615	620,000
C2. Develop policy documents	2	27,266	805,631	594,365	184,000
C3. Implement policies	3	789,800	797,165	1,124,365	623,000
C4. Promote soil fertility	2	1,027,933	2,740,033	1,017,100	695,000
C5.Promote integrated land and pastoral spaces	2	415,000	1,545,000	920,000	210,000
C6. Promote multiple land use systems	3	150,000	1,400,000	650,000	600,000
C7.Integrated management of biodiversity	3	201,714	1,446,737	1,183,872	61,151
C8. Support to NARS	2	1,195,000	2,931,000	800,000	936,000
C9. Participation of vulnerable groups	1	254,333	1,246,797	732,185	260,279
C10.Permanent dialogue framework	1	100,000	755,000	600,000	55,000
C11. Scientific teams exchanges	2	1,575,000	3,394,286	1,454,286	365,000
Total C		***6,493,265***	***18,900,483***	***9,537,788***	***4,609,430***
Grand Total				**33,537,307**	**15,970,000**

Appendix 2: Financial Tables

Table 1

ICRISAT-Cost Allocation : Allocation of Projects Costs to CGIAR System Priorities, 2006 - 2010
(In US $ Million)

Project	System Priorities	2006 (Actuals)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
1. Improving Policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT						
	Priority 5A	2.937	2.139	1.509	1.554	1.601
	Priority 5B	0.938	1.434	2.282	2.350	2.421
	Priority 5C	0.450	0.573	0.420	0.433	0.446
	Priority 5D	0.547	0.712	0.557	0.574	0.591
	TOTAL BY PROJECT	4.872	4.858	4.768	4.911	5.059
2.Sustaining biodiversity of Sorghum, Pearl Millet, Small Millets,Groundnut,Pigeonpea and Chickpea for current and future generations						
	Priority 1A	2.156	2.875	3.211	3.307	3.407
	Priority 1B	1.844	1.026	1.418	1.461	1.504
	Priority 2B	0.017	0.308	0.467	0.481	0.495
	TOTAL BY PROJECT	4.017	4.209	5.096	5.249	5.406
3. Producing more and better food at lower cost of the staple cereals and legumes of the WCA SAT (Sorghum, Pearl Millet and Groundnut) through genetic imp.						
	Priority 2A	1.467	1.689	1.554	1.601	1.649
	Priority 2B	0.581	0.742	0.850	0.875	0.902
	Priority 2C	0.528	0.664	0.592	0.610	0.628
	TOTAL BY PROJECT	2.576	3.095	2.996	3.086	3.179
4. Producing more and better food at lower cost of the staple cereals and legumes of the ESA SAT (Sorghum, Millets, Groundnut, Pigeon pea and Chickpea) through genetic improvement						
	Priority 2A	1.337	1.236	1.186	1.222	1.258
	Priority 2B	0.897	0.982	1.095	1.128	1.162
	Priority 2C	0.465	0.582	0.509	0.524	0.540
	TOTAL BY PROJECT	2.699	2.800	2.790	2.874	2.960

Table 1

5. Producing more and better food at lower cost of staple cereal and legume hybrids in the Asian SAT (Sorghum, Pearl Millet and Pigeon pea) through genetic improvement.	Priority 2A	0.750	0.745	0.817	0.842	0.867
	Priority 2B	0.668	0.575	0.678	0.698	0.719
	Priority 2C	0.581	0.587	0.649	0.668	0.689
	Priority 2D	0.044	0.042	0.072	0.074	0.076
	TOTAL BY PROJECT	2.043	1.949	2.216	2.282	2.351
6. Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (Sorghum, Millets, Pigeon pea, Chickpea and Groundnut through genetic improvement	Priority 2A	1.062	1.286	1.552	1.599	1.647
	Priority 2B	0.785	0.841	1.248	1.285	1.324
	Priority 2C	0.980	0.744	1.098	1.131	1.165
	TOTAL BY PROJECT	2.827	2.871	3.898	4.015	4.136
7. Reducing Rural poverty through Agricultural Diversification and Emerging Opportunities for High-Value Commodities and products	Priority 3A	2.392	2.120	2.155	2.220	2.286
	Priority 3B	0.468	0.635	0.970	0.999	1.029
	Priority 3D	0.368	0.329	0.367	0.378	0.389
	TOTAL BY PROJECT	3.228	3.084	3.492	3.597	3.704
8. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources, particularly at the Desert Margins of the Sahel and the dry lands of ESA	Priority 4A	3.257	1.835	2.110	2.173	2.238
	TOTAL BY PROJECT	3.257	1.835	2.110	2.173	2.238

Table 1

ICRISAT-Cost Allocation : Allocation of Projects Costs to CGIAR System Priorities, 2006 - 2010
(In US $ Million)

Project	System Priorities	2006 (Actuals)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
9. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources through sustainable agro-ecological intensification in low- and high-potential environments						
	Priority 4A	0.953	0.742	0.317	0.327	0.336
	Priority 4C	1.608	1.521	1.435	1.477	1.521
	Priority 4D	2.598	2.777	2.960	3.049	3.141
	TOTAL BY PROJECT	5.159	5.040	4.712	4.853	4.998
10. The Virtual Academy for the African and Asian SAT						
	New Research Areas	1.393	1.350	1.197	1.233	1.270
	TOTAL BY PROJECT	1.393	1.350	1.197	1.233	1.270
11. Others (Development Oriented Activities, Science Park Activities, Generic Training etc.)						
	Development Activities	1.171	1.287	1.214	1.251	1.288
	Stand-alone Training	0.670	0.057	0.064	0.066	0.068
	New Research Areas	0.186	0.175	0.177	0.182	0.188
	TOTAL BY PROJECT	2.027	1.519	1.455	1.499	1.544
	TOTAL BY CENTER	**34.098**	**32.610**	**34.730**	**35.772**	**36.845**

Table 2

ICRISAT - Cost Allocation of Resources by CGIAR System Priority 2006 - 2010

(In US dollar Million)

Priorities	Actuals 2006	Estimated 2007	Proposal 2008	Plan 1 2009	Plan 2 2010
Priority 1A	2.156	2.875	3.211	3.307	3.407
Priority 1B	1.844	1.026	1.418	1.461	1.504
Priority 2A	4.616	4.956	5.109	5.262	5.421
Priority 2B	2.948	3.448	4.338	4.467	4.602
Priority 2C	2.554	2.577	2.848	2.933	3.022
Priority 2D	0.044	0.042	0.072	0.074	0.076
Priority 3A	2.392	2.120	2.155	2.220	2.286
Priority 3B	0.468	0.635	0.970	0.999	1.029
Priority 3D	0.368	0.329	0.367	0.378	0.389
Priority 4A	4.210	2.577	2.427	2.500	2.574
Priority 4C	1.608	1.521	1.435	1.477	1.521
Priority 4D	2.598	2.777	2.960	3.049	3.141
Priority 5A	2.937	2.139	1.509	1.554	1.601
Priority 5B	0.938	1.434	2.282	2.350	2.421
Priority 5C	0.450	0.573	0.420	0.433	0.446
Priority 5D	0.547	0.712	0.557	0.574	0.591
Development Activities	1.171	1.287	1.214	1.251	1.288
Stand-alone Training	0.670	0.057	0.064	0.066	0.068
New Research Areas	1.579	1.525	1.374	1.416	1.458
Total	**34.098**	**32.610**	**34.730**	**35.772**	**36.845**

Table 3

ICRISAT - Cost Allocation : Project Cost Summary, 2006 – 2010

(In US dollar Million)

Project	Actuals 2006	Estimated 2007	Proposal 2008	Plan 1 2009	Plan 2 2010
1. Improving Policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT	4.872	4.858	4.768	4.911	5.059
2.Sustaining biodiversity of Sorghum, Pearl Millet, Small Millets,Groundnut,Pigeonpea and Chickpea for current and future generations	4.017	4.209	5.096	5.249	5.406
3. Producing more and better food at lower cost of the staple cereals and legumes of the WCA SAT (Sorghum, Pearl Millet and Groundnut) through genetic imp.	2.576	3.095	2.996	3.086	3.179
4. Producing more and better food at lower cost of the staple cereals and legumes of the ESA SAT (Sorghum, Millets, Groundnut, Pigeon pea and Chickpea) through genetic improvement	2.699	2.800	2.790	2.874	2.960
5. Producing more and better food at lower cost of staple cereal and legume hybrids in the Asian SAT (Sorghum, Pearl Millet and Pigeon pea) through genetic improvement.	2.043	1.949	2.216	2.282	2.351
6. Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (Sorghum, Millets, Pigeon pea, Chickpea and Groundnut through genetic improvement	2.827	2.871	3.898	4.015	4.136
7. Reducing Rural poverty through Agricultural Diversification and Emerging Opportunities for High-Value Commodities and products	3.228	3.084	3.492	3.597	3.704
8. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources, particularly at the Desert Margins of the Sahel and the dry lands of ESA	3.257	1.835	2.110	2.173	2.238
9. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources through sustainable agro-ecological intensification in low- and high-potential environments	5.159	5.040	4.712	4.853	4.998

Table 3

ICRISAT - Cost Allocation : Project Cost Summary, 2006 – 2010

(In US dollar Million)

Project	Actuals 2006	Estimated 2007	Proposal 2008	Plan 1 2009	Plan 2 2010
10. The Virtual Academy for the African and Asian SAT	1.393	1.350	1.197	1.233	1.270
11. Others (Development Oriented Activities, Science Park Activities, Generic Training etc.)	2.027	1.519	1.455	1.499	1.544
Total	**34.098**	**32.610**	**34.730**	**35.772**	**36.845**

Table 4

ICRISAT-Undertaking, Activities and Sectors, 2006-2010
(in US $ million)

Undertaking, Activities and Sectors	2006 (Actuals)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
Increasing Productivity	**16.259**	**16.225**	**17.539**	**18.065**	**18.608**
Germplasm Enhancement & Breeding	9.108	9.880	10.878	11.204	11.541
Production Systems Development & Management	7.151	6.345	6.661	6.861	7.067
Cropping systems	6.435	5.711	5.995	6.175	6.360
Livestock systems	0.501	0.444	0.466	0.480	0.495
Tree systems	0.215	0.190	0.200	0.206	0.212
Fish systems	0.000	0.000	0.000	0.000	0.000
Protecting the Environment	**5.466**	**4.841**	**5.086**	**5.239**	**5.396**
Saving Biodiversity	**2.909**	**2.609**	**2.772**	**2.854**	**2.940**
Improving Policies	**4.286**	**4.141**	**4.225**	**4.352**	**4.482**
Strengthening NARS	**5.178**	**4.794**	**5.108**	**5.262**	**5.419**
Training and Professional Development	2.862	2.645	2.826	2.911	2.998
Documentation, Publications, Info. Dissemination	1.846	1.717	1.825	1.880	1.936
Organization & Management Counseling	0.000	0.000	0.000	0.000	0.000
Networks	0.470	0.432	0.457	0.471	0.485
TOTAL BY CENTER	**34.098**	**32.610**	**34.730**	**35.772**	**36.845**

Table 5

ICRISAT-Cost Allocation: Allocation of Projects Cost to CGIAR Regions, 2006-2010
(in $ million)

Project	Regions	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
1. Improving Policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT						
	SSA	2.874	2.915	2.861	2.947	3.035
	Asia	1.998	1.943	1.907	1.965	2.024
	TOTAL BY PROJECT	4.872	4.858	4.768	4.912	5.059
2.Sustaining biodiversity of Sorghum, Pearl Millet, Small Millets,Groundnut,Pigeon pea and Chickpea for current and future generations						
	SSA	2.370	2.525	3.058	3.149	3.244
	Asia	1.647	1.684	2.038	2.100	2.162
	TOTAL BY PROJECT	4.017	4.209	5.096	5.249	5.406
3. Producing more and better food at lower cost of the staple cereals and legumes of the WCA SAT (Sorghum, Pearl Millet and Groundnut) through genetic improvement.						
	SSA	1.520	1.857	1.798	1.851	1.907
	Asia	1.056	1.238	1.198	1.234	1.272
	TOTAL BY PROJECT	2.576	3.095	2.996	3.085	3.179
4. Producing more and better food at lower cost of the staple cereals and legumes of the ESA SAT (Sorghum, Millets, Groundnut, Pigeon pea and Chickpea) through genetic improvement						
	SSA	1.592	1.680	1.674	1.724	1.776
	Asia	1.107	1.120	1.116	1.149	1.184
	TOTAL BY PROJECT	2.699	2.800	2.790	2.873	2.960
5. Producing more and better food at lower cost of staple cereal and legume hybrids in the Asian SAT (Sorghum, Pearl Millet and Pigeon						

Table 5

ICRISAT-Cost Allocation: Allocation of Projects Cost to CGIAR Regions, 2006-2010
(in $ million)

Project	Regions	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
pea) through genetic improvement.						
	SSA	1.205	1.169	1.330	1.369	1.411
	Asia	0.838	0.780	0.886	0.913	0.940
	TOTAL BY PROJECT	2.043	1.949	2.216	2.282	2.351
6. Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (Sorghum, Millets, Pigeon pea, Chickpea and Groundnut through genetic improvement						
	SSA	1.668	1.723	2.339	2.409	2.482
	Asia	1.159	1.148	1.559	1.606	1.654
	TOTAL BY PROJECT	2.827	2.871	3.898	4.015	4.136
7. Reducing Rural poverty through Agricultural Diversification and Emerging Opportunities for High-Value Commodities and products						
	SSA	1.905	1.850	2.095	2.158	2.222
	Asia	1.323	1.234	1.397	1.439	1.482
	TOTAL BY PROJECT	3.228	3.084	3.492	3.597	3.704
8. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources, particularly at the Desert Margins of the Shale and the dry lands of ESA						
	SSA	1.922	1.101	1.266	1.304	1.343
	Asia	1.335	0.734	0.844	0.869	0.895
	TOTAL BY PROJECT	3.257	1.835	2.110	2.173	2.238

Table 5

ICRISAT-Cost Allocation: Allocation of Projects Cost to CGIAR Regions, 2006-2010
(in $ million)

Project	Regions	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
9. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources through sustainable agro-ecological intensification in low- and high-potential environments						
	SSA	3.044	3.024	2.827	2.912	2.999
	Asia	2.115	2.016	1.885	1.941	1.999
	TOTAL BY PROJECT	5.159	5.040	4.712	4.853	4.998
10. The Virtual Academy for the African and Asian SAT						
	SSA	0.822	0.810	0.718	0.740	0.762
	Asia	0.571	0.540	0.479	0.493	0.508
	TOTAL BY PROJECT	1.393	1.350	1.197	1.233	1.270
11. Others (Development Oriented Activities, Science Park Activities, Generic Training etc.)						
	SSA	1.196	0.911	0.873	0.900	0.926
	Asia	0.831	0.608	0.582	0.600	0.618
	TOTAL BY PROJECT	2.027	1.519	1.455	1.500	1.544
TOTAL BY CENTER		**34.098**	**32.610**	**34.730**	**35.772**	**36.845**

Table 6

ICRISAT
Research Agenda : Expenditure by Functional Category 2006 – 2010
(in US$ million)

Object of Expenditure	2006 Actual	2007 Estimate	2008 Proposed	2009 Plan	2010 Plan
Personnel	15.889	16.910	17.530	18.056	18.598
Supplies and Services	10.708	8.010	9.441	9.724	10.016
Collaborators/Partnership	3.989	4.029	4.069	4.191	4.317
Operational Travel	2.833	2.861	2.890	2.977	3.066
Depreciation	0.679	0.800	0.800	0.824	0.848
TOTAL	**34.098**	**32.610**	**34.730**	**35.772**	**36.845**

Table 7

ICRISAT
Research Agenda : Financing 2006 - 2008
(in US$ million)

Member	2006 Actuals	2007 Estimate	2008 Proposed
Unrestricted Grants			
Australia	0.375	0.377	0.377
Belgium	0.245	0.254	0.254
Canada	0.799	0.766	0.766
China	0.060	0.060	0.060
Germany	0.304	0.197	0.197
India	0.150	0.150	0.150
Ireland	0.437	0.262	0.262
Israel	0.185	0.185	0.185
Japan	0.046	0.052	0.052
Korea	0.050	0.050	0.050
Morocco	0.012	-	-
Netherlands	0.289	-	-
Norway	1.229	1.126	1.126
Philippines	0.032	0.032	0.032
Sweden	0.495	0.538	0.538
Switzerland	0.736	0.735	0.735
Thailand	0.010	0.010	0.010
USA	2.303	2.428	2.428
UK	1.817	1.544	1.544
World Bank	1.700	1.700	1.700
Total	**11.274**	**10.466**	**10.466**

Table 7

ICRISAT
Research Agenda : Financing 2006 - 2008
(in US$ million)

Member	2006 Actuals	2007 Estimate	2008 Proposed
Targeted Grants			
Globally Restricted			
CEC (European Union)	-	1.376	1.376
France	0.096	0.098	0.098
India	0.520	0.521	0.521
Iran	0.030	0.030	0.030
Italy	0.077	0.079	0.079
Japan	0.220	0.220	0.220
World Bank	0.286	-	-
Total	**1.229**	**2.324**	**2.324**
Sub Total	**12.503**	**12.790**	**12.790**
Restricted Projects			
ADB	0.138	-	-
AGRHYMET, Niger	0.006	-	-
Australia	0.430	0.561	0.468
Belgium	0.465	0.364	0.145
BMG & F	0.322	0.191	0.210
Canada	0.343	0.999	0.926
CEC (European Union)	0.763	1.066	0.957
CFC	0.791	0.716	0.513
Challenge Programs-Generation	0.570	1.068	1.717
Challenge Programs-Harvest Plus	0.302	0.212	0.295
Challenge Programs-Water and Food	0.945	0.733	1.052
CORAF	0.045	0.027	0.055
CRS	0.033	0.010	-

Table 7

ICRISAT
Research Agenda : Financing 2006 - 2008
(in US$ million)

Member	2006 Actuals	2007 Estimate	2008 Proposed
FAO	0.125	0.084	-
Finland	0.071	0.218	0.100
Germany	0.890	0.958	0.930
IFAD	0.824	0.935	1.922
India	1.129	2.257	2.660
Iran	0.003	0.020	0.006
Islamic Development Bank	0.068	0.033	-
Italy	0.020	-	-
Japan	0.006	0.024	0.005
Mcknight Foundation	0.090	0.280	0.309
Mozambique	0.532	0.247	-
Netherlands	0.395	0.558	0.666
Norway	0.056	0.074	-
OPEC	0.072	-	-
Philippines	0.029	0.022	0.015
Pool of Donors	0.329	0.362	0.023
Rockefeller Foundation	0.244	0.119	0.102
Seed Companies	0.610	0.664	1.035
Sir Dorabji Tata Trust	0.265	0.140	-
Syngenta Foundation	0.032	0.189	0.167
Switzerland	0.041	0.055	-
Tanzania	-	0.046	0.086
UK	0.844	0.272	0.300
UNEP/GEF	3.398	1.250	1.569

Table 7

ICRISAT

Research Agenda : Financing 2006 - 2008

(in US$ million)

Member	2006 Actuals	2007 Estimate	2008 Proposed
USA	3.952	2.542	3.260
World Bank	0.592	0.427	0.426
WWF	0.015	-	-
Various	0.137	0.277	0.081
Total	**19.922**	**18.000**	**20.000**
Total Targeted	**21.151**	**20.324**	**22.324**
Total Grants	**32.425**	**30.790**	**32.790**

Table 8

ICRISAT-Financing: Allocation of Members/Non Members Grants to Projects, 2006-2008
(in US $ million)

Project	Members/Non Members	2006 (Actuals)	2007 (estimated)	2008 (proposal)
1. Improving Policies and facilitating institutional innovation, markets and impact to support the sustained reduction of poverty and hunger in the SAT	**MEMBERS**			
	Australia	-	0.014	-
	European Commission	-	0.459	0.459
	FAO	0.051	0.048	-
	Germany	-	0.006	-
	India	0.011	0.159	0.194
	Netherlands	0.136	0.148	0.163
	Philippines	0.006	0.004	0.007
	United Kingdom	0.013	-	-
	United States	2.665	1.867	2.520
	World Bank	0.217	0.138	
	TOTAL MEMBERS	3.099	2.843	3.343
	NON MEMBERS			
	Catholic Relief Services	0.017	0.005	-
	Common Fund for Commodities	0.189	0.207	-
	IFPRI	0.057	0.101	-
	IPGRI	-	0.002	-
	ICARDA	-	0.011	-
	ILRI	0.013	0.038	-
	Mozambique	-	0.170	-
	McKnight Foundation	0.022	0.030	0.033
	Others	0.022	0.073	-
	TOTAL NON MEMBERS	0.320	0.637	0.033
	TOTAL MEMBERS + NON MEMBERS	3.419	3.480	3.376
	Unrestricted + center inc	1.453	1.378	1.392
	TOTAL BY PROJECT	4.872	4.858	4.768
2.Sustaining biodiversity of Sorghum, Pearl Millet, Small Millets,Groundnut,Pigeonpea and Chickpea for current and future generations	**MEMBERS**			
	Australia	0.010	0.022	
	European Commission	-	0.458	0.459
	FAO	0.024	-	
	France	0.048	0.049	0.049
	Germany	0.173	0.157	0.307
	India	0.337	0.947	1.196
	Iran	-	0.019	
	Japan	0.080	0.080	0.080
	Netherlands	-	0.013	0.013
	Rockefeller Foundation	0.016	0.030	0.057
	Switzerland	0.021	0.027	-

Table 8

ICRISAT-Financing: Allocation of Members/Non Members Grants to Projects, 2006-2008
(in US $ million)

Project	Members/Non Members	2006 (Actuals)	2007 (estimated)	2008 (proposal)
	Syngenta Foundation	0.021	-	-
	UNEP	1.333	0.531	0.963
	United States	0.201	0.103	-
	World Bank	0.422	0.192	0.426
	TOTAL MEMBERS	2.686	2.628	3.550
	NON MEMBERS			
	Generation/CP	0.180	0.288	0.178
	HarvestPlus/CP	0.068	0.021	0.070
	IPGRI	0.026	0.033	-
	Others	-	0.021	0.033
	TOTAL NON MEMBERS	0.274	0.363	0.281
	TOTAL MEMBERS + NON MEMBERS	2.960	2.991	3.831
	Unrestricted + center inc	1.057	1.218	1.265
	TOTAL BY PROJECT	4.017	4.209	5.096
3. Producing more and better food at lower cost of the staple cereals and legumes of the WCA SAT (Sorghum, Pearl Millet and Groundnut) through genetic imp.	**MEMBERS**			
	Australia	0.010	0.021	-
	Canada	-	0.030	0.063
	Germany	0.456	0.479	0.308
	IFAD	0.166	0.361	0.455
	India	-	0.015	0.016
	Italy	0.038	0.039	0.040
	Japan	0.006	0.020	0.020
	Netherlands	0.088	0.155	0.199
	Rockefeller Foundation	0.095	0.067	0.102
	Syngenta Foundation	0.003	0.069	0.084
	Switzerland	0.021	0.027	-
	United States	0.163	0.123	-
	TOTAL MEMBERS	1.046	1.406	1.287
	NON MEMBERS			
	Bill and Melinda Gates Foundation	-	0.284	0.683
	Catholic Relief Services	0.016	0.005	-
	Common Fund for Commodities	0.189	0.207	-
	Generation/CP	0.127	0.149	0.047
	HarvestPlus/CP	0.151	0.107	0.148
	ILRI	0.019	0.007	-
	IPGRI	0.020	-	-
	McKnight Foundation	0.057	0.152	0.169
	Others	-	0.021	0.032
	TOTAL NON MEMBERS	0.579	0.932	1.079
	TOTAL MEMBERS + NON MEMBERS	1.625	2.338	2.366
	Unrestricted + center inc	0.951	0.757	0.630
	TOTAL BY PROJECT	2.576	3.095	2.996

Table 8

ICRISAT-Financing: Allocation of Members/Non Members Grants to Projects, 2006-2008
(in US $ million)

Project	Members/Non Members	2006 (Actuals)	2007 (estimated)	2008 (proposal)
4. Producing more and better food at lower cost of the staple cereals and legumes of the ESA SAT (Sorghum, Millets, Groundnut, Pigeonpea and Chickpea) through genetic improvement	**MEMBERS**			
	European Commission	0.343	0.664	0.459
	France	0.048	0.049	0.049
	Germany	0.192	0.015	0.016
	IFAD	0.266	0.144	-
	India	0.260	0.029	-
	Japan	0.020	-	-
	Netherlands	0.022	0.078	0.115
	Rockefeller Foundation	0.165	0.082	0.057
	Syngenta Foundation	0.008	0.120	0.084
	United States	0.009	-	-
	World Bank	0.095	-	-
	TOTAL MEMBERS	1.428	1.181	0.780
	NON MEMBERS			
	ASARECA	0.089	0.160	0.316
	Bill and Melinda Gates Foundation	0.322	0.475	0.893
	Harvest Plus/CP	0.083	-	-
	Generation/CP	0.048	0.011	0.010
	ILRI	0.002	-	-
	McKnight Foundation	0.003	0.082	0.090
	TOTAL NON MEMBERS	0.547	0.728	1.309
	TOTAL MEMBERS + NON MEMBERS	1.975	1.909	2.089
	Unrestricted + center inc	0.724	0.891	0.701
	TOTAL BY PROJECT	2.699	2.800	2.790
5. Producing more and better food at lower cost of staple cereal and legume hybrids in the Asian SAT (Sorghum, Pearl Millet and Pigeon pea) through genetic improvement.	**MEMBERS**			
	India	0.114	0.199	0.061
	OPEC Fund	0.036	-	-
	United Kingdom	0.016	0.002	
	TOTAL MEMBERS	0.166	0.201	0.061
	NON MEMBERS			
	Harvest Plus/CP	-	0.086	0.078
	Generation/CP	0.091	-	
	ICARDA	0.007	-	
	Seed Companies	0.610	0.629	1.035
	TOTAL NON MEMBERS	0.708	0.715	1.113
	TOTAL MEMBERS + NON MEMBERS	0.874	0.916	1.174
	Unrestricted + center inc	1.169	1.033	1.042

Table 8

ICRISAT-Financing: Allocation of Members/Non Members Grants to Projects, 2006-2008
(in US $ million)

Project	Members/Non Members	2006 (Actuals)	2007 (estimated)	2008 (proposal)
	TOTAL BY PROJECT	2.043	1.949	2.216
6. Producing more and better food at lower cost of staple open-pollinated cereals and legumes in the Asian SAT (Sorghum, Millets, Pigeon pea, Chickpea and Groundnut through genetic improvement	**MEMBERS**			
	Australia	0.197	0.342	0.354
	European Commission	0.003	0.003	-
	IFAD	-	0.227	0.917
	India	0.085	0.522	0.520
	Iran	0.033	0.055	0.041
	Netherlands	-	0.004	-
	Norway	0.056	0.074	-
	OPEC Fund	0.036	-	-
	Philippines	0.023	0.018	0.007
	United Kingdom	0.123	0.004	-
	United States	0.099	0.052	0.022
	World Bank	0.029	0.021	
	TOTAL MEMBERS	0.684	1.322	1.861
	NON MEMBERS			
	Common Fund for Commodities	0.207	0.151	0.257
	Harvest Plus/CP	0.001		-
	Generation/CP	0.091	0.012	-
	Water & Food/CP	0.282	0.159	0.256
	ICARDA	0.007	-	-
	IWMI	0.008	-	-
	IRRI	0.036	-	-
	Others	0.015	0.010	-
	TOTAL NON MEMBERS	0.647	0.332	0.513
	TOTAL MEMBERS + NON MEMBERS	1.331	1.654	2.374
	Unrestricted + center inc	1.496	1.217	1.524
	TOTAL BY PROJECT	2.827	2.871	3.898
7. Reducing Rural poverty through Agricultural Diversification and Emerging Opportunities for High-Value Commodities and products	**MEMBERS**			
	Australia	0.110	0.068	0.114
	European Commission	0.003	0.297	0.500
	FAO	0.050	-	-
	Finland	0.071	0.218	0.100
	Germany	0.070	0.173	0.315
	Islamic Development Bank	0.068	-	-
	India	0.365	0.527	0.715
	IFAD	0.036	-	

Table 8

ICRISAT-Financing: Allocation of Members/Non Members Grants to Projects, 2006-2008
(in US $ million)

Project	Members/Non Members	2006 (Actuals)	2007 (estimated)	2008 (proposal)
	Iran	-	0.033	
	Japan	0.060	0.060	0.060
	Netherlands	0.075	0.071	0.079
	United Kingdom	0.014		
	United States	0.645	0.181	0.199
	TOTAL MEMBERS	1.567	1.628	2.082
	NON MEMBERS			
	Water & Food/CP	0.292	-	-
	Common Fund for Commodities	0.206	0.151	0.257
	ILRI	-	0.030	0.007
	IWMI	0.003	-	-
	Sir Dorabji Tata Trust	0.265	0.140	-
	Others	0.033	0.104	-
	World Wildlife Fund	0.001	-	-
	TOTAL NON MEMBERS	0.800	0.425	0.264
	TOTAL MEMBERS + NON MEMBERS	2.367	2.053	2.346
	Unrestricted + center inc	0.861	1.031	1.146
	TOTAL BY PROJECT	3.228	3.084	3.492
8. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources, particularly at the Desert Margins of the Sahel and the dry lands of ESA	**MEMBERS**			
	Canada	-	0.030	0.063
	Italy	0.039	0.040	0.040
	UNEP	1.906	0.532	0.784
	World Bank	0.029	0.020	-
	TOTAL MEMBERS	1.974	0.622	0.887
	NON MEMBERS			
	ICARDA	0.006	0.002	-
	TOTAL NON MEMBERS	0.006	0.002	-
	TOTAL MEMBERS + NON MEMBERS	1.980	0.624	0.887
	Unrestricted + center inc	1.277	1.211	1.223
	TOTAL BY PROJECT	3.257	1.835	2.110
9. Poverty Alleviation and Sustainable Management of Water, Land, Livestock and Forest Resources through sustainable agro-ecological intensification in low- and high-potential environments	**MEMBERS**			
	ADB	0.138	-	-
	Australia	0.104	0.096	-
	Belgium	0.465	0.364	0.145
	Canada	0.231	0.722	0.751

Table 8

ICRISAT-Financing: Allocation of Members/Non Members Grants to Projects, 2006-2008
(in US $ million)

Project	Members/Non Members	2006 (Actuals)	2007 (estimated)	2008 (proposal)
	European Commission	0.304	0.374	0.071
	FAO	-	0.036	-
	IFAD	0.356	0.318	0.550
	India	0.178	0.193	0.172
	Italy	0.020	-	-
	Japan	0.060	0.060	0.060
	Netherlands	0.074	0.089	0.097
	United Kingdom	0.678	0.265	0.300
	UNEP	0.159	0.187	-
	United States	0.170	0.216	0.340
	TOTAL MEMBERS	2.937	2.920	2.486
	NON MEMBERS			
	AGRHYMET, Niger	0.006	-	-
	ASARECA	0.021	0.027	0.070
	CORAF/WECARD	0.045	0.039	0.070
	IFPRI	-	0.012	-
	IPGRI	-	0.002	-
	IWMI	0.430	0.121	-
	Others	0.065	0.023	-
	McKnight Foundation	0.008	0.015	0.016
	Tanzania	-	0.046	0.086
	Water & Food/CP	0.069	0.554	0.795
	World Wildlife Fund	0.011	-	-
	TOTAL NON MEMBERS	0.655	0.839	1.037
	TOTAL MEMBERS + NON MEMBERS	3.592	3.759	3.523
	Unrestricted + center inc	1.567	1.281	1.189
	TOTAL BY PROJECT	5.159	5.040	4.712
10. The Virtual Academy for the African and Asian SAT	**MEMBERS**			
	Canada	0.112	0.217	0.050
	World Bank	0.085	-	-
	TOTAL MEMBERS	0.197	0.217	0.050
	NON MEMBERS			
	TOTAL NON MEMBERS	-	-	-
	TOTAL MEMBERS + NON MEMBERS	0.197	0.217	0.050
	Unrestricted + center inc	1.196	1.133	1.147
	TOTAL BY PROJECT	1.393	1.350	1.197
11. Others (Development Oriented Activities, Science Park Activities, Generic Training etc.)	**MEMBERS**			
	India	0.300	0.253	0.309
	World Bank	-	0.055	-
	TOTAL MEMBERS	0.300	0.308	0.309

Table 8

ICRISAT-Financing: Allocation of Members/Non Members Grants to Projects, 2006-2008
(in US $ million)

Project	Members/Non Members	2006 (Actuals)	2007 (estimated)	2008 (proposal)
	NON MEMBERS			
	Mozambique	0.532	0.077	-
	TOTAL NON MEMBERS	0.532	0.077	-
	TOTAL MEMBERS + NON MEMBERS	0.832	0.385	0.309
	Unrestricted + center inc	1.195	1.134	1.146
	TOTAL BY PROJECT	2.027	1.519	1.455
	TOTAL BY CENTER	**34.098**	**32.610**	**34.730**

Center Totals

Total Targeted Funding	**21.151**	**20.324**	**22.324**
Total Unrestricted Funding	11.274	10.466	10.466
Total Center Income Earned during the year	2.920	1.850	2.000
Reserves	(1.247)	(0.030)	(0.060)
Unrestricted and Center Income	**12.947**	**12.286**	**12.406**
Total	**34.098**	**32.610**	**34.730**

Table 9

ICRISAT Staff Composition: Internationally and Nationally Recruited Staff, 2006 - 2010

Staff Type	2006 (actual)	2007 (estimated)	2008 (proposal)	2009 (plan 1)	2010 (plan 2)
Internationally-Recruited Staff (IRS)	68	77	82	83	83
Other Staff	956	960	952	954	954
TOTAL BY CENTER	**1024**	**1037**	**1034**	**1037**	**1037**

Table 10

ICRISAT - Financial Position: Currency Structure of Expenditures, 2006-2008
(In US $ Millions)

Currency	2006 Actual			2007 Estimate			2008 Proposed		
	Amount	$ value	% share	Amount	$ value	% share	Amount	$ value	% share
US Dollar		18.291	53.64		18.203	55.82		19.386	55.82
Indian Rupee	425.0	9.387	27.53	351.0	8.556	26.24	383.0	9.112	26.24
Francs CFA	2,005.0	3.826	11.22	1737.0	3.487	10.69	2035.0	3.714	10.69
Zimbabwe Dollar	59,574.0	0.986	2.89	225.0	0.898	2.75	239.0	0.957	2.76
Kenyan Shillings	52.0	0.735	2.16	45.0	0.670	2.05	55.0	0.713	2.05
Malawi Kwacha	29.0	0.238	0.69	30.0	0.217	0.67	24.0	0.231	0.66
METS	960.0	0.036	0.11	722.0	0.033	0.10	910.0	0.035	0.10
EURO		0.389	1.14		0.355	1.09		0.378	1.09
Others		0.210	0.62		0.191	0.59		0.204	0.59
Total		**34.098**	**100.0**		**32.610**	**100.0**		**34.730**	**100.00**

ICRISAT STATEMENT OF FINANCIAL POSITION 2006 - 2008
(in US dollar Million)

Assets	2006	2007	2008
Current Assets			
Cash and Cash Equivalents	22.086	8.000	8.500
Investments	0.607	3.000	2.500
Accounts Receivable			
Donors	2.596	2.700	2.600
Employees	0.305	0.300	0.250
Other CGIAR Centers	0.293	0.300	0.400
Others	1.609	1.700	1.800
Inventories	0.566	0.600	0.575
Prepaid Expenses	0.303	0.275	0.300
Total Current Assets	**28.365**	**16.875**	**16.925**
Non - Current Assets			
Property, Plant and Equipment, net	5.075	5.275	5.475
Investments	9.620	22.000	22.000
Other Assets	1.005	1.000	1.000
Total Non Current Assets	**15.700**	**28.275**	**28.475**
Total Assets	**44.065**	**45.150**	**45.400**
Liabilities and Net Assets			
Current Liabilities			
Overdraft/Short Term Borrowings	0.000	0.000	0.000
Accounts Payable			
Donors	8.304	8.500	8.500
Employees	1.082	1.077	1.077
Other CGIAR Centers	0.280	0.350	0.330
Others	4.708	5.200	5.200
Accruals and Provisions	0.478	0.550	0.550
Total Current Liabilities	**14.852**	**15.677**	**15.657**
Non Current Liabilities			
Accounts Payable			
Employees	11.300	11.500	11.500
Differed Grant Revenue			
Others			
Total Non Current Liabilities	**11.300**	**11.500**	**11.500**
Total Liabilities	**26.152**	**27.177**	**27.157**
Net Assets			
Unrestricted			
Undesignated	5.723	5.753	5.813
Designated	9.822	9.652	9.512
Permanently Restricted	2.368	2.568	2.918
Total Net Assets	**17.913**	**17.973**	**18.243**
Total Liabilities & Net Assets	**44.065**	**45.150**	**45.400**

International Crops Research Institute for the Semi-Arid Tropics
Statement of Activities 2006 - 2008
(in US dollar Million)

	Unrestricted	Restricted		Total		
		Temporary	Challenge Programs	2006	2007	2008
Revenues and Gains						
Grant Revenues (Schedules I and II)	11.274	19.334	1.817	32.425	30.790	32.790
Other revenues and gains	2.920			2.920	1.850	2.000
Total Revenues and Gains	14.194	19.334	1.817	35.345	**32.640**	**34.790**
Expenses and Losses						
Program related expenses	7.310	19.334	1.817	28.461	28.801	30.824
Management and general expenses	7.317			7.317	5.509	5.706
Sub Total Expenses and Losses	14.627	19.334	1.817	35.778	**34.310**	**36.530**
Indirect Cost Recovery (Schedule IV)	(1.680)			(1.680)	(1.700)	(1.800)
Total Expenses and Losses	12.947	19.334	1.817	34.098	**32.610**	**34.730**
Net Surplus	**1.247**	**-**	**-**	**1.247**	**0.030**	**0.060**
Expenses by Natural Classification						
Personnel cost	9.793	5.501	0.595	15.889	16.910	17.530
Supplies and services	1.735	8.188	0.785	10.708	8.010	9.441
Collaborators/Partnerships Costs	0.001	3.727	0.261	3.989	4.029	4.069
Operational Travel	0.739	1.918	0.176	2.833	2.861	2.890
Depreciation	0.679			0.679	0.800	0.800
Total	**12.947**	**19.334**	**1.817**	**34.098**	**32.610**	**34.730**

Appendix 3: Acronyms

AATF	African Agricultural Technology Foundation
AB	Ascochyta Blight
ADB	Asian Development Bank
AE	Agro-ecosystems
AMG	African Market Garden
ANGRAU	Acharya NG Ranga Agricultural University
APAARI	Asia-Pacific Association of Agricultural Research Institutions
ARI	Agricultural Research Institutes
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASP	Agri-Science Park
AVRDC	Asian Vegetable Research and Development Center
BGM	Botrytis Grey Mold
CAADP	Comprehensive African Agricultural Development Program
CAAS (China)	Chinese Academy of Agricultural Sciences
CBD	Convention on Biodiversity
CBO	Community Based Organization
CCAA	Climate Change Adaptation in Africa
CCER	Center-Commissioned External Review
CEH	Centre for Ecology and Hydrology
CFC	Common Fund for Commodities
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento del Maiz y del Trigo
CMS	Cytoplasmic-nuclear male-sterility
COS	Conserved Ortholog Sets
CORAF/WECARD	Conseil Ouest Africain pour la Recherche et le Développement Agricole/West and Central African Council for Agricultural Research and Development
CRS	Catholic Relief Services
CSI	Consortium on Spatial Information
DMP	Desert Margins Program
ECARSAM	Eastern and Central Africa Regional Sorghum and Millet Network
EMR	External Management Review
EPR	External Program Review
ESA	Eastern and Southern Africa
GAP	Good Agricultural Practices
GCP	Generation Challenge Program
GE	Genetic Engineering
GIS	Geographic Information system
GOFAU	Global Open Food and Agriculture University
GoI	Government of India
GT	Global Theme
HVCs	High value Commodities
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
ICRAF	World Agroforestry Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT/KM	Information and Communication Technology/Knowledge Management
IDM	Integrated Disease Management
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IGNRM	Integrated Genetic and Natural Resource Management
ILAC	Institutional Learning and Change
ILRI	International Livestock Research Institute

IMPI	Institutions, Markets, Policy and Impact
INERA (Burkina Faso)	Institut d'études et de recherches agricoles
INRAN (Niger)	Institut National de Recherches Agronomiques du Niger
IPG	International Public Goods
IPGRI	Bioversity International
IPM	Integrated Pest Management
IRD (France)	Institut de Recherche et Développement
IT-PGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IWMI	International Water Management Institute
JIRCAS	Japan International Research Center for Agricultural Sciences
KARI	Kenya Agricultural Research Institute
KMS	Knowledge Management and Sharing Office
LGPs	Lengths of Growing Periods
LLS	Late Leaf Spot
MAB	Marker-assisted Backcrossing
MET	Multi- Environment Trials
MSSRF	MS Swaminathan Research Foundation
NASFAM	National Smallholder Farmers' Association of Malawi
NPV	Nuclear Polyhedrosis Virus
NRM	Natural Resource Management
OU	Osmania University
PGRs	Plant Genetic Resources
PGRA	Plant Genetic Resources for Agriculture
PR&D	Participatory research and development
PSCs	Private Seed Companies
REIA	Research Evaluation and Impact Assessment
RITC	Research in Tobacco Control
SADC	Southern African Development Community
SAT	Semi-Arid Tropics
SAUs	State Agricultural Universities
SCOSA	Sustainable Commercialization of Seed in Africa
SEF	Sahelian Eco-Farm
SGRP	System-wide Genetic Resources Programme
SINGER	System-wide Information Network on Genetic Resources
SLP	Systems-wide Livestock Program
SMIP	Sorghum and Millet Improvement Program
SPS	Sanitary/Phyto-Sanitary Standards
SROs	Sub Regional Organizations
SSA	Sub-Saharan Africa
SWEP	System-wide Ecoregional Program
SWIHA	System-wide Initiative on HIV/AIDS
SWMnet	Soil and Water Management Research Network
TSBF	Tropical Soil Biology and Fertility Programme
UNCCD	UN Convention to Combat Desertification and Drought
VASAT	Virtual Academy for the Semi-Arid Tropics
VLS	Village Level Studies
WARDA	Africa Rice Center
WCA	West and Central Africa
YCMOU	Maharashtra Open University

About ICRISAT®

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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