ICRISAT Research Strategy in the Medium Term

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Looking to the future, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) believes that any center of the Consultative Group on International Agricultural Research (CGIAR) needs to refocus on its comparative advantages as an international, nonprofit, apolitical, scientific organization. We think that ICRISAT researchers are uniquely positioned to bridge technology gaps between north and south, and south-south. They are well suited as trusted brokers in mediating complex science-based tradeoffs, e.g., for genetic resources and natural resources, and they are ideal catalysts of new scientific initiatives that address international problems, which lie beyond what individual national agencies can handle alone.

Like all CGIAR centers, ICRISAT also recognizes the need to more directly link its work to impacts on reducing poverty for the poorest of the poor. We describe this approach as 'Science with a Human Face'. We are increasing our investment in socioeconomics research to more fully understand the nature of poverty in the semi-arid tropics (SAT), and how technological interventions can more effectively relieve it. We are emphasizing an impact culture so that all scientists recognize the urgency of following their work through until it benefits the poor.

As per the CGIAR mission to alleviate poverty, sustain food security, and protect the environment, ICRISAT does targeted research-for-development (R-D) with a very broad range of partners in:

- Genetic conservation and enhancement;
- Natural resources management; and
- Socioeconomics and policy.

Our research aims to help the most disadvantaged people living at the beginning of the new millennium in this modern but contrasting world. Hence, we expect that investments for R-D in SAT will allow the rural poor of today to have a brighter future with the adoption of emerging technology ensuing from ICRISAT research. Our philosophy in R-D considers a "small landholder development trajectory" from subsistence to commercial scale (Fig. 1), in which we consider that the farmers are not homogeneous and that research products should help them to move along the trajectory. Hence, scientists of the Genetic Resources and Enhancement Program have an array of products to offer. Low input environments require a yield stabilizing technology, whereas matching technology to achieve high yield potential should be developed for high input environments. Such a moving target needs to be addressed by a heterogeneous, but dynamic moving strategy, which often changes at a given point of time. Our scientists along this trajectory are using ICRISAT research tools for development. In this way SAT farmers may move from marginal agriculture to an improved system.

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ICRISAT has been allocating resources for developing its research agenda using a demand-driven method that looks for efficiency, equity, sustainability, and impact. Targeting the poverty domain remains a problem in R-D aiming poverty alleviation, especially if the selected geographic area

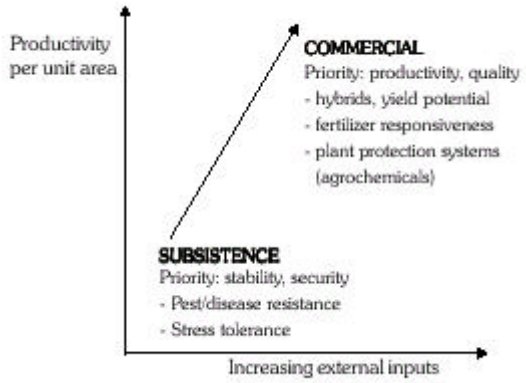

Figure 1. Smallholder development trajectory.

does not match 100% with ICRISAT "preferred poor clients", i.e., non-target clients may obtain benefits or the poor people living in SAT may be missing these benefits. ICRISAT should define few areas because large domains are ineffective for targeting poverty alleviation. Targeted investment in a few areas seems to be more rewarding than large funding for many areas.

To achieve success in its endeavor, research at the Genetic Resources and Enhancement Program of ICRISAT is demand-driven and has a problem-solving orientation. The keys for success, keeping in mind the people who are working or will be working with us are:

- Enhanced communication and interaction;
- Clear and decentralized organizational structure;
- Appropriate working and corporate culture;
- Research planning and transparent budgets;
- Staff accountability through milestones or agreed standards such as publication outputs, fund raising, technology exchange, resource management, and public awareness campaign; and
- Incentives for performers.

Partnerships

While bringing new partners [(e.g., private sector or non-government organizations (NGOs)] to implement together our R-D agenda, ICRISAT researchers are still building synergy with national agricultural research systems (NARS) and keeping joint strategic research with advanced research institutes. A proactive role was taken by ICRISAT Management since 1999 to attract the investment of the private seed sector to support the genetic enhancement of cereal crops such as sorghum (*Sorghum bicolor* (L.) Moench) and pearl millet (*Pennisetum glaucum* (L.) R. Br.). Already, support from the largest Indian seed company, the Maharashtra Hybrid Seeds Company Limited (MAHYCO) was obtained few years ago to support breeding of pigeonpea (*Cajanus cajan* (L.) Millsp.) hybrids. In the first quarter of 2000, we received positive responses from the

private seed sector (about 50% of those who were approached by ICRISAT) for breeding sorghum and pearl millet and some of them have already provided their funding as per signed project document, in which clearly it was agreed that any product ensuing from the research they are supporting will remain as international public goods.

Information Management and Knowledge Sharing

In this era of globalization and mass flow of information, any center of excellence needs to be perceived as freely sharing knowledge with their stakeholders. ICRISAT has started its work in this field to become in the short-term the organization that provides the right information timely and share knowledge freely about SAT agriculture. Likewise, ICRISAT has taken a pro-active role in "learning-by-doing" as the new means of providing training to our partners in R-D.

Applied Genomics for Research-neglected Crops of the Semi-arid Tropics

Molecular markers are descriptors that offer reproducible results for characterizing genotypes. Genomics refers to the investigations of whole genomes by integrating information provided by molecular markers with informatics. Applied plant genomics improves the understanding of crop gene pools, which are being enlarged by including transgenes and "native" gene pools that are becoming available through comparative analysis of plant biological repertoires. Nowadays, molecular markers are being used to tag specific chromosome segments bearing the desired gene(s) to be transferred (or incorporated) into the breeding lines (or populations). Furthermore, finding new genes adds value to traditional agricultural products. Genetic resources available in gene banks are still the best source for a routine gene discovery but this work will be facilitated by gene databases assembled with the aid of applied plant genomics, which can also accelerate the utilization of available genes through transformation or meiotic-based breeding methods.

Genomic research, which began receiving major emphasis at ICRISAT in 1999, continues with its implementation. A new staff joined in April 2000 to lead the Applied Genomics Laboratory at Patancheru, India and to coordinate the new center-project in the subject, which was included in ICRISAT's Medium-Term Plan (MTP) 2001–03. A significant capital investment was allocated for 2000 to acquire high-throughput lab equipment for genomics at ICRISAT. New polymorphic markers are being identified or mapped in pearl millet, sorghum, chickpea (*Cicer arietinum* L.), and groundnut (*Arachis hypogaea* L.), and gene flow will be investigated with molecular markers in pigeonpea.

ICRISAT has attracted restricted funding for pearl millet genomics and gene flow investigations with deoxyribonucleic acid (DNA) markers in pigeonpea with partners in the UK, for mapping drought tolerance taking advantage of sorghum-rice (*Oryza sativa* L.) gene synteny with Indian partners, and very likely from 2001 onwards for the rapid crop improvement of sorghum, groundnut, and chickpea with DNA-marker technology with NARS in Asia. ICRISAT with partners in USA will start in 2000 a new project for the identification of molecular markers for cultivated and wild groundnuts. We will be also working in mapping genes for fodder and stover quality in cereal and legume crops of the SAT. A new initiative to obtain funding from Aventis, USA for chickpea genomics was undertaken together with the International Center for Agricultural Research in the Dry Areas (ICARDA), Syria and with the assistance of the CGIAR Secretariat. Discussions are under way between Aventis and the three research partners that include Avesthagen Graine, a not-for-profit biotechnology provider from Bangalore, India.

Sorghum Grain Mold Management and the Potential Impact on the Poor

The introduction of high-yielding rainy season (kharif) sorghum hybrids in India over 20 years ago has led to dramatic increases in grain yield (from 587 kg ha^{-1} in 1970 to 1407 kg ha^{-1} in 1996/97). High levels of adoption of hybrids by farmers occurred in the major sorghum-growing state Maharashtra (about 80% of rainy season acreage). Despite this achievement, grains of hybrid sorghum suffer from infection and colonization by several fungi towards the end of the rainy season. This infection results in moldy growth often referred to as "blackening". The fungi are *Fusarium moniliforme* Sheld., *Alternaria alternata* (Fr.) Keissler, and *Aspergillus flavus* Link. These fungi have been shown to produce such harmful mycotoxins as zearalenone, fumonisins, aflatoxins, alternaria toxins, and ochratoxins.

ICRISAT in partnership with Indian researchers, and with the funding support from the Department for International Development (DFID), UK started a project aiming to assess the potential or developing integrated pre-and postharvest strategies for sorghum grain mold management in the semi-arid tropical production and utilization systems, and to suggest recommendations to address priority needs. The immediate beneficiaries will be donors and policy organizations engaged in planning and funding strategies to deal with sorghum grain mold, which will also include the private brewing, poultry, and seed sectors.

ICRISAT and its partners expect that the key stakeholders and ultimate beneficiaries of this research will be the resource-poor producers and consumers of rainy season sorghum whose access to safe and affordable food will be assured and whose produce will find expanding markets. We believe that sorghum needs from the industry will raise the demand of a commodity that is primarily grown by small and marginal farmers. The increased demand from the private sector will commercialize the crop and enhance the livelihood of the poor by raising cash income.