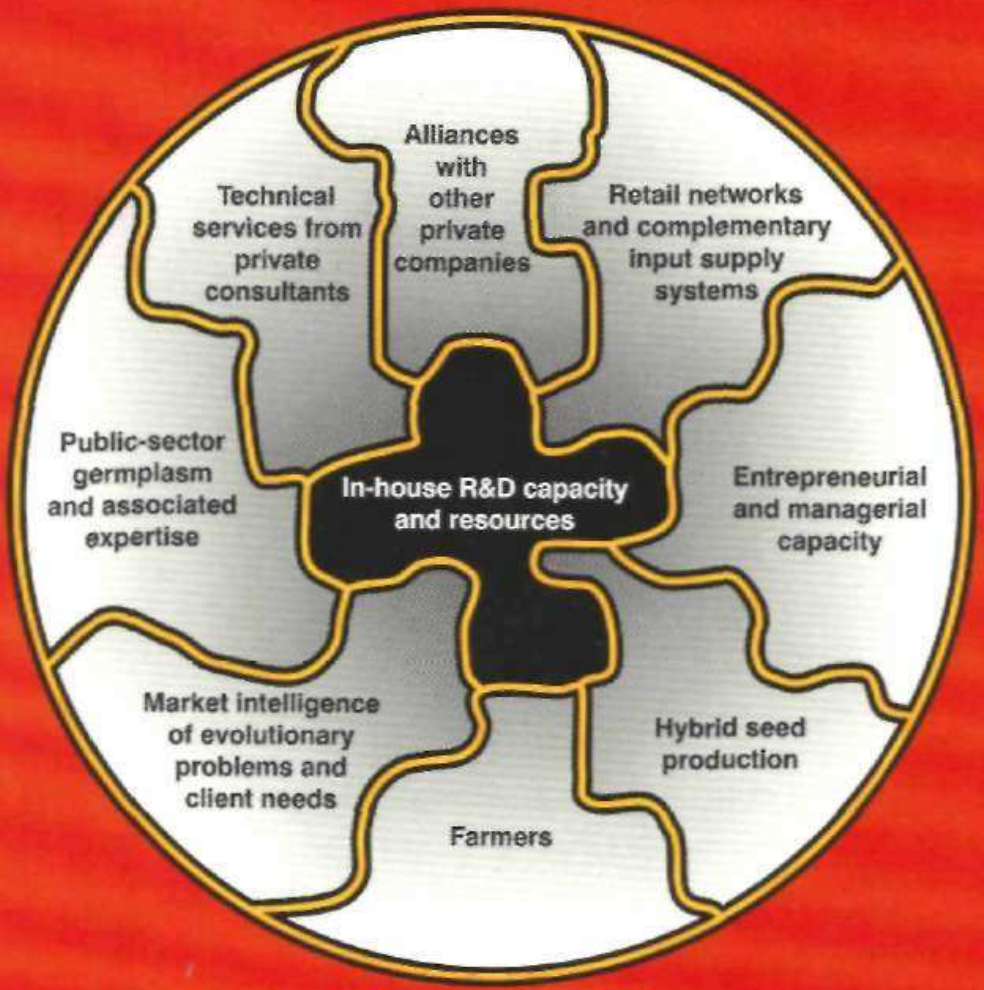
Natural Resources Institute

CPHP

Sharing Perspectives on Public–Private Sector Interaction



National Centre for Agricultural Economics and Policy Research

International Crops Research Institute for the Semi-Arid Tropics

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It is now widely recognized that both national and international public sector agricultural research institutions need to interact more closely with the private sector. Although public-private interaction is starting to develop, there is still a need for a clearer understanding of ways to re-map the relationship between the two sectors. The objective of this workshop was to gather together both agricultural scientists and industry representatives to discuss patterns of interaction. These proceedings provide some background orientation for this discussion by explaining: why research partnerships have become important, the types of interaction that are possible, and some new ways of exploring this from a policy perspective. The notion of a technology system may be a useful way to identify how public sector expertise can contribute to private initiatives.

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Cover: Stylized private-sector technology system organized around the principle of profit from hybrid seed (see page 38).

Sharing perspectives on public-private sector interaction

Proceedings of a workshop, 10 April 2001
ICRISAT, Patancheru, India

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Acronyms

AICPS	All India Coordinated Project on Sugarcane
AIIMS	All India Institute of Medical Sciences
AVI	AIDS Vaccine Initiative
BBI	Bharat Biotech International Limited (India)
CBD	Convention on Biological Diversity (FAO)
CBT	Centre for Biochemical Technology (India)
CCMB	Centre for Cellular and Molecular Biology (India)
CDC	Center for Disease Control (USA)
CFTRI	Central Food Technology Research Institute (India)
CGIAR	Consultative Group on International Agricultural Research
CNRRI	Chinese National Rice Research Institute
DFID	Department for International Development (UK)
DG	Director General (ICRISAT)
FAO	Food and Agriculture Organization of the United Nations (Italy)
GREP	Genetic Resources and Enhancement Program (ICRISAT)
ICAR	Indian Council of Agricultural Research
ICGEB	International Centre for Genetic Engineering and Biotechnology (India)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
ICSB	International Consortium of Sugarcane Biotechnology (USA)
IDG	Interim Director General (ICRISAT)
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
IPR	intellectual property rights
MoU	memorandum of understanding
MTA	material transfer agreement
NCAP	National Centre for Agricultural Economics and Policy Research (India)
NEERI	National Environmental Engineering Research Institute (India)
NIH	National Institute of Health (USA)
NRI	Natural Resources Institute (UK)
NRMP	Natural Resource Management Program (ICRISAT)
NRSA	National Remote Sensing Agency (India)
ODI	Overseas Development Institute (UK)
PARS	private agricultural research systems
R&D	research and development
SAT	semi-arid tropics
SBI	Sugarcane Breeding Institute (India)
SEPP	Socioeconomics and Policy Program (ICRISAT)
SPRI	Sugar Processing Research Institute (USA)
SRI	Sugarcane Research Institute (Australia)
SRS	Sugarcane Research Station (India)
SSC	State Seeds Corporations (India)
SSCA	State Seeds Certification Agencies (India)
TNAU	Tamil Nadu Agricultural University (India)
UNDP	United Nations Development Programme (USA)
UNEP	United Nations Environment Programme (Kenya)
WHO	World Health Organization (Switzerland)

The policy significance of new patterns of interaction in agricultural research: an introduction

A J Hall[1], V Rasheed Sulaiman[2], N G Clark[3], and B Yoganand[4]

These workshop proceedings record part of an on-going effort to understand the agricultural research process in terms of its institutional context and the way this context conditions the ability of science to contribute to international development. The work is funded by the Crop Post-Harvest Programme (CPHP) of the UK Department for International Development (DFID) and undertaken jointly by international, Indian, and British partners. The driving force behind the study is the growing realization among donors, agricultural research institutes, and policy bodies that for too long scant attention has been given to the way prevailing institutional arrangements for science and technology impinge on the research process. A related element of this is the recognition that research initiatives can interact with this context to develop new institutional relationships and arrangements that represent more effective systems of competence.

By not recognizing the importance of these issues earlier, potentially important lessons about ways of managing and applying science and technology as part of the wider process of innovation have been missed. By innovation we mean the group of activities through which new knowledge is created, transferred, and applied. We now know that these tasks, and the process they underpin collectively, are achieved through clusters of competencies, held in different institutions and linked by various relationships, that together form an innovation system. Ignoring this institutional context, and its collective competence, makes it difficult to manage innovation processes, and therefore to mediate the outcomes and impact of scientific research. The result of this lacuna is all too apparent to those of us who have been faced with technically successful projects that fail to impinge on the lives of poor people. The real problem is that the success of projects, and research in general (at least in the public sector), is judged in terms too narrow to take account of the institutional context, the constraints it may exert, and the opportunities institutional innovation may provide.

This workshop is part of a larger study that is exploring these institutional issues both conceptually and empirically, and is drawing lessons from diverse

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commodity and economic sectors. In these endeavors our objective is not to precipitate another swing of the pendulum, marginalizing science at the expense of greater emphasis on institutional analysis. We believe that, for many of the world's poorest, technological advances hold the only hope of escaping crushing poverty. Our caveat being that the potential of technology will only be fully exploited when the discourse on technical possibilities is accompanied by a corresponding engagement with issues of institutional context, and innovation system competence. In other words research, as a learning process, needs to expand from contributing technical knowledge, to include knowledge on the contextual elements concerning the way agricultural problems are identified and solved, and the way that the solutions can be applied and sustained. For example, much of the discussion in these proceedings is concerned with the importance of knowledge about ways of engaging and working with new types of partner — in other words what is important about partnerships is not just the technical knowledge that is generated and shared, but knowledge about institutional mechanisms that allow this generation and sharing to take place.

The real surprise is that for public-sector research, this type of process knowledge is only very recently being recognized as important. Ways of capturing this knowledge and acting upon it are truly in their infancy. Our greatest fear is that unless international (and national) agricultural research policy grasps the significance of the need to match technical advances with institutional learning processes, international donors and national governments will grow increasingly weary of supporting otherwise excellent agricultural science endeavors that are failing to fulfill their developmental potential. A policy shift away from science for development that this disilusionment may precipitate would be a grave mistake.

In order to try and better inform policy of the importance of these issues the project ofwhich these proceedings form part is developing an innovation systems institutional model to provide a framework for better understanding the institutional context of agricultural science and technology. This framework widens the scope of analysis of institutional context from the traditional discussion of R&D capacity in terms of public research and extension agencies, to a much wider set of actors with both research and non-research competencies. This approach reveals the inadequacies of the institutional model that underpins most public-sector agricultural R&D and associated policy.

Examining such issues as public-private sector interaction from this wider systems perspective tends to suggest that the discussion concerns much more than new partnerships and allegiances. It suggests that a new model of innovation is starting to emerge that is less hierarchical, more iterative, and more systems-performance dependant. The private-sector seed consortium funding of research at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) discussed in these proceedings is an example of the way the center of gravity is starting to shift; the way the primacy of public-sector research institutes in innovation process is starting to be challenged (albeit in a positive and mutually negotiated fashion); and the way this is creating systems that more effectively link farmers to science. This raises a series of rather fundamental issues for public-sector agricultural science: the need to redefine its institutional role in the context of this emerging innovation system; the need to redefine its

constituency and its relationship and linkages with this diverse and evolving group of stakeholders; and the mechanism through which it responds to priorities that this constituency identifies.

The papers presented in these proceedings represent therefore much more than a discussion of; which new partnership we should join? how should we engage these new partners? and what is their value as a funding source? — although these issues are also clearly very important. The discussion raises far more fundamental issues about the role of national and international public-sector science organizations such as ICRISAT and its Indian Council of Agricultural Research (ICAR) colleagues. We hope that sooner rather than latter such fundamental issues will be more fully recognized, discussed, and addressed. In the meantime, the papers presented here give voice to the fact that issues of institutional context are of enormous importance, and that engagement with such issues will underpin the productive use of agricultural science and technology in the service of international development.

Chairman's opening remarks

Mruthyunjaya[1]

The need to develop close working relationships with the private sector has been accepted as an important strategy that can achieve greater research effectiveness by the Indian Council of Agricultural Research (ICAR), and already four interface meetings with the private sector have been held. In recent years, ICAR has taken a number of initiatives to provide access to its products, services, and expertise to the private sector: for instance, by providing clear guidelines on the provision of consultancies, contract research, and contract services to the private sector. Though these initiatives have been highly appreciated by private-sector representatives, little progress has been achieved at ground level in terms of joint collaborative research activities. Hopefully, the results of the ongoing study between the National Centre for Agricultural Economics and Policy Research (NCAP) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on public-private partnerships will provide insights into the broad issues that are hindering the development of close working relationships between the two sectors.

As we all know, there are a number of differences in the organizational structure, personnel management, and operational procedures in the public and private sectors. The prevailing work culture in the public sector is not generally conducive to the development of greater participation by the private sector. However, ICAR has initiated a number of measures to reform the system through the implementation of organizational and management reforms. Many of the powers that were earlier vested with ICAR headquarters have now been delegated to the directors of ICAR institutes to avoid delays in decision-making. Powers have been given to the principal investigators of research projects to take routine decisions on project implementation. The constitution of a Consultancy Processing Cell at institute level, the preparation of a Perspective Plan by each institution, greater emphasis on research-priority setting, monitoring and evaluation, and the creation of a Competitive Grant Scheme (under the National Agricultural Technology Project) — whereby public and private sector organizations can apply for funds to implement research projects — are just some of the other important Council initiatives. Many of these reforms are expected to provide more flexibility to ICAR directors and scientists to enable them to work closely with the private sector.

Changing the work culture of organizations is difficult, and can only be achieved incrementally. Even though this may be frustrating, we hope it will provide dividends in the long run, and that more and closer partnerships will emerge onto the Indian agricultural research scene in the years to come.

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Perspectives on public-private sector interaction: the way for the future

W D Dar[1]

In agricultural research systems around the world, the roles of public and private sectors, and the relationships between them are changing. This is to some extent due to the re-evaluation of the role of the State in providing research services, and the need to improve the efficiency of public-sector research agencies. It is also a response to the expanding research and development (R&D) capability of the private sector, associated intellectual property regimes, and a more liberal trade and economic environment. Today, in general, the private sector is leading in such new sciences as biotechnology and information technology.

These changes have highlighted the possibilities of privatizing some public institutions and functions, and of reassessing the roles of the public and private sectors. However, it is accepted that it is also important to examine the patterns of interactions between the two sectors, focusing on the adjustments that need to be made to achieve the goals of the public sector in its new and evolving role.

It is now widely recognized that, in the next decade, international efforts to apply science to the problems of the world's poorest people will be characterized by the joint efforts of both public and private sectors. At the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) we have known for a long time that the private sector is a critical mechanism for delivering our seed-based technology to poor people. But in recent years, the expansion of private research capability, associated with new technology and a more encouraging policy environment, has prompted us to take a fresh look at this relationship. What we see are many opportunities to enhance the impact of agricultural research on the poor. We see new opportunities to share skills, knowledge, and costs. We recognize the complementarity of agendas and physical and human resources. Together these can contribute to the development of new technologies and their delivery to those who need them.

But we also recognize that new relationships cannot emerge overnight. They need to be founded and nurtured on trust and transparency. Often there is a need to make changes to accommodate the working practices and preferences of new partners. Similarly, issues of intellectual property rights (IPR), confidentially, and public interest have to be considered, discussed, and negotiated. At the same time, we don't want to lose sight of the importance of our existing partnership with the national agricultural research systems, who are also engaged in re-evaluating their relationships with the private sector. There are many experiences and concerns that we share with them.

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At ICRISAT we are fortunate that we started our relationship with the private sector in India in a small way and have been able to build on it. Since 2000 we have had a growing number of privately funded research projects. This is a first for ICRISAT and is novel for the Consultative Group on International Agricultural Research (CGIAR) as a whole. We hope that it marks the beginning of a new era for the Institute, and that we can further expand collaboration on topics that are at the interface between public and private interests and expertise. Dr G Harinarayana, Research Director of Ganga Kaveri Seeds Private Limited, Hyderabad, summed up his perceptions of partnership with ICRISAT at a presentation made to the Chairman of the CGIAR, Dr I Johnson on 11 Feb 2001 when he said: 'Excellent finished and pipeline products, competent expertise, commitment, impartiality, and above all a willingness to share have contributed to better understanding between ICRISAT and private sector'. This is good testimony and a good example, based on the principle of participation, sharing, and exchange. We would like to continue such partnerships, for the benefit of the poor farmers of the semi-arid tropics. The consortium of private seed companies working with ICRISAT today exemplifies a truly strategic partnership for the poor that is worth emulation and enhancement. It could be a seed for the 'Grey-to-Green Revolution' we need to pursue in dry and marginal agroecoregions.

Recently, the ICRISAT Governing Board approved the *ICRISAT Policy on Intellectual Property Rights, and Code of Conduct for Interaction with the Private Sector.* This document provides guiding principles for ICRISAT in: IPR management, genetic resources exchange, and the mechanisms governing IPR and protected material use by recipients to ensure they assist the Institute in achieving its mission. It also provides a code of conduct for interaction with the private sector. While dealing with the private sector and other research-for-development partners, ICRISAT will act according to the *CGIAR Center Statements on Genetic Resources, Intellectual Property Rights, and Biotechnology* jointly approved by the CGIAR Center Directors and Center Board Chairs. These statements include the *CGIAR's Ethical Principles Relating to Genetic Resources* and the *Guiding Principles for the CGIAR Centers on Intellectual Property and Genetic Resources.* I would encourage all participants to acquire a copy for their reference.

This workshop is an opportunity to share different perspectives. We have a strong panel of speakers from private industry. Not only the seed industry, but also from the sugar industry (a vertically integrated agro-industrial enterprise with strong R&D capacity) and from the biomedical research and technology sector. The experiences of these organizations and their perspectives on future collaboration with the public sector will provide valuable insights. Today's participants are also drawn from both private and public sector research communities. Discussion is important. Fresh insights will contribute to building more productive public-private sector interaction at ICRISAT. This will underpin our continuing efforts to make science count for the world's poorest people and because our joint efforts resonate 'Science with a Human Face'.

Public-private sector interaction: a framework for discussion

A J Hall[1]

Introduction

It is now widely recognized that both national and international public-sector agricultural research institutions need to interact more closely with the private sector. Similarly it is known that the private sector has a lot to offer. Although public-private interaction is starting to develop, there is still a need for a clearer understanding of ways to re-map the relationship between the two sectors. This is required to ensure that effective collaboration can take place on research topics that are at the interface between public and private interests and expertise. Current policy research at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the National Centre for Agricultural Economics and Policy Research (NCAP) is examining the evolving landscape of agricultural research. This paper provides some background orientation for discussion of these issues by explaining: why research partnerships have become important, the types of interaction that are possible, and some new ways of exploring this from a policy perspective; it also sets out the issues that still need to be considered if the public-private sector interface is to be strengthened.

Background

The evolving landscape of agricultural research

In agricultural research systems around the world the respective roles of the public and private sectors, and the relationship between them, is changing. In part this has been a response to the re-evaluation of the role of the State in providing research services and the associated desire to improve the efficiency of public agencies. However, it has also been a response to the related phenomena of the expanding R&D capability of the private sector that has resulted from a combination of technical advance, improved intellectual property regimes, and a more liberal trade and economic environment. These changes have highlighted the possibility of privatizing some of the organizations and functions previously under State control, and indeed, the reform process in many countries initially focused on reassessing public and private sector domains.

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It is now recognized that it is more important to examine the patterns of interaction between the two sectors, focusing on the necessary adjustments that need to be made to the goals and principles of the public sector in its new and evolving role.

Opportunities presented by public-private sector interaction in agricultural research

The possibility of three broad patterns of interaction and roles for public and private sectors exists. All three can potentially contribute to a more effective research system.

- **Private distribution of public technologies**
  Potential opportunities exist for the private sector to multiply and distribute publicly developed material. Hybrid technology exists for a number of important commodities, providing incentives for the private sector to further develop public genotypes and distribute new material. This implies that the private sector may be able to expand its involvement in adaptive research. The public sector may need to focus on facilitating private input supply and to switch its research attention to more strategic areas of germplasm improvement and conservation.
- **Private purchase of public research services and technologies**
  There is a range of routine testing and adaptive research services that the private sector needs, and would be able to pay for. Similarly there are a large number of publicly developed technologies with potential commercial significance. For the public sector this presents opportunities for both cost recovery and the generation of funds through the sale or licensing of technology to private organizations that lack sufficient R&D capacity of their own. Contract research for the private sector is another way in which this can be achieved.
- **Public-private research partnerships**
  Traditionally, public agricultural research organizations have predominately engaged in research partnerships with other public research agencies. Of potential importance are joint collaborative arrangements where public and private agencies pool resources to take advantage of complementary skills, infrastructure, and even proprietary science. This can improve access to scientific and technical resources and provide opportunities for cost sharing. So, for example, public agricultural research institutions could collaborate in areas where the private sector has a technological advantage, such as plant and animal biotechnology. Conversely there may be areas where fledgling private organizations may want to take advantage of research facilities and expertise held by the public sector. This suggests that both the private and public sectors may need to play both strategic and applied roles, depending on their relative competencies, patterns of resource, and technology ownership.

Policy analysis

Conventional analysis of the roles of the public and private sectors in agricultural research has focused on the nature of their technology products and the extent to which private organizations will be able to appropriate benefits from investment in R&D. The study of institutional roles and patterns of interaction is an

increasingly common approach to understanding systems phenomena such as public-private sector relationships. One approach is to view these patterns of institution intervention as an 'innovation system'. This builds on a number of observations about the nature of innovation — by innovation we mean the process of generating new knowledge and applying it productively. These observations provide three broad principles for examining the relative performance of innovation systems.

- **Integrated systems of diverse institutional actors**
  Successful innovation systems are judged to be those where productive relationships have developed between research and non-research organizations and between public and private organizations. These relationships are important as they facilitate the knowledge flows that underpin creativity. This analysis helps focus attention on the barriers to interaction and thus aids the development of measures that foster better integration of the system as a whole.
- **Institutional learning and institutional innovation**
  In many countries institutional roles and mandates, particularly in public-sector research systems, tend to be rather static, reflecting a rigid view of 'public-goods' and the need to produce these independently of the private sector. Successful innovation systems are judged to be those where novel institutional relationships between, for example, research and non-research organizations and between public and private sectors, are used as a way of addressing new tasks. Institutional innovation and the ability to create such new structures — institutional learning — is seen to be of equal importance to technical innovation.
- **Overall institutional set-up in the national context**
  The extent to which different institutional actors are well-integrated, the inherent ability of the innovation system to learn, and the way this is achieved in practice, all relate to the overall institutional set-up of a particular country. This is observed to be shaped largely by historical patterns of institutional development and by cultural factors. This national context is particularly important as it provides an understanding of why current institutional arrangements exist and operate in the way they do. It also emphasizes the point that there is no institutional blueprint for a successful innovation system. Rather, it suggests that principles of innovation system thinking can be used to guide institutional change, and that ways of actually achieving, for example, more intimate public-private sector interaction, are best devised on a case-by-case basis that takes local contexts into account.

Challenges ahead

The emergence of new relationships between public and private sectors in India is still at a relatively early stage. But, an important first step has already been made by recognizing that we need to revisit our patterns of interaction. Both sectors are entering into these new sets of relationships with caution, but also with hope. The public sector is having to re-evaluate the boundaries of its public-good mandate. It is asking such questions as: Does public-good research have to be publicly funded and publicly executed? Who has ownership of research

products jointly developed by the public and private sectors? How can public ownership be retained? The private sector also has many valid concerns. Like the private sector it also wants to know if it can recoup its investments in research. Will other companies also have access to research products jointly developed with the public sector? How can confidentiality be maintained? The two sectors also have different professional and administrative traditions. Can the public sector adapt to the urgency of the private sector?

As we move into an era where agricultural innovation systems are likely to see stronger patterns of interaction between the two sectors, these questions will have to faced, discussed, and resolved. We hope that today's workshop will take a step forward in these discussions.

Public and private sectors: the seed links

G Harinarayana[1]

Introduction

Public-private partnership germinated with the seeds of the Green Revolution. The accelerated transfer of technology transformed traditional agriculture to commercial farming. This uncommitted partnership maximized the potential of improved and hybrid seeds during the 1970s and 80s.

The ever-increasing demand for good-quality seed, and the potential of such seed to support, elevate, sustain, and stabilize production and productivity prompted private seed companies to diversify into seed research to develop proprietary products. The extension of hybrid technology to both self- and cross-pollinated crops, the potential of worldwide biotechnological research, and the changing needs of countries following the liberalization of world trade have added new dimensions and infused confidence in private agricultural research systems (PARS). Forging strong linkages with public agricultural research systems, both national and international, has the potential to usher in an era of everlasting green revolution.

ICRISAT-PARS: partners in progress

The understanding between the PARS and ICRISAT is based on: their common mandate crops, excellent finished and pipeline products, competent expertise, commitment, impartiality, and above all a willingness to share. Their joint research within an agreed consortium aimed at the diversification of pearl millet and sorghum hybrid parents is an outstanding and unique example and is based on the principles of participation, sharing, and exchange. It is expected that the products of consortium research will be available and benefit to everyone.

Technical program

Consortium activities include: exchange of germplasm accessions and breeding products, particularly male-steriles, maintainers and restorers for product development; performance assessment of ICRISAT-PARS cultivars, and evaluation of parental lines; staff training to upgrade knowledge and technical skills; and the promotion of information transfer through field visits, seminars, symposia, and discussions.

Genetic resources: freely shared

ICRISAT has assembled germplasm of its mandate crops — sorghum, pearl millet (and minor millets), chickpea, pigeonpea, and groundnuts from national and

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international gene banks worldwide. Collections made to broaden the base collections, fill the gaps, and supplement the accessions from hitherto unexplored and inaccessible countries and regions have truly enriched the germplasm. ICRISAT freely exchanges landraces and breeders' products with PARS to broaden the base for their parental lines and products (see Endnote).

Landraces. The natural assets of local and exotic collections are a unique source of latent (useful and usable) genes. Private seed companies depend on these collections to enhance the genetic base of their products, and ICRISAT freely exchanges collections for direct/indirect use by PARS.

Breeding products. Gene pools, synthetics, composites, genetic and cytogenetic stocks, inbred parents of varieties and hybrids, and transgenic plants are the result of incessant breeding efforts in which the 'human touch' plays a significant role. Exchange of such material demands the acknowledgement and recognition of scientists' efforts.

Product development

Parental lines. Depending on whether their company is new or established, private seed companies can obtain finished and/or semi-finished parental lines from ICRISAT. The Institute's scientists develop seed parents (male-steriles) and pollen parents (maintainers and restorers), where some degree of variation is deliberately left for selection at local level and identity-maintenance by the PARS. These parents are either used directly to produce varieties and/or hybrids, or indirectly in breeding programs. Private companies are known to purify the parents and share them with ICRISAT for wider use.

Hybrids. The PARS sell public and proprietary cultivars. ICRISAT-bred pearl millet varieties, e.g., ICTP 8203 and hybrids, e.g., ICMH 451 broke new ground with farmers, and provided succor during the years of downy mildew devastation and recurring droughts. That these cultivars are preferred by farmers in specific areas even today bears testimony to ICRISAT expertise. The fact that PARS depend extensively on ICRISAT-developed male-steriles and restorers of pearl millet and sorghum for their hybrid development is no secret. It is obvious, since more than 50 private seed companies are marketing approximately 75 hybrids of pearl millet, and nearly 11 companies are producing 20 hybrids of sorghum based on seed and pollen parents from ICRISAT.

Both private and public sectors predominantly market single-cross hybrids. ICRISAT has demonstrated the production potential of top-cross hybrids and three-way hybrids of pearl millet whose genetic diversity effectively barricades disease/pest spread. Their underused (late/tall) parents (male-steriles) can be effectively used, and the identity of their hybrids guarded. Three-way hybrids in particular have caught the imagination of private seed companies, and some companies have been producing and marketing them for the last 5 years. Experiments are also in progress to demonstrate the potential utility of rare cytoplasms with little restoration.

Product testing

Performance assessment is crucial to product release and its popularization. PARS participate in All India Coordinated Trials and in ICRISAT-PARS trials. Unlike All India Coordinated Trials, ICRISAT-PARS variety trials enable inter-company cultivar comparisons with released public/proprietary cultivars to be made.

The second type of ICRISAT-PARS parental trial includes A-, B-, and R-lines. Besides providing information on sterility-fertility reactions, these trials permit selection for local adaptation. Again, this would not be possible in the All India Coordinated Trials. In addition, the number of private-sector entries in the All India Coordinated Trials is limited.

Types of partnership research

Contract research. Contract research is by nature bilateral and breeds exclusive proprietary products. Public agricultural research organizations are by definition public trusts, therefore, exclusive products are against the partnership spirit of public research organizations committed to share for 'public-good'.

Multilateral research. The principle of multilateral or consortium partnership research is in the domain of public-good research. Promoting such multiple participation among PARS, and between PARS and public-sector research systems promotes the spirit ofgive and take, fosters human understanding, and eventually benefits those who need help. The benefits of multilateral research are expected to be reaped by one and all, and should therefore be preferred by such international agricultural research organizations as ICRISAT.

Farmer's participatory research. The farmers' invisible hand is perceived in the evolution, conservation, and bequeathing of landrace cultivars. Farmers have an invaluable treasury of genetic wealth. It is therefore essential to work with the end-beneficiary, the farmer, in genetic enhancement and initial selection schemes. Farmers' feedback fortifies the research base, and builds information linkages that are essential for sustained agricultural growth.

Timeframe

The idea of multilateral research originated during informal discussions among scientists of ICRISAT and the seed industry. It is expected that joint funding of mutual areas of interest will speed up research activity, besides being light on the finances of the small- and medium-sized seed companies that form the backbone of current commercial seed activity in India. Following specific discussions with selected seed companies, the technical and financial commitments were drafted, refined, and finalized in less than 6 months. Considering the nature ofthe project proposal and its implications, this agreement was concluded in the shortest possible time by any standard. The project has also left its doors open to all future entrants in keeping with the nature and spirit of multilateral research activity.

Seed registration/patenting

Seed should be registered or patented, but registration should be distinguished from patenting. Registration confers cognition, does not permit direct commercialization except under a Memorandum of Understanding (MoU), but should not preclude utilization for research. Registration covers all discoveries. Patenting confers exclusive rights, and precludes exploitation or utilization except under contract. Patenting covers all inventions, including transgenics, etc. Registration does not imply automatic patenting, but patenting does imply registration with exclusive rights. Registration should be extended to the following:

- **Germplasm.** Accessions with 'latent' characters, gene pools, synthetics, composites, etc.
- **Novel products.** Genetic and cytogenetic stocks, transgenics, etc.
- **Parental lines.** Inbred parents of varieties including synthetics, composites, and hybrids
- **Cultivars.** Open-pollinated varieties including multilines and hybrids.

Anticipated benefits

- **Germplasm enhancement**
  - Availability of accessions with latent/novel characters for direct/indirect utilization in breeding products.
  - Trait-specific gene pools that offer in situ selection for desirable traits.
- **Diverse variety and hybrid products**
  - A wide range of cultivars that could provide effective barriers against the horizontal spread of pests/diseases
  - Stabilized production in diverse agroclimatic zones.
- **Increased research activity**
- **Knowledge transfer**
  - Training seedsmen: Seed production is a chain process involving seed researchers (scientists and technicians), seed managers, seed organizers, and seed farmers. The researchers generate, modify, or upgrade knowledge and materials that need to be disseminated. ICRISAT organizes regular training programs to educate seedsmen in new material, techniques, and technologies, and to upgrade their skills in good seed quality management.
  - Information interlinks: ICRISAT conducts field days and invites seedsmen to participate in seminars, symposia, and discussions. Seedsmen are also invited to identify areas of research and air their views on project proposals and appraisal. This provides an opportunity to interact with the scientists and among themselves. PARS research scientists are also free to call on their ICRISAT counterparts as and when necessary.

Prospects and opportunities

Generation of finance

The State Seeds Corporations (SSC) and the PARS owe their origins to public research. While the seed industry progressed and the end-user prospered, public research suffered a financial crunch. The SSC and PARS should now join hands

to revitalize and sustain the tempo of research for the mutual benefit of all. Public funds should be supplemented by SSC and PARS.
This could be achieved by:

- **Product sales.** Public research organizations should strive to continuously develop and market: breeding, semi-finished, finished, and end-products to supplement their finances
- **Seed cess.** A uniform one-rupee cess on each kilogram of 'seed' or 'grain' sold would generate enough financial resources to supplement or support new research.
- **Licensing.** Certification is compulsory for public-bred varieties and hybrids. Certification is administered by State Seed Certification Agencies (SSCA). Proprietary products, privately bred varieties, and hybrids are not subject to certification, but private seed companies issue truthful labels under voluntary certification. SSCA are also unwilling to undertake proprietary products certification for the inherent monopoly of private products. PARS should therefore be permitted to undertake independent voluntary certification. Private seed certification agencies should be licensed to certify privately bred varieties and hybrids. Part of the income could be contributed to public research.

On similar lines, private seed-testing laboratories should also be encouraged. Such private facilities could provide the following services:

- **Variety identification.** Registration and patenting demands distinct, uniform, and stable characterization of inbred parents, varieties, and hybrids. Service centers for DNA finger-printing, and the generation of protein and amino-acid profiles could provide job alternatives and income sources for aspiring private entrepreneurs.
- **Genetically modified organisms.** The development of transgenics through DNA transfer technology is a laborious and time-consuming specialized task that is beyond the mandate of the classical breeder. Special laboratories could undertake genetic transformations under contract.
- **Disease/pest screening.** Recurring outbreaks of crop diseases and pests demand the identification of races/biotypes and repeated screening of segregating progenies for resistance. A service sector could find this work remunerative.

Endnote
Exchange is conducted under the ICRISAT policies for intellectual property rights (IPR) and the procedures by which ICRISAT is bound in relation to material designated under the Food and Agriculture Organization of the United Nations (FAO) Convention on Biological Divesity (CBD).

Fostering partnership in R&D — a case from the Indian sugar industry

M C Gopinathan[1]

Introduction

India has one of the oldest and largest sugar industries with the most extensive area under sugarcane in the world. India is also the largest global producers of sugar. Worldwide, sugar is a political commodity; it is a protected industry with a protected market, grown on large landholdings, and processed in factories with large capacities. In India sugar is also a political commodity — it has a dual pricing structure and an insulated market, but it is grown on small landholdings using old technology, and processed in factories with small capacities.

R&D at EID Parry

EID Parry (India) Limited, an important private-sector sugar company, is part of the Murugappa Group which has a turnover of Rs.3700 crores (US$ 925 million). The Group presently manufacture and market fertilizers, pesticides, seeds, sugar, alcohol, chemicals, bio-pesticides, organic fertilizers, and ceramics. The company has been in sugar production since 1842. Parry's Sugarcane Research and Development (R&D) Centre was established in 1994 with a mission to increase the profitability of the sugar business and to improve the standard of living of farmers through research, development, and extension.

The specific objectives of Parry's R&D include; developing the processes and products to improve the bio-productivity of sugarcane, increasing productivity at the farm level through better management practices, achieving faster technology adoption through extension and farmer training, providing reliable and timely supply of inputs through extension services, adding value through by-products, and developing a critical mass of scientific expertise capable of monitoring, evaluating, and adapting to the technological needs of the future.

The company has R&D centers at five locations, attached to each of the four sugar factories and at the main R&D Centre at Bangalore. Their activities include research, development, extension, farmer training, and production and supply of inputs. Parry R&D staff have specialized capabilities in; agronomy, bio-technology, extension, breeding, physiology, pathology, entomology, soil sciences, and sugar chemistry.

The company has two broad types of research agenda, one client-driven (i.e., by cane producers) and the other business-driven. Extension is part of R&D and the company values the feedback it receives from its extension staff. Company profit comes from the whole value chain (Figure 1) and not just sugar.

1. EID Parry (India) Limited, 145, Devanahalli Road, Bangalore 560 049, Karnataka, India.

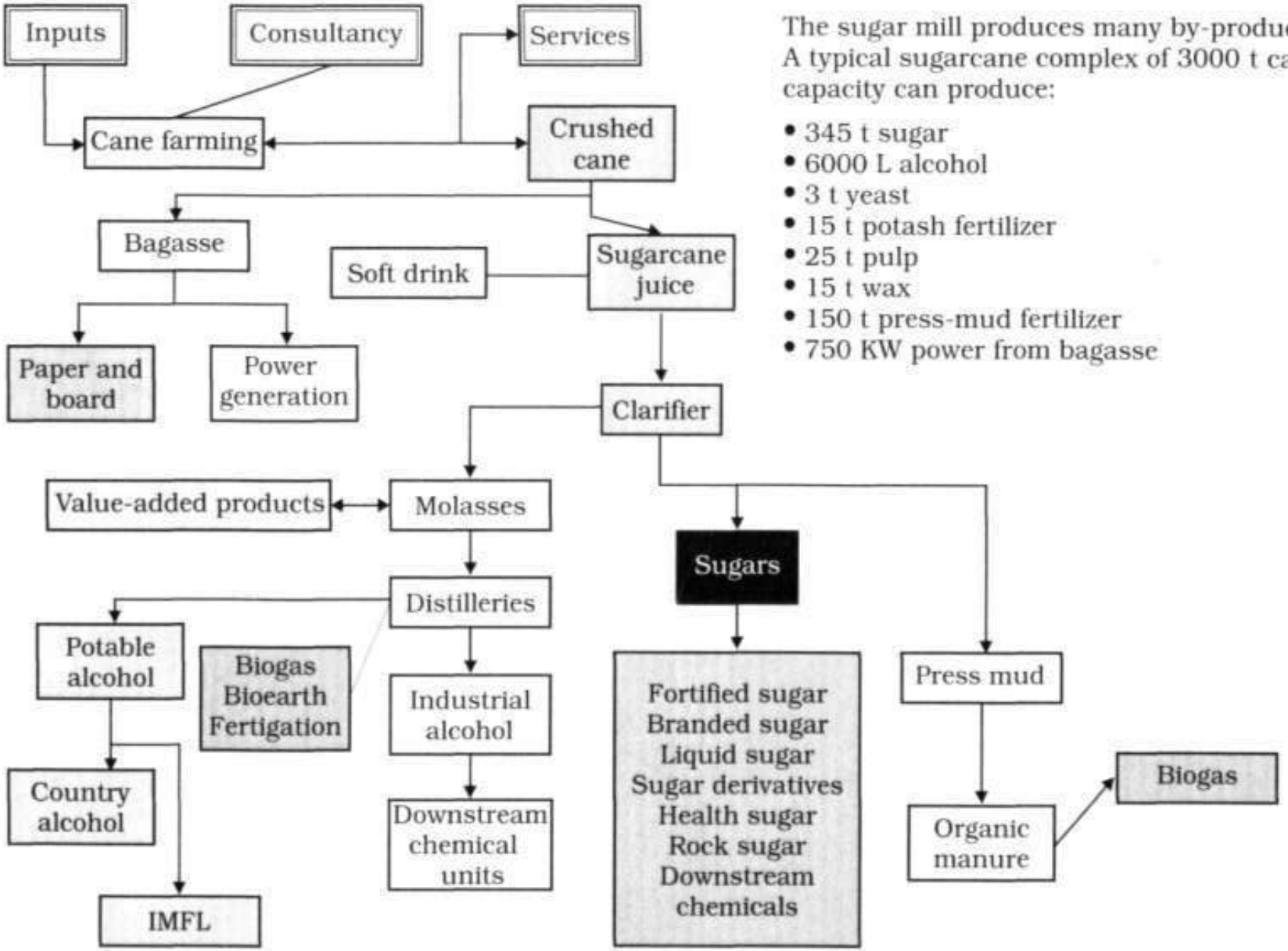

Figure 1. The sugar business value chain

As a consequence, EID Parry has established a cluster of downstream enterprises, including those capable of adding value through distilling, power generation, and waste management. The company's R&D skills thus span sugarcane production, sugar extraction, downstream agro-processing, and waste management. These various company strategies indicate that EID Parry has integrated its R&D into a complex vertically integrated agribusiness. The scope of this business is large, spanning primary agricultural producers to sophisticated upstream processing. The company is structured in such a way that its R&D activities are well-integrated into these different areas of economic activity. This helps to provide a research framework that is organized around the company's mission. So while the company does have conventional blocks of scientific expertise in its departments of breeding, physiology, etc. — it is the way that these scientific research elements form part of the larger system, i.e., the company's business process — that is important. This type of R&D integration is at the heart of modern technology-based companies such as EID Parry.

The way EID Parry visualizes its R&D model and the way in which the various elements are integrated into the company and its objectives are presented in Figure 2.

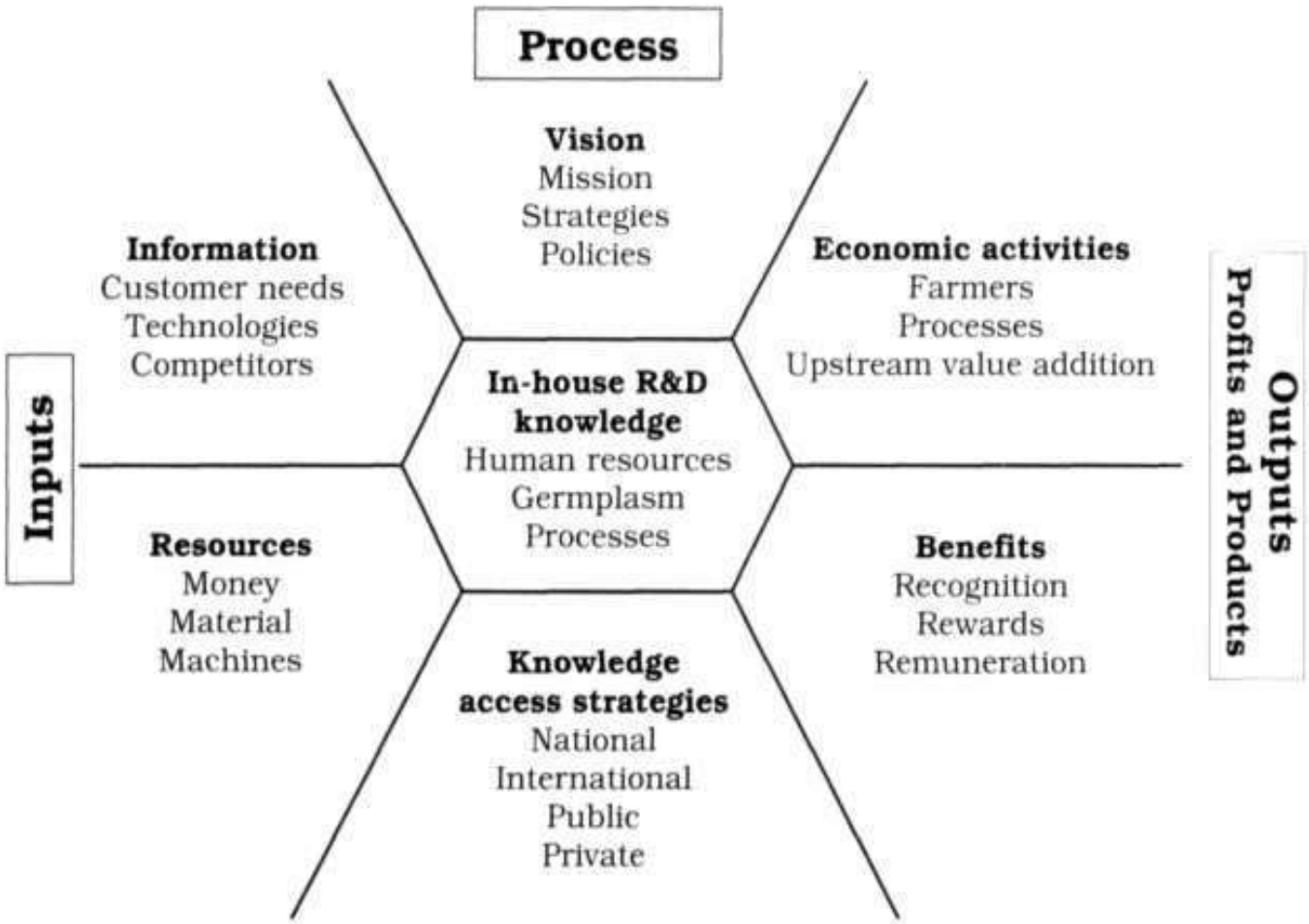

Figure 2. Cellular functional R&D model used by EID Parry

Patterns of partnership

Although EID Parry has a significant R&D resource in-house, it also supplements its technology system by accessing skills, expertise, knowledge, and research infrastructure from other agencies. These R&D access strategies involve a number of different types of collaborative agreement and both public and private organizations from the research and enterprise sectors, both in India and overseas. These include the following:

- **Collaboration**
  - National Environmental Engineering Research Institute (NEERI), Nagpur
  - Tamil Nadu Agricultural University (TNAU)
  - National Remote Sensing Agency (NRSA), Hyderabad
  - Mitrphol Sugarcane Research Centre, Thailand
- **Licensing**
  - Chinese National Rice Research Institute (CNRRI), China
  - TrifolioM GmbH, Germany
  - Dekalb Plant Genetics (seed company), USA
  - Biotim BV (effluent consultants), Sweden
- **Sponsored research**
  - Annamalai University, Tamil Nadu
  - Indian Institute of Science (IISc), Bangalore
  - Sugarcane Breeding Institute (SBI), Coimbatore
  - Centre for Cellular and Molecular Biology (CCMB), Hyderabad
  - Sugarcane Research Station (SRS), Cuddalore, India
- **Contract research**
  - Central Food Technology Research Institute (CFTRI), Mysore
  - Sugarcane Research Institute (SRI). Australia
- **Fellowships**
  - Annamalai University
  - Tamil Nadu Agricultural University (TNAU)
- **Graduate programs**
  - Annamalai University
- **Industrial training**
  - Gulbarga University, Karnataka
  - Madras University
  - Indian Institute of Technology (IIT), Chennai
- **Consortium**
  - International Consortium of Sugarcane Biotechnology (ICSB), USA
- **Networks**
  - Sugarcane Research Institute (SRI)
  - Sugarcane Breeding Institute (SBI)
  - All India Coordinated Project on Sugarcane (AICPS)
  - Sugar Processing Research Institute (SPRI), USA
- **Consultancy**
  - Sugar Processing Research Institute (SPRI)
  - Sugarcane Research Institute (SRI)
  - Tamil Nadu Agricultural University (TNAU)

The power of partnerships

The company values its collaboration and networking with various organizations, particularly in these days of increased demand for faster development of the product-development cycle, the flat and shrinking technical advantage from re-engineering, the squeezing of profit margins, and the increasing complexity of technical know-how.

EID Parry wants to produce technologies for the global market. They also want to add to and access the faster and higher growth of research knowledge, and to increase the talent pool available to them. Partnership with the public sector could enhance the industry's access to new ideas, and this could lead to business opportunities, high-quality scientific research (especially research of a fundamental nature) and identifying consultants and graduates for potential recruitment. It would also help the industry to lower its overheads. Large public investments have been made in research infrastructure and personnel. The private sector should not needlessly duplicate these resources. Partnership with the private sector would in turn provide public research with access to innovation cycles, and different cultures of thinking on important and emerging problems on which to conduct research. It would also increase its market awareness, enrich teaching programs, and help save research costs.

The two systems differ in goals and values. Industry is market-driven; conscious of costs, time, profits and returns on investments; and values the development of technologies that it can use exclusively to maintain competitive advantage. In contrast, public institutions aim to advance knowledge, place more importance on the publication of results, and work in a relaxed timeframe. The private sector persues profit for itself and society. The public sector persues excellence in science for society. These goals are not mutually exclusive.

Intellectual property rights (IPR) issues are currently receiving much attention, but there are many available ways to address them. Good partnership depends on mutually agreed clarity on goals and roles, complementary and overlapping strengths in core technologies, mutual sharing of success and failure, and agreement on IPR issues. It also depends on able leadership, effective communication, and good teamwork.

The following Chinese maxim is highly relevant in this context, *Those who thought too long making any step will remain all their lives on one foot'.*

Public-private partnership — reflections from the biomedical industry

Krishna M Ella[1]

Introduction

This paper presents the experiences of Bharat Biotech International (BBI) Limited, a private company in the biomedical sector. As with many companies in this sector, BBI is both research- and technology-intensive, its profitability relating to its ability to use scientific advances to produce new products ahead of its competitors. The company has been successful in using recombinant DNA technology to produce vaccines, including one for Hepatitis B. Looking to the future, the company sees the possibility of agro-medical applications of biotechnology in which crop plants can be used to synthesize biomedical products.

Not only are such companies very research-intensive, but scientific advances in the field are moving very quickly. The technology strategies adopted by BBI reflect the need for the company to keep ahead in a fast-moving game where competitors often have more sophisticated research facilities, research capabilities, and resources. One of the key mechanisms of BBI is to develop R&D alliances or partnerships with both public and private partners. This paper discusses the way that such partnerships are used as ways of funding fundamental research, sharing skills, acquiring new knowledge, and leapfrogging competitors.

Risk, rewards, and partnerships for business and society

The biotechnology sector is undergoing a major transition — perhaps the greatest since it began 25 years ago. The sector is very dynamic, and for those companies willing to adapt with flexible strategies, there are many opportunities ahead. However, 'learning' processes and the ability to change approaches and objectives to exploit new opportunities are essential strategies. Companies like BBI need to base themselves on the highest scientific skills that they can afford. Excellence in science alone, however, is not enough. It needs to be coupled with entrepreneurial marketing and increasingly with entrepreneurial fund-raising.

One of the strategies that BBI recognizes as important is the increasing opportunity to compete for public and philanthropic sources of research funding from such organizations as the Gates Foundation. This benefits the company by subsidizing the development of knowledge and skills, and also produces 'public-good' outputs. Another way of describing this research is to call it pre-competitive research. In other words, it is research from which a private company will ultimately benefit, but in which they will probably not invest themselves.

1. Bharat Biotech International (BBI) Limited, Plot 726. Road 3. Banjara Hills, Hyderabad 500 034, Andhra Pradesh, India

From the public-sector perspective, funding public-good research through the private biomedical industry has many advantages. Malaria and AIDS vaccine initiatives are well-known examples of this type of partnership between the public sector and the pharmaceutical industry. Similar arrangements have recently been established to address the development of a vaccine for East Coast Fever — an important priority in the veterinary health sector.

There are two models by which such partnerships can work. In the first, commonly referred to as the 'push' model, public agencies define research priorities and fund private industry through a competitive research-tendering process. This allows the public sector to select the best skills available and ensures value for money. The private sector benefits by being able to undertake fundamental research. The risks of success or failure are borne by the public sector. In the second model know as the 'pull' model, the public sector identifies areas of research that would benefit poor people, but where the market for research products would not be sufficiently attractive to private-sector investment. Again, malaria vaccine development is a good example as malaria is predominantly a disease of developing countries where the ability to pay for the product is low. The public sector then commits to underwrite such research by, for instance, undertaking to subsidize vaccine sales until the company makes a profit. In this 'pull' funding arrangement, the risk of a successful outcome of research is borne by the private sector. The public sector only pays for successful research and then only when those research products are delivered to poor people.

The judicious used of combinations of pull and push types of funding hold great potential for exploiting public-private sector partnerships. One particularly innovative instance of this is in the case of the AIDS Vaccine Initiative (AVI), where public funds are being used as a 'social venture capital' fund. Rather than giving grants for research (or setting up a public research laboratory), the AVI becomes a major stakeholder in private companies by investing money on the understanding that their research is related to developing an AIDS vaccine or related health product. Presumably, once the company successfully launches a product, AVI, like any venture capitalist, can make a public offering of shares and recoup its investment for use in other socially useful ventures.

For small companies in particular, it is funding of this type that can be of enormous importance, as it is usually in areas where the potential market may be large, but the research is highly risky. Not only do small companies have difficulty investing themselves, but it is difficult for them to raise money from the venture capital markets. This is particularly the case in India where the capital markets tend to be more conservative in their investment choices. In part this reflects the fact that since there is no long history of biomedical industry investments, the market has yet to build up knowledge on ways of assessing such investment opportunities and their relative degrees of risk.

Figure 1 illustrates this problem, indicating that only 35% of the funding of technology development in the capital markets is available for the upstream bio-entrepreneur. In contrast, 65% of investments are available for downstream investments in application and new product manufacture.

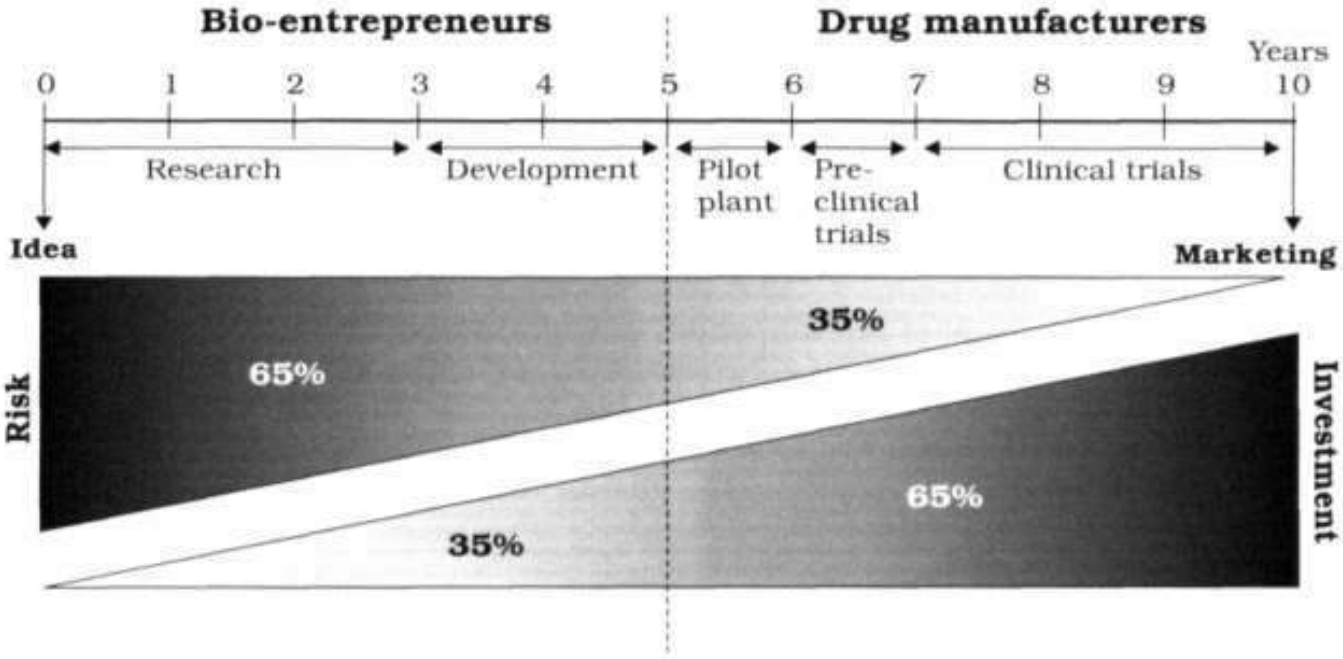

Figure 1. Risk and investment in technology development

The situation in India with regard to investment in biomedical research can be contrasted with that in the USA — home of the world's largest and most successful biomedical industry. As a result, the USA industry is at the forefront of exploiting biotechnology applications, so, for example, Federal funding supports the National Institute of Health to the tune of US$ 20 billion. Dedicated venture capital funds have emerged to support the biomedical sector. Since 1980 venture capital investments in the biomedical sector have been US$10 billion. This has lead to initial public offering of stock in biomedical companies worth US$ 90 billion.

Patterns of partnership

It is little wonder that the biomedical market is so competitive. For an organization like BBI, partnerships for public funding, partnerships with public expertise, and R&D alliances with private companies are the only possible way to stay ahead, produce quality products, and make profit. In the case of Indian companies the potential partnerships and alliances are not only with Indian organizations, but also with foreign ones. Boxes 1 and 2 give examples of the organizations with whom BBI has alliances.

BBI has used this approach to great effect and currently has a diverse range of partnerships with other organizations, in both India and overseas. For example, it has a research alliance in India with the Centre for Biochemical Technology (CBT), New Delhi. The collaborative work program focuses on developing recombinant DNA production techniques for lysostaphin, staphylokinase, and insulin. It is envisaged that this will lead to low-cost production techniques for these important medical products.

Box 1. Indian R&D partners of BBI

- All India Institute of Medical Sciences (AIIMS), New Delhi
- Centre for Biochemical Technology (CBT), New Delhi
- Department of Biotechnology, New Delhi
- Department of Science and Technology, New Delhi
- International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi
- Indian Institute of Science (IISc), Bangalore
- Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore
- National Institute of Virology, Pune

Box 2. Overseas R&D partners of BBI

USA

- Center for Disease Control (CDC)
- National Institute of Health (NIH)
- National Institute of Allergy and Infectious Diseases
- Stanford University
- University of Hawaii

Switzerland

- World Health Organization (WHO)

Similarly BBI has research alliances with international institutions for:

- Rotavirus vaccine development with the Center for Disease Control, Stanford University, National Institute of Health, All India Institute of Medical Sciences, and Indian Institute of Science
- Malaria vaccine development with the Center for Disease Control, and International Centre for Genetic Engineering and Biotechnology
- Dengue fever vaccine development with the University of Hawaii

R&D alliances

Discussed above are some of the broad factors that have meant that partnerships and R&D alliances of various types are increasingly a fact of life in the biomedical industry. Underlying these reasons is a common understanding that nowadays no one company or organization holds all the pieces of the complex jigsaw that together make up the picture of new, profitable products. Increasingly business success depends on the ability of bio-entrepreneurs to bring all these pieces together and to use them collectively to make profitable products. Some of the important facets underpinning R&D alliances are summarized in Boxes 3-5.

An important feature of alliances is that they are often task-bound. The significance of this feature is not that partners eventually fall out with each other and go their separate ways, rather that partners come together because

Box 3. Reasons to join together

- Opportunities for sharing knowledge
- Reduced capital investment
- Facility, recruitment, and equipment cost-sharing
- Risk reduction
- Sharing the common goal of success and ideas
- Encouraging scientific competitiveness
- Encouraging talent and work culture through critical peer review
- Creation of system synergies where the total is greater than the sum of the parts
- Sharing tax money in the interests of society
- Faster technology development
- Exploitation of partners' accumulated learning to leapfrog competitors.

they have some shared interest and complimentary resources and competencies. In other words, each partner holds part of the jigsaw. Once a specific problem is solved or a product developed and commercialized there is not necessarily any reason for the alliances to continue. The skill of the bio-entrepreneur is to able to draw all of these pieces together for just long enough to achieve a goal, and then to reconstruct new alliances around new problems or opportunities as they arise. An important aspect of this being that research may need to change direction and this may require a reassessment of the resources and competencies that need to be brought to bear. Patterns of partners can change!

Box 4. Issues in alliances

- Personal pride
- Technology is not the only factor in the business
- Alliances are sensitive
- External factors — purchase/hurts relationships
- Scientists change focus, they are interest-driven
- Industry changes focus, it is market-driven

There is a common perception that intellectual property rights (IPR) are a major concern in R&D alliances. It is true that contractual agreements need to be concluded before an R&D alliance can start, but the importance of formal IPR, patents, etc., in BBI's experience, is that technology is advancing so quickly that going for watertight IPR protection, particularly of technology processes, is often simply not feasible. The BBI experience is that in practice working relationships in R&D alliances have to be built on a certain degree of trust. In the most successful R&D alliances, more often than not, trust can substitute for formal IPR protection. In unsuccessful alliances, IPR protection can never substitute for trust.

Box 5. Precautions before entering alliances

- Understand the basic technology you propose to adopt
- Align with a partner to enhance core potential
- Enter into proper legal documentation before starting work
- Ensure that goals are well set in the beginning to avoid confusion later
- Be prepared to adopt strategy changes during the development process

Options for establishing public-private sector partnerships

The earlier discussion of push and pull funding mechanisms, and innovative combinations of the two, is one example of how the public and private sectors can work together. Equally important are ways in which human resources (and skills) and research infrastructure can be shared. There are two methods by which this can be usefully achieved. In the first, various mechanisms can be used to second public-sector scientists to work in the private sector. This can be done in the context of a number of different arrangements, such as; a collaborative research project, novel forms of private contracting of public scientists (or even conceivably the other way around), or in-service training at public expense.

The second method is through 'incubator' arrangements or science parks. This is particularly appropriate in cases where public research institutions have taken an early lead in a particular area of research. Similarly, it is appropriate when, as part of public policy, there is a desire to support a fledgling industry for which huge economic potential is seen. In such cases, the fledgling industry is usually under-capitalized in terms of research infrastructure and human resources, so mechanisms such as science parks can be used as ways of giving access to the infrastructure, skills, and knowledge that have accumulated in public bodies such as universities.

Conclusion

Many of the issues facing the biomedical sector are no different from those facing agriculture. The scientific frontier is advancing rapidly and this is providing enormous opportunities for both business and human development. Innovative approaches to financing, resource-sharing, and relationships with partners will lay the foundations for the exploitation of these exciting opportunities.

The long road to partnership: private support of public research on sorghum and pearl millet

Belum V S Reddy[1], A J Hall[2], and K N Rai[1]

Introduction

In January 2000 the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) signed agreements with a consortium of private-sector seed companies to develop sorghum and pearl millet hybrid parents. This marked the beginning of a new era in the relationship between the Institute and the private sector. However, it was not that this was a new relationship — there had already been a long history of interaction — what was novel was that for the first time a private consortium had made grants to ICRISAT to support two research projects that were in the interests of both the private consortium and the 'public-good' mandate of the Institute. Not only did this break fresh ground by establishing new patterns of interaction with the private sector at ICRISAT, it also provides important generic lessons for the development of future interaction between the private sector and national and international public agricultural research organizations. These lessons concern: the reasons that led up to the development of a new type of relationship with the private sector; the types of approach needed to attract the private sector to fund ICRISAT research; the intellectual property rights (IPR) context and the way this shaped the approach; and the institutional hurdles encountered while introducing this type of public-private interaction into a public research institution.

The main message of this paper is that institutional change is an inevitable facet of modern agricultural innovation systems and should be welcomed. However, accessing new sources of funding from the private sector should not distract ICRISAT from the pressing need to set priorities and to redefine its institutional role and patterns of interaction in the context of its international public-good mandate. Without a thorough discussion of these issues, the rules of engagement with private organizations will be marred by lingering ambiguities.

To understand the significance of the consortium approach discussed in this paper it is useful to start by looking at the way that ICRISAT's relationship with the private sector has evolved over time, and the ways in which this relationship has been nurtured.

1. Genetic Resources and Enhancement Program (GREP), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.
2. Socioeconomics and Policy Program (SEPP), ICRISAT, and Food Systems Department, Natural Resources Institute (NRI), University of Greenwich, Chatham Maritime, Chatham, Kent ME4 4TB, UK.

The evolution of public-private interaction at ICRISAT

In one sense the history of ICRISAT's relationship with the private seed companies is part of the bigger story of the development of the Indian seed industry. As a result of the Central Seed Act of 1966, public organizations dominated seed production and supply for most staple food crops in the country (Morrison et al. 1998). This policy restricted the development of the private seed industry and tended to emphasize the distinction (and competition) between the public and private sectors. It was not until the enactment of the new policy for seed development in 1988, that the private sector began to grow. Pray and Kelley (2001) suggest that, following liberalisation in 1988, private-sector organization investment in research in the Indian seed industry increased from US$1.2 million in 1987 to US$ 4.7 million in 1995. The private sector now dominates seed production and supply in a number of important food crops including pearl millet and sorghum.

These developments shaped the way the relationship between ICRISAT and private companies evolved over time. In the early years, ICRISAT played a nurturing role to the fledgling industry and provided breeding material, often through informal networks. Similarly, skilled personnel trained at ICRISAT found fresh opportunities in the emerging private seed industry and this helped to strengthen informal networking. During the early 1990s private companies continued to value breeding material derived from ICRISAT's genetic enhancement activities. However, ICRISAT's sorghum and pearl millet breeders recognized that this was going to change for both technical and institutional reasons. As the private seed industry grew, it started to develop a significant research capability of its own, particularly in the larger companies. It also became a major mechanism for delivering ICRISAT material to farmers. ICRISAT breeders recognized that the Institute's traditional relationship with public-sector breeding programs while important, was no longer the only route to farm-level adoption of research products and the delivery of research impacts. This realization was all the more pertinent as a succession of funding shocks in ICRISAT and other Consultative Group on International Agricultural Research (CGIAR) centers was accompanied by increased scrutiny of the value and impact of international agricultural research efforts.

At the same time it was also realized that changes in breeding priorities at ICRISAT were making its new material less attractive to the variety and hybrid development programs of the private sector in India. Because of concerns for sustainable productivity improvement, especially for semi-arid tropical areas in Africa, ICRISAT's breeding strategy had shifted its emphasis from yield potential alone to resistance to various abiotic and biotic stresses. Meanwhile, the Indian private sector had identified that the chief characteristic that farmers looked for in new rainy-season sorghum and pearl millet hybrids was a combination of high grain and fodder yields with bold (large) grain type. The emphasis in the 1970s on early-maturing sorghum hybrids as a drought-avoidance strategy had been criticized because of their inferior grain quality. This is because sorghum is frequently damaged by late monsoon rains and as a consequence suffers mold infection. The shift in emphasis in ICRISAT's breeding program meant that while grain mold resistance remained a priority, the focus was on the improvement of small, hard-grained types. While these are acceptable to consumers in Africa,

they are not the preferred types in India. As a consequence, the Indian private sector began to seek ways to develop mid- to late-maturing, dual-purpose (i.e., grain and fodder) hybrids with bold grain. This opened the door to joint research with ICRISAT.

Building new relationships with the private sector

A number of ICRISAT breeders had the foresight to realize that the way forward was actually to enter into a new form of relationship with the private sector. The change needed was to shift from viewing the private sector as a passive recipient of ICRISAT breeding material, to seeing them as a research partner. Moreover, the private sector needed to be a research partner both as a source of funds and research expertise, and in its conventional role as an uptake and delivery mechanism for ICRISAT material. Before entering into a collaborative agreement a number of hurdles had to be overcome. At first there was some degree of caution on the part of the private sector; there were confidentiality concerns, particular about the source of breeding material in their varieties and hybrids. In part this was due to a reluctance to reveal public-sector sources — although, of course, in reality ICRISAT was only too glad to see its material being used in this way. This attitude also reflected the historical view in India of the private sector as a profit-maker and competitor of the public sector. The caution of the private sector also related to 'trade secrets' among private-sector competitors. Another issue was that one seed company alone was unlikely to enter into an agreement to sponsor research at ICRISAT because any new material developed would still be in the public domain and therefore any other non-investing company could 'free ride', accessing material at no cost.

ICRISAT addressed these issues through a series of confidence-building exercises with the private sector. The Institute continued to provide useful parental lines to private seed companies and facilitated their participation in conferences, field-days, and study tours. ICRISAT also made great efforts to demonstrate the value of its work in terms of its breeding strategy and approach, and to provide information on the sources required to produce useful variability to develop heterotic coordinations. The key breakthrough however, was the suggestion made by the then President of the All India Seed Association to orchestrate funding through a consortium of private seed companies. This had two implications. Firstly, it meant that the costs of funding ICRISAT research would substantially decreas for individual members of the consortium. Secondly, because all major competitors would be involved in the consortium, and as all material and results are shared, there are fewer opportunities for 'free riders'.

Once the concept of a consortium was agreed, discussions were held between ICRISAT breeders and the seed companies on the level of funding required. The technical limits for the research to be addressed had already been set by the gap between the research agenda of ICRISAT and the types of hybrid quality characteristics that Indian farmers (and therefore the market) perceived as important. Based on an estimation of the total funding and time-scale needed to undertake this type of research it was agreed that the consortium members (8-10 were anticipated) would each need to make an annual contribution of US$ 5000 for 5 years.

The proposal that was developed by the ICRISAT breeders consisted of technical terms of reference for research on the two target commodities together with a project structure and terms of engagement by which research could be funded through multiple small grants from private seed companies. This came to be known as the 'small grants proposal' and contained two important features. Firstly, as will be discussed in the next section, for IPR reasons the small grants proposal had to be structured and administered as private research grants to ICRISAT, rather than as contract research agreements. Secondly, there is no formal agreement between the consortium members. Instead, each seed company joins the consortium by entering into a separate agreement with ICRISAT to provide a research grant under the technical and administrative terms of the small grants proposal. One consequence of this is that the consortium is open-ended, allowing further members to join if they provide research grants to ICRISAT. The agreements between ICRISAT and the consortium members include details of reporting and review mechanisms, as well as setting out the IPR framework. To date, 8 seed companies are supporting hybrid parents research on sorghum, and 12 on pearl millet. As the next two sections will illustrate, however, the establishment of this approach at ICRISAT involved a long process of discussion and negotiation.

Intellectual property rights issues

Entering into agreements with private-sector companies raised a number of IPR issues. These are somewhat unique in the case of ICRISAT and result from its status as a member of the CGIAR and the policies that govern its management of intellectual property, particularly germplasm (ICRISAT 2001) (see Endnote). In brief, these policies relate to the 1993 Convention on Biological Diversity (CBD) and the 1994 agreement between the CGIAR centers and the Food and Agriculture Organization of the United Nations (FAO) by which germplasm designated to be held in trust for the world community is made freely available to anybody, provided a Material Transfer Agreement (MTA) is signed. The MTA requires recipients of designated germplasm to forego claims of ownership or IPRs over the material received. By preventing ownership by a third party, the MTA allows germplasm to remain in the public domain without relying on public ownership per se.

This type of IPR regime creates a number of dilemmas for private-sector support of ICRISAT research, shaping as it does the type of agreement into which ICRISAT can enter with the private sector. If ICRISAT could retain ownership of new material, it could then licence out products, providing exclusive rights to private companies and thus enhancing incentives to specific private companies to distribute material. This also raises difficulties should ICRISAT wish to enter bi-lateral contract research agreements with private companies. This would imply a quite different type of relationship with the private sector, although it would not necessarily contradict the Institute's international public-good mandate. ICRISAT IPR policy does not presently permit such an approach. However, it currently allows private companies (as well as public partners) to have ready access to material through MTAs.

It was just these types of issues that initially prevented some companies from entering into the consortium. Most notable was the case of Monsanto

Technologies (India) Limited. After much deliberation and scrutiny of the agreement by the company's IPR specialists in USA, Monsanto posed a simple question to ICRISAT, 'If Monsanto were to develop further products from material developed under its agreement with ICRISAT, who would have ownership of these subsequent developments?'. The answer came back from ICRISAT that Monsanto would have ownership of subsequently developed products. Monsanto joined the consortium immediately. However, a few major Indian companies did decline to join the consortium. The reasons differ for each of them. Apprehensions on IPR issues, budget limitations, and their internal strengths/weaknesses are among reasons explaining their reluctance.

It is important to note that it is the research capabilities of a company (in combination with its own breeding lines) and its ability to make use of the ICRISAT-derived materials and develop its own hybrids that will determine whether a company can capture market share and make a profit as a result of consortium membership. In other words, it is the resources and skills of the company rather than an exclusive IPR agreement, that in this case, gives a competitive edge over other private seed companies. Under the present ICRISAT IPR policy regime, company competencies are therefore acting as a substitute for an exclusive licensing agreement. For larger investments by the private sector, this mechanism will probably prove inadequate. It seems likely that ICRISAT will have to investigate both the feasibility and desirability, given its international public-good role, of entering into bi-lateral funding agreements with the private sector, and the IPR implications of this.

Breaking new ground at ICRISAT

Having convinced the private sector that funding ICRISAT research through a consortium was the way forward, ICRISAT breeders were also faced with the need to convince ICRISAT to approve this approach. It needs to be remembered that these negotiations started at a time when the mandate of the Institute was still interpreted in a highly circumscribed fashion, based on a rather rigid notion of the nature of its public-good role. No previous agreement had been entered into whereby the private sector provided financial support for research. There was a perception that the Institute's public-good mandate could only be maintained through purely public funding and execution of research.

In fact, much of the Institute's policy on this aspect related right back to principles set out in the early 1970s when ICRISAT was established. It was assumed at this time that the Indian national research organization [the Indian Council for Agricultural Research (ICAR)] would remain the main partner and uptake pathway for ICRISAT research products. A related assumption was that ICRISAT research should be exclusively for the benefit of farmers, and that any research that would benefit private organizations was outside the mandate of an international public-good institution. The argument made at that time was that the private sector would invest adequately in areas where it could make profit, and that therefore this defined areas of research in which ICRISAT should not engage. It is now widely acknowledged that such arguments are flawed (Hall et al. 2001b). However, it was not until the mid- to late-1990s that it started to become recognized (albeit tacitly) that this sort of institutional dualism was no longer strictly relevant to the broader developmental mandate of ICRISAT.

Chronology of events at ICRISAT in developing private-sector partnership

Early to mid-1990s	ICRISAT's breeding strategy priorities changed from yield enhancement to resistance to biotic and abiotic stresses with a view to improving production sustainablity in Africa
Mid-1990s	The private sector became aware that new breeding material from ICRISAT did not include characteristics prefered in the Indian market for sorghum and millet hybrids
Mid-1998	ICRISAT scientists made initial contacts with seed companies with a view to developing a project that would produce outputs directly related to seed companies
Oct 1998	Decline in unrestricted core funding necessitated seeking funds from alternative sources. The need to mobilize funds from the private sector was emphasized at the Consultative Group on International Agricultural Research Centers' Week in Washington (CGIAR. 1998)
Early 1999	ICRISAT scientists continued discussion with the private sector on the possibilities of providing financial support for ICRISAT's research portfolio on diversifying sorghum and millet hybrids
Early 1999	'Small grant proposals' for sorghum and millet were developed and submitted to the Director of ICRISAT's Genetic Resources and Enhancement Program (GREP)
Mid 1999	Further discussions between private-sector and ICRISAT scientists
Sep 1999	ICRISAT Governing Board in principle approved partnerships with private sector
Oct 1999 (1st week)	The Director of Pioneer Hybrid International, USA, visited ICRISAT- Patancheru. His interactions triggered ICRISAT to seek support from Pioneer for a large grant proposal. This grant proposal to Pioneer was submitted to the Interim Director General (IDG) for approval. He advised the GREP Director of his concerns about private-sector support. (Pioneer subsequently declined to support the proposal)
28 Oct 1999	ICRISAT Donor Relations Office received the small grant proposals from the GREP Program Director
29 Oct 1999	Budget estimates of the small grant proposals were cleared and approved by Finance Division
2 Nov 1999	Small grant proposals (for sorghum and pearl millet) were modified to make them uniform in terms of structure, budget, and terms and conditions. Improved versions sent to Donor Relations Office
11 Nov 1999	Small grant proposals were sent to the IDG's Office
Nov 1999	The IDG advised against persuing the private sector for small grants. Detailed explanation by scientists and their intention to seek funds from the private sector were made to Donor Relations Office who conveyed the IDG's reservations to scientists
Dec 1999	Small grant proposals were sent to the Officer-in-Charge for the DG, who advised they should be sent to the new DG who would take charge in Jan 2000
20 Jan 2000	Donor Relations submitted proposals to the new DG, who advised that an assesment be made of the ramifications/implications of this partnership. Discussions between the GREP Director and the new DG resolved pending issues
24 Jan 2000	Small grant proposals were approved by the DG and dispatched to private seed companies.

The small grant proposal was first passed to the Director of ICRISAT's Genetic Resources and Enhancement Program (GREP) in Oct 1998 (see page 32). It was then sent to the Institute's Management Committee who passed it to the ICRISAT Governing Board for approval. The Board passed it to ICAR for approval, and it was then passed back to the ICRISAT Director General for final approval. At that time, a previous Director General from the 1970s and 80s had returned to ICRISAT as Interim Director General (IDG), following the sudden departure of the previous incumbent. The small grant proposals again met resistance in ICRISAT, with concerns raised over the relatively small sums of money involved, and worries over the administrative burden of managing multiple small grants. When the new Director General took up his appointment in January 2000, he felt that new partners and partnerships would contribute more to the Institute than the small sums involved, so he and the seed companies signed individual agreements. The entire process had taken nearly 20 months of hard work.

Lessons for policy

The establishment of the consortium demonstrates some important practical lessons: the need to build the confidence and trust of the private sector; the importance of a transparent and secure intellectual property environment; and the need to challenge the boundaries of institutional mandates. But perhaps a more important lesson for public-sector policy is the lesson of learning, and particularly institutional learning. The long road to partnerships has ushered in a whole raft of new possibilities for funding and executing research that straddles the boundary of public and private interest. Future ambitions included the establishment of a science park to act as an 'incubator' for small agricultural sector biotechnology companies. ICRISAT now recognizes that it is moving into a new era of international development, where the role and mandate of international agricultural research organizations is evolving rapidly. New players and novel technological possibilities are emerging. These players often have strong patterns of linkage with client sectors that ICRISAT can exploit through such partnerships. ICRISAT's approach needs to co-evolve with these Institutional developments if it is to exploit them for the benefit of poor people.

Tripp and Byerlee (2000) raise a note of caution on private funding of public research. They point out that the public sector does indeed have resources, expertise, and infrastructure that the private sector can and should pay for. However the eagerness of the public sector to attract private-sector funding should be tempered by the wider public-good role of organizations such as ICRISAT and the need to set priorities, establish institutional relationships and allocate resources in this context. Hall et al. (2001a; 2001b) suggest that a systems conceptualisation of the institutional underpinning of the innovation process may be useful, both in helping to define the most appropriate role of public agricultural research organizations, and in formulating institutional arrangements through which systems competancies can be enhanced.

So while ICRISAT has learned some important lessons on ways of engaging new partners, the road to partnership has been so long precisely because these new relationships (and the Institute's role in this context) had to emerge in a policy vacuum. The environment of uncertainty to which this gave rise meant

that it was extremely difficult for the Institute to take a decision on how to move forward. The future of ICRISAT and the way it contributes to poor peoples' lives in the semi-arid tropics, will increasingly be defined by the way it chooses its partners. This requires a full and frank discussion of these institutional issues and the adoption of an unambiguous policy position. We hope that this paper can contribute to this debate by illustrating that embracing institutional change is inevitable, on-going, and consistent with the Institute's guiding principles. This institutional dynamism needs to be mainstreamed in the Institute's practices and policies. Perhaps, as never before, to stand still is to truly to go backwards!

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Endnote

In fact it is somewhat ambiguous to indicate that the IPR policy of ICRISAT relates per se to its status as a CGIAR center. It is probably more accurate to say that like most CGIAR centers, a large proportion of its material is designated under the FAO Convention on Biological Diversity (CBD) and therefore must be held in public trust in perpetuity. It is this designated material that must be transferred under a Material Transfer Agreement (MTA). However, not all ICRISAT material is designated under the CBD. There is a certain amount of ambiguity about the non-designated material, particularly concerning material that would be viewed as 'developed by ICRISAT jointly with public partners' rather than 'developed independently by ICRISAT'. There are strong cost and public-good arguments suggesting that it may be in the interest of CGIAR centers not to designate all new material under the CBD (Personal communication. Dr Paula Bramel, Genetic Resources Expert, ICRISAT). There is a need to clarify such points and to reflect them in IPR policy.

Shared perspectives: a synthesis of obstacles and opportunities

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Introduction

Each of the papers in the previous sections stimulated a wide-ranging discussion. After the main presentations a general discussion also took place. Rather than a verbatim transcript of these discussions the following section summarizes the key points and draws out policy implications based on the perceptions and concerns that were shared at the workshop. This section has been supplemented by a series of one-to-one meetings with a number of the seed companies whose representatives participated in the workshop. These meetings were conducted shortly after the workshop to clarify specific points arising out of the general discussion at the workshop, and to help draw out key conclusions and recommendations.

General discussion

There is now no doubt that the roles of the public and private sectors in agricultural research are changing and that there is an increasing need for an interface between them. The workshop revealed a consensus that it is in the interests of the public sector to engage the private sector more productively. Similarly the willingness and desire of the private sector to enter into partnerships with the public sector is evidenced by their pledge to pay for research. The example of consortium funding at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) demonstrates this commitment. However the private sector is still struggling to understand the ways and mechanisms required to enter into a more broad-based set of relationships with public research, particularly with national agricultural research institutions in India. The workshop participants representing the Indian Council of Agricultural Research (ICAR) at the workshop expressed their similar concern and puzzlement that, despite their own desire to attract private-sector partners, progress has been far less than expected. During the discussion considerable time was spent explaining ways in which policy changes had been implemented within ICAR specifically to encourage these types of partnership. These included: allowing ICAR institutions to undertake consulting

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and contract research, allowing free access to germplasm, and facilities for licensing public technology to private companies. Similarly, some policy issues have been addressed in the operating environment, most significantly a number of seed-related issues that are currently passing through the Indian legislative process.

Despite all these positive steps to improve interaction, the central conundrum to which the discussion returned time and time again was the fact that these types of partnership had simply not happened. No single answer directly emerged to resolve the current impasse, but reviewing and interpreting the discussion there was some very strong — albeit implicitly articulated — reasons why a significant distance exists between the two sectors. A number of participants made the point that the private and public sectors are not two uniform blocks of players. The private sector contains a vast diversity of players ranging from the multinational corporations, through family businesses and public limited companies to non-governmental organizations (NGOs), farmers' associations and cooperative societies, and of course, the farmers themselves. Similarly the discussion revealed that while ICAR institutions and ICRISAT have a number of shared issues that need to be resolved, they also have separate considerations and constraints related to historical patterns of development, and the wider policy and institutional frameworks in which they sit. Intellectual property rights (IPR) and the national versus international 'public-good' mandate are clearly areas of contextual difference that mean that ICRISAT and ICAR each need to consider their relationship with the private sector in a slightly different fashion. However, in relation to the overarching problem of defining new ways of working with the private sector, ICRISAT has made progress, albeit in a small way, and as a result of a fairly long process of relationship and trust-building over many years. There are certainly lessons that the ICRISAT/private-sector seed consortium experience can provide and these were usefully presented by Harinarayana (see pages 11-15), and Reddy et al. (see pages 27-34).

In the specific context of the national public sector institutions, the discussion revealed quite different world-views, value systems, and patterns of incentives between the two sectors. However, perhaps even more fundamental were the contrasting visions of the way science and technology is used productively. It is worth highlighting the insights that the discussion gave into these critical areas.

The parallel worlds of the public and private sectors

It goes without saying that the private sector's primary interest concerns profit and therefore its approach is based around developing and producing the quality products that its clients want. The public sector on the other hand has a more diffuse, although no less important, purpose. Participants from the seed industry stressed this point on numerous occasions, reiterating that the customer really is king. This very clear articulation of a tangible purpose has two consequences. Firstly, administrative systems, timeframes, and professional incentives are set up around a profit motive. Secondly, a successful company structures itself, and its relationships and alliances, around ensuring that it makes a profit. In the discussions and follow-up interviews it was clear that the gap between the public and private sectors revolves around these two issues of norms and structures.

Norms

In contrast to the private sector, public-sector research institutions have a less-tangible purpose — public-good. As a result the performance of the system is harder to monitor in output terms and, as a consequence, an administrative system has evolved in the public sector that focuses on input monitoring. The procedures of checks and counter checks that these administrative norms put in place are usefully referred to (pejoratively) as bureaucracy. Both public- and private-sector participants acknowledge that such procedural norms can cause time delays and that this is ill-suited to the commercial urgency of private-sector projects. However many private-sector organizations perceive another more fundamental dimension to this problem. These administrative structures are famously complex and the lines of command from the center to periphery are greatly extended. As a result, entering into an agreement to undertake a task with public-sector scientists and their institutions is perceived as highly precarious, subject to the ambiguities and inconsistencies that such a system can create, and with unclear means to deal with unsatisfactory performance. Policy reforms within ICAR have clearly not allayed such fears. Perhaps one problem here is that, because science is still seen as the key organizing principle of public research (and this is not an error per se), rules of engagement with private for-profit organizations are still subject to diverse interpretation.

Structure

During the course of the discussion and in subsequent interviews with seed companies it became clear that the private and public sectors have different perceptions of what the former wants and what the latter has to offer. This we believe relates to the organizing principle around which the two sectors are structured. Public-sector institutions are structured as scientific institutes producing technology. This conceptualization relates to the notion of the 'technology shelf', an enduring myth in agricultural research policy. This conceptualization was both referred to and questioned at the workshop. The idea is that public-sector research institutions are producing technologies that another agency, in this case the private sector, will take up and commercialize. An intrinsic element of this way of thinking is that technology has relevance per se and that it is only a matter of identifying those who need it, and transferring it to them. Participants from the public sector lamented that the private sector 'has not taken up our technologies'. Figure 1 stylizes the institutional model that this implies.

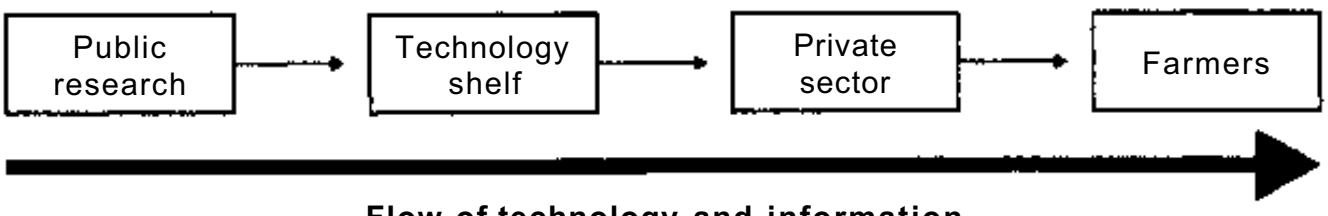

Figure 1. Stylised technology shelf model of public-private sector interaction

In contrast the private sector, as we have already discussed, has a different organizing principle — that of profit. So, while a private company might be producing a series of technology products such as seed, it is doing so within the overall framework of profit, rather than the overall framework of science. As a result the private company needs to bring together a more diverse set of competencies and resources, some of which it will source in-house, and some of which it will get from other agencies. The product (be that seeds, sugar, or health products) along with a strong profit and client/market orientation defines the elements that are required to produce the product in a profitable way. These elements may be technical and managerial capabilities and processes as well as physical inputs and infrastructure It may be useful to think of these different elements as a 'technology system' (Figure 2).

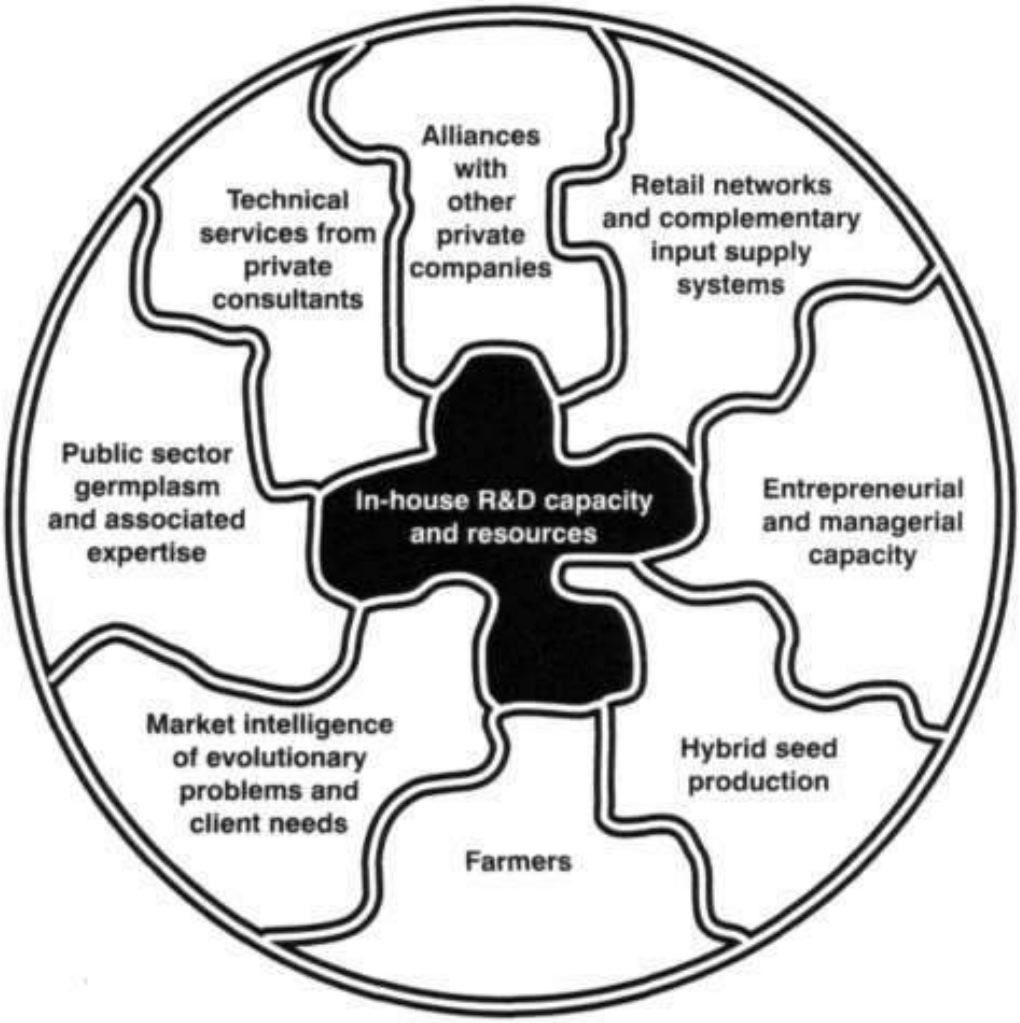

Figure 2. Stylized private sector technology system organized around the principle of profit from hybrid seed.

A further feature of these technology systems, and one that was that frequently referred to by seed companies, is that they are evolutionary in nature. By this we mean that new client demands arise in an unpredictable fashion, (for example, new pest problems) and this means that technology and ways of producing it need to change along with these evolving demands. In contrast to conventional

research systems, the private sector alters its technology system to create new ways of addressing new problems and opportunities. This may involve new partnerships and associated strategies.

These institutional innovations that the private sector routinely employs are of equal importance to the technological innovations they produce. The systems structure, together with the evolutionary nature of client demands for technology, has significant implications for the types of assistance that the private sector is seeking from the public sector. The question of how public-sector research should interact with the private sector is really a question of its ability to contribute to these types of technology systems. The clearest implication is that the private sector is not necessarily seeking shelves of finished technologies, rather it is seeking complementary competancies.

The example of ICRISAT and the seed consortium illustrates this. While superficially it may appear that the private sector actually seeks a physical input of technology from ICRISAT in the form of advanced breeding lines, this is an oversimplification. The private sector views this as an issue of accessing the expertise of ICRISAT — in combination with its genetic resources and research infrastructure — and directing this expertise so that it contributes to the technology systems of individual private companies. In other words, the consortium mechanism is a way of ensuring that the private-sector company can include the capabilities and resources of a public-sector organization like ICRISAT as part of its own technology system. Therefore, the need of the private sector is not for the technology per se, but for the expertise — along with strategic resources and infrastructure — that it can combine with its own capabilities and resources. Figure 2 illustrates a stylized private-sector technology system organized around profit from hybrid seed.

Ways forward

One strategic implication of this idea of technology systems is that the role of the public sector will need to co-evolve along with the nature of these systems and the resources and competencies that are available in other agencies. For international organizations such as ICRISAT there will continue to be questions on whether and how they should interact and contribute to these private technology systems. While IPR issues were not discussed extensively at the workshop, subsequent interviews have highlighted that this issue will increasingly circumscribe the relationship between ICRISAT and the private sector. The issue perhaps needs to be considered, not just in the context of how ICRISAT contributes to private-sector technology systems in India, but rather in the wider institutional context of agencies, competencies, and resources that are being brought to bear on broad-based development problems. Private technology systems are certainly part of this larger effort. However, just as the role of ICRISAT in these private technology systems is determined by their constituent elements and competencies, the overall institutional role of ICRISAT in achieving its international public-good mandate needs to be understood and evaluated in this wider systems perspective. Redefining this role and presenting it unambiguously to partners in the public, private, and non-governmental organization (NGO) sectors is a task that needs to be completed with some urgency.

For both Indian research institutions and private companies who recognize that their interface needs to increase significantly, a key problem still remains: it is not possible to learn to swim without getting wet. So while recognizing that there might be some differences in the way the two sectors perceive each other's needs and capabilities, both public and private sectors indicted that they wanted to know how to initiate the process of engagement. There was some disappointment on the part of the some of the private-sector companies that more examples were not provided of ways that this had been achieved elsewhere. (There was perhaps even some disappointment that the workshop did not discuss the details of potential joint projects). However, those present who have international experience of these issues cautioned against trying to find blueprints for public-private sector partnerships. Instead, the advice was the need to recognize that public- and private-sector actors were all part of a system that is producing innovations. The key was the need to create institutional devices that improved public- and private-sector contributions to these systems. And to build in processes that indicate which institutional devices work or do not work in the Indian context; to learn what stops technology systems emerging; and, most important of all, to be able to act on these lessons. Put another way, there is a need for the private sector to build up knowledge on how to access public-sector resources. Equally, the public sector still has a lot to learn on ways of engaging the private sector.

Having provided these principles it is probably useful, by way of recommendations from the workshop, to lay out ways that this process of closer interaction has been initiated in other contexts. These include:

- Joint public/private bodies used to identify areas of pre-competitive research to be undertaken with money raised from both public and private sectors
- Industrial placement for postgraduate students working on joint projects between industry and universities
- Job swaps and secondments between public and private sectors
- Challenge funds where public agencies are challenged to raise half of a project's funds from the private sector, the other half having been provided from the (public) fund
- Private membership of institute boards, research committees, and advisory committees of competitive research funds.
- Commodity boards, networks, and associations with joint public/private-sector membership.
- Joint public/private-sector task forces
- Science parks and infrastructure sharing.

We hope that this workshop and the discussions that followed highlight the fact that there is no easy way to develop more effective patterns of interaction. Institutional innovations, like their technical counterparts, arise from experimentation and shared learning. Research managers, particularly those in the public sector, need to take heed of this and recognize that progress is intimately bound-up with institutional change.

Further reading

Details of recent ICRISAT and NCAP publications relevant to discussion of public-private sector interaction in agricultural research are given below. Copies are available from the Socioeconomics and Policy Program (SEPP), International Crops Research Instititute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

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About NCAP

The National Centre for Agricultural Economics and Policy Research (NCAP) was established by the Indian Council of Agricultural Research (ICAR) with a view to upgrading agricultural economics research through the integration of economics input in the planning, design, and evaluation of agricultural research programs and to strengthen the competence in agricultural policy analysis within the Council. The Centre is assigned a leadership role in this area, not only for various ICAR institutions, but also for the State Agricultural Universities. In order to make agricultural research a more effective instrument for agricultural and rural change and to strengthen policy-making and planning machinery, NCAP will undertake and sponsor research in agricultural economics relating to problems of regional and national importance.

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The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

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