POST HARVEST INNOVATIONS IN INNOVATION

REFLECTIONS ON PARTNERSHIP AND LEARNING

Hall A J, Yoganand B, Sulaiman R V, and **Clark N G. (eds.).** 2003. Post-harvest innovations in innovation: reflections on partnership and learning. Crop Post-Harvest Programme (CPHP), South Asia, c/o International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India: Crop Post-Harvest Programme South Asia. 180 pp.

In the post-harvest area and in agriculture research in general, both in India and internationally, policy attention is returning to the question of how innovation can be encouraged and promoted and thus how impact on the poor can be achieved. This publication assembles several cases from the post-harvest sector. These provide examples of successful innovation that emerged in quite different ways. Its purpose is to illustrate and analyze the diversity and often highly context-specific nature of the processes that lead to and promote innovation. The presented cases suggest a number of generic principles needed to develop the capacity of innovation systems: the need to pay more attention to revealing and managing the historical and institutional context of partnerships and relationship; the need to build on local contexts and circumstance rather than introducing external blueprints; and the need to strengthen the learning process and to link this to the broader agenda of institutional change, particularly concerning the governance of public science endeavors.

This publication is an output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID (R7502: Crop Post-Harvest Programme).

Post-harvest innovations in innovation: reflections on partnership and learning

Edited by

A J Hall, B Yoganand, R V Sulaiman, and N G Clark

CPHP
South Asia

Crop Post-Harvest Programme, South Asia
Patancheru 502 324, Andhra Pradesh, India

nr international

Natural Resources International
Park House, Bradbourne Lane, Aylesford, Kent ME20 6SN, UK

2003

The **Department for International Development** (DFID) is the UK government department responsible for promoting development and the reduction of poverty. The policy of the Government was set out in the White Paper published in November 1997. The central focus of the policy is a commitment to the internationally agreed target to halve the proportion of people living in extreme poverty by 2015, together with associated targets including basic healthcare provision and universal access to primary education by the same date. A second White Paper on International Development, published in December 2000, reaffirmed this commitment, while focusing on how to manage the process of globalization to benefit poor people.

The **Crop Post-Harvest Programme (CPHP)** is one of DFID's 10 renewable natural resources research programmes. These programmes commission research on the natural resources systems that support the livelihoods of poor people. The CPHP geographic focus is on South Asia and Western, Eastern and Southern Africa where projects are implemented by scientific and developmental organizations from partner countries, often in collaboration with counterpart organizations in the UK. **CPHP, South Asia,** one of four regional offices of CPHP, works in India, Bangladesh, and Nepal, where its mission is to support the livelihoods of poor people by promoting the development of post-harvest innovation capabilities through partnership-based research, networking and strengthening relevant communities of practice.

This publication is an output from the Crop Post-Harvest Programme, South Asia funded by the UK Department for International Development for the benefit of developing countries. The views expressed are not necessarily those of DFID (R7502 and R7551 Crop Post-Harvest Programme].

HALL, A.J., YOGANAND, B., SULAIMAN, R.V. and CLARK, N.G. (Eds) (2003) *Post-Harvest Innovations in Innovation: Reflections on Partnership and Learning.* DFID Crop Post-Harvest Programme, South Asia, Patancheru 502 324, Andhra Pradesh, India and Natural Resources International Limited, Aylesford, UK. 180 pp. ISBN 0-9539274-8-2

South Asia Regional Coordinator
Crop Post-Harvest Programme (CPHP)
ICRISAT, Patancheru 502 324
Andhra Pradesh
India
Tel: +91 (40) 23296161 ext. 2522
E-mail: a.hall@cgiar.org

The Communications Coordinator
Natural Resources International Ltd
Park House, Bradbourne Lane
Aylesford, Kent ME20 6SN
United Kingdom
Tel: +44 (0)1732 878670 (direct line)
Tel: +44 (0)1732 878686/7 (switch board)
Fax:+44 (0)1732 220497
Website: www.nrinternational.co.uk
Email: info@nrint.co.uk

Contents

Preface

Innovations in innovation: reflections on partnership and learning

A J Hall[1]

The workshop held on 6 May 2002 was part of a project funded by the Crop Post-Harvest Programme (CPHP) of the UK Department for International Development (DFID) that arose from a growing recognition among researchers and policy-makers that attention needs to be given to the circumstances from which innovations emerge. By innovations we do not just mean new technology, but also the institutional and organizational innovations that emerge as new ways of developing, diffusing, and using new knowledge.

The origins of this orientation in the CPHP was a series of multi-agency projects dealing with mango export quality management systems during the period 1995–98 (see pages 82–83 of this publication for background details). During this work it became increasingly apparent that both the effectiveness of the innovation process and its relevance to poor stakeholders was determined to a large extent by the nature of partnership groupings and the way the institutional environment (the norms and working conventions among and between partners) shaped relationships and learning. Realizing the importance of partnerships and the institutional context of its work (in the sense of rule sets, norms, and routines), CPHP commissioned research to explore these aspects of the innovation process in greater detail. The workshop was part of that research initiative.

The workshop was intended to illustrate and explore the diversity of systems that have emerged to generate innovations. This is reflected in its title, **Innovations in Innovation** that alludes to the constant search for new ways to generate and promote innovation, and indeed the diversity of approaches that have evolved to do just that. The focus of the workshop and this publication was predominantly post-harvest issues, but the underlying principles are generic to the agricultural research sector. At the workshop three cases of innovation were presented and discussed. All three have developed different modus operandi, each involves different patterns of partners and relationships that are shaped by the specific historical, organizational, institutional, political and technology-related contexts from which they have emerged. All three are relatively successful in the sense that systems have been established that can generate innovations relevant to poor people.

1. University of Greenwich, UK, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India

Workshop modus operandi

At the workshop the three main papers were presented in the morning session with time given for specific questions on each. During the afternoon session three working groups were formed where participants analyzed the presented cases in the terms of the five questions mentioned above.

Publication contents

The papers presented at the workshop have since benefited from the working group discussions and analyses and have used the five questions as a framework to describe innovation and its context, and to synthesize the significance of each case. We have taken the opportunity to collect together other relevant material that has been added as supplementary background papers that provide more information for interested readers, and also provide further insights to help in the overall analysis of the workshop debate. As a way of synthesizing the presentations, discussion and additional material, an Overview is presented that initially develops a conceptual framework for the presentations. It then attempts to answer some of the questions raised and suggests some of the general principles and policy recommendations emerging from this work.

A list of workshop participants is presented in Appendix 1, a list of acronyms used in Appendix 2, and brief bio-sketches of the authors in Appendix 3.

Acknowledgement

CPHP South Asia acknowledges the help of Sue Hainsworth and T N G Sharma, Editorial and Publishing Services, in the preparation of this publication.
Printed in India at Pragati Offset Private Limited www.pragati.com

Endnote

This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID (R7502: Crop Post-Harvest Programme).

Foreword

ICRISAT – an innovating organization in a changing world

W D Dar[1]

At ICRISAT, we recognize and accept that change and evolution are central characteristics of modern human society. If science and technology is to be effectively used to combat poverty in this changing world, one cannot stand still. Organizations like ICRISAT and our development partners must adapt, innovate, and evolve. I would like to share with you this morning some of the innovations within ICRISAT that have been introduced to cope with this changing world, and the core principles and values of partnership, trust, and excellence that the Institute uses to keep pace with the developments which surround it.

As ICRISAT approaches its 30th anniversary it is useful to reflect on the way the semi-arid tropics (SAT) and indeed the wider world have changed. When the Institute was established in 1972, the successes of the seed-based technologies of the Green Revolution were just starting to become apparent to all. Food storages in both Asia and Africa were still a major concern for the international development community. There was still a critical need to build capacity in public-sector plant breeding programs and in seed production and distribution systems – particularly for crops grown and consumed by the poor. These imperatives were reflected in the establishment of ICRISAT as an international center of excellence in the crops of the SAT – sorghum, pearl millet, chickpea, pigeonpea, and groundnut– with a core competence in plant breeding and genetic enhancement.

In the intervening years much has changed. Eight features stand out:

- Firstly, in the world's SAT, increasing food production, while still necessary, is no longer sufficient to reduce poverty. The rural poor have developed diversified livelihood strategies to cope with their vulnerability and to exploit new, often market-driven, opportunities
- Secondly, international development goals have widened from merely increasing food supply to include poverty reduction, and environmental sustainability. As a consequence, international support for agricultural science and technology has now to compete with a wider set of development objectives
- Thirdly, shifts to a development paradigm that seeks to build stronger stakeholder participation, partnership, and governance, are now exerting a major influence on approaches and priorities
- Fourthly, the public sector as the main source of technological innovation has been supplemented by the private sector, in both the seed industry and related areas of biotechnology in particular and in life sciences in general

1. Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India

- Fifthly, the role and sophistication of the non-governmental organization (NGO) sector has emerged as a major force for rural change and innovation
- Sixthly, as the rural sector is drawn further into market-based economies, the distinctions between pro-poor development agendas and the priorities of enterprise and industry have become increasingly blurred
- Seventhly, the emergence of new generic technologies, particularly information technology and biotechnology, and the possibilities and controversies that these present
- Eighthly, the emergences of global markets and technology systems and the threats and opportunities these offer to the poor people of the SAT.

Perhaps the only thing that hasn't changed is the scourge of poverty that continues to blight the lives of millions of men, women, and children in the SAT – 40% of all those living in South Asia and 46% of those living in sub-Saharan Africa. In the SAT alone this currently amounts to a staggering figure of nearly 450 million people.

ICRISAT has coped with this changing world by re-orientating two key features of its operation – its programs and its approach to partnership. The first has involved the restructuring of the entire research portfolio away from disciplinary programs – breeding economics, pathology and so forth – by creating six broad thematic areas, the **Global Research Themes.** These six themes focus on some of the major developmental drivers of the SAT:

1. Harnessing Biotechnology for the Poor
2. Crop Management and Utilization for Livelihood Security and Health
3. Water, Soil, and Agro-biodiversity Management for Ecosystem Health
4. Sustainable Seed Supply Systems for Productivity
5. Enhancing Crop–livestock Productivity and Systems Diversification
6. SAT Futures and Development Pathways.

This new structure has shifted the focus of the Institute to a forward-looking, opportunity-driven agenda. This agenda is still based on excellence in science, but in a totally new framework, moving away from disciplinary contributions alone to include developmental goals and agendas.

The second key shift is also concerned with the framework of scientific excellence, but this time in terms of our patterns of partnership. The Institute has always had very strong partnerships with national programs in the countries of the SAT. During the last 5 years, however, ICRISAT has adopted a much broader-based partnership approach. Both NGO and private-sector organizations are now core partners in ICRISAT endeavors. This has been a direct response to the need to have more intimate relationships with the users of technology, particularly farmers, and the need to partner with organizations that have complementary skills and resources. And this response has not just been about new partners, it has been about new types of partnership and participation with stakeholders.

These generic shifts are exemplified in a number of key institutional innovations in ICRISAT. One of my first tasks on assuming my position as Director General was to sign an agreement with a consortium of private seed companies to fund hybrid development research here at ICRISAT. At that time this was an almost unique innovation in the whole of the CGIAR.

More recently ICRISAT has entered into an agreement with a major rural development project – the Andhra Pradesh Rural Livelihoods Project (APRLP) supported by DFID. This project is helping to cement an entirely new type of relationship between scientific research on watershed development and natural resource management at ICRISAT and the developmental activities of APRLP. Such a linkage between an international agricultural research center and a major, long-term rural development program is a key institutional innovation, embedding science in a new framework of stakeholder governance.

A new innovation that is still at an early stage is an initiative to develop an incubator facility for small and medium-sized biotechnology companies. This will create a new dynamic between ICRISAT and the life-science industry, and is expected to generate enormous amounts of creative synergy for both us and our partners.

These are just some of the more high-profile innovations that have taken place. I share them with you to illustrate the way we as ICRISAT have responded to our changing world. We have done so in ways that reflect our own history, our core expertise in science, and our long-term commitment to reducing world poverty. There is no blueprint for responding to the challenges of the changing world around us, what we see today at ICRISAT is the result of a truly evolutionary process in which we have adapted and are continuing to adapt to fit our niche in international development.

Our partners have all adapted to the changing world in different ways, each brings with them their own history and their own evolution. The main things that we at ICRISAT can share with others are the principles and values that have shaped our evolution and innovation. These include: the centrality of partnership in our approach; the need to develop mutual trust, respect, and transparency with our partners; and the need to maintain excellence in our science. But we have not left the development of these principles and values to chance. In our partnerships and teamwork we have made explicit effort to emphasize, develop, and build awareness of our philosophy and approach. These values will take us forward and ensure that science continues to play its role in supporting the livelihoods of poor people in the SAT. This is the core of our credo of 'Science with a human face'.

Overview

Innovations in innovation: partnership, learning and diversity in the generation, diffusion and use of new knowledge

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

Abstract

The paper provides an overview and synthesis of three cases of ***innovation in innovation*** *from the post-harvest sector in India. Using the innovation systems framework five themes are used to compare these cases, namely: context, partnership, institutional rigidities, learning, and poverty focus. While we argue that this comparative analysis suggests a number of general principles, it also leads us to stress that there is no universal model or blueprint. Instead what seems to be important are interventions that rely on and encourage the development of capabilities that allow adaptation to local circumstances, resources and opportunities, and that relay on learning processes as a way of finding new ways to achieve goals. The conclusion raises two cautionary points. Firstly much greater attention needs to be given to understanding the institutional and historical context of partnerships than was perhaps previously thought necessary in research planning and management. Part of this task concerns monitoring stakeholder interests during project implementation and particularly testing assumptions about the poverty relevance of certain courses of action and the implications of decisions. Secondly, institutional change in the agricultural sciences is long overdue and is emerging as a serious impediment to the agricultural innovation system.*

Introduction

The papers in this publication discuss the process of innovation in the post-harvest sector. We use the term 'innovation' in its broad sense to cover the activities and processes associated with the generation, production, distribution, adaptation, and use of new technical, institutional, and organizational or managerial knowledge. The emphasis on **innovations in innovation** alludes to the constant search and emergence of new ways of generating, promoting, and using new knowledge.

A central aim of the workshop held on 6 May 2002 was to assemble and discuss a number of cases from the post-harvest sector that are examples of successful innovation that emerged in quite different ways. The purpose was to demonstrate and analyze the diversity and often highly context-specific nature of the processes that lead to and promote innovation. The relevance of this topic is that in the post-harvest area in particular, and in agriculture research in general, both in India and internationally, policy attention is returning to the question of how

1. University of Greenwich, UK, seconded to International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India
2. ICRISAT
3. National Centre for Agricultural Economics and Policy Research (NCAP), PO Box 11305, Library Avenue, Pusa, New Delhi 110 012, India
4. Graduate School of Environmental Studies (GSES), Wolfson Centre, University of Strathclyde, Glasgow G4 0NW, UK

innovation can be encouraged and promoted and thus how impact on the poor can be achieved.

The three workshop papers are presented in such as way that they do not just discuss the objectives and outcomes of each of the initiatives they cover. Instead, the focus is on the processes that were involved; the 'hows' of what led to success; and the ways these 'hows' changed over time. Given the increasing policy interest in improving the effectiveness and impact of research, such process narratives of research projects and other interventions are surprisingly rare.

The first case by Sulaiman and Pillai (2003) and discusses the experience of a large horticultural sector development program and its efforts to establish technology development arrangements primarily with the local agricultural university and eventually with farmers. The case provides in considerable detail the nature of constraints to effective partnership in the prevailing institutional environment. It also discusses the way a learning-based management approach evolved alternative arrangements for both technology development and the wider sphere of activities related to supporting smallholder horticultural producers. The second case by Phansalkar (2003) deals with the partnership dynamics in a project exploring support to post-harvest systems in Himachal Pradesh, India. The case explains an approach that relied on establishing technology, production, and retail systems. The approach had been successful elsewhere, but this case discusses its novel application in the post-harvest sector. The third case by Abrol (2003) provides an overview of the People's Science Initiatives and provides details of the innovation in the area of agro-process addresses. The approach described is relatively novel in that it explicitly sets out to develop the capacity of local technology systems. This involves building on indigenous knowledge and resources, and strengthening networks within the local economy. The approach also links into the formal science community when required, relying on a network of scientists that subscribe to the overall philosophy of the People's Science Movement.

Along with these case studies a number of supplementary papers are presented. These include a more detailed discussion of the conceptual debate about innovation in the post-harvest sector, as well as papers relevant to the general topic of innovation and capacity-building in relation to international development. These papers are not discussed in detail in this overview which concentrates on providing a conceptual orientation for the rest of the papers, and distils the main arguments and lessons presented.

R&D in its contemporary setting

There is now widespread concern that the conventional model of formal research and development (R&D) as the central source of innovation needs to be replaced by something more suited to contemporary development agendas (Biggs 1990; Byerlee and Alex 2003; Hall et al. 2000; 2001). However, what is less clear is what these new arrangements might be. In part this need for change relates to a shifting development agenda, with poverty reduction and environmental sustainability as key organizing principles for strategies that also need to improve economic growth and international competitiveness in global markets. This shift is happening at a time when the agriculture and rural development sector is seeing the

emergence of new capabilities, organizations, and organizational forms, and where partnerships are increasingly discussed as part of a new vision of agricultural and rural innovation. Similarly, advances in modern science are offering new opportunities, while at the same time new patterns of accountability and governance are changing the role of scientists and their relationship with society (Murthynja and Ranjitha 1998; Echevia 1998; Byerlee and Alex 2003).

Biggs and Matsaert (1999) argue that in the contemporary setting of agricultural research and rural development, managers of R&D systems are often faced with making a range of decisions for which old frameworks of analysis are often inadequate. These old frameworks include economic rates of return, computer simulation models and conventional monitoring and evaluation (Biggs and Matsaert 1999). One of the ways the agricultural research community is beginning to respond to the complex realities in which it finds itself is to plan its activities within the context of an **innovation system** [Byerlee and Alex 2003, Biggs and Matsaert 1999; Hall et al. 1998; 2000; 2001; 2002; 2003 (in press)].

At its simplest an innovation system is the groups of organizations and individuals involved in the generation, diffusion, adaptation, and use of knowledge of socio-economic significance, and the institutional context that governs the way these interactions and processes take place. The usefulness of this concept is that it recognizes that the innovation process involves not only formal scientific research organizations, but also a range of other organizations and other non-research tasks. It recognizes the importance of linkages, making contacts, partnerships, alliances and coalitions and the way these assist information flows. It also recognizes that innovation is an essentially social process involving interactive **learning by doing,** a process that can lead to new possibilities and approaches. Furthermore because the process depends on relationships between different people and organizations the nature of those relationships and its political economy is critically important. The conventions or institutions governing the way research and allied activities are conducted, and the role assigned to different organizations, is a defining context of the innovation process. As all scientists know, the nature of collaboration can make or break a research project.

Of course, in reality, agricultural research has always taken place in the context of an innovation system. In the past, however, this wider context has been assumed away in the planning process. The convention has been for R&D managers to set research priorities and allocate resources within the framework of good science. Little or no attention has been given to the need to build relationships with partners working in complimentary fields, nor to seek linkages, relationships and processes that would embed research in the wider innovation system and improve its relevance to developmental agendas. Much of this social side of innovation – the software – was assumed to be outside of the remit of R&D managers, whose job was to deal with scientific research – the hardware of innovation. As a result the process of networking, forming alliances and partnerships, negotiating priorities and approaches to research and evaluation – which everybody knows are necessary activities – took place at an informal level with limited systematic support or planning. It is these sorts of activities and decisions with which R&D managers are now faced. The concept of an innovation system can act as a framework for analysis and planning in a more all-

encompassing fashion and hence include consideration of ways of developing the software of innovation.

Principles of innovation system analysis

Linear and systems models of innovation

As has already been mentioned the emergent view is that it simply no longer holds true that knowledge can be independently produced in specialized research organizations and that this knowledge can then be transferred to passive users. Innovation, as distinct from research and invention, is a much more complex process, often requiring technical, social, and institutional changes, and involving the interaction of actors across the conventional knowledge producer–user divide. Douthwaite (2002) believes that this holds true in cases of innovation ranging from rice drying in South Asia to wind turbines in Europe and North America. He shows how innovative success is a complex process of learning and adaptation.

Innovation and its context

An innovation systems perspective brings together thinking from a broad set of disciplinary perspectives that view development and change in systems terms [see Edquist 1997 for a review of this topic]. At its heart lies the contention that change – or innovation – results from, and is shaped by, the system of actors and institutional contexts at particular locations and points in time. A related recognition is that knowledge production and use is a highly contextual affair.

This has many analytical implications: the need to consider a range of activities and organizations related to research, particularly technology users, and how these might function collectively; and the need to locate research planning in the context the norms, culture, and political economy in which it takes place – i.e., the wider institutional context. As already discussed the convention in R&D planning has been largely to ignore this context.

Similarly, it is no longer useful to think of institutional and organizational arrangements for research as fixed or optimal – clearly these must evolve to suit local circumstances. In the same way, the evaluation of innovation performance also becomes much more context-specific relating to the perspective of stakeholders and current imperatives, rather than either scientific peer review or economic justification alone.

Innovation systems thinking – origins and principles

The origin of innovation systems thinking can be traced to the idea of a 'national system of innovation' proposed by Freeman (1987) and Lundvall (1992). The concept, which build on empirical observations of best practice in different national and sectoral settings, states that innovations emerge from evolving systems of actors involved in research and the application of research findings. Lundvall identifies learning and the role of institutions as the critical components of these systems. He considers learning and knowledge production to be an interactive and thus socially embedded process that cannot be understood without reference to its institutional and cultural context, usually in a national setting.

The innovation system concept therefore provides a framework for: 1. exploring patterns of partnerships; 2. revealing and managing the historical and institutional context that governs these relationships and processes; 3. understanding research and innovation as an interactive social process of learning; and 4. thinking about capacity development in a systems sense. On this last point, Velho (2002) observes that national systems of innovation, made up of actors who are not particularly strong, but where links between them are well developed, may operate more effectively than another system in which the actors are strong but links between them are weak.

Innovation themes for analysis

Flowing from this discussion of the concept of innovation systems five themes present themselves for analysis of our workshop cases. The themes and the questions they imply are:

- **Context.** What were the key contextual factors that shaped each case, i.e., both the historical context that shaped approaches and relationships and the opportunities, resources, and capacities that were specific to the case and influenced its form and direction?
- **Partnerships.** What were the critical partnerships involved, how were they established, and what led to the relative success or failure of these partnerships? What were the roles of partners and what essential/complementary skills/resources did they bring with them? How were roles negotiated? and What were the formal and informal rules that governed the partnerships?
- **Institutional rigidities and change.** What were the rigidities encountered in the organization or practices and norms of partners or wider structures (particularly public bureaucracies) and how did the nodal organizations cope with these rigidities or induce change?
- **Learning.** How do organizations learn and build up skills on partnering? Are processes intuitive and ad hoc, or do they have specific learning mechanisms? How could these be strengthened? What other types of competencies do organizations build up that help to generate innovations?
- **Poverty.** What specific steps were used to ensure that a poverty/technology-user perspective influenced the outcome of partnership processes? Has this been verified either internally or independently?

Innovation and poverty relevance

This last theme on poverty relevance needs special attention since the policy agenda is not just seeking ways to improve innovation performance in a general sense, but doing so in pro-poor ways. A useful framework for making a judgment of this kind is to explore the **poverty relevance** of interventions, an approach used by, for example, the UK Department for International Development (DFID) to classify all its development projects. The approach involves sorting projects into one of three categories that describe the main way in which they address the poverty-reduction aim (see Underwood 2002 for an example of the application of this approach in the post-harvest sector). It is recognized that all categories are important and that choices will depend on specific circumstances and the strategy

adopted to support poverty reduction. The three categories of poverty relevance are:

1. **Enabling.** Addresses an issue that underpins pro-poor economic growth or other policies for poverty reduction that leads to social, environmental, and economic benefits for poor people. Examples are:
   - Access/rights to resources/assets
   - Safeguarding environment
   - Reforms to regulatory, incentive, and institutional frameworks
   - Promotion of small-scale enterprises
2. **Inclusive.** Addresses an issue that affects both poor and non-poor, but from which the poor will benefit equally (given economies of scale). Examples are:
   - Pest and disease control
   - Improved extension services
3. **Focused.** Addresses an issue that directly affects the rights, interests, and needs of poor people primarily. Examples are:
   - Improvement for crops grown mainly by the poor – reduction of losses/ vulnerability
   - Adding value to crops produced by the poor
   - Increased market access/diversification opportunities for the poor

While this framework is relatively simple, it at least allows us to move beyond a rhetorical engagement with poverty in relation to the innovation process. In terms of the analysis of the cases presented here it helps us consider which innovations in innovation are relevant to the poor specifically, and which will only assist rural communities in a more general sense. This is an important distinction for innovation policy. For further discussion on policies for pro-poor innovation see Berdegue and Escobar (2002).

Cases of innovation in innovation

Kerala Horticultural Development Programme (KHDP): a learning-based approach to technology development and promotion and rural innovation

This case describes KHDP a project supported by the Commission of European Communities and Government of Kerala. This pilot program started field implementation in November 1993 with the objective of developing replicable models. The major objective was to improve the overall situation of vegetable and fruit farmers of Kerala by increasing and stabilizing their income through reduced production costs and by improving the marketing system. The KHDP interventions included R&D, provision of planting materials, extension service and demonstration plots, training, credit package, marketing support and processing unit. KHDP organized self-help groups of farmers. A critical partnership in the project was a contract research arrangement with the Kerala Agricultural University (KAU). While this arrangement faced many challenges and ultimately failed, the case provides a useful illustration of the way learning and experimentation with approaches can underpin programme success. This was a general philosophy of KHDP management and was implemented across the Programmes' activities. The other notable feature about this case was that partnerships of various kinds

were critical to the success of this program. However, the instance of the relationship with KAU suggests that partnerships can only work when they exist in an institutional environment that supports flexibility, transparency, trust and shared objectives and values.

Evolving technology through collaboration and partnership: the case of IDE(I)'s work with tomato packaging in Himachal Pradesh, India

This case discusses a project implemented by International Development Enterprises, India [IDE(I)] with funds received from the Crop Post-Harvest Programme (CPHP) of the DFID. A UK-based international non-governmental organization (IntNGO) was chosen as the project leader. The IntNGO contracted IDE(I) to carry out field work connected with identifying the specific post-harvest stage for intervention. IDE(I) also undertook technology identification, sourcing, and adaptation. IDE(I) identified tomato as the main crop for intervention and the development and commercialization of suitable cardboard box packaging as the main task. The project was implemented in partnership with another NGO based in the region. Scientists from the Indian Institute of Management, Ahmedabad (IIMA) and manufacturers of the boxes became project partners during the technology development and design phase. While the partnership between the IntNGO and IDE(I) was formalized through an agreement, other partnerships were not. The partnership with the IntNGO ultimately failed. The case suggests a number of issues about the partnership process: 1. inclusion of a partner for formal, legal, or stylistic reason alone may not lead to a productive partnership; 2. the existence of prior personal rapport between key individuals seems to lead to effective partnerships; 3. partners need to evolve mutual roles and responsibilities while remaining sensitive to mutual concerns rather than formalize such roles in a memorandum of understanding (MoU) or other written agreement.

People's Technology Initiatives (PTI): embedding technology in community-based production systems

This case discusses an alternative paradigm of science and technology (S&T) and rural development promoted by PTI. The approach emerges out of the broader People's Science Movement in India, itself a backlash against what was viewed as the weak governance of science and its failure to meet the needs of the poor and to enhance their productive capacities. The elements of the PTI philosophy reflect these contextual origins with an approach that seeks to build technology systems around local knowledge, resources, and economies – rather than visa versa as is the case with conventional models of technology development. This is explained in the case by giving examples of the application of the approach to developing rural agro-processes based co-operative enterprises. Networking and building partnership has been a very important component in the PTI – both in terms of individual initiatives as well as in terms of promoting and supporting the approach. Notable also is the capacity development focus of the PTI. This is capacity development not only in terms of enhancing the skills and technologies of poor people, but also capacity development in the sense of linking the poor to sources

of S&T and thus enhancing the capacity of the local technology system. The evolutionary characteristics of this capacity development are typical of such a learning-based approach. This case perhaps presents a rather radical alternative to mainstream S&T and rural development initiatives; however it contains principles of partnership and learning that others could adopt. The other notable feature of the PTI is that out of the three cases discussed at the workshop, this was the only one was designed specifically to focus on the poor.

Innovation system analysis

The three case studies presented here give considerable detail about the nature of the innovation process with which they each deal. Before discussing them its useful to point out that all of them have been successful in the conventional terms of technologies adopted, production and incomes increased (details can be found in the papers). More importantly, however, the projects have been successful in terms of the innovation capabilities that they have created. Innovations in the innovation process have strengthened the innovation systems involved. Put in another way, each intervention represents incremental improvements in the software of innovation in their own particular sphere of influence.

Rather than attempting to summarize the lesson from each case the following synthesizes the general principles that emerge from across the three cases. The five innovation themes of context, partnership, institutional rigidities, learning and poverty focus are used to organize this synthesis (a summary of which is presented in Table 1).

Context

All three cases quite clearly demonstrate the way interventions, programs and projects are shaped by geographical, institutional, and historical contexts. The technology development strategy of KHDP was shaped by the fact that the institutional context of its main partner, the KAU, made it virtually impossible to conduct farmer-relevant research in collaboration with a formal research body. Learning from this KHDP developed its own arrangements to conduct farmer-participatory technology development.

All of the cases illustrate the way in which novel approaches to innovation were developed based on the philosophy or culture of different organization. For example, IDE(I) pursues a marketing-based approach that depends on establishing retail systems that deliver technology to the poor. Many of their staff have a marketing background and the approach had been developed successfully in the small-scale irrigation sector. This context was enormously influential in the way IDE approached its post-harvest project – as with the small-scale irrigation sector it approached post-harvest with the aim of improving input supply systems.

The PTI is shaped by an entirely different philosophical context. It is an approach that emerged from a leftist critique of development and relies on developing technology systems around co-operatively managed agro-processing enterprises. An important feature of PTI is the way that it recognizes that these systems have to be tailor-made to local circumstances, using a system design group to achieve this.

Table 1. Summary of the key feature of the three cases of innovation in innovation

	KHDP	IDE(I)	PTI
Context	• KHDP was purposely established outside the administrative structure of the State government. This allowed it to operate in a context where flexibility and experimentation were possible • The focus of KHDP on horticulture reflected specific livelihood constrains in the socio-economic and agro- climatic context of Kerala	• The approach developed from IDE(I)s experience of establishing technology supply systems for irrigation equipment • The geographic focus of the project and selection of local NGO partners built on existing activities and relationships of IDE(I)	• The approach was shaped by dissatisfaction with conventional R&D and economic development models and the emergence of science and technology voluntary organizations as an alternative • Specific rural production context shapes technology system design for each intervention
Partnership	• The partnership with the agricultural university was thought to be the most important in term of technology development. This proved to be unworkable • Partnerships with farmers groups were important not just for technology development but also for a range of other activities	• A formal partnership, required to access funding, failed due to unequal roles in decision-making and accessing resources • Informal partnerships built on joint history and trust and shared objectives succeeded • Efforts were made to nurture these successful relationships as these partners formed the supply chain being developed • Partner identification was a key skill	• Involves partnerships with rural households, scientists and scientific organizations, government agencies and donors. • The approach is built on the development of strong rural networks of partners. • Partnership also important in promoting the PTI approach in mainstream research and rural development domains
Institutional rigidities	• Research conventions in the university system • Coped by developing its own arrangements for participatory technology development	• Some public-sector research organizations not willing to work with an NGO • Coped by by-passing unhelpful organizations	• Difficulties encountered with donors and their fixed ideas about how projects should be organized and monitored • Coped by seeking financial independence
Learning	• Intuitive as part of management philosophy	• Intuitive as part of organizational culture of sharing results and ideas	• Intuitive through a tradition of debate and self-analysis
Poverty relevance	• *Preventative* Targeted small-scale farmers with the rationale of preventing them falling into poverty • No systematic assessment	• *Inclusive and enabling* Targeted a commodity that was imported to the poor, but which was also important to the non-poor • Helped the poor and non-poor cope with environmental policy changes • No systematic assessment	• *Focused* Targeted landless households through non-farm rural employment, the rationale being that only the non-poor benefit from land-based activities • Assessment only through donor monitoring

KHDP also has its own organizational context. It was originally going to be a program with the State government of Kerala. However, a senior bureaucrat had the foresight to advocate for its establishment as an autonomous agency. This gave KHDP the freedom to do many things that would simply not have been possible as part of a large public-sector bureaucracy, such as failing and learning.

All of these approaches have thus been quite different for the very good reason that they emerged from different contexts. The fact that they approached post-harvest innovation in different ways does not make any of them better or worse. Instead it highlights the fact that the approaches adopted were the right ones for the circumstance being addressed and that they built on existing strengths, organization cultures and lessons learned along the way. A general principle for designing innovation interventions therefore seems to be the need to recognize the importance of organizational histories and cultures and building upon these (or finding ways of coping with them) rather than pretending that they do not exist or matter. This would also seem to support the general observation that externally developed blueprints rarely work.

Partnerships

All the case studies illustrate the importance of partnership of various types in the innovation process. All three cases used partnership for technology development including partners from scientific organizations as well technology users and farmers as partners. KHDP and IDE(I) used partners to assist with technology and information dissemination. In the case of KHDP this involved farmer groups and master farmers to spread information on production and post-harvest technology as well as market information. IDE(I) used partnerships with both a local NGOs and with local entrepreneurs to establish its technology supply system.

PTI used partnership with rural communities as a way of designing locally relevant technology systems as well as a way of developing the capacity of these systems, i.e., by identifying local artisans with specific skill and linking them into the system. Both the IDE(I) and the PTI allude to a partnership with sponsors of their program that is both important and needs to be managed. A final type of partnership that the PTI discusses is networks to spread advocacy for an new approach. The network of science and technology voluntary organizations have been a powerful way of raising the profile of PTI in mainstream debates and interventions

Both the KHDP and the IDE(I) cases included formal contractual relationships with partners. Both of these partnerships did not last the duration of the project. In the case of KHDP the institutional context of the partner, the State agricultural university, made it impossible for it to deliver its contribution to the partnership. IDE(I) case was slightly different in that it was a partnership that was to some extent forced on them by conventions of the donor at that time. The weakness of this partnership was compounded by an earlier history between the two partners that was characterized by skewed power dynamics, a lack of trust between them, and a good deal of resentment. Again, the contribution of IDE(I)'s partner, IntNGO, was less than expected and the partnership dissolved.

Conversely both the IDE(I) and the PTI case illustrate the way successful partnerships emerge from longstanding relations where trust has been established

and where interests, philosophies, and organizational cultures overlap. Both organizations, having recognized the importance of partners, have developed skills and devote efforts to identifying partners and strengthening relationship with them. A related observation is that KHDP, IDE(I), and PTI seem to play a nodal role facilitating and coordinating the relationships required to promote innovation through the cluster of organizations with whom they partner.

A number points flow from this. As already discussed partnerships and the relationship they involve often emerge from institutional and historical context and this can define the nature and effectiveness of them. This context needs to be revealed and managed if innovation systems are to be strengthened. A related point is that partnerships don't emerge overnight. Time and resources need be to spent identifying new partners and exploring and mapping relationships and linkages that need to be strengthened and nurtured. It is important that those seeking to promote innovation recognize their role as systems coordinators and mangers, helping to make the right connections between the right partners.

Institutional rigidities

All three of the cases discuss the institutional rigidities encountered in dealing with public- sector research organizations. The PTI case explains the way its has coped with this by identifying scientist working in the formal research system who sympathize with the PTI and who might, for example, be members of science and technology voluntary organizations themselves. This approach has been described as 'science organizations without walls'. One could speculate that in the long term, if enough of these types of scientist are identified and involved in the PTI and allied approaches, it may start to alter the organizational culture of the formal research system. But there is clearly a long way to go.

The KHDP and the IDE(I) illustrate a more worrying phenomenon whereby the institutional context of public-research organizations is so rigid and unhelpful that they simply get by-passed and alternative arrangements are made. The KHDP case is probably the most dramatic illustration of this. Not only does it document the institutional obstacles to conducting farmer-relevant research, it also reveals that even though scientist working in the university realized the weaknesses in the set-up, there was no way that changes could be implemented, or even discussed. In other words the system had no capacity to learn and evolve. This is a major restriction to developing stronger links between scientific organizations and others involved in innovation systems.

What is all too clear from this is that institutional learning and change will be required in the Indian agricultural innovation systems and particularly the institutional arrangements that govern the way science is conducted in public-research organizations (Hall et al. (2003) discuss the nature of institutional change required in detail, see pages 123–146, this publication). A useful starting point might be to legitimize the discussion of failures in research organizations, and develop skills of scientists in the areas of reflection and learning.

Learning

A key feature of all the cases discussed is that the organizations involved have approached them in an experimental fashion. That is to say that none of the

organizations approached innovation with a set plan, but instead had principles and guidelines that were tested and developed by trial and error. In other words each organization accepted that failure was a learning opportunity that helped develop more effective strategies. In the case of IDE(I), its approach had developed over nearly a decade of experience in the small-scale irrigation sector. The case discussed is about a project to experimentally apply this approach a new sector – post-harvest.

All of the cases allude to the fact that learning was an important aspect of their strategy and that their approaches are evolutionary and dynamic. What is much less clear, however, is the precise nature of the learning process. One gets the impression, perhaps unfairly, that learning is an intuitive ad-hoc process that takes place because the organization's culture encourages or legitimizes this process. None of the cases illustrate a purposeful mechanism by which learning takes place in a systematic fashion.

One can draw a number of conclusions from this apparent paradox. Firstly, learning processes are chiefly intuitive and tacit and that given a suitable organizational culture lessons from past and on-going experience can help organizations adapt and enhance performance. The second conclusion is that there is scope to enhance learning and make it a more systematic activity. Those seeking to promote innovation could usefully devote resources to building learning capacities in project staff, including scientists, as well as ensuring that the organizational culture is conducive to the constructive discussion of both successful activities as well as those conventionally viewed as failures.

Poverty relevance

Of all the three cases only the PTI indicated that it was explicitly designed to support the livelihoods of the poor. The KHDP case had a less-focused agenda, seeking to improve the livelihoods of small-scale horticultural producers, the rationale being that this would prevent them falling into poverty. This does not fall into the poverty relevance categories discussed earlier, but perhaps it represents a new category – **preventative.** The IDE(I) approach did make specific efforts to target its intervention on households with limited land-holdings. It did this by using a needs assessment study to identify the crop which was most important to the livelihoods of small scale producers. The intervention thus became inclusive of the poor, as non-poor households also produced this crop.

In the PTI case, the philosophy of the organization determined that the intervention would focus on landless households only, and that it would therefore concentrate on creating rural non-farm employment. The rationale was that all land-based interventions benefit the non-poor to a greater extent than they benefit the poor. The other aspect of this intervention is that PTI sought to increase the ability of the poor (as a collective group) to compete with organized entrepreneurs in the market. PTI highlights this as being important as it says this prevents the usual patterns of events whereby agro-process interventions cause competition between different groups of poor people.

All three cases made assumptions about what the poverty relevance/livelihood outcome would be at the beginning of their interventions, but, certainly in the KHDP and IDE(I), these assumptions were not revisited periodically during the

intervention. One might perhaps find this surprising given the emphasis now placed by sponsoring agencies on poverty relevance. One conclusion here is that innovations systems could be strengthened if more attention were given to monitoring assumptions along the way. This is not an issue of undertaking conventional impact assessment, but rather being aware that some processes and decisions during projects are going to affect outcomes on different stakeholder groups and that this needs to be monitored. Similarly critical assumptions need to be challenged as events unfold during a project.

The PTI case suggests that targeting non-farm rural employment maybe a better way of focusing specifically on the poor. This is certainly laudable as it breaks out of the often rhetorical discussion of the poor as farmers, and the accompanying conventions this imposes on agricultural research as a means to increasing productivity and safeguarding household food stocks. Developing rural agro-processing enterprises and the innovation systems to support them has therefore many attractions in terms of using science creatively to support the poor. The same caveat, however, remains. Namely that the assumptions about poverty relevance need to be monitored and that this needs to part of the capability of the innovation system put in place.

Emerging issues

Flowing from the discussion are a number of points that warrant emphasis and which need to be drawn to the attention of practitioners, research mangers, and policy-makers.

The first point is that emphasis seems to need to shift from supporting research that delivers a stream of technology products, but instead also concentrates on developing the capacity of innovation systems. Research products are still important. But in rapidly evolving circumstances supporting the continuous development of the innovation systems seems to be an equally important part of this task. This suggests an innovation coordination manger role for nodal agencies. It also suggests that program and other interventions need to be evaluated in different ways that also appreciate this capacity-development function.

The second point relates to the importance of allowing locally relevant approaches and arrangements to develop and evolve. While recognizing the administrative attractions of devising widely replicable intervention models, innovation systems and their development have to be context-specific.

The third point is about the need for tools and strategies to understand institutional contexts and histories and to map and monitor relationship. All the cases pointed to the fact that it is these issues which provide the foundation of strong innovation systems and that unless these contexts are revealed and managed, failure is likely to occur. Tools are available, but are probably not yet made sufficient use of, particularly by R&D managers, for example, stakeholder analysis (Grimble and Wellard 1997) and the actor-linkage matrices (Biggs and Matsaert 1999; 2003). The action research tradition is also useful in this regard.

The fourth point concerns the need for institutional learning and change in agricultural innovation systems and particularly the institutional arrangements that govern the way science is conducted in public research organizations. The side-stepping or by-passing of public research organizations should be seen as a

warning sign that unless somebody grasps the nettle of institutional change vast science and technology resources that a country such as India possess will be become irrelevant.

Conclusion

The cases presented at the workshop amply illustrate that in India, scientists and rural development practitioners are being enormously creative in the way they approach innovation. A diversity of approaches exists and it is hoped that this publication will bring these experiences to the attention of a wide audience. The cases highlight the fact that partnership and learning are at the heart of the innovation process. However these experiences raise two cautionary points. Firstly, much greater attention needs to be given to understanding the institutional and historical context of partnerships than was perhaps previously thought necessary in research planning and management. Part of this task concerns monitoring stakeholder interests during project implementation and particularly testing assumptions about the poverty relevance of certain courses of action and the implications of decisions. Secondly, institutional change in the agricultural sciences is long overdue and is emerging as a serious impediment to the agricultural innovation system.

Endnote

This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID [R7502: Crop Post-Harvest Programme].

References

Abrol D. 2003. People's technology initiatives: embedding technology in community-based production systems. Pages 45–61 *in* Post-harvest innovations in innovation: reflections on partnership and learning (Hall A J, Yoganand B, Sulaiman R V, and Clark N G, eds.). DFID Crop Post-Harvest Programme, South Asia, Patancheru 502 324, Andhra Pradesh, India and Natural Resources Limited, Aylesford, UK.

Berdegué J A, and **Escobar G.** 2002. Rural diversity, agricultural innovation policies and poverty reduction. ODI Agricultural Research and Extension Network (AgREN) Paper no. 122. London, UK: Overseas Development Institute (ODI).

Biggs S D. 1990. A multiple source of innovation model of agricultural research and technology promotion. World Development 18(11):1481–1499.

Biggs S D, and **Matsaert H.** 1999. An actor-oriented approach for strengthening research and development capabilities in natural resources systems. Public Administration and Development 19: 231–216.

Biggs S D, and **Matsaert H.** 2003. Strengthening poverty reduction programmes using an actor orientated approach: examples from natural resources innovation systems (Draft manuscript, unpublished). 35 pp.

Byerlee D, and **Alex G.** 2003. National agricultural systems: recent developments and key challenges. Note prepared for the Interim Science Council of the Consultative Group on International Agricultural Research (CGIAR). 8 pp.

Douthwaite B. 2002. Enabling innovation. London: Zed Books. 238 pp.

Echeverría R G. 1998. Agricultural research policy issues in Latin America: An overview. World Development 26(6): 1103–1111.

Edquist C. (ed.). 1997. Systems of innovation approaches: technologies, institutions and organisations. London, UK: Pinter, Cassell Academic. 432 pp.

Freeman C. 1987. Technology and economic performance: lessons from Japan. London, UK: Pinter.

Grimble R. and **Wellard K.** 1997. Stakeholder methodologies in natural resource management: A review of principles, contexts, experiences and opportunities. Agricultural Systems 559(2): 173–179.

Hall A J, Suliaman R V, Clark N G, and **Yoganand B.** 2003 (in press). From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research. Agricultural Systems.

Hall A J, Suliaman R V, Clark N G, Sivamohan M V K, and **Yoganand B.** 2002. Public–private sector interaction in the Indian agricultural research system: An innovation systems perspective on institutional reform. Pages 155–176 *in* Agricultural research policy in an era of privatization: experiences from the developing world (Byerlee D, and Echeverria R G, eds.). Wallingford, Oxon, UK: CAB International.

Hall A J, Sulaiman R V, Yoganand B, Raina R S, Clark N G, and **Naik Guru C.** 2003. Institutional learning and change: towards a capacity building agenda for research. A review of recent research on post-harvest innovation systems in South Asia. Pages 123–146 *in* Post-harvest innovations in innovation: reflections on partnership and learning (Hall A J, Yoganand B, Sulaiman R V, and Clark N G, eds.). DFID Crop Post-Harvest Programme, South Asia, Patancheru 502 324, Andhra Pradesh, India and Natural Resources International Limited, Aylesford, UK.

Hall A J, Sivamohan M V K., Clark N, Taylor S, and **Bockett G.** 2001. Why research partnerships really matter: innovation theory, institutional arrangements and implications for the developing new technology for the poor. World Development 29(5): 783–797.

Hall A J, Clark N G, Rasheed Sulaiman V, Sivamohan M V K, and **Yoganand B.** 2000. New agendas for agricultural research in developing countries: policy analysis and institutional implications. Knowledge, Technology and Policy 13(1): 70–91.

Hall A J, Sivamohan M V K., Clark N, Taylor S, and **Bockett G.** 1998. Institutional developments in Indian agricultural R&D systems: the emerging patterns of public and private sector activity. Science, Technology and Development 16(3): 51–76.

Lundvall B A. (ed.). 1992. National systems of innovation and interactive learning. London, UK: Pinter. 161 pp.

Mruthyunjaya and **Ranjitha P.** 1998. The Indian agricultural research system: structure, current policy issues, and future orientation World Development. 26: 1089–1101.

Phansalkar S J. 2003. Evolving technology through collaboration and partnership: the case of IDE(I)'s work with tomato packaging in Himachal Pradesh, India. Pages 32–44 *in* Post-harvest innovations in innovation: reflections on partnership and learning (Hall A J, Yoganand B, Sulaiman R V, and Clark N G, eds.). DFID Crop Post-Harvest Programme, South Asia, Patancheru 502 324, Andhra Pradesh, India and Natural Resources International Limited, Aylesford, UK.

Sulaiman R V, and **Pillai M.** 2003. Kerala Horticultural Development Programme: a learning-based approach to technology development, promotion and rural innovation. Pages 19–31 *in* Post-harvest innovations in innovation: reflections on partnership and learning (Hall A J, Yoganand B, Sulaiman R V, and Clark N G, eds.). DFID Crop Post-Harvest Programme, South Asia, Patancheru 502 324, Andhra Pradesh, India and Natural Resources International Limited, Aylesford, UK.

Underwood M P. 2002. Annual poverty relevance review of DFID's Crop Post-Harvest Programme projects in South Asia – 2002. Patancheru 502 324, Andhra Pradesh, India: CPHP South Asia Regional Co-ordination Office, 37 pp.

Workshop papers

Kerala Horticultural Development Programme: a learning-based approach to technology development, promotion, and rural innovation

R V Sulaiman[1] and M Pillai[2]

Abstract

The Kerala Horticultural Development Programme (KHDP) is a project supported by the Commission of European Communities and the Government of Kerala. This pilot project started field implementation in November 1993 with the aim of developing replicable models. The major objective was to improve the overall situation of vegetable and fruit farmers of Kerala by increasing and stabilizing their income through reducing the cost of production and improving the marketing system. The KHDP interventions included research and development (R&D), provision of planting materials, extension service and demonstration plots, training, credit packages, marketing support, and a processing unit. KHDP organized self-help groups (SHGs) of farmers. A critical partnership in the project was a contract research arrangement with the Kerala Agricultural University (KAU). While this arrangement faced many challenges and ultimately failed, the case provides a useful illustration of the way learning and experimentation with approaches can underpin project success. This was a general philosophy of KHDP management and was implemented across the program's activities.

Introduction

This case study explores issues associated with technology development in a state-wide program for horticulture promotion – the Kerala Horticultural Development Programme (KHDP). The significance of the case is that it demonstrates that the success of partnerships in technology development is determined to a very large degree by the wider institutional environment in which these initiatives take place. Furthermore, it makes the case that **learning by doing** or a **trial and error** approach to establishing arrangements is the key to success. Another element of this story is that the technology development components of the initiative needed to be woven into a broad-based set of activities that included organizational development at the village level, and the creation of new marketing and credit arrangements. Once again a learning-based approach was important in the establishment of these arrangements. We believe that these experiences hold many lessons for the post-harvest research sector in particular, and for agricultural research and extension efforts in general. The KHDP case was neither research alone, nor was it only technology transfer. Similarly, it was more than simply community mobilization. On the contrary, it was an initiative that transcended these institutional distinctions and organizational mandates and, we believe, this was the reason for its evident success.

1. National Centre for Agricultural Economics and Policy Research (NCAP), PO Box 11305, Library Avenue, Pusa, New Delhi 110 012, India
2. Attapadi Hill Area Development Society (AHADS), Agali PO, Palakkad 678 581, Kerala, India

The paper begins by providing the background to KHDP and the range of partnerships that were involved. The main part of the paper provides a detailed account of the history and evolution of KHDP's experience of entering into a partnership with Kerala Agricultural University (KAU). This partnership was of a contract research type. The case is important for two reasons. Firstly, it reveals some of the realities of establishing partnerships between research and non-research organizations in the area of production and post-harvest technology. In particular, it highlights implications of existing institutional arrangements in R&D at a State agricultural university. The following sections analyze these experiences in terms of the five areas of interest of the workshop: 1. context; 2. partnerships; 3. institutional rigidities; 4. learning; and 5. poverty reduction. The conclusion draws out some of the general principles and lessons from this case.

Background to KHDP

Kerala is an agricultural state with 74% of its land under cultivation. Smallholder and marginal farmers dominate the production sector, where 92.56% of holdings are marginal (<1 ha) and 5.19% are small (1–2 ha). Average yields of vegetables and fruits are low. Local production of vegetables and fruits meet only 15–25% of the total volume being handled by the market, the rest come from out of state. Demand for vegetables exists all year round but 60–70% of the local production takes place in a span of 4–6 months.

The KHDP is a project supported by the Commission of European Communities and the Government of Kerala. This pilot program started field implementation in November 1993. It aimed to develop replicable models. The major objective was to improve the overall situation of vegetable and fruit farmers of Kerala through increasing and stabilizing their income by reducing the cost of production and improving the marketing system. The KHDP interventions included R&D, provision of planting materials, extension service and demonstration plots, training, credit packages, marketing support and a processing unit. KHDP organized self-help groups (SHGs) of farmers. Each SHG included 15–20 vegetable and fruit growers. All activities of the project converge at the SHG level. By the end of 1998, the KHDP had about 1630 SHGs, with a total membership of 34,381 farmers.

In setting up the project it was clear that many forms of partnership would be necessary to ensure its long-term sustainability. And so it has proved. There are partnerships with farmers (seed growers) to multiply good quality breeder seed materials. Another type of partnership is that formed with financial institutions, for example, KHDP has made arrangements with banks to provide credit to lease-land farmers by developing an appropriate credit plan. Partnership with farmers was established through SHG formation. From each SHG, three master farmers were selected and trained to facilitate three different activities, i.e., production, credit, and marketing. To ensure farmers have a dependable source of income through processing produce, KHDP established a modern fruit-processing factory with farmers as shareholders. Today the produce from the factory is traded in both domestic and international markets. Other important partners are the traders dealing in agricultural produce. As most of the fruit and vegetables are produced and marketed by small-scale producers without any grading or processing, the

traders were deciding the prices unilaterally and there was much exploitation in weighing and price-fixing. But through the establishment of farmers' markets, this exploitation has been considerably reduced.

However, it is the partnership with KAU with its headquarters at Trichur that provides the main focus of this paper. The discussion concentrates on this partnership as it illustrates in extensive detail the challenges faced by organizations who wish to access the considerable science and technology resources of the Indian public sector. KHDP needed research services if it was to assist farmers, but as we shall see this required a flexible approach on the part of KHDP in efforts to negotiate and design R&D arrangements that contributed effectively to this task.

History and evolution of contract research between KHDP and KAU

In view of the high costs of vegetable cultivation in Kerala, farmers required a package of agricultural practices that would reduce costs and lead to high yields and longer shelf-life. KHDP did not wish to spend its resources on establishing a separate research infrastructure that would duplicate the activity of KAU, and so KAU was contracted to implement an adaptive R&D project to make improved practices available to KHDP for wider promotion among the farmers.

Institutional context

KAU has 8 colleges and 28 research stations spread throughout the State and approximately 670 scientists work in these units. The university receives financial assistance mainly from the State government (about 73% in 1997/8). The Indian Council for Agricultural Research (ICAR) and other agencies contribute around 12% of KAU's budget. The co-ordination, direction, and administration of research activities in KAU are vested with the Director of Research. KAU has a Faculty Research Committee (FRC) which scrutinizes research proposals received from different coordinators and reviews the progress of research periodically. In addition to this, there are project co-ordination groups that are authorized to critically examine research proposals received from Project Leaders/Principal Investigators and to review their progress.

Signing of contract

A Memorandum of Understanding (MoU) was signed between KHDP and KAU in March 1993 through which KAU agreed to undertake for KHDP R&D on production of vegetable breeder seed, supply of improved fruit planting materials, and provision of facilities for training extension officers. The MoU was to be valid for 6 years. The total budget approved was Rs.20,688,000 (approximately US$ 0.7 million at 1993/4 conversion rate) from 1994–99.

The important features of this agreement were:

- The principle of 'payment linked to results' would be followed for each line of research activity
- The main emphasis would be on on-farm research at identified sites in pilot project areas to demonstrate R&D results and activities to farmers effectively

- The project would have a Research and Development Management Committee with equal number of representatives from KHDP and KAU, and the Vice-Chancellor of KAU as its Chairman.

Initial phase of 'accommodation'

KAU identified scientists who were to be associated with the project and efforts to prepare a detailed research program were initiated. The Year 1 work plan (October 1993–March 1995) was approved in October 1993. A full-time Project General Coordinator was appointed by KAU in January 1994 and KAU took several steps to arrange for redeployment of its scientists and to provide infrastructural support (buildings, vehicles, etc.) immediately.

The R&D unit started functioning in KAU by March 1994 and by June KAU scientists presented detailed research plans for KHDP's approval. Even though KHDP had requested KAU to provide details of planned field experiments, KAU did not provide these plans until they were approved by the FRC in October 1994. KAU experiments were mostly concentrated at its two large campuses, Trichur and Trivandrum (about 300 km apart). The General Coordinator, who was vested with authority to take decisions, was functioning from the Trichur campus. At the request of KHDP, KAU identified one scientist at each campus and instructed them to take decisions in the absence of the General Coordinator. KAU also constituted a diagnostic team for each of the two pilot districts of KHDP.

The Programme Director of KHDP made a critical review of R&D activities in August 1994 expressing his doubts about the utility of some of the on-going experiments and his fear that results might not emerge before the close of the Project. He passed on his comments to his Horticultural Unit. But they were not communicated to KAU for comments or necessary action. The Programme Director and his Horticultural Unit had different perceptions of the progress of research done by KAU. For instance, in the first R&D Management Committee meeting held in November 1994, his colleagues from KHDP appreciated the progress of work. These differences in perception on research performance became clear in subsequent instances, especially when payments were to be released to KAU in March 1995 and January 1996. However, concerns about the need for the R&D project to become more farmer-oriented (with emphasis on field problems) and about the need to initiate measures that could reduce delays, were highlighted by KHDP.

Monitoring problems

Towards the end of Year 1, quarterly progress reports were coming late, and KHDP realized that it was impossible to monitor the progress of R&D based on qualitative reports from KHDP. A format was devised by KHDP so that each experiment was divided into activities such that the number of activities completed in each quarter might be reported. The problems did not end there. According to the agreement, the payment had to be linked to results emanating from the Project. This was not possible through activity reports. The only way to do it was by examining the findings/results of the experiments funded by KHDP. But this was not forthcoming after the completion of Year 1 because: firstly, there was undue delay in statistically

analyzing data collected from experiments to arrive at meaningful conclusions; and secondly, the General Coordinator of the R&D project did not have powers to pass on findings directly to KHDP. According to the practice and norms of KAU, all research findings were reported only once a year through the Director of Research.

Under these circumstances, the only way to link payment with results was by making available interim trend reports of experiments. This would also help KHDP to use findings to modify the package of practices – thereby assisting farmers. During the second R&D Management Committee meeting held in July 1995, KAU agreed to provide KHDP with informal and provisional recommendations from experiments conducted under the KHDP framework (though this was not practiced) and also agreed to expedite the official approval of the projects included under the second work plan. On transfer of findings/results to KHDP for early dissemination to farmers, KAU was not, however, willing to speed up the process before completion of farm trials considering the involvement of risk (releasing unscientifically validated information). According to KAU, the only way forward was to have more informal meetings between KAU scientists and KHDP officials to understand and share the ad-hoc findings.

It is interesting to reflect here on two points. Firstly that scientists involved could clearly see the paradoxical situation whereby they were contracted to conduct research for an external body but were prevented from reporting the results in a timely fashion by the norms of their own organization. Though informal reporting of results resolved this impasse, the research management of KAU was not willing to review the clause that was hindering the progress of a contracted research project. Equally, there was a genuine perception of risk among scientists about reporting results in an informal way thus transgressing the norms of the scientific organization in which they worked.

The middle phase of 'criticism'

By Year 2, KHDP realized that even after considerable amounts of research had been conducted, definite results were not forthcoming and KHDP were finding it increasingly difficult to provide technological solutions to farmers. Even ad-hoc results were not provided although KAU has agreed to do this earlier. KHDP was also unhappy about lack of progress on many other activities which it had funded (for example: results from catalogue fields laid out by KAU with farmers' varieties made available by them to KAU; establishment of pest and disease monitoring stations; and development of pesticide residue detection kits). As a result KHDP decided to make a substantial cut in the budget for Year 2. This was objected to by KAU who wanted reimbursement for expenditure incurred during the first 7 months of the project, irrespective of the comments made by the Mid-Term Review Mission (MTRM) in October 1995.

MTRM the 'turning point'

The MTRM made several remarks about the functioning of the project, which were selectively projected by both parties to argue their points of view. The following observations made by MTRM were highlighted by KHDP to show the non-utility of funding many of the on-going experiments of KAU:

- Some of the experiments conducted by KAU under the KHDP contract R&D were not in line with the objectives of KAU, or with the objectives of KHDP, and hence may not lead to the outputs envisaged in the work plan
- Results of the experiments should be made available to farmers immediately
- There is a need for more on-farm research

KAU was clearly not willing to read between the lines and appreciate the full meaning of these comments. They quoted the following observation of MTRM to prove their point. "Many of the experiments conducted by KAU would prove valuable to the development of horticulture in the State, especially those related to fertilizer application and integrated pest and disease management." Moreover, they argued that all the experiments had been approved by KHDP initially and in the FRC of KAU, and also by the R&D Management Committee.

KHDP then made a serious review of ongoing experiments and found that most of them were not going to be completed in the foreseeable future, some would not lead to useful technical advice, and some were either redundant or not need-based. KHDP wanted KAU to re-orient its research and emphasized that those experiments, that did not satisfy KHDP objectives should be abandoned or concluded immediately. KAU agreed to the early conclusion of experiments, which were not in tune with KHDP objectives, but insisted on reimbursement of expenditure incurred in Year 2. (Some experiments were discontinued by KAU by the end of Year 2). Though the Programme Director was not willing to continue this type of funding, his own Horticultural Unit expressed satisfaction at the progress of the R&D project and recommended release of funds to KAU immediately, keeping in view the preparation for the Year 3 work plan. The report of the auditors on KAU's booking of certain expenditure that was not related to meeting project objectives also caused some mistrust between the two parties.

An important point here is the divergent options of what constitutes good science. Quite clearly KAU and KHDP had different perspectives. The former took a long-term perspective bounded by notions of the generic value of scientific knowledge and the norms that validate this. KHDP on the other had had quite different perspectives and was much more interested in short-term goals, specifically the utility of research findings in the context of farmers' production and post-harvest systems.

Review, reorientation and the introduction of participatory technology development approaches

Before the end of Year 2 (February 1996), the Programme Director expressed his strong reservations on the progress of R&D funded by KHDP. He observed that the routine procedures of the university are time-consuming, that they affect the ability of scientists in responding quickly to field-level concerns, and that they adversely affect starting experiments and releasing results. He gave several suggestions for a revised approach to R&D in the years to come so as to address the issues that arose and to improve the effectiveness of R&D funded by KHDP. These included revised research questions, field research orientation to address farmers' real concerns, i.e., more on-farm trials and a participatory technology development (PTD) approach, and a new approach to research wherein the

technical staff of KHDP and KAU scientists would work as a team in the field, with each performing some common and some specific responsibilities.

This is possibly a crucial point of learning. Namely that having realized that the conventional research approach of KAU and the norms that govern it were not delivering, KHDP looked for a different research approach. Indeed they chose an approach that engaged directly with the problems of farmers and involved them in technology development and testing. Needless to say this did not require the approval of research committees to validate results, or at least it made such arrangements meaningless.

To facilitate this approach, KHDP suggested the idea of deputing KAU scientists to KHDP and KHDP paying rent/service charges to KAU for such infrastructure facilities as field and laboratory facilities etc. KHDP made it clear to KAU in March 1996 that no advance payment would be made from then onwards, and that payment would be linked to results received at the farm level. KHDP also made efforts to educate the KAU R&D team on the PTD approach. The scientists expressed their willingness to re-orient on-going research efforts to match this approach, but pointed out some operational constraints such as travel support, to which KHDP agreed.

By this time, the relationship between KHDP and KAU top management had deteriorated considerably. KAU, in March 1996, objected to all the above suggestions made by KHDP to improve the interface and decided not to provide even ad hoc recommendations based on R&D until conclusive results were obtained. This meant effectively returning to the items in the MoU signed with KHDP in 1993. Based on the MTRM's comments and its decision to endorse a PTD philosophy, KHDP in April 1996, terminated 60 experiments out of the 84 proposed (including on-going experiments) with immediate effect and asked for details of the remaining experiments before committing further funding. KAU did not provide these details to KHDP in the next 9 months, arguing non-receipt of that particular letter. KHDP also made it clear to KAU that from Year 3, KHDP would provide greater emphasis to PTD and funds earmarked for on-station experiments would be negligible.

Even though five KAU scientists participated in a PTD training project and the scientists were willing to experiment with the PTD approach, KAU officially communicated to KHDP that on the PTD approach, KAU was yet to take a firm decision. Issues related to re-imbursement of expenditure already incurred by KAU were settled by mid-1997 through negotiations. The number of experiments was reduced to 17 in 1996/7. It was also decided to review each experiment individually to arrive at a decision. The number of scientists in the R&D unit was brought down to 6 from 14. The R&D unit continued functioning until 1998/9 on a limited scale.

Outcomes, learning, and impacts on the research approach adopted by KHDP and KAU

According to KHDP, the contract research with KAU did not contribute much towards generation of suitable technological recommendations in line with the objectives of KHDP even after extensive on-station research conducted between

April 1994 and September 1999. The second MTRM (2000) of this project noted that the completion of 48 experiments resulted in 24 promising research findings, of which 15 were considered ready for field adoption. The MTRM further noted that the KAU research in the initial years was mainly focused on increasing productivity (or reducing costs) and not sufficiently focused on the marketability of fruits and vegetables, including consumers' preferences (tastes and color) and perishability, as a factor in research.

The procedural delays in initiating experiments and releasing research results had also affected the outcome of the project. But KHDP valued the cooperation and expertise of the KAU scientists and was still interested in getting their support albeit definitely in a different mode of contract. The KAU scientists who were involved in the project felt that many of these delays could have been avoided if KAU had shown greater flexibility rather than sticking rigidly to existing procedures, that were not in tune with the demands of a contract research framework. But they also felt that a lot of good work was done in the R&D project with KHDP. Though serious differences existed between the management of both organizations, the relationship between KAU scientists, KHDP field officers, and farmers was very cordial.

KHDP valued the professional skills of KAU scientists in terms of diagnosing field problems and as resource persons and facilitators for its PTD and farmer-training programs. For KAU scientists, this provided greater opportunities for wider interaction with horticultural growers, helped them to learn more about actual field problems in various locations, and to obtain direct feedback on the performance of their technologies.

KHDP and KAU have now realized the limitations of the earlier contract arrangement and are in the process of identifying and institutionalizing better contractual arrangements. The mode under consideration is the competitive grant framework followed by ICAR. The future areas of cooperation identified include: supply of foundation seeds, screening local germplasm collections, support in PTD experiments, training and extension, and long-term on-station experiments. The emphasis on PTD since 1996 subsequently gained momentum. This led to enhanced capacity building of staff working with participatory approaches, the establishment of a core PTD team within KHDP, and the promotion of active participatory research with SHGs, also to addressing problems related to pest and disease management and (low-cost) production inputs.

Wider activities undertaken by KHDP

KHDP's interventions were not restricted to the development and transfer of production and post-harvest technology. KHDP facilitated horticultural farmers to access all other support services including access to:

- Good-quality planting materials (promoting seed producers and establishment of a seed producing plant)
- An efficient office-less extension service (through its own recruitment of young graduates and post-graduates in agriculture and allied fields working with SHGs, who in turn facilitate the development of master farmers trained in production, credit, and aspects of marketing)

- An innovative credit package that allows even lease-land farmers to access credit from commercial banks
- A unique credit-linked crop insurance package that also covers losses due to pests and diseases
- Market information on price and volume of fruit and vegetable traded in important markets in Kerala and nearby states through establishment of a market intelligence network
- Unexploitive markets offering transparent transactions, higher prices and proper weighing (by the development of group marketing through field centers that bulk the produce of member growers belonging to 10–15 SHGs).

To ensure a dependable source of income to farmers, KHDP also established a modern agro-processing plant with farmers as majority shareholders. It finally ensured its future by registering in 2001 as a company, the Vegetable and Fruit Promotion Council, Kerala to provide continued support to farmers. Farmer SHGs hold 50% of the shares in this company. The remaining shares are held by the State government and agencies such as banks.

Lessons from the case study

KHDP acted as a link in identifying and passing on the problems of horticultural farmers to a research organization (KAU) and in facilitating farmer experimentation and PTD. They also had qualified manpower who could effectively communicate the problems in the field and the inappropriateness of some of the recommended practices to KAU scientists. However, bearing in mind the investments made in terms of time, expenses, and human resources, the outcome was less than satisfactory. KHDP and KAU entered into contract research without fully understanding the institutional dimensions of the R&D process. Both parties were very ambitious and optimistic and this could be seen from the funds committed and the number of projects sanctioned at the beginning of the project. Institutional evaluation on the capability of the system to deliver technology was not made although, as this case amply illustrates, it is equally or more important than the technical expertise of scientists. Although the project emphasized payment linked to results, the mechanism to monitor results (in terms of objectively verifiable indicators) was never put into place, and a mechanism to monitor activities was put in place only much later.

The deliverability of proposed experiments could have been understood much earlier if enough attention had been provided when the projects were proposed. The institutional culture prevailing in KAU continues to be bureaucratic and this is not conducive to the flourishing of contractual research arrangements. KAU did not try to review or change its procedures with respect to managing R&D even when it realized the limitations of the old procedures in the new environment.

The principal investigators (e.g., the KAU scientists in charge of executing the research under the KHDP contract) of projects have only limited authority (administrative and financial) to take decisions on implementing research projects and have to increasingly depend on the Head of the Division/Institute for routine activities. KHDP was bearing all the costs of KAU personnel associated with the project (scientific, technical, administrative, and support staff) in addition to the

costs of recurring and non-recurring items to be used in the project throughout the project period. It was as good as working for KHDP, but the scientists were under the administrative and technical control of KAU. KHDP found this arrangement very constraining and put forward a proposal for the deputation of KAU scientists to KHDP who would pay rent/service charges to KAU for facilities used for KHDP work. KAU did not agree, indicating the confusion this arrangement would create. In the light of the rigidity in the functioning of KAU, this approach could at least have been given a try.

Lack of a learning culture in KAU prevented it from experimenting, learning, and reflecting on new approaches and opportunities to serve its clients, in this case the smallholder and marginal farmers growing horticultural crops. This type of finding mirrors the now widely acknowledged observation that hierarchical institutional arrangements of centralized agricultural research are unable to deal with the complex technology needs of farmers, particularly those of small-scale farmers. In this case it happened even when a supportive intermediary organization (KHDP) was helping the farmers to articulate their technological constraints.

Discussion

This case study was concerned with the recent evolution of an innovative regional development initiative focused on small-scale farmers in Kerala. While we have reflected more widely on its inception and subsequent relationships and activities, the study concentrated on the attempt at a new type of partnership in the Indian context, i.e., that between a research organization and a horticultural sector development scheme. What then can we conclude in terms of the questions raised by this workshop and its investigation of the innovation process on: 1. context; 2. partnership; 3. institutional rigidities; 4. learning; and 5. poverty.

Context

The KHDP was established with the aim of increasing and stabilizing the income of fruit and vegetable farmers in Kerala, the majority of whom are smallholder and marginal farmers. To meet this objective, this new organization (KHDP) was created with staff who had expertise in agriculture, business management, credit, marketing, program implementation, etc. Most of the staff for this project originally deputed from different organizations. For instance the human resources for field operations came from the Department of Agriculture (Government of Kerala), for technical research support from KAU, and for monitoring and evaluation from the European Union. Apart from the wide range of expertise with which it was established, KHDP also developed its own norms, procedures, and guidelines for its operation and was thus provided with plenty of flexibility to respond, learn, and evolve to meet new challenges.

The other defining context of this case was that of KAU and the norms and working conventions that were embodied in the organization. This context played an important role in shaping how KHDP tackled research support to its farmers. What is particularly notable is that a conventional contract research arrangement was unworkable in this context, and that alternative arrangements had to be developed that more effectively serviced the needs of farmers.

Partnership

A guiding principle in designing KHDP's approach was to establish partnership with key stakeholders. For the purposes of this case study we have concentrated on one of these partnerships, namely that with the KAU whose projects were designed to produce high quality planting materials, screen varieties/lines for specific characteristics, and provide problem-solving research. There were many others, but, it is perhaps the link with KAU that showed the most evident problems of institutional rigidity and change, and as a result it was not possible to arrive at a satisfactory long-term contract research arrangement.

KHDP's partnerships with other organizations have been relatively satisfactory, though there has been lots of experimentation with different approaches, including partnership with: farmers through SHGs, banks through innovative credit plans, and traders through repeated negotiations on the value of co-operating with farmers' markets.

Institutional rigidities

The research partnership with KAU is the area where institutional rigidities are most notable. Despite a promising start to the contract research arrangement, a series of problems arose that related to the procedural norms of the university and the way these obstructed the successful execution of the research contract. This lesson was learned over a protracted and uneasy series of negotiations to try and arrive at adequately farm-focused research and adaptive technology development protocols. Through experimentation (and necessity) KHDP found that much of the envisaged formal research role of the university could be replaced by employing graduate-level agricultural officers who were willing and able to undertake PTD with farmers. It was found, however, that some formal research assistance is still required. This is now contracted out for very specific and well-defined short-term tasks.

Learning

The KHDP experimented with different approaches and brought many lessons into its planning and implementation strategies in subsequent years. The flexibility of its organizational design, wider professional expertise, accountability to client groups (SHGs), strong and effective monitoring and evaluation system, and performance- based incentives, have each added to the ability of the organization to respond to the evolving scenario. In its early years KHDP quickly found that it needed to organize farmers into groups, both to help promote new technology and PTD skills and to help farmers access credit and strengthen their negotiating power through collective marketing. The subsequent development of SHGs with master farmers arose out of a process of trial and error, to determine the size of groups, how they would be managed, the types of activity in which they could engage collectively, and procedures for resolving disputes.

Initially the State Department of Agriculture, Government of Kerala was not willing to provide young staff on deputation to KHDP. But finally through several rounds of discussion, the Government permitted KHDP to do its own recruitment. Again, traders were not willing to collect produce from KHDP farmers' markets

and a lot of persuasion and reasoning became necessary to convince them of the benefits they would receive in cooperating with these markets. Finally, once they were convinced of the benefits of procuring better quality produce in large quantities from a single place, these traders started cooperating with the farmers' markets. Moreover, through traders' workshops KHDP are presently trying to balance the production and availability of fruit and vegetables based on estimates from traders.

In the beginning, KHDP envisaged the provision of credit to farmers through cooperative credit societies. But, on realizing the difficulties of cooperative credit societies with respect to fund mobilization (resulting from low recovery rates) KHDP shifted to arranging credit from commercial banks. The banks were reluctant to provide credit to landless farmers, but KHDP's willingness to put equivalent money on deposit with these banks, changed the situation. Unlike the usual end of most externally funded programs, the KHDP re-invented its future by registering in 2001 under the Indian Companies Act, in order to provide continuing support to growers.

Poverty reduction

It is perhaps too early to pronounce a verdict on the social impact of KHDP. Certainly the emphasis on smallholder farmer agriculture indicates a basic objective of increasing the incomes of small-scale farmers so that they do not fall into poverty. But relevant survey work still needs to be carried out to assess the extent of the projects' success. It is probably fair to say that this project with its focus on small-scale horticulture producers benefits both poor and non-poor households. It should also be noted that in the context of Kerala the poorest communities are tribal people and fisherfolk and that if poverty is the main focus then these communities should be targeted. This program never claimed to be targeting the poor, instead it recognized that small-scale horticultural producers are vulnerable to exploitation in the market and that declining incomes can be supported by technical and market interventions. The evidence available suggests that the program has helped farmers in these aspects.

Conclusions

The emerging principles can be summarized as follows:

- **Partnership as the basic organizing principle.** This provided the organization with wider expertise and ability to provide a wide range of services (access to technology, credit, markets, value addition, and organizational development of farmers) than would normally be the case. The top and middle management of KHDP spent a considerable amount of time and energy on building trust and relationship with a wide range of partners, i.e., farmers, scientists, traders, banks, State government, management institutions, etc.
- **Organizational autonomy and the ability of the leadership to exercise it.** A new organization (KHDP) was created free from bureaucratic traditions and with complete autonomy. The KHDP leadership had the flexibility and authority to continuously improve procedures thus enhancing managerial effectiveness.
- **Learning as the key management strategy.** A continuous process of self-reflection and learning whereby approaches and institutional arrangements

could effectively adapt to deal with changing contexts, demands, and opportunities.

- **Systematic procedures for monitoring and evaluation (internal and external) of staff and project interventions.** Apart from formal monitoring systems, the willingness of the KHDP management to quickly and effectively respond to emerging issues also contributed to the projects effectiveness.

Endnote

This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID [R7502: Crop Post-Harvest Programme].

Evolving technology through collaboration and partnership: the case of the International Development Enterprises (India)'s work with tomato packaging in Himachal Pradesh, India

S J Phansalkar[1]

Abstract

This paper discusses a project implemented by International Development Enterprises, India [IDE(I)] with funds received from the Crop Post-Harvest Programme (CPHP) of the Department for International Development (DFID). A UK-based agency was chosen as the principal project leader. The UK agency contracted IDE(I) to carry out field work connected with identifying the area, the issues for work, the specific post-harvest stage for intervention, technology identification, sourcing, and adaptation. IDE(I) identified tomato as the main crop for intervention and the development and commercialization of suitable cardboard carton packaging as the main task. The project was implemented in partnership with Rural Centre for Human Interest (RUCHI), an non-governmental organization (NGO) based in the region, the Indian Institute of Management, Ahmedabad (IIMA), and manufacturers of the cartons. While the partnership between the UK agency and IDE(I) was formalized through an agreement, the other two were not. Analysis of the partnership processes permits the following inferences to be made: (i) inclusion of a partner for formal, legal, or stylistic reason alone may not lead to a productive partnership; (ii) existence of prior personal rapport between key individuals seems to lead to effective partnerships; and (iii) partners need to evolve mutual roles and responsibilities while remaining sensitive to mutual concerns rather than formalize such roles in a Memorandum of Understanding (MoU) or other written agreement.

Introduction

This paper discusses IDE(I)'s work on the post-harvest systems of small-scale horticultural farmers. The specific intervention concerns a project that explored ways of introducing a new type of tomato packaging technology in Himachal Pradesh. The project was commissioned by the Department for International Development, UK, (DFID) Crop Post Harvest Programme (CPHP). The approach adopted by IDE(I) builds on more than a decade of experience in establishing technology production and supply systems that serve the poor. This experience has been gained in the small-scale irrigation sector. A key aspect of the novel IDE(I) approach and philosophy is that marketing principles are used to identify the needs of the poor and to establish retail systems that will address these needs. The rationale is that once these systems have been established, IDE(I) can then withdraw to concentrate its efforts on new technology sectors and need.

This project was an attempt to apply such an approach to the post-harvest sector. IDE(I) had never worked in the post-harvest sector before. However, emerging from consultation between IDE(I) and CPHP, was the hope that the approach had much to offer and that by adapting and innovating along the way, important

1. G-2 Lakshmikrupa Apartments, T-7 Lakshminagar, Nagpur 440 010, Maharashtra, India

lessons could be learned that could be further promoted in the CPHP's work. The project therefore began as a fairly open-ended task involving establishing needs, identifying a technology niche and then establishing the partnerships and systems to develop, produce, and supply that technology. This paper emerges from a process documentation exercise that was used to draw out lessons. The question of partnership was central to the way the project evolved over time, and indeed the success of the project was clearly a result to the importance that IDE(I) placed on identifying the right partners and nurturing relationships that worked. A detailed discussion and analysis of IDE(I) experience in the post-harvest sector and the generic lessons emerging from its approach can be found in Clark et al. 2003 (in press).

Overview of project focus

The project was originally established as a partnership between IDE(I) and an international NGO based in the UK (subsequently referred to as IntNGO). The latter was designated the project leader, although the majority of the work was sub-contracted to IDE(I) as the in-country partner. The project, whose work commenced in early 2000, was phased, so that CPHP could revisit its progress after a year.

After undertaking an assessment of different commodities and the relevance of these to small-scale farmers in Himachal Pradesh, IDE(I) chose the tomato crop. Through further investigation it emerged that wooden boxes, conventionally used for packaging by farmers were seen as being environmentally unsustainable and increasingly unfeasible because of the ban imposed on tree-felling in the State. It was therefore decided to identify a suitable technology that would replace wooden boxes for packaging tomatoes.

IDE(I) persuaded the Indian Institute of Management, Ahmedabad (IIMA) to take an interest in the project. The latter then involved the largest corrugated cardboard manufacturer in India to design and test the technology. In order to develop an interface through which to work with the farmers IDE(I) also collaborated with the Rural Centre for Human Interest (RUCHI), an NGO engaged in development work in Himachal Pradesh and with whom IDE(I) had previous association during development and demonstration of its mountain micro-irrigation kits.

By the end of the first phase of the project in June 2001 a prototype corrugated cardboard carton (CCC) had been developed and tested through farm-level and transportation trials. This design know as Venture Capital (VC) VC-15 – was a box with dimensions 363 × 192 × 373 mm made out of 5-ply 150 gsm cardboard material with 8 ventilation holes. A review of the first phase by CPHP concluded that the second phase should directly implemented by IDE(I). This phase envisaged further adaptation and modification of the technology (to reduce the carton volume, improve its moisture resistance, improve its acceptance in trade circles, and reduce its costs) and commercialization of the technology through sustainable engagement of local private- sector players. By early 2002, the producers had an agreement with a manufacturer based in Delhi to produce 100,000 cartons[2] with credit

2. In actual fact only (a not insignificant) 30,000 boxes were produced as tomato production was lower in the season.

arrangements with a local bank facilitated by both IDE(I) and RUCHI. IDE(I) expects the technology to be widely and repeatedly used in future. RUCHI, the CCC manufacturer, IDE(I), and the trade circle also expect rapid expansion of the adoption of the CCC for packing peaches, capsicum, and other produce from this region. The time line of relevant events is given in the Table 1.

Agencies involved

The following range of agencies was involved in the project. The key players and their roles were:

- **Crop Post-Harvest Programme (CPHP), Department for International Development (DFID), UK.** CPHP is managed on behalf of DFID by Natural Resources International a small, private consultancy and research-management company based in the UK. CPHP has a Regional Coordinator based in India at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The Programme commissions research relevant to the crop post-harvest sector under an overarching mandate of poverty reduction.
- **UK Agency.** A division of a well-known group of development organizations and individuals that concerns itself with collaborative evolution of appropriate technology for use in the developing world. For this project it appointed and outsourced relevant expertise and was itself only concerned with donor relation and fund management.
- **International Development Enterprises, India [IDE(I)].** Originally, a liaison office of IDE (US). It became an independent Indian entity in May 2001. IDE(I) has been engaged in the development and marketing of divisible, affordable technology, and its commercialization through the private sector to help small-scale farmers raise their incomes. With prior experience in irrigation, IDE(I) was exploring the concept of a 'mountain market-shed' with a view to improving the market performance and net incomes of farmers in 1997/98 using a Ford Foundation grant. This was their first foray into post-harvest work, but they were familiar with conditions in Himachal Pradesh. They were encouraged by CPHP to apply their methodology of mass marketing and the understanding of a 'market-shed' to the post-harvest theme.
- **Indian Institute of Management, Ahmedabad (IIMA).** Arguably the best-known management institution in India, IIMA has a specialized division working on agriculture. Rather than a formal institutional partnership, what seems of greater relevance to this project is the collaboration with one specific faculty member at IIMA in this division. He had previously worked on food packaging, and had assisted Gujarat farmers to adopt to CCCs.
- **Rural Centre for Human Interest (RUCHI)** is an established NGO that works in Solan district, Himachal Pradesh on a range of development issues including watershed development, earthquake-proof housing, promotion of horticulture, and micro-credit. RUCHI has created a network of self-help groups (SHGs) in over four dozen villages in Solan. RUCHI had collaborated with IDE(I) in demonstrating its micro-irrigation equipment around the same time. Due to the personal rapport of the Chief Executive Officer of RUCHI with a key functionary of IDE(I), the two organizations developed a mutually supportive

Table 1. Time line of relevant events

Event/stage	Started	Ended	Remarks
IDE(I) association with RUCHI	1997	-	For work on micro-irrigation kits and mountain market-shed study
Initial discussions with CPHP	June 1999	August 1999	
Initial familiarization study	May 1999	October 1999	Continuation of market-shed study
Ban on tree felling in Himachal Pradesh	August 1999		On-going, initially a transportation subsidy for wood imported from Haryana was given, now withdrawn
Agreement between IntNGO and IDE(I)	March 2000		Retrospective, from Jan 2000
Study as per SRL formats	Febuary 2000	May 2000	Concluded with crop tomato, intervention about replacing wooden box with CCC
Contact with IIMA	October 2000	Continues	Serendipity, IDE(I) happened to see Professor Girija Sharan's paper
Design and lab testing, initial discussions on VC-15			
Himachal Pradesh government begins seizing all outbound vehicles carrying fruit in boxes made from prohibited species			
Visit of UK food packaging expert			
Transportation trial of VC-15	May 2001	May 2001	Packages given free, no guarantee for tomato, transport cost borne by IDE
Phase II starts, exit IntNGO project links IDE(I) directly with CPHP	June 2001		
Modification and evolution of gen. 2, 3, 4 packs	June 2001	Dec 2001	Involvement of a Delhi box manufacturer
Farmers discussion with adtis for scaling up of CCC packaging	Jan 2002	On-going, formal meet in March 2002	Decision to shift to CCC by members of 4 SHG of RUCHI in Shargaon
Linking SHG to bank for financing of CCCs	March 2002	On-going	Facilitated by IDE/RUCHI IDE(I) offers a 20% promotional incentive
Large-scale adoption of CCCs	Exp. June 2002		It is hoped that 100,000 CCCs will be used for packing 1500 t of off-season tomatoes in summer 2002
Partnership process study	April 2002	April 2002	

relationship. RUCHI looked to IDE(I) as the source of new and beneficial technology and provided them with access to farmers, and local support.

Three other organizations were also involved. The Indian Institute of Packaging (IIP) in Delhi, a public agency concerned with research, development and testing of packing materials supported by the Council of Scientific and Industrial Research (CSIR). IDE(I) approached IIP and explored the possibility of collaborative development work. Eventually, IIP did help by testing prototype CCCs for a fee. The two other agencies were manufacturers of CCCs. One of them Core Emballage Ltd. (CORE), the largest manufacturer in India is based in Ahmedabad. The top management of CORE there had live and vibrant relations with IIMA, which they cherished. The second manufacturer is based in Delhi and has commercial interests in the success of the CCCs. The interests and competencies of the various agencies are summarized in Table 2.

Process in brief

Following formal agreements between CPHP and IntNGO on the one hand, and IntNGO and IDE(I) on the other, IDE(I) undertook a detailed study in Himachal Pradesh using the Sustainable Rural Livelihoods (SRL) framework.[3] They studied four communities in Solan district with the intermediation of RUCHI, and four in Kullu district mediated by a private sector agricultural input dealer. IDE(I) did not embark on the research with a pre-conceived notion that its work would be concerned with tomato packaging. However, during its research it discovered that:

- It was much easier for the researchers to interact with farmers when they worked in collaboration with RUCHI than when they went through the input dealers. RUCHI had a presence in villages through Watershed Committees or SHGs, it had credibility and enjoyed the trust of the people. Farmers interacted freely and with confidence with IDE(I) personnel. The input dealer could make primary introductions of researchers to his clientele, but since his own equation with them was only commercial, he had little influence on relevant social processes.
- Farmers in both locales had expressed grave concern about the likely impact of the Government ban on tree felling on packaging, and hence on the potential profitability of their produce, because using wooden packaging provided them with access to high-value markets.
- Farmers in villages serviced by RUCHI had acquired access to irrigation for growing off-season tomatoes through RUCHI's watershed development work, and had quickly grabbed the initiative to cultivate. Tomatoes are grown by small-scale and marginal farmers who could deploy their family labor cultivating, harvesting and post-harvest packing the crop.

3. The SRL framework is an approach to analysing the circumstances of rural people that recognises the complexity of their livelihoods. It explores the different types of resources or capital that poor people have, and the way these are used to generate livelihood outcomes. Similarly it looks at the factors which make these livelihoods precarious or vulnerable and the way policy and institutional arrangements can change people's circumstances for the better (or worse). For details see Carney (1998).

Table 2. Agencies and their interests

Agency	Main mandate	Competency	Short-term interest in CPHP project	Long-term interest in CPHP project	Remarks
IDE	Evolving divisible, affordable technology and marketing it to benefit farmers	Marketing, supply chain, adaptive research, coalition building	Funds available for supporting work	Broadening of product portfolio	
IntNGO	Adaptive research on appropriate technology	Network with donors access to experts on diverse fields	Accessing funding	Strengthening network in Indian subcontinent	Had very good rapport with erstwhile IDE(I) Country Director
IIMA	Premier management teaching and research institute	Credibility, access to government, large and expert faculty pool, special focus on agriculture	Seeing the research work being actually implemented	Strengthening rural/agricultural research portfolio	Involvement restricted to one faculty member
RUCHI	Comprehensive rural development in the Solan district	Strong network with farmers, close observations and knowledge of local issues	Furthering interests of farmers	Protection of environment	Had earlier collaborated with IDE(I) Its mandate tends to be influenced by farmers served
CORE	For profit manufacturers of CCCs	Carton design, development, testing and manufacture	Supporting development work of IIMA Establishing links with users	Commercial interest in a growing segment	Was involved in the process by IIMA Located in Delhi, hence closer to Himachal Pradesh
Supreme	For profit manufacturers of CCCs	Carton design, development, testing and manufacture	Establishing links with users	Commercial interest in a growing segment	

- Two traditional forms of packaging – the *kilta* (a type of woven basket carried on the back) and wooden boxes, and one relatively new form – plastic crates, were being used. Of these, wooden boxes were used for tomatoes sold in the Delhi market, often subsequently transported beyond the market. This form of packaging was the one affected by the ban on tree felling. Since the Delhi market was the most lucrative, farmers perceived the ban as a major threat to their income in coming years.
- Packing in wooden boxes was labor-intensive. Wood had to be first procured and then boxes prepared by nailing pieces together in the prescribed style. Men, women, and children would all be busy making the boxes one day ahead of the predetermined time for harvesting and sending the material to Delhi.

- Farmers reported that if they could not make enough boxes ready by the time the fruit was ripe then even top-quality produce would have to be sold at a discount in the local market. An alternative was thus sorely needed.
- The IDE(I) team identified packaging tomatoes as an important issue. In the parlance of the SRL framework, this was expected to lead to 'reduced vulnerability' for rural farm households. Searching for leads, they came across a paper by Professor Girija Sharan, a faculty member in IIMA on the very same subject and promptly co-opted him into the research. He was enthusiastic about the research programme because he saw an opportunity to apply his own research in a practical setting, and the potential to solve an important issue. In fact, this involvement and interest was sufficiently strong that beyond meeting out-of-pocket costs, the IIMA team never mentioned reward for their work. The IIMA team used their good offices and designed a CCC at CORE in Ahmedabad. CORE top management has close contacts with IIMA, and saw a possibility of being able to contribute to development by this association. They also saw a potential business opportunity.

IntNGO was kept informed of the whole process at periodic intervals. They operated through the agency of a UK-based consultant they appointed for this purpose. No staff from IntNGO, or their consultant visited India at any point. The IntNGO dealt almost exclusively with the tasks of donor relations and providing leads and contacts in the UK. As a part of this work, the IDE(I) team visited UK and completed a formal literature review and technology scan. IntNGO also identified a food-packaging specialist who visited India towards the end of 2000. Having interacted with IIMA faculty, he suggested to IDE(I) that they were on the right track and confirmed that they needed to continue work in that direction.

A thorough transportation trial of the CCCs was undertaken in the summer of 2001. IDE(I) paid for the cartons for this trial and bore the cost of transportation. The ownership and the risk of the tomatoes remained with the farmers who agreed to participate in the trial. The trial proved that CCCs could indeed be a viable alternative to wooden boxes. Around this time, after all this work had been completed, a consultancy firm, Economic Development Associates (EDA) Rural Systems, was contracted by IntNGO as part of the project to conduct a socio-economic assessment of the region. EDA concluded that while tomato was an important crop for the farmers, packaging was not the most important issue. This clearly contradicted the findings of IDE(I) and indeed the rationale for the ongoing work on CCCs.

Later, IDE(I) and the IIMA team effected design changes in the CCC after considering the performance parameters (capacity, stacking height and strength, bursting strength, moisture resistance and so on.) and also consulting RUCHI, farmers, trade channels and local manufacturers. By 2002, there had been five rounds of redesigning and by the summer of 2002, the product was ready for commercialization. The local manufacturer and farmers together negotiated the terms of supply. The manufacturer insisted on advance payment of half the cost of the CCCs. Since farmers obtain wooden boxes or box material on credit, this seemed to pose a roadblock. RUCHI stepped in to suggest that they would facilitate the financing of the CCCs by way of a loan from the local bank to the SHGs and then on-lent to the farmers. This arrangement was sweetened by IDE(I) offering to

make an incentive of 20% in the form of CCCs, i.e., farmers would not have to pay for 20% of the cartons they ordered.

The commission agents in Delhi market are kingpins in tomato marketing for these farmers and they saw their interests being adversely affected. Hence, they tried to oppose the new form of packaging. However, concerted action from farmers has since seen them back down. This arrangement between farmers, bank, RUCHI, the manufacturer, and IDE(I) is unwritten and informal. It is hoped that once the first lot of 100,000 CCCs are sold, demand from both farmers and market players will make marketing the new product sustainable.

Interestingly, different stakeholders identified and defined the problem being addressed in different ways. The IDE(I) team viewed it as an issue of technological redundancy (the disappearance of tomato boxes) and the potential this had to jeopardize farmers access to high-value markets. RUCHI saw the regeneration of tree cover in the region as the task to be addressed by the project – presumably by facilitating the shift away from wooden boxes. Farmers saw reduced drudgery and expenses incurred in obtaining the CCCs as the key benefits. (While making wooden boxes, nails had to be hammered into wooden planks, and most men and children working on the task would end up with bleeding hands.) Choosing to address a post-harvest problem thus perhaps coincidentally addressed all these concerns. **Clearly, unless a new technology effectively addresses genuine but possibly differing concerns of all the parties involved, it may not be acceptable.**

Analysis of the partnership processes

Any organization works with a whole network of agencies or organizations in its task environment. In fact, organization theorists identify five classes of organizations and entities in the task environment. These are: suppliers, buyers, competitors, regulators, and the organs of the society/community within which the focal organization works. Some or all of these actors in the task environment may be organizations pursuing their own objectives and goals. All the exchanges between the focal organization and those outside it in the task environment cannot be called partnerships. For example, an organization buys a computer from, say, IBM, but this act does not become a partnership. To amplify this example, the same company may work jointly with a computer consultant for six months to install an enterprise resource planning (ERP) system. Yet this will still not be called a partnership. To amplify even further, the computer consultant may represent the focal organization in equipment purchase and still this may not become a partnership. In all the three activities, the computer seller and the consultant are essentially providing a service for a specific consideration. Their interest is limited to the consideration and the impact on their image of a good or a bad performance by the installed system.

It is thus useful to differentiate between partnership or organizational collaboration on one hand, and the highly specific and focused work achieved by the joint co-operation of two agencies. A partnership between two agencies can be defined as an arrangement in which both the agencies, primarily motivated in coming together by their commonality of interest in the shared objective, work to achieve it. Keeping IDE(I) as the focal organization, four partnerships/ organizational collaborations are of importance in this whole process.

These are:
- IDE(I)–CPHP
- IDE(I)–IntNGO
- IDE(I)–RUCHI
- IDE(I)–IIMA

The process variables of interest can be stated as:
- Pre-partnership relationship, if any
- Personal rapport between key persons
- Mutual assessment of ability, standing, competence, etc.
- Existence of a formal agreement
- Perception about ownership of the tasks
- Frequency and nature of contacts
- Transparency and mutual accountability
- Irritants if any, and how are they sorted out
- Social distance
- Centrality of financial relationship

The process outcomes can be stated as:
- Trust
- Enhanced mutual respect
- Enhanced sensitivity to the other's concerns
- Willingness/ability to continue relationships beyond project period

IDE(I)'s partnership with CPHP has been very productive and has led to significant mutual satisfaction. CPHP has been very supportive of the work IDE(I) has done and has actively taken steps to ensure that the work on this project is facilitated. IDE(I) was especially appreciative of the supportive role of CPHP's South Asia Coordinator (Dr A J Hall). CPHP's involvement has been at more a strategic level and not at the level of carrying out detailed tasks. An attempt is made to characterize the remaining three **operational partnership** processes in terms of process variables and process outcomes in the tables below:

Inferences

The following inferences seem to be possible from Tables 3 and 4 and from the process described earlier.

- Inclusion of a partner into the process for formal, stylistic or legal reasons alone is unlikely to make for a great partnership. In India we have plenty of experience of this. State agencies involved in specific facets of a development process are often included as partners in the process for such reasons. Their interest in the task at hand is tepid and their participation perfunctory. On the other hand, they have disproportionate say in the structuring of the partnership and the tasks, and this creates tensions. IntNGO was included because, "normally a UK agency becomes the principal contractor for a UK donor", as noted by an earlier process documentation exercise notes.[4]

4. Subsequent to this project CPHP made a significant policy shift that emphasised the development of locally lead projects. This was a response to the desirability of embedding research in local relationships and institutional contexts. The case of the IDE(I) project admirably demonstrates why this should be so.

Table 3. Process outcomes

	IDE(I) partnership with organization		
Process outcome	**IntNGO**	**RUCHI**	**IIMA**
Mutual trust	Fairly high	High	High
Enhanced mutual respect	Arguable. Respect exists for the consultant who dealt with IDE	Significant	Substantial
Enhanced sensitivity to the other's concerns	No information	High. IDE(I) knows that it will have to prolong its staff presence beyond project period to satisfy expectations from RUCHI/SHG	Moderately high
Willingness/ability to continue relationship beyond project period, etc.	Not demonstrated	Stated emphatically as high desire, need and ability	Indicated willingness to support second transportation trial

Table 4. Process variables

	IDE(I) Partnership with organization		
Process variable	**IntNGO**	**RUCHI**	**IIMA**
Pre-partnership relationship	Existed in connection with micro irrigation (MI) project. IDE(I) was unhappy about the relationship which was felt to be paternalistic	Informal association in demo of MI kits. Mutually satisfying	None other than alumni connection of one of the IDE(I) team
Personal rapport between key individuals	Rapport existed with ex-Country Director of IDE(I) and the Director of IntNGO	Rapport existed between the RUCHI Executive Director and a key senior manager in IDE	Rapport existed between a senior manager of CORE, the CCC manufacturer, who was student of the concerned faculty member
Mutual assessment of abilities and standing	Assessment of role to be played by IntNGO proved to be incorrect in implementation.	Clear assessment of mutual strengths	Good assessment of mutual strength
Formal agreement	Yes	None	None
Ownership of the task	IDE(I) owned the task, IntNGO in fact deployed none of its own staff	Between them IDE(I) was the owners, but for the farmers, the lines between the two were blurred	IIMA came as an interested, keen and responsive consultant and owned jointly the development process
Frequency and nature of contacts	Periodic contacts on the phone	Frequent and long personal visits of IDE(I) staff	Several visits/contacts from both the sides
Transparency and mutual accountability	Fairly high	High	Fairly high

- At least in the cultural context of India, prior personal rapport between key individuals is almost a precondition for even starting a meaningful partnership. For example, the Executive Director of RUCHI explained that rapport and relationship between him and a key functionary in IDE(I) were quite important to making the relationship so productive. The concerned functionary of IDE(I) echoed this sentiment saying that he chose RUCHI over some other potential grass-roots partners because he had rapport with RUCHI. Thus, a start needs to be made using personal relationship between individuals from the two organizations. This is, of course, never sufficient since the nature of the partnership emerges through frequent and continuing interactions between people at all level. In this instance, IDE(I) staff at all levels were appreciative and respectful about their counterparts in RUCHI and reciprocated the help they received.
- It would appear that unless a financial relationship is central to the partnership, a formal agreement or MoU that specifies mutual roles and responsibilities is superfluous at best, and counterproductive at worst. Roles and responsibilities need to evolve over time and through mutual respect and concern for each other's point of view.
- It is critical to back the partner in matters that involve risk and potential loss of face. RUCHI staff explained that, had the farmers incurred big losses in the first transportation trial, there would have been a loss of face for them. Farmers thought until then that IDE(I) people were really 'new RUCHI staff' taken on for the project. IDE(I) responded on the issue by stating that they had provided incentives in the form of packaging and transportation costs. They had deliberately left the responsibility of the risk to the goods unstated so that the farmers would have a stake in the trials. But they would have bailed RUCHI out by settling with the farmers in the event of any loss. This willingness to back each other may not be formally stated but emerges only out of mutual trust.
- Clearly, if there is large social distance, then the nature of interactions has to be deliberately designed in order to establish rapport and mutuality. Formal interactions seldom help in this matter.
- Finally, and obviously, the basis of choosing partners must lie in the partners' operative mandate, competence or demonstrated interest, not in an ephemeral infatuation with new ideas or perfunctory statements of interests.

Conclusions

This case study has reviewed an approach to technology development that is relatively new. Rather than conform to conventional development aid projects of either a 'research' or an 'interventionist' nature, it combines both approaches in a research-action program. In this sense it has more in common with a business development approach than a formal social science one. It is also one in which a series of partnerships have played an important role. What then can we conclude in terms of the questions raised by this workshop?

1. In terms of the **context** what is clearly important is the terms of reference of the organizations involved. Hence, the lead organization IDE(I) has a mission to catalyze sustainable development and is constantly searching for useful

projects that fit within its mandate. Tomato packaging clearly fitted the bill. Similarly the IntNGO was looking for needs-driven cases that explored the issue of sustainable technology development and IDE(I) appeared a relevant example. There were thus important organizational synergies in all cases. It did, however, require the management skills of IDE(I) staff to realize these synergies effectively.

2. The key **partnerships** are outlined in the text. What appear to have been crucial to success are two factors. The first is the good personal relationships between lead individuals in the co-operant organizations. The second is the ability of the lead organization to ensure trust on the part of the most vulnerable groups (in this case through the use of an NGO as the intermediary vehicle). If formal agreements had been used it appears that this in itself would have been an indication of relative failure. It follows, at least in this case, that personal enthusiasm and mutual interest facilitated by the team-building skills of the lead agency were the catalysts needed.
3. In fact **institutional rigidities** were encountered on a number of occasions, especially with the public-sector research and production bodies. The response of IDE(I) was then simply to bypass the public sector and make use of other bodies from the private and NGO sectors. In particular, negative experiences with the IIP and a government CCC factory taught IDE(I) that an efficient outcome required such a response, if only because available resources were time-limited. Going through the public system would have killed the project stone dead!
4. In terms of **learning** the important overall conclusion is that the work (and apparent success) of this IDE(I) project is consistent with an understanding of development that emphasizes the importance of innovation systems. It is also an example of the importance of continuous learning and of institutional change. In fact, IDE(I) has not stood still in its work in the sense that earlier experience with irrigation projects clearly provided a heuristic framework that guided the organization in adapting its research to changing contexts and needs. At the same time, however, it is not apparent that IDE(I) has consciously reflected on its experiences. Or at least the actual mechanics of that reflection have not been documented. Doing so therefore remains an important task for the future. IDE(I) have subsequently addressed this lacuna through a self-assessment exercise, although this in itself is only the start of a learning-based process.
5. Finally, it is clear that a **poverty focus** was explicitly on the IDE(I) agenda in the sense that the IntNGO were persuaded of the project's poverty relevance and that the poor hillside farmer was a target. It might be argued that such a group of farmers are not representative of the absolute poor since they are involved in selling a cash crop to a wider market. However, such a view would be short-sighted. Improved incomes for a significant cohort of the region will clearly impinge on all groups in terms of both straight incomes and through environmental benefits. Subsistence groups might well be encouraged to enter the cash market. Also, it should not be forgotten, that prevailing topographic conditions in Himachal Pradesh generate great vulnerability. Better economic conditions for key groups of farmers will positively affect security for all groups.

As for the future policy agenda, it appears that there is a clear need to involve the public sector in ventures of this kind. But the hiatus appears to be an

institutional one. It is the personal relationships involved that mark the success of this case, mainly through the trust engendered on all sides. Certainly bridges need to be built with public-sector bodies but this will only be possible if space is given to individual initiative. In the absence of such freedom it is likely that many of the best talents in India will continue to remain marginal to national development and therefore remain an under-utilized resource.

Endnote

This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID [R7551: Crop Post-Harvest Programme].

References

Clark N G, Hall A J, Rasheed Sulaiman V, and **Guru Naik.** 2003. Research as capacity building: the case of an NGO-facilitated post-harvest innovation system for the Himalayan Hills. World Development 31(11) (in press).

Hall A J, Clark N G, Taylor S, and **Sulaiman R.** 2001. Institutional learning through technical projects: horticultural technology R&D system in India. ODI Agricultural Research and Extension Network (AgREN) Network Paper no.111 (January). London, UK: Overseas Development Institute (ODI).

Carney D. 1998. Implementing the sustainable rural livelihoods approach. Pages 45–61 *in* Sustainable rural livelihoods: what contributions can we make? (Carney D, ed.). London, UK: Department for International Development (DFID).

Naik G. 2001. Sustainable retailing of technologies to the poor: identification of a high value commodity base and the key technological constraint to its mass marketing. New Delhi: International Development Enterprises, India [IDE(I)] (unpublished internal report).

IDE(I). 2001. Crop Post-Harvest Project Annual Review and Planning Report. New Delhi: International Development Enterprises, India [IDE(I)] (unpublished internal report).

Thompson J D. 1968. Organizations in action. Princeton, USA: Englewood Clifts.

People's Technology Initiatives: embedding technology in community-based production systems

D Abrol[1]

Abstract

The People's Technology Initiatives (PTI) espouse an alternative paradigm of science and technology (S&T) and rural development. The approach emerges out of the broader People's Science Movement in India, itself a backlash against what was viewed as the weak governance of science and its failure to meet the needs of the poor and to enhance their productive capacities. The elements of the PTI philosophy reflect these contextual origins with an approach that seeks to build technology systems around local knowledge, resources, and economies – rather than vice versa as is the case with conventional models of technology development. Networking and building partnership has been a very important component in the PTI – both in terms of individual initiatives as well as in terms of promoting and supporting the approach. Notable also is the capacity development focus of the PTI. This is capacity- development both in terms of enhancing the skills and technologies of poor people and in the sense of linking the poor to sources of S&T and thus enhancing the capacity of the local technology system. The evolutionary characteristics of this capacity development reflect the learning-based nature of this approach. This case perhaps presents a rather radical alternative to mainstream S&T and rural development initiatives; however it contains principles of partnership and learning that others could adopt.

Introduction

This paper discusses the generic principles of a rural innovation movement collectively known as the People's Technology Initiatives (PTIs). The PTI are structured to specifically support the livelihoods of the rural poor through the development of locally based economic systems by connecting science and technology (S&T) to production and marketing undertaken by enterprises characterized by worker participation in management. The approach represents an alternative to mainstream thinking and practice on technology development and application in poverty-reduction interventions. The PTI are part of the People's Science Movement, the activities of which go much beyond rural innovation, but which share a common set of values and principles. The approach owes its origin to the wider People's Science Movement that emerged in the early 1980s around a range of science and society contentions. The PTI approach challenges many given assumptions that form the (tacit) framework for the discussion of conventional S&T and development interventions. The paper begins with a discussion of some of the key theoretical underpinnings that the approach of PTI implies for the development of a framework for rural innovation. The main elements of the approach are then discussed with the help of examples. The remainder of

1. National Institute of Science, Technology and Development Studies (NISTADS), K S Krishnan Marg, New Delhi 110 012, India

the paper is structured around the five questions of the workshop: context (historical and institutional), partnership, institutional rigidity and change, learning, and poverty focus.

The PTI as an approach to rural innovation in the framework of innovation systems

Despite the apparently radical philosophy behind the PTI approach (and indeed the People's Science Movement as well), many of the concepts and principles that it uses are clearly recognizable elements of contemporary policy thinking on innovation systems. Its distinctive use of these conceptual elements is reflected in the way the PTI approach the process of restructuring arrangement for rural innovation.

The PTI believes that mainstream, thinking is only focused on how to remove the barriers to interaction and integration of research and non-research organizations' in the context of public–private sector relationships. PTI also believes that the question of 'participation' of end-users from the weaker sections in innovation systems is effectively neglected by mainstream thinking. The PTI approach posits that the formulation of a strategy for system transition must begin by determining how to improve the 'participation' of poor end-users also. It suggests that mainstream thinking is viewing the patterns of interaction with end-users in the innovation system approach with the lens of an 'informational conception' of barriers to interaction and integration. Such end-users as poor peasants, artisans, and agricultural laborers are never targeted for the purpose of user development. User support is not oriented to improving the participation of the rural poor in the process of technology development. Mainstream thinking does not help to make the rural poor competitive and stand on their own feet in competition with large and medium private- sector organizations. When it does come to the formulation of strategies to develop knowledge markets, the target for user development and the development of user-support organizations is private-sector organizations. The perspective of the large-scale private organizations essentially guides the pursuit of competitive advantage.

The PTI believes that mainstream thinking is wrong in treating technology transfer failures as merely a consequence of the poorly developed out-reach of the public- sector research system. It holds that, even if private-sector organizations are encouraged to develop partnerships with the public-sector research system they will not be able to fill the gap to the benefit of end-users among the rural poor. PTI suggests that calculations of economic viability of technologies to be implemented by potential adopters among the weaker sections should not be ipso facto undertaken as if the weaker section cannot organize themselves and their access to the knowledge markets. It is wrong to promote these weaker sections in the market as atomized competing individual producers of small means. It is incorrect to reduce them to merely making their land and labor available for agricultural production, or at best, participating in the process of value addition as lower-end producers in long value chain controlled by large-scale private and public-sector organizations.

The PTI suggests that policy-makers should not characterize and target the potential domains of multiple stakeholders based on existing comparative advantages. Strategies of transformation of technological and innovation systems that go beyond the primitive conception of competitiveness of poor peasants, agricultural laborers and artisans who populate the production systems of Indian agriculture and its allied sectors should be sought. The selection of technology development objectives and the choice of partners for user development need to be designed bearing in mind what weaker sections can offer through their appropriate organizations. The designs should interface economies of scale and scope, and ensure that network and cluster effects, often ignored when evaluating competitiveness, are considered.

PTI considers that a major premise preventing the achievement of anti-poverty objectives for the rural poor has been that in anti-poverty strategies each poor individual household is targeted separately for assistance to raise it above the poverty line by providing access to credit, and training in traditional occupations. This premise has resulted in the approach of promoting small-scale producers who alone are unable to compete with large-scale producers in the market place. PTI believe that no small-scale producer can be made individually competitive. The PTI propose that policy-makers must shift away from the assumption that a small-scale producer or a single village can, through new technology, be made individually competitive in a market where large-scale producers are present as competitors. Its critique of the co-operative movement is that even though in some areas co-operatives or groups were formed to procure input and/or credit, mutual competition amongst small-scale producers resulted in these co-operatives/groups breaking up. It believes that this step, while in the right direction, was inadequate and has to be complemented by establishing co-operation in production. It is suggested that policy-makers will have to abandon the approach of promoting stand-alone small-scale producers.

The PTI suggests that self-employed small-scale producers must not only come together to access resources under competitive conditions, but should also emerge as multi-sectoral/multi-occupation collectives, co-operating in production. Economies of scale in production are required to overcome adverse competition. It is necessary to organize production units that are based on mutually complementing technological elements packaged into consciously networked production systems that will be accessible to the rural poor.

The implication is that the rural poor will have to pool their resources and capabilities to raise the scale and scope of their existing production organization. This change in the scale and scope of their collective production organization is absolutely necessary to allow participating members to lower the barriers facing them in the adoption of improved technologies. To gain a superior access to resources, markets, and technology improvements the rural poor will therefore need to avoid mutual competition. Landless labor, artisans, and poor peasants will need to consider the possibilities of upgrading their local economies as a system.

PTI: the key elements

Establishment of *taluk*-wide peasant–artisan–agricultural labor cooperation

The PTI has undertaken a large number of feasibility studies to demonstrate the validity of its approach in a wide variety of field areas. Studies show that in order to be competitive the rural poor will have to come together to implement *taluk*-wide, area- based, multi-sectoral, large-scale networks of production.[2] The approach suggests that no village can or should exist as a closed self-sufficient entity. PTI believes that *taluks* are viable units for planned development at the local economy level. Every Indian village, for all its major needs, is today closely dependent on the local *taluk*-wide economy. This local economy should be approached as a multi-sectoral network. In such networks the rural poor are themselves both producers and consumers of most items. In the interest of weaker sections, sectors should be upgraded competitively and this can only be done successfully if the approach is not based on small-scale producers but on the principle of co-operation in production across sectors.

To get started, the PTI base their efforts on the existing local peasant–artisan economy. The assumption is that this economy is still under the control of the rural poor to a large extent. It is organized as a rudimentary *taluk*-wide network in which even today secondary and primary production are carried out in an inter-linked manner by poor people. The strategy should be to upgrade their production activity for local markets as a system in itself. The rural poor can hope to establish a large-scale networked system of collective production in addition to this production system, because the local economy is accessible and several of its elements are already under their control. In the initial period of development non-local markets are assigned a supplementary role in this strategy. It is suggested that it would be possible for them to develop a participatory *taluk*-wide network in the hope that a large number of small-scale producers would eliminate mutual competition among themselves and thus have fewer problems in achieving economies of scale and scope in production.

These systems of inter-related occupations also cover a spectrum of settlement patterns in a way that encourages the introduction and development of technology systems for the creation of area-based, well organized, *taluk*-wide, multi-sectoral production networks comprising a mix of both large- and small-scale enterprises. For rural economy systems in the plains, the *kasbas*, or weekly bazaars with their characteristic concentrations of artisans, service nearby villages. Therefore, at the *kasbas* those unit operations/sub-systems that involve fabrication/ manufacturing can be located (Figure 1 B point). Within each of the *kasbas*-level units of local economy, there are villages inhabited by *tolas/dhanis* (i.e., places where casual laborers live). These (Figure 1 M points) comprise concentrations of agricultural labor. Such people earn their living by going out to nearby cultivator settlements for daily labor (Figure 1 S points), and these sub-areas (which are also normally equivalent to *panchayats* in area*)* form sub-units (M/S complexes,

2. A *taluk* is an administrative unit equivalent to a district and will usually include an area containing approximately 250 villages

Figure 1) of inter-linked villages. At these settlements intermediate processing functions can be located. *Kasbas* in their turn are inter-linked to the local *taluk* town that provides access to non-local products. *Taluk* towns also serve as outlets for local products to non-local economies. At *taluk* towns (Figure 1 N level) the functions of technological services, fabrication, sales, and distribution can be located.

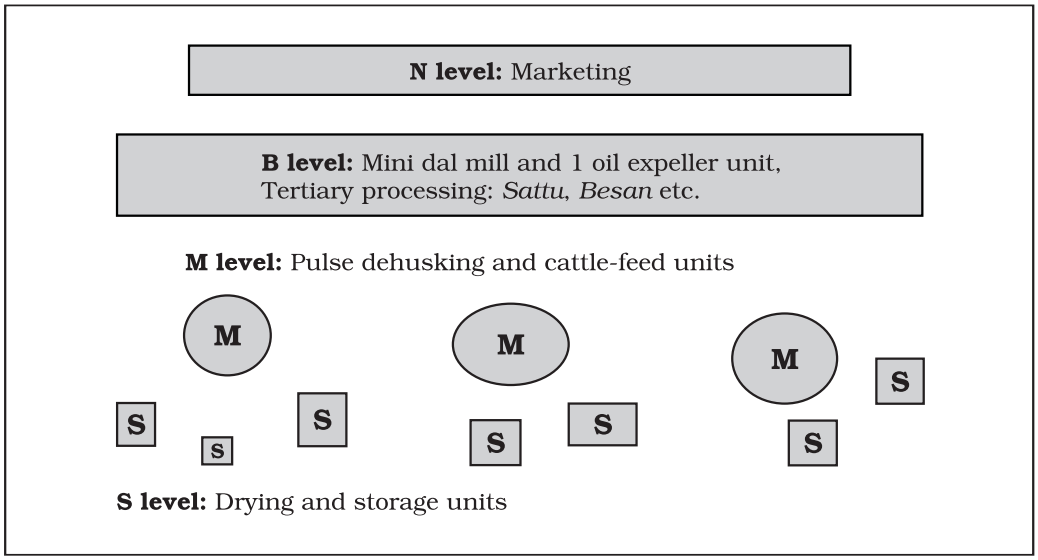


Figure 1. Example of a production system using mother/satellite units, with few levels (TPD is a type of small-scale oil seed processing unit)

New mechanisms of technology implementation

Experience indicates that interventions are required to consistently develop this cooperation. To improve the transfer of available technologies and to establish multi-sectoral production networks of rural poor, S&T-oriented development agencies need an active intervention approach in five key domains:

- Identification of the needs of peasants, artisans, and agricultural laborers as producers
- Adaptation of technologies to make them fully competitive in local markets
- Development of users' capabilities that aim to make the local producers competitive against non-local goods
- Formation of production networks to establish forward and backward linkages within the local economy area thus strengthening the competitiveness of the local system
- Establishment linkages with laboratories, financial institutions, and governmental bodies as a way of continuously improving of the competitiveness of the local system.

To take charge of these interventions the proposed approach of establishing a multi-sectoral network system of group enterprises requires a new system of technology implementation – PTI refers to this as the network system of technology

implementation. This system incorporates four new mechanisms of need identification, technology adaptation, user development, and network formation.

These new mechanisms are needed to incorporate integrated solutions to such problems as rural enterprises face while adopting the technologies:

- Choice of markets, product mix, and production system design to tackle competition from large urban producers who have cheaper access to finance, raw materials, technological inputs, and markets
- Adaptation of technology to connect the available technologies to local resources, capabilities, and markets to improve the competitiveness of rural enterprises in the market
- Acquisition of matching economic and technological competence by local enterprises so they can master technology and market development
- Selection and implementation of strategies for network development to establish the required forward and backward linkages.

Need identification. Need identification in the proposed approach to technology implementation is undertaken for system design to provide integrated solutions to the above problems faced by the users. Needs are identified in the form of a feasibility study through field investigations by the S&T field persons in collaboration with technology generating scientists and those identified for technology system development. In such field investigations the users participate actively, assisted by the facilitation of the S&T field persons.

User development. Efforts are needed to help users organize themselves to become competitive. In the case of rural enterprises the industries under consideration are highly competitive and people- based initiatives need special efforts if they are to succeed. By creating group enterprises, networked systems of production, and participative management in production, people-oriented development is created. Successes in user development are achieved via the guidance and support for economic competence development provided by S&T field persons who also stimulate users to organize themselves to make use of the help.

Technology adaptation. Technology adaptation efforts are undertaken by technology-generating laboratories through a field-level program of adaptive research, development and design (RDD) in which identified scientists collaborate with S&T field activists identified for the development of system functions. Through a program of adaptive RDD selected technological designs are made compatible with locally available resources, locally controllable markets, and local capabilities. The process of shaping the technology package is guided by the design heuristics of the networked system of production.

Network formation. Network formation is provided for in the efforts for production network development, technology proving, and technology replication to tackle the problems of establishment of appropriate forward and backward linkages. The development of the local economy as a system in itself is incorporated in the approach to system design of production technology implementation. It is again taken up as a collaborative program between the S&T field persons, scientists identified for bridging roles and the technology-generating team.

Spread and scope technology models developed for rural non-farm sectors

Currently, PTI focuses on the development of technology application models for the rural non-farm sector. This choice of a priority target is because of the understanding that interventions that encourage local value addition by linking primary and secondary production, and through the technological upgrading of existing occupations will realize the economies of scale and scope, assure network and cluster effects, and develop the local economy as a system. In 6–7 Indian states users whose access to land is limited and who engage in mainly non-farm occupations are already using this principle for technological upgrading of some of the rural non-farm sectors. People's Science Movement activists are helping these users to implement the innovative technology models developed to get started for the development of local economies as a system. Innovative technology models have been developed with the support of such agencies as the Department of Science and Technology (DST), the Council for Promotion of Application of Rural Technologies (CAPART), and the Technology Mission on Oilseeds and Pulses (TMOP). Today a wide range of technology models are available for rural application by S&T voluntary agencies, including those for processing fruit and vegetables: economic and medicinal plants, biomass based energy systems, and leather, meat, and carcass products. For further details contact the author directly.

Readers unfamiliar with the approach may be surprised that already more than a dozen groups have been established with these principles in India. Each group has been able to involve about 200–300 households spread over about 30 rural and semi-rural settlements. Each initiative directly or indirectly benefits a target population of approximately 0.1–0.12 million rural people. Most of the initiatives have been implemented through the financial support of government programs for rural technologies. The approach has, however, received limited exposure in innovation literature, and is practically absent from general debates on agricultural technology and development and in particular from those dealing with institutional reform in research and extension systems.

Examples processing in rural non-farm sectors using the PTI approach

Fruit and vegetables. Several organizations[3] are already implementing suitably designed systems of fruit and vegetable processing managed by the group enterprises. Products are marketed using a common brand name **'Farmers'**. The niche selected for intervention emphasizes the development of natural products. Technology models have been standardized under field conditions of networked systems of production for pulping/juicing/jamming, pickling/fermentation, and drying/osmo-dehydration. The system design involves a network of women beneficiaries organized in small, village-level units, and a nodal processing unit

3. Including: Society for Technology and Development (STD), Mandi; Centre for Technology and Development (CTD), Dehradun; Forum of Scientists, Engineers, and Technologists (FOSET), Kolkatta; Centre for Social work and Research (CSR), Agartala; Centre for Ecology and Rural Development (CERD), Pondicherry; Himalayan Environmental Studies and Conservation Organization (HESCO), Garhwal; Haryana Vigyan Manch (HVM), Rohtak, etc.

at the town/*kasba* level which receives semi-processed materials for final processing and packaging.

Small-scale systems for processing oilseeds. Developed at Mechanical and Engineering Research and Development Organization (MERADO), Ludhiana, a constituent establishment of Central Mechanical Engineering Research Institute (CMERI), Durgapur, 1 t day^{-1} (1 TPD) Oil Expeller is a small-scale oilseed processing unit with several advantages: extraction of pungent oil from mustard oil, high oil-extraction efficiency, low residual oil in cake, better hygiene than a *ghani* (a type of traditional expeller), and longer life of critical components. To process mustard, the machine was developed by the Council of Scientific and Industrial Research (CSIR) laboratory as a substitute for the *kolhu* (a traditional oil press used in rural areas to produce pungent mustard oil). When the PTI considered it for incorporation into its technology system design as a commercial system, the 1 TPD oil expelling unit was yet to be tried out in the field. The edible oil industry is highly competitive with a price-sensitive market, and large mill owners can even make money through speculative trading of oilseeds and oil. It was a foregone conclusion that it would not be easy for the rural enterprise to run a viable business based on this machine. Further, as the capacity of this expeller is four times the capacity of a *kolhu*, it posed such problems as 'How would rural enterprises access markets outside the village? How would they dispose oilcake?, and How could working capital be raised to run a relatively higher-scale unit?

MERADO scientists had not applied their minds to such problems. They did not have a technology package to deal with them from the standpoint of rural enterprise. It was necessary to develop a complete technology package based on a system design that would make this machine accessible to rural enterprises.

Based on the need to develop system designs that would allow the rural poor to access local markets and to successfully establish forward and backward linkages within the local economy, PTI successfully implemented its system design in Hisar, Haryana. It commercialized the oil expeller by diversifying into the sale of packaged oil and compound cattle feed made from oilcake, a by-product of the process. Cattle feed made from mustard oilseed cake has started to be adopted in an area where previously animals were mainly fed cotton oilseed cake. Single filter based oil filtration is working successfully and processing 1 t d^{-1} oilseed in a worker-owned rural enterprise. Such innovations involve a significant contribution from the workers who implement them. The single filter based oil filtration was developed on the basis of inputs received from workers in large-scale industry. Cattle-feed recipes had inputs from scientists of Haryana Agricultural University (HAU), Hisar. The worker-owned model has been shown to be a successful organizational innovation in respect of both production and marketing.

The success of the 1 TPD oil expeller is only a beginning of the plans developed for the development of a local economy as a system. This group enterprise is now getting ready to implement a mini dhal mill developed by the Central Food Technology Research Institute (CFTRI), a constituent laboratory of the CSIR system. Technology demonstrations of the mill are already taking place on behalf of this laboratory in the major markets. Licensed fabricators are marketing mini dhal mill units as commercial entities in the states of Bihar and Madhya Pradesh. Already, in Bihar, some parties are successfully working mini dhal mills and hand-operated pulse

de-husking machines as viable commercial units in city markets. It appears that many of them are successful only due to the forward integration they have been able to undertake because of their competitive access to markets for such local food products as *sattu, besan, vadi, papad,* and *chanachur*. They are mainly using the machines as in-house units to make the food products. However, in rural environments close to the centers of raw material production, the commercial viability of such mills is yet to be established. HVM, Haryana is establishing mini dhal mills as a part of a networked system of group enterprises in Hisar, where it is attempting to integrate the operation of mini-dhal mills with the system design developed for the implementation of the oil expeller.

PTI and the context that shaped its emergence and evolution

The People's Science Movement owes its emergence to a complex of conceptual, ideological, historical, and personal contexts. One part of this context relates to a disillusionment with the mainstream development process and specifically to a Marxist critique of its progress that included:

- The failure of many national programs to really address then needs of the poor. This includes both the Green Revolution paradigm of agricultural development and the integrated rural development program of that period
- The failure of poverty-targeted programs to address poverty
- The global context of the emergence of the appropriate and intermediate technology movement and its ultimate failure to restructure technology development relations.

The other part of this context is related to factors during the 1980s that nurtured an alternative to mainstream approaches among an activist movement which has its origins in the discourse on the future practice of Marxist philosophy in an underdeveloped country like India.

A notable feature of the PTI is that the movement activists have intervened in the debate on development in the tradition of constructive work. In India, as experiments, these initiatives represent a constructive response to the ongoing protests against:

- Large-scale public technology interventions such as large dam schemes
- Agricultural technology development trajectories that are not environmentally sustainable, that do not conserve biodiversity and that were viewed as socially divisive
- A centralized model of industrial development where agricultural and other natural resources production and supply relationship were structured around a Western capitalist techno-economic paradigm of development.

Unlike some civil society movements, the People's Science Movement recognizes the importance of science and technology for the realization of alternate development to achieve the aims of poverty reduction and empowerment. It, however, took issue with the prevailing patterns of governance and power associated with science and technology and with the way this skewed the outcome of the emerging development paradigm. These concerns led to the development of an alternative perspective with regard to technology/production/society relationships

that was both rooted in science and society contentions, in combination with a leftist critique of the development process.

The following points in respect of the conceptual and philosophical perspectives seem to matter to the PTI activists:

- A commitment to constructive protest for change – an activist philosophy
- A commitment to enabling access to scientific knowledge for all
- A commitment to reshaping technology systems so that they embed in, and are shaped by the visions of the social systems to be established
- Conceptual principles that recognize the need to break down the organizational and institutional (in the sense of rule sets and norms) boundaries of formal scientific research, seeking more socially relevant organizing principles
- Conceptual principles that view needs assessment not in terms of technical constraints analysis, but rather in terms of the systems, resource, and skill embedded in and linked to rural communities; the potentials these present, and the way linkages with other S&T nodes can be strengthened. This also helps focus on an entry point that can be used to strength local systems and the capacities they contain
- A view of the development process that recognizes that primary production through land-based activities is unlikely to be poverty-focused. This has led to greater emphasis on non-farm, secondary processing and value addition through the development of (mainly) agro-based enterprises
- An ideological perspective that views the local or community economy as the unit of production. Operationally this means that a network or collective system of production has to be adopted. This is achieved through the establishment of workers co-operatives
- A commitment to developing systems and nodal capacities that can allow the poor to interface with formal S&T and other individuals and agencies, and to do so independently of external intervention.

Several critical developments allowed the disparate parts of this movement to coalesce and take organizational form. These included:

1. DST programs of S&T for weaker sections and similar state-sponsored schemes.
2. The visionary role of individuals both in the DST and within the activist movement itself.
3. The emergence of S&T voluntary organizations (STVOs), starting with the Delhi Science Forum and others.
4. The emergence of a collective identity of these organizations as a national People's Science Movement

A further context that allowed this alternative approach to take shape concerned a loosening of institutional rigidities in public-sector research organizations, particularly in the CSIR. The PTI viewed sources of knowledge in systems terms, seeking to reorganize S&T expertise around technology systems embedded in community-based contexts (rather than disciplinary and corporate enterprise contexts). Program support from the DST helps to draw together cross-organizational expertise, breaking down the barriers of disciplinary funding and rigid mandates inherent in research council institutional arrangements.

A final contextual feature relates to the evolution of different SVTO's and the way they have adapted the PTI ideals to different local institutional and development

contexts, introducing considerable variation. Processes within the People's Science Movement are being consciously utilized to articulate and communicate these conceptual and philosophical perspectives within and between the PTI. Needless to say, the processes are less than smooth. Debates exist inside on who is implementing, to what extent the rules are enunciated, and how much of the informal shared values are shared within the broader People's Science Movement.

The nature and role of partnerships in the PTI

As discussed earlier in the description of technology implementation mechanisms, the approach needs the formation of bridging organizations for the creation of relevant partnerships. The partnerships involved in the PTI approach are of two types. The first is partnerships within the movement and its different organizational elements and the critical partnership with the poor themselves. The second is the partnerships between PTI and the formal (usually) public research institutions and the agencies funding the programs with which the PTI is involved.

The role of bridging organizations

In the proposed approach the bridging institutions to be set up have a very important role in partnership building. The approach suggests the formation of technology generating groups, system design and development groups, and S&T field groups as bridging institutions. The organization that plays the role of a system development group is critical. The approach to technology implementation suggests that laboratories, as technology generating groups, will be required to collaborate with the two new groups: the S&T field groups and the system design and development groups. The S&T activists being identified for the bridging role are asked to act as part of the system design and development group and to take care of the functions of: executive co-ordination of opportunity analysis; system design; technology specification; technology adaptation and proving; management information systems; monitoring; and. organizational guidance for enterprise development, network formation and technology replication.

In this approach the S&T field groups are important as they provide the connection with the rural poor to every other actor. The S&T field groups are formed by such persons who are capable of performing the functions of entrepreneurial leadership. The S&T field persons are selected from among the users, and are themselves users. They are selected from among the users for their ability to provide entrepreneurial leadership to the local producers. They are an active interface of the technology-generating organization in the field. Their income comes from participation in production. They participate in the tasks of need identification, user development, technology adaptation, and network formation. They are selected and trained by the S&T persons identified for system group development and technology development functions. They may be selected either from among the S&T voluntary agencies that are willing to perform this role, or from among the potential users who are willing to establish the role of mother units for the satellite users.

Needless to say, the above-mentioned collaborators need to be nurtured by the agencies as close network partners in an interactive, bottom-up, and user-oriented process of technology implementation.

Partnerships as a process

To understand this concept some details of the process are necessary. Such interventions have led to the successful establishment of a range of rural enterprises serving local markets in selected field sites. These have usually been related to agro-based products or natural resources; for example, pottery, leather tanning, and agro-processing of fruit and vegetables. Experience shows that there are a number of elements involved.

Partnerships in planning: need identification

A PTI initiative usually starts with a system design group involving the members of an S&T field group who together with poor people from rural areas undertake a field investigation and develop an implementation plan. The term 'system design' signifies an approach that is different from needs assessment in the conventional sense. The approach is to identify resources in rural areas and opportunities in local economies and then formulate the nature of the **technology system** that would be required to strengthen the local economy and the participation of the poor in it. An important aspect of the approach is its preference for primarily selecting those opportunities that will help the S&T field group to act as a hook to network small producers over a large area. The focus on non-farm interventions allows this and is used to anchor a related set of activities alongside, e.g., processing different crops or other value addition or marketing activities. This approach suggests the implementation of an important and different type of partnership to that conventionally found in development interventions. It is a partnership between rural people and bridging organizations wanting to work in the local economy, with a view to identifying ways in which the whole can be strengthened.

Partnership in participatory technology proving and shaping

Technology proving and replication are seen as participatory jobs to be implemented in collaboration with users through the system of S&T field groups and system design and development groups. Technologies developed in laboratories have to often go through a phase of participatory proving for successful technology replication. This is particularly applicable when the enterprises are of the rural poor and are to operate in competitive markets. Such a phase helps the S&T field groups to also build into the process a skeletal production network in which the local people are fully involved. In this way it is possible to avoid the commonly observed phenomena whereby local people are alienated from the process of enterprise development. An understanding of the existing knowledge, resources, relations, and culture is considered a pre-condition for the success of technology implementation. It helps technologies to be rapidly replicated and eases network development.

The S&T personnel cannot be expected to provide 'ready to implement' technology variants to field groups working in diverse environments. They will need persons who can interact with them to identify requirements of design modification and improvements in quality control protocols. Persons will be needed who can document varied field experiences and create knowledge bases, decision-support systems, and training manuals for use in the multiplication phase of

technology implementing units. Successful enterprise establishment needs not only technology that is adapted to local conditions, but also support in terms of management information systems, arrangements for access to finance, land and other resources, and training. Such functions can be performed successfully when these services are provided in an integrated manner. This means that the capabilities required for interface are in the nature of system analysis/synthesis and can be provided only if there is a dedicated system design and development group specifically constituted to perform these functions. The persons comprising this group normally therefore include those who are/were field activists/or persons who have been intimately associated with field activists for a period of time.

Partnerships in capacity development and implementation: user involvement and participation

The S&T field group is a key link of PTI with the poor people in rural areas. It arranges to mobilize poor people to participate in the initiative as technology users. Therefore, one of the key tasks of the system design and development group is to identify members of the S&T field group. The members of the system design and development group help in the capacity development of the S&T field group. They are groomed to develop their entrepreneurial leadership qualities, and in turn to take the responsibility of developing more entrepreneurial leaders among the rural poor. For this to happen successfully the organizational model that they adopt is that of the **worker-managed cooperative.** The S&T field group also performs the crucial role of mother unit in the network. It helps to organize users to establish networked units, be these satellite or independent. For the supply and implementation of technological inputs, the role of field- level interaction with the users, particularly from among artisans, landless labor, and small-scale farmers, is performed by the S&T field group. But what is important, is that this group is not a parasite. It actively participates in production to ensure continuity and development. It also undertakes interaction with technology generating institutions to upgrade the skills of producers in new/improved technology and their organization and management. Since the new/improved technologies are often not readily available, the approach also envisages the involvement of technology generators from various institutions in such functions as guiding field investigations and opportunities analysis and technology development and implementation. The system design and development group and technology-generating groups (TGs) help the S&T field groups perform the functions of guiding field investigations and opportunity analysis, training, design of manuals, assistance in start-up and trouble shooting, prototype design, pilot-scale demonstration, adaptive research, etc. S&T field group members learn a lot while working on the job. The system design and development group systematically co-ordinates capacity development; it undertakes the task of continuously training S&T field group members and orients them to group entrepreneurship and participative management. Once again, the relationship between the PTI and S&T field group members is a critical partnership that is nurtured as the intervention develops and evolves along the way.

Partnership with the science community: scientific organizations without walls

As already suggested, the task of the system design and development group is also to develop linkages with scientists within the formal science system. The approach is that this group will first look at the indigenous knowledge of rural people and use this as a starting point to build the technological system and its capabilities. Formal science is therefore used as a way of strengthening existing technological starting points and building techno-economic trajectories from the bottom up. The PTI takes the perspective of starting with the occupations of the rural poor in non-farm sectors, and looking at how formal S&T can improve the technologies involved and can help develop the quality of primary production and supply systems to link decentralized processing to the local and wider economy.

However, when it comes to developing partnerships with the formal science system, the PTI does not partner with organizations, instead preferring to link with individuals. In fact this has been one of the key networking achievement of the PTI as it has built up a network of individuals working in the formal science system who recognize that S&T can be exploited in different ways. The PTI recognize this approach as one that helps to construct scientific organizations without walls. Building up these ties with the formal scientific (and as can be seen below) government establishment has been an important mechanism for garnering sufficient support to make PTI initiatives a reality. Without this network support one could quite easily see how such an idea could remain little more than a pipedream.

Partnerships with funders

As was alluded to in the introductory sections of this paper, an initial impetus for launching the PTI was the start of the S&T for Weaker Sections scheme within the Indian Government's Department for Science and Technology (DST). More specifically, it was the funding that the DST made available, and indeed other sources of funding have been made available. An important point here is that DST was a key partner in the evolution of the PTI. The S&T for Weaker Sections scheme recognized the value of an approach that one could argue flies in the face of all that is held to be good scientific practice in the formal scientific organizations of India. This type of partnership needs to be recognized.

Institutional rigidities faced by the PTI

Naturally an approach such as that of the PTI has repeatedly encountered institutional rigidities, rule sets and norms of formal S&T organizations, and other administrative systems. As has already been discussed, networking at an individual level has been an important way of dealing with rigidities. This has been important as a way of bring together formal S&T expertise from different institutional settings, an outcome that would have been much more difficult to achieve through partnerships at the organization level.

One persistent area of rigidity concerns the rules that accompany many sponsors. The main problem is that sponsors like to have a clear statement at the beginning of the project about the nature of the problem and how it will be resolved

and the project executed. This tends to sit uncomfortably with an approach that is evolutionary in nature, i.e., in the sense it is process-driven, concentrating on developing local capacities and pursuing opportunities in the local economy as and where they arise. In fact the PTI felt that its reliance on grants was becoming rigid within the organization itself. In other words, it has to make serious efforts to overcome a norm that is both creating dependency and bringing with it the rigidities and norms of the outside funding agency.

Lessons and the learning process in the PTI

The critical issue for the PTI is that as an approach it has developed and evolved over time. And it has not developed and evolved uniformly across the country. Instead, a number of variants in the approached have emerged. This diversity is seen as a healthy sign that the approach is adapting itself to different contexts and circumstances. There are a number of lessons that PTI has learned along the way these include the:

- Importance of using indigenous knowledge as a starting point
- Importance of developing networks with individuals in formal scientific and administrative organizations
- Cost of failure and the need to insulate the poor from this in program implementation
- Importance of concentrating on the local economy as the unit of intervention
- Value of networking together small rural enterprise units
- Critical importance of selecting the best entry point and the importance of by whom this is selected, and how. The make-up of the system design and development group and the involvement poor people have been very important
- Recognition that the system design and development group has to complete its task relatively quickly to maintain momentum.

Take for example, the lessons learned from the case of development of a system design based on the oil expeller developed by CSIR by the People's Science Movement. In face of the competition from cheap imports of palm oil the main weakness faced by the implementing team in Hisar was the slow pace of local market development for the packaged mustard oil. Experience indicated that though it was quite possible for the rural poor based group enterprise to grow on the basis of the opportunities available in local markets through the introduction of compound cattlefeed, but the development of local markets for packaged mustard oil was taking time. It has always been clearly realized that a wide range of factors could easily adversely affect the pace of local market development. It came out that often these factors are such that the rural poor would find them difficult to control. For example, as in the case of oil expeller, right from the beginning the unit had to face the additional difficulty of unfair competition inflicted on the sale of unadulterated, unblended, pure mustard oil due to the import of cheaper palm oil. During this period all over India the markets for mustard oil were heavy sufferers due to the lack of safeguards at both at the level of the legislation required on blending and labeling, and the customs duty leveled on imported oils. The expected premium for pungency of mustard oil was also not easy to obtain in the local rural market segments of Hisar. As a result, throughout the project period the unit established in Kanwari was definitely faced with heavy competition in

the local market. Local markets of Hisar were not sufficient as such to absorb fully the main value-added product yielded by the technology system. To sustain itself the enterprise was induced to tap the non-local mustard oil markets of Rohtak, Jind, and Delhi where the FG had its contacts. Clear lessons were learnt about the role that non-local markets can play even in the initial stage.

Experience with the implementation of interfaces in the innovation system, the support to Jan Taknik Network (JATAN), Hisar, HVM, the S&T field group established at Kanwari from the youth of the village has been quite critical to the successful implementation of PTI including competence development for technological innovations. Village youth supported the efforts for mobilization of local funds. As some of the young people are working in the mills in Hisar the S&T field group was able to use those contacts to build links with skilled innovative people working in large oil mills. Thanks to these contacts this S&T field group has contributed extremely useful inputs to the successful development of the technology system, particularly in respect of oil filtration.

The nodal team (N-level group) formed at Hisar with the help of the activists of HVM, a People's Science Movement group was found to be an essential condition for success in the implementation of system design It had access to external competencies of HAU, and National Institute of Science, Technology, and Development Studies (NISTADS), Delhi, CSIR, etc. With the help of this nodal group the S&T field group could easily make all the efforts needed to learn the capabilities required for network development. Innovative protocols needed to be designed for in-house filtration, quality control and packaging of mustard oil to be competitive in the local market. The nodal group located was able to help the S&T field group to gain access to the competencies needed to complete the technology package.

Active encouragement to the participation of workers in the management of group enterprises has been a point of debate within the movement. It has been generally found that while selected workers are always quite comfortable in these initiatives with the learning of technological competences they have taken more time to develop such economic competences as market-building, sales recovery, and management. Particularly, experience with the reformist leadership practices of activists and preference for comfortable funding approaches have been debated. Conclusions are that the movement must shun these weaknesses at the earliest if it is to succeed better with the replication process.

And there are undoubtedly many more specific and general principles that have been learned along the way. But perhaps a more important question in relation to an approach that has successfully learned and developed in new and useful ways is how this learning takes place. Formal evaluations, usually associated initiatives supported by external funds, have been an important way of monitoring outcomes of the approach against stated aims (see below on poverty relevance). However, probably much more important has been the constant debates and interactions among those involved in the Peoples Movement. This relates closely to the organizational culture of the PTI. Members all have a very strong personal commitment to the underlying ideology of the movement and as such have a personal stake in the way it is interpreted and implemented. This appears to have lead to a tradition of robust debate and reflection on the relative merits of

approaches practices and principles. This sort of organizational culture seems to be the most recognizable mechanism by which the PTI learns and evolves, and with a fair degree of such success by all accounts.

PTI's poverty focus

The PTI has an explicit poverty focus to its work, seeking only to work with the poor. It achieves this focus in a number of ways. Perhaps the most important way is that it believes that if the poor are to be reached by interventions these interventions should not be based on the ownership of land. In other words, by placing greater emphasis on non-farm, secondary processing and value addition through the development of (mainly) agro-based enterprises, the approach seeks to focus on households without land. In many rural areas this landless category should contain the poorest households.

As mentioned earlier PTI programs have been evaluated formally by their sponsors. These evaluations have tended to confirm that the approach is specifically addressing poverty reduction and targeting the poor. The PTI itself is not satisfied and feels its needs to strive harder to work for the poor and focus specifically on their needs.

Conclusion

The PTI espouses an alternative paradigm of S&T and rural development. The approach emerges out of the broader People's Science Movement in India, itself a backlash against what was viewed as the weak governance of science and its failure to meet the needs of the poor and to enhance their productive capacities. The elements of the PTI reflect these contextual origins with an approach that seeks to build technology systems around local knowledge and resources – rather than vice versa as is the case with conventional models of technology development. As can be seen, networking and building partnerships has been a very important element in the PTI – both in terms of individual initiatives and in terms of promoting and supporting the approach more widely. A final point that is notable is the capacity-development focus of the PTI. This is capacity development both in terms of enhancing the skills and technologies of poor people, and but also in the sense of linking the poor to sources of S&T and thus enhancing the capacity of the local technology system. The evolutionary characteristics of this capacity development are typical of a learning-based approach where the goals are the competitive advantage of the poor, and not of the nation in whose name the rich only benefit more. This case perhaps presents a rather radical alternative to mainstream S&T and rural development initiatives, however the principles of partnership and learning are clearly more widely relevant and could be adopted by others.

Endnote

This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID [R7502: Crop Post-Harvest Programme]. The author is grateful to A J Hall for providing an initial draft based on the author's oral presentation at the workshop held on 6 May 2002.

Supplementary papers

Strengthening science and technology policy in the field of environment and development: the case of the African Centre for Technology Studies Capacity Development Programme

N G Clark[1] *and J Mugabe*[2]

Abstract

A capacity-building program was undertaken over a 4-year period during the mid 1990s. The African Centre for Technology Studies (ACTS) Capacity Development Programme [CDP] was established in 1994 to enhance policy analysis capacities in sub-Saharan Africa with special reference to issues of technology and environmental policy arising out of Agenda 21 at the Rio Earth Summit, 1992. A number of important features and lessons emerged from this experience: 1. the introduction of policy analysis directly to the recipients (government officials) and the providers of knowledge (research sector), 2. focus on the problem as the unit of analysis rather than the academic discipline, 3. combination of broad orientation lectures and seminars (to bring participants up to speed with basic issues and agendas) with field research project work (to show participants that there is much to be gained by interacting directly with those at the receiving end of public policy, 4. training in basic communications skills (verbal and written), and 5. focus on a specific set of policy issues (those arising from the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climatic Change). Despite some success with this approach it became clear that this a new form of capacity building that needs further exploration. The main lesson perhaps is that such initiatives should be tried out in other contexts. What is certainly true is that the need for this type of capacity building program is a sad reflection on the higher education sector in many countries.

Introduction

The African Centre for Technology Studies (ACTS) Capacity Development Programme [CDP] was established in 1994 to enhance policy analysis capacities in sub-Saharan Africa (SSA) with special reference to issues of technology and environmental policy arising out of **Agenda 21 of the United Nations Conference on Environment and Development (UNCED).** Agenda 21 was negotiated and agreed at the Earth Summit in Rio in 1992. It set out the goals and mechanisms designed to achieve sustainable development. Its main focus was to build capacity amongst public officials to implement sustainable development programs related to the major international environmental conventions with special emphasis on the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCC). The CDP training courses were also

1. Graduate School of Environmental Studies (GSES), Wolfson Centre, University of Strathclyde, Glasgow, G4 0NW, UK
2. Commission of Science and Technology, New Partnership for Africa's Development (NEPAD) Secretariat, based at the Development Bank of Southern Africa, Midrand, South Africa

made available to selected personnel from research institutions, the NGO sector, and private enterprise. The concentration was on public policy analysis and the skills imparted covered: policy research, formulation, implementation, monitoring, control, and evaluation. Over the 4 years between 1995 and 1998 nine courses took place, including an initial trial course early in 1994. Some 60 people in all benefited from the training. Typical issues covered included intellectual property rights (IPR) protection and technology transfer promotion, protection of indigenous knowledge, regulation of access to genetic resources, biosafety regulation, environmental planning, the valuation and sustainable use of biodiversity, local incentives for environmental protection and the transfer and adoption of 'clean' technologies.

This paper has been included in this publication for two reasons. Firstly, it represents an innovation in technology development; as far as we know nothing similar has been attempted previously. Secondly, it is an example of a consortium of organizations getting together for a common purpose and then learning how to do things better as the project proceeded. In fact the CDP as a whole was a learning experience and for this reason evolved significantly over the period from 1994–98. A number of early assumptions and procedures were found to be misplaced and corresponding changes were put in place. The second Section attempts a definition of capacity building and explores how it was becoming increasingly important in the period before the CDP was launched. The third Section describes in detail why the CDP was started, while the fourth Section outlines how the CDP was structured and implemented. The fifth Section deals with finance and administration, and the sixth explains how the training course received academic validation from a northern university with relevant expertise. This is followed by an overall evaluation, and finally some overall conclusions about partnerships and the need for institutional reform are drawn.

Capacity building

The notion of capacity building has come on to the developmental agenda comparatively recently and is now enshrined as a primary objective in the mission statements of a number of relevant international bodies. Discussion of 'capacity' probably goes back to the Berg Report of the early 1980s (World Bank 1981) when it seems to have been used as a 'catch-all' concept to denote the need for many Third World countries to take charge of their own developmental destiny. Later on perhaps the agency that has made it most central to its mission statement is the United Nations Development Programme (UNDP), particularly in relation to environmental conservation. The mission was launched at the United Nations Conference on Environment and Development conference in Rio de Janeiro in 1992 as **Capacity 21** and was hailed as the 'main post-UNCED international effort to take forward the principles that were agreed at Rio [to] assist countries to attain sustainable development' (UNDP 1994). UNDP define capacity building as the 'sum of efforts needed to nurture, enhance and use the skills of people and institutions to progress towards sustainable development' (UNDP 1994). In 1993 UNDP instituted a funding program to enhance this capacity, this was a program designed specifically to involve as wide a spectrum of 'stakeholders' as possible. A

typical project under this program was one for Swaziland, designed to integrate environmental management strategies into the National Development Strategy and to do so using 'new participatory processes'. Another was a project co-sponsored with the United Nations Environment Programme (UNEP) designed to build capacities in the field of environmental law; such capacities are needed for the implementation of national obligations incurred under various international protocols.

Environmental management has increasingly come on to the international policy agenda as a result of UNCED and the subsequent meeting at Kyoto in 1997. The problem is that despite good intentions on the part of politicians who sign up to international agreements, the 'capacity' of governments to fulfill resultant obligations at national level is often weak. Administrative organizations are used to the applications of fairly standard policy instruments such as those associated with monetary and fiscal interventions, but these have difficulty in coping with issues involving the natural environment. Thus, for example, Clark and Juma (1998) have criticized the 'incremental cost' rule used by the Global Environmental Facility (GEF) in decision-making about projects designed to fulfill such agreements at national level. Their proposition is that measures to deal with environmental degradation cannot rest solely on a project basis that is informed **only** by (such a) rule, analytically useful though (this) is. Economic systems are complex things that evolve in unpredictable ways and whose development is of central importance to those who live and work in them. Donors are sometimes curiously ambiguous on this point. On the one hand they prefer lending rules that are bureaucratically easy to administer, while on the other hand they would like recipients to behave in ways that reflect their own political agendas which in turn reflect pre-dispositions about how development really takes place. What they tried to show, however, is that since economic systems evolve unpredictably (at least relatively so) there is a prima facie case for capacity-building at the policy level to accompany project decisions that are environmentally related.

A similar point has been made by Hayes and Smith (1993) who point out in a detailed survey of relevant contributions that 'a greenhouse regime must be flexible enough to demonstrate what is possible rather than to strive for final policy commitments that are simply ignored' (Hayes and Smith 1993). There is little point, for example, in relying on the importation of (environmentally) clean technologies (through project aid) in the absence of the capacity to understand what these technologies are, and how they may be diffused throughout the economic system. Instead they call for donors to 'accept longer time horizons and invest in long-running training programs rather than (rely only upon) traditional aid projects' (Hayes and Smith 1993).

But what exactly is 'capacity' and how can it be defined? In its earlier guises it was mainly about management of structural adjustment through local ownership of resources, local human resource development, and the relative avoidance of expatriate influences (e.g., through consultants). In its more recent guises it has become more to do with governance and how institutional innovations can help ensure greater efficiency and accountability in the mobilization and control of national resources (King 1992). The CDP, however, was influenced by a yet more recent orientation, the **technological** capabilities that countries have (or do not

have) to transform their economic systems. Although interest in this area is comparatively recent in the development literature it is arguable that capacity defined in this way probably underlies all other definitions, simply because it relates to the capacity of an economic system to transform itself. It therefore has the following broad properties:

- It is concerned with people-embodied skills and competences
- It carries with it the notion that such 'capacities' go well beyond **expertise** in the normal (reductionist) sense of that word. In particular they are not isomorphic with academic disciplines
- The idea of 'capacity' is often concerned with technology and technological transformation of resources for socio-economic ends
- There is a frequent, if tacit, assumption that 'capacities' are underrepresented in disadvantaged groups (i.e., women, the rural labor force, the poor, etc.)
- It is frequently stated (or implied) that more resources ought now to be channeled into 'capacity building', if necessary at the expense of such traditional instruments of economic development as higher education, major investment projects or the employment of expatriate consultants.

Perhaps the best way of approaching the concept is through the recent writings of a school of economists who take inspiration from the writings of Joseph Schumpeter. Schumpeterians, although very few of them have actually paid much attention to Third World problems, start off from the position that innovation is the key ingredient in economic transformation, stressing the importance of a total systems approach to the development problem and, within this, the great significance of what have come to be known as 'technological capabilities'. While there is no single accepted definition of this term, nevertheless a growing minority of analysts and practitioners have begun to realize that it somehow captures the essentially creative and non-linear realities of the change process, a process that it is essential to understand if the world is to proceed rapidly towards sustainable development (see Adeboye and Clark (1996) for a fuller discussion of this point).

Technological capabilities have recently been defined in various ways by a range of analysts. Lall (1992), for example, sees them as a range of capacities that allow an economic system to understand best-practice technology on a world scale and to use this understanding to promote more rapid economic growth than would otherwise have been possible. Such capacities are closely determined by indigenous technological efforts to master new technologies, adapt them to local conditions, improve and diffuse them within the economy, and then exploit them overseas by manufactured export growth and diversification, and eventually by the export of the technologies themselves. Bell and Pavitt (1993) for whom the notion of 'capability' is equally concerned with the capacity for change but is expressed rather differently have suggested another definition.

'We draw a distinction between two stocks of resources: **production capacity** and **technological capabilities.** The former incorporates the resources used to produce industrial goods at given levels of efficiency and given input combinations: equipment (capital embodied technology), labor skills (operating and managerial know-how and experience), product and input specifications, and the organizational methods and systems used. Technological capabilities (on the other hand) incorporate the resources needed to generate and manage technical change,

including skills, knowledge and experience, and institutional structures and linkages. We emphasize the distinction between the two because we are primarily interested in the dynamics of industrialization, and hence in the resources necessary to generate and manage that dynamism.' (Authors' emphasis)

Traditionally there was emphasis on the former because it was simply assumed that the latter would occur automatically as a kind of marginal 'add on' to direct foreign investment. However, nowadays it is slowly being realized that with the growing knowledge intensity of production that is not so. Indeed, if we can accept the historical research of authorities like Fukusaku (1995) and Fransman (1995), it was probably never really the case. Fukusaku shows how the technological development of the Japanese shipbuilding sector over the period 1880–1939 was heavily dependent on systematic investments in technological capabilities carefully orchestrated by both corporate and national policy. And for Bell and Pavitt (1993) it is therefore essential for policy to focus on this area. In particular they stress:

1. The importance of direct foreign investment
2. The growing importance of the science base, and therefore the need for heavy investments in education, training, and skills
3. Appropriate incentives for innovation and imitation
4. Favorable product-market conditions
5. Institutions and policies that will encourage learning.

However, they readily admit that we still do not have much idea about the conditions for successful learning, arguing that 'we have too few careful empirical studies in developing countries of the nature and determinants of successful learning at the level of the firm or industry, including the role of government policy and supporting institutions' Bell and Pavitt (1993). What is common to both sources, and indeed to many others such as Hobday (1994a; 1994b); Weiss (1993); and Ernst et al. (1998), is that capacity-building in this (technological) sense has a number of specific characteristics which tend to set it apart from traditional definitions. These characteristics are that:

1. The acquisition, validation, and use of knowledge is fundamental to capacity-building
2. This knowledge is not freely available, but on the contrary, has to be sought through the committal of scarce resources
3. It is not universally applicable across time and space but has to be adapted to the context in which it is to be used
4. It can be held both by individuals and by organizations
5. Its effective promotion and use in an economic sense needs to take place as close as possible to the process of economic production
6. Its effective promotion will need new types of institutional structures.[4]

Programme rationale

As outlined above the CDP began in 1994 although its planning began in 1993 under the auspices of the Second ACTS Medium Term Plan. Prior to 1993 ACTS had developed primarily as a contract research institution funded mainly through

4. A discussion of how these factors relate to governance issues in Africa more generally is contained in Juma and Clark (1995)

project grants and consulting income. The rationale for moving into human resource development as well was as follows: 1. Interdisciplinary research bodies breaking new ground have always had great problems recruiting suitable staff. 2. The existing pool has often been brought up in conventional ways, i.e., learning analytical techniques in university systems structured on the basis of single disciplines. 3. By the time a student has proceeded to the graduate level (and gone on to obtain a masters or a doctoral degree) he/she usually has great difficulty in engaging in the kinds of activities needed by such research bodies as ACTS.

This problem was compounded in two further ways. Firstly, the idea of 'policy research' is extremely novel even in such industrialized countries such as the UK, so that temporary assistance from an international pool is hard to obtain notwithstanding the normal difficulties associated with the acquisition of work permits. Secondly, many African universities have regrettably declined greatly over the past 15–20 years in terms of the quality of their educational provision. And this is particularly so at postgraduate level where it is actually very hard to identify a school providing the types of **empirical** training necessary for the production of good quality research staff relevant to ACTS. All too often, for example, students appear able to obtain masters degrees without ever having engaged in sustained field research; the absence of this type of 'research culture' in graduate schools appears to strongly influence subsequent research performance. In short, ACTS was forced into 'growing its own staff' and the CDP was established partly for this reason.

It was also becoming clear at ACTS that despite considerable success in producing the normal output of a research institution (i.e., through reports, articles, books, etc.) these were not apparently having the direct impact on policy that was expected. In fact, it had become clear that policy advice is only acceptable if recipients actually understand it and since few apparently did, this meant that ACTS would need to begin to create its own 'constituency' of policy-makers. It was partly for this reason that the CDP concentrated primarily on building capacity amongst public officials to implement sustainable development programs associated with obligations incurred by national governments under recent environmental conventions. The focus was therefore to be on public policy (i.e., on analysis, research, formulation, implementation, monitoring, control, and evaluation) pertaining to sustainable development in general, although subsequently the program narrowed down mainly to issues associated with biodiversity conservation. In addition it was expected that operating at a regional level would help to create a regional 'constituency across SSA'.

However, probably the most important factor was objective need. For it was already becoming clear that although much of Africa had signed up to Agenda 21 and the associated conventions, the actual implementation of associated action plans, policies, etc would certainly be hindered because of lack of public policy-making capacity. If progress towards fulfilling the goals of the CBD is to be made, for example, national governments would need at the very least a cadre of trained people that not only understood the CBD but could also advise on its substantive implementation. Hence the need for suitable training courses was also self-evident. Indeed subsequently ACTS found (through discussions at COP 4) that it is still the only international organization mounting policy-oriented courses to meet such a need.

Course format

Typically the CDP training courses lasted for 3 months. They normally specified a particular theme and were implemented on a dual-track approach. In the first place participants were introduced, through a series of lectures, workshops, discussion groups, and plenary sessions, to a range of topics of relevant to the overall theme of the course. In most cases these were provided by ACTS own training staff although international experts were often brought in from such bodies as the World Resources Institute (WRI), Washington at various points in CDP to provide up-to-date insights on specific issues and organizations. In addition, field trips were arranged to enable participants to visit institutions whose work relates closely to the implementation of international environmental agreements.

Besides this general orientation, emphasis was also given to a second activity, that of the preparation of a policy paper. Participants were expected to bring with them a problem of particular relevance to their own country that they then researched during the training course. All participants were assigned a personal tutor whose function it was to act as an academic adviser throughout the course. In particular, the personal tutor advised participants on developing their project proposals. During the course they were provided with relevant writing, presentation, policy research techniques, problem formulation, and other skills necessary to carry out this task. Participants also had available a series of specially selected texts in the ACTS library and were taken to the UNEP and the International Union for the Conservation of Nature (IUCN) libraries from time to time. By the end of the course they were expected to prepare and submit a policy paper and to present their findings at a final regional workshop.

International quality standards

Course certificates were validated through a special arrangement with the Graduate School of Environmental Studies (GSES), University of Strathclyde, UK (see further discussion below). This link was supported by a grant from the UK Darwin Initiative for the Survival of the Species. Besides supporting the travel costs of Strathclyde staff to Africa the Darwin Initiative also provided a number of fellowships to fund travel, maintenance, and tutorial costs for trainees who perform well enough on the courses to be considered for acceptance into the Research Degree Programme at Strathclyde. What was particularly innovative about the ACTS/Strathclyde relationship is that these research students spend most of their time (65%) in Africa on both fieldwork and supervised desk research.

Links to other ACTS activities

It is important to stress links to other ACTS programs. For example, through its regional workshops the CDP provided a forum for raising public awareness on international and national environmental policy issues. The research output of ACTS provided updated materials for the courses while very often the policy papers of the participants contributed to ACTS published output. Finally, on returning home trainees began to provide a 'constituency' for ACTS policy research in many parts of the continent, since they provided a focus for the comprehension, interpretation, and implementation of associated policy recommendations.

Finance and administration

CDP had two types of funding 'core' and 'fellowship'. The former was designed to cover the overhead costs of administration, while the fellowships covered the marginal costs of the individual courses. Core funding for CDP was originally supplied by Norwegian Agency for Development Co-operation (NORAD). Subsequent core finance was provided by Norway (NORAD) and Sweden (SAREC), the UK Darwin Initiative, and the John D and Catherine McArthur Foundation. Fellowships were supplied by Finland (FINNIDA), NORAD, McArthur and the Sasakawa and Ford Foundations. These fellowships, worth some US$10,000 per participant, were normally split into two equal parts. One part was to meet the maintenance, incidental and travel costs of participants, while the other covered the tutorial costs of the course.

Administration was handled by a Programme Administrator under the guidance of a part-time Academic Director. This latter position has been filled since the inception of the CDP by the author of this paper under an arrangement with the University of Strathclyde, Glasgow. Besides providing an academic 'backstop' for the CDP he and his colleagues also collaborate on ACTS research activities.

Academic validation

Right from its inception the CDP decided that its training courses should have adequate academic validation and that the certificates on offer should be treated as internationally accredited postgraduate qualifications. The main reason for this was to give the program as a whole a high degree of credibility. It also acts as an incentive for participants to treat the courses more seriously than perhaps they otherwise might. The means used was to enter into an arrangement with a northern university that would validate the ACTS certificate as part of its normal postgraduate operations. This is quite a usual activity these days and is used internationally in many contexts. Validation by a university had the added attraction that it created possibilities for the best participants to go on to register for a research degree, thus giving them another incentive.

The question then was – what kind of validating institution would be most suitable? Here the most important criterion was capacity to handle the interdisciplinary nature of environmental management. This is not so straightforward as it might appear simply because the knowledge needed for the policy-maker is often locked away in 'cognitive boxes' that are not only inaccessible to the intelligent lay person but actually also to different professional interests. For example, the issue of 'desertification' is about prices and resource allocation to the economist, stress responsiveness of different soil types/aggregates to the soil scientist, the weather and its vagaries to the climatologist, the structure of power to the political scientist, etc. Sometimes they talk to each other. On occasion they even understand each other. But, regrettably, often they do not.

The reasons for this are well known. Academic life is still very much about reducing issues to narrow problems that are amenable to rigorous experiment, and this is reflected in how universities are traditionally organized. Small wonder then, that those actually responsible for environmental sustainability have difficulty knowing whose advice to seek on questions of public policy. To fill this

gap we are beginning to see organizational innovations in the 'knowledge market' (the interaction between those who need the knowledge and those who supply and validate it). A key feature of these is the fostering of interdisciplinary training on the part of a small number of universities; training that often takes the form of postgraduate management and policy studies. In the end, after reviewing a number of possibilities, GSES was chosen because it most closely fitted what was needed.

GSES was established in 1992 to provide training facilities for those with a first degree or equivalent in any discipline (science, humanities, social science, engineering, etc.) who are interested in developing skills/perspectives relevant to environmental management. GSES- taught programs over two semesters require students to take a constrained choice of 10 modules (out of the approximately 25 available). Those students, whose grades are good enough are allowed to proceed to the dissertation phase, culminating hopefully in the award of a master's degree, those who do not proceed will normally qualify for a diploma. The modules are drawn from all aspects of environmental studies and range from straight environmental sciences and engineering (such as ecology and solid waste management) to more 'decision-making' subjects like environmental law and environmental economics. The dissertation is usually based on an empirical research project (often involving work placement) on a topic relevant to industry, local government, NGO, or regulatory authority interests. In this way the GSES is primarily focused to build policy capacity for the years to come. Its research interests include the international conventions, biotechnology policy, environmental economics, and decision tools for public policy. It also has a successful short course program.

Evaluation

As outlined above, the CDP as a whole was a learning experience and as such evolved significantly over the period 1994–98. The most important changes during its evolution were:

Choice of applicants

At the beginning ACTS underestimated the problem of securing suitable applicants. Reliance upon formal advertisements and circulars to ministries across the region tended to produce participants who were technically unsuitable, who saw the courses mainly as a means of making money, or in some cases, both. In extreme cases some participants were sent home. Of course, those who remained benefited to some extent but nevertheless the CDP put significant efforts into improving the quality and motivation of applicants. It learned to do this through: personal contacts, announcements at relevant fora (such as regional workshops), its own publications, and more conventional channels. As a result of these changes the quality of applicants certainly improved.

Period of stay at ACTS

The first training courses were only held in Nairobi. However, 3 months of intensive training proved hard, even for the most committed of participants. It was difficult to keep concentration levels up on the part of people who were not used to this

type of activity, as was the case with the primary target group (government officials). In addition, there were often problems associated with absence from home for a long period (especially, but not exclusively, for women who had children). On the content side, although great efforts were made to ensure that policy problems were those encountered at home base, participants frequently lost touch with that reality since their research work was based on materials and people available in Nairobi. Even if they had been asked to bring relevant materials with them, they either did not do so, or they did not typically bring enough to deal adequately with their project requirements. Finally this original course format was very expensive in terms of resources, including staff time.

Need for research-based training

Right from its inception the CDP tried to ensure that the training activities would relate to relevant problems and issues in participants' home countries. What gradually became clear, however, was that the best results were achieved when participants were able to have direct 'hands on' empirical experience. All too often participants were found to have little field experience, being used to spending most of their time behind office desks in traditional bureaucratic pursuits. The chance to pursue fieldwork clearly enhanced both the knowledge and the motivation of participants, judging from their performances at final regional workshops. Conversely the earlier Nairobi-based courses tended to produce 'bookish' policy papers without much analytical or real policy content. There were still some residual problems about field supervision but with time, experience, and more staff these had lessened.

Policy/'politics' tension

One of the most pervasive problems encountered in the initial phases of the CDP was the assumption that 'policy' emanates from 'on high' and has to be implemented unquestioningly by subordinate civil servants. The notion that competent professional civil servants should be in a position to inform and advise their superiors on a range of policy options was not widely understood. Considerable time was therefore spent in dealing with this issue in interactive workshops and simulated discussion sessions, often based on an evaluation of selected case studies. In addition the participants were strongly encouraged to write up and present their final policy papers in such a way as to present findings as a series of policy options with accompanying prognoses of likely impact. The balance between 'chalk and talk' lecture sessions and workshop sessions also moved in favor of the latter 'training' mode over the period.

Background environmental knowledge

ACTS found that even comparatively senior civil servants have a very weak grasp of relevant background knowledge. For this reason rather more time was spent in actually introducing the international conventions, their history, institutional context, etc than had originally been anticipated. In addition, efforts were made to leave participants with copies of overhead transparencies and lecture notes. ACTS began to produce specially designed 'readers' for some courses and these,

combined with copies of suitable ACTS literature, were usually sufficient to bring participants up to speed with the necessary background to cope with course issues. A related point concerned participants with varying technical backgrounds when too much was initially assumed by the course organizers. Here experience showed that it is safest to assume very little prior technical knowledge on the part of participants, regardless of paper qualifications, at least at the beginning of courses. This was so even in the case of participants from the research sector since their specialized knowledge tended on the whole to be too narrow from a public policy standpoint. Starting from first principles in had the added advantage of providing a common baseline for all participants.

Follow-up arrangements

These were not handled systematically and were therefore a weakness of the CDP. Originally it had been hoped that a database would be established that would include co-ordinates and other details of alumni, resource persons, relevant institutions, etc. Two problems stopped this idea from progressing. One was the ongoing lack of adequate IT facilities within ACTS. The second was the loss of the first Programme Administrator and the subsequent illness of her replacement.

Library facilities

The ACTS Library, while still in the process of establishment, was available to all participants during the period of their stay in Nairobi. Although there were problems in material access in the early years ACTS became satisfied that sufficient literature was available for training purposes. This was helped especially through the ACTS Press.

Class size

Experience of the CDP showed that relatively small class sizes tend to be appropriate for training courses of this type. At first sight this may appear to be expensive in terms of resources. However, it was found that class sizes of greater than 8–10 students tend to lose cohesion and the quality of training tends to suffer. Quality was also affected by the interactive and person-based training mode that the CDP found to be the most effective.

Conclusions

On the basis of its experience, ACTS came to believe that the CDP was a successful initiative that broke new ground in socio-economic development activity. Although mistakes were made, the positive features outweighed the negative ones, and even in the latter cases lessons were learned. On the positive side the features were:

- The introduction of policy analysis directly to both the recipients (government officials) and the providers of knowledge (research sector)
- The focus on the problem as the unit of analysis rather than the academic discipline
- The combination of broad orientation lectures and seminars (to bring

participants up to speed with basic issues and agendas) with field research project work (to show participants that there is a lot to be gained by interacting directly with those at the receiving end of public policy
- Training in basic communications skills (verbal and written)
- The focus on a specific set of policy issues (those arising from the CBD and the UNFCCC)

Nevertheless, it became clear that this a new form of capacity building that needs further exploration. There is still some way to go. Undoubtedly the course organizers learned a great deal from their activities and indeed, continuously attempted to improve form and content over the duration of CDP. But undoubtedly mistakes were made and the main lesson perhaps is that initiatives like this one should be tried out in other contexts. What is certainly true is that the need for this type of capacity-building program is a sad reflection on the higher education sector in many countries. At an individual level, while many African academics make a useful contribution to ACTS activities (and some have formal positions in the organization) one of the biggest problems faced by ACTS was how to involve African universities institutionally. Early on an attempt was made to establish a MoU with a Kenyan university but this failed. More generally, problems appear to include: weaknesses at postgraduate level, an apparent inability to deal with policy analysis, low empirical research capacities, and little experience of interdisciplinary work. One of the challenges for future programs is therefore how to build capacity within the African university sector. Ideally it should be the universities themselves who produce graduates able and willing to fulfill these sorts of roles in developing-country governance. The fact that they do not indicates the more general need for substantial reform in postgraduate education.[5]

The other main (and related) lesson learned is the need for new types of partnership to promote such activities. For example, as outlined above, academic validation for the CDP was provided by the link with the GSES. But the CDP benefited from a much wider range of links. Thus, considerable assistance was received from local such NGO bodies as IUCN, UNEP, and the Kenya Wildlife Service (KWS). These institutions regularly provided resource persons, library facilities and help on field trips that proved essential to CDP's success. Links were also established with a range of sympathetic donors and with many helpful government officials in ministries throughout SSA who assisted in numerous ways. And, despite the institutional problems mentioned above, many individual academic personnel from the university sector were able to contribute significantly to specific courses. In short, the success of programs like this one will always be crucially dependent on the orchestration of a wide range of expertise. Accessing and mobilizing such expertise will generally mean developing new types of partnership arrangements. In this sense institutional innovation must be a key component in capacity building for development in the Third World.

5. For a more detailed discussion of this and related issues see Clark (2000)

Endnote

This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID [R7502: Crop Post-Harvest Programme].

References

Adeboye T, and **Clark N G.** 1996. Methodological issues in science and technology policy research: technological capability. Science, Technology and Society 2(1): 74–97.

Bell R M, and **Pavitt K L R.** 1993. Technological accumulation and industrial growth: contrasts between developed and developing countries. Industrial and Corporate Change 2(2): 157–210.

Clark N G, and **Juma C.** 1998. Incremental costs, capacity building and the global environmental facility. Science, Technology and Development 16(1): 1–16.

Clark N G. 2000. Public policy and tertiary education in Africa: aspects of institutions and management capacity. Journal of Economic Studies 27(1/2): 75–93.

Ernst D, Ganiatsos T, and **Mytelka L. (eds.).** 1998. Technological capabilities: an export success in Asia. London, UK: Routledge.

Fransman M. 1995. Japan's computer and communications industry. Oxford, UK: Oxford University Press.

Fukusaku Y. 1992. Technology and industrial development in pre-war Japan. London, UK: Routledge. 189 pp.

Hayes P, and **Smith K. (eds.)** 1993. The global greenhouse regime: who pays? London, UK: Earthscan.

Hobday M. 1994a. Export-led technology development in the four dragons: the case of electronics. Development and Change 25(2): 333–361.

Hobday M. 1994b. Technological learning in Singapore: a test case of leapfrogging. Journal of Development Studies 30(4): 831–858.

Juma C, and **Clark N G.** 1995 Policy research in sub-Saharan Africa: an exploration. Public Administration and Development 15(2): 121–137.

King K. 1992. The external agenda of aid in internal educational reform. World Development 12(4): 257–263.

Lall S. 1992. Structural problems of African industry. Pages 103–144 *in* Alternative development strategies in sub-Saharan Africa (Stewart F, Lall S, and Wangwe S M S, eds.). London, UK: Macmillan.

UNDP. 1994. Annual report for 1993. New York, USA: United Nations Development Programme (UNDP). 262 pp.

World Bank. 1981. Accelerated development in sub-Saharan Africa: an agenda for action (Berg Report). Washington DC, USA: World Bank.

Post-harvest innovation systems in South Asia: key features and implications for capacity development

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

Abstract

Post-harvest research and development (R&D) could make a valuable contribution to pro-poor rural development. Evidence suggests, however, that technological innovations need to be supplemented by institutional innovations that encourage broader participation from researchers, entrepreneurs, and users of the technology. Furthermore, greater attention will need to be given to the wider institutional context in which innovation takes place. This paper presents the concept of a post-harvest innovation system as a way of exploring these issues and explains the capacity-development implications of this perspective. Examples of post-harvest innovation systems are presented to illustrate the critical importance of partnerships and the influence of the institutional context on research outcomes. Ways of implementing this in research programs are then discussed.

Introduction

Post-harvest research and development (R&D) offers the potential to support the livelihoods of poor people in developing countries as: farmers, small-scale agro-processing entrepreneurs, off-farm laborers, and consumers of food and agricultural products. It is increasingly recognized, however, that efforts to strengthen post-harvest systems in developing countries will need to pay much greater attention to the institutional environment in which change takes place (Hall et al. 2002a). This institutional environment does not just concern the organizations involved, but more importantly the norms, routines, and rules that govern the way organizations operate and interact with each other. This distinction is necessary as our discussion is not just about who is involved in R&D and innovation, but also about what are the rules and norms that govern the way learning and change emerges from organizations individually as well as through their interaction with partners. This is important because it influences not only the effectiveness of innovation processes generally, but also in terms of the relevance of these innovations to different interest groups including the poor.

It is all too evident that new technology, although necessary, is not sufficient to bring about changes in food and marketing systems. Equally, the impact of technical change in post-harvest systems has often had questionable impact on rural communities, particularly on the poor. There is, however, growing evidence that relevant innovations can emerge through partnerships between organizations

1. University of Greenwich, UK, seconded to International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India
2. National Centre for Agricultural Economics and Policy Research (NCAP), PO Box 11305, Library Avenue, Pusa, New Delhi 110 012, India
3. ICRISAT
4. Graduate School of Environmental Studies, Wolfson Centre, University of Strathclyde, Glasgow G4 0NW, UK

from research, enterprise, implementation, farming, and market sectors, particularly where institutional conditions support consensus building, synergy, and learning. In this paper we discuss innovation in the broad sense of the activities and processes associated with the generation, distribution, adaptation, and use of new technical, institutional and managerial knowledge. We make this distinction to emphasis that our discussion is not about innovation in the narrow sense of the invention of new technology in R&D laboratories. Rather it is about how R&D needs to be viewed as part of a bigger process that brings about changes in post-harvest systems.

Post-harvest innovation systems

Post-harvest R&D seems to sit uncomfortably in the conventional arrangements for agricultural research. Crop improvement research, for example, can clearly identify plant breeders (and increasingly molecular biologists) as the central scientific personnel. The product – new varieties – is well-defined and the systems for disseminating this technology and the roles of extension services and seed supply agencies are relatively straightforward. The main client, the farmer, is clearly identified, as is the role of the client in applying this new input technology. In this view of agricultural research the number of players is fairly limited – scientist, extension workers, farmers – and their roles are clearly defined and mutually exclusive. While this is a stylized description of the R&D process and the way it is arranged, it is all too recognizable as the conventional model of agricultural research that persists in many parts of the world.

Post-harvest R&D, on the other hand, cannot be so neatly categorized. Professionally the sector spans engineering, food science, pathology, marketing systems economics, and beyond. The post-harvest sector is also characterized by its linkages and relationships between producers and consumers, between rural and urban areas, with markets playing a large role in mediating these linkages. The sector includes technology clients and intermediary organizations from the whole range of organizational types – from both public and private sectors and from an equally diverse set of stakeholder agendas and interests. Furthermore, post-harvest technology applications often form part of complex techno-economic systems where many players are involved, each with different skills, responding to different incentives. As a result post-harvest innovation is frequently embedded in a wider set of relationships and contexts than is implied by the conventional research–extension–farmers model of R&D. Managing post-harvest innovation and doing so in ways that supports a pro-poor policy goal is therefore challenging.

To deal with these realities a policy perspective is required that provides an understanding of the institutional and organizational arrangements that lead to innovations relevant to the livelihoods of poor people. We argue that conceiving post-harvest innovation as a process emerging from a **system** of supportive actors, relationships and institutional contexts, is a policy perspective that can be used to plan R&D more effectively. To explain what a **post-harvest innovation system** perspective might entail we begin by introducing some of the contemporary debate on the innovation process in relation to agriculture.

Innovation systems perspectives

The debate about ways of improving the effectiveness and impact of agricultural research (including post-harvest) is not a new one. However the influence of institutional arrangements and the dynamics of innovation process are issues that many theories of agricultural research and technical change find most problematic. For example, in the induced innovation model (Hayami and Ruttan 1981) factor prices and user demand are predicted to **induce** scientists to develop appropriate technology – a **demand–pull** theory. This has not proved to be the case. The chief reason being that such a model ignored the political and institutional context in which resource allocation decisions are made in R&D. Rogers' (1983) diffusion of innovations model is blind to similar institutional issues that not only determine the types of technology developed, but also decisions over how it is promoted and to who – a **technology–push** theory.

Another branch of this debate concerns the role of farmers in the research process. This led to the participatory research movement. However, while the original conceptual basis of this debate explicitly made the link between the nature of institutional arrangements (i.e., who had control of the research agenda) and the performance of the R&D process, much of the subsequent debate has focused on participatory methods rather than underlying institutional issues. Biggs and Smith (1998) argue that this 'methods bias' masks the fact that the most successful participatory methods have arisen in specific institutional and political circumstances and have often evolved to deal with a specific problem area in that context. This, it is suggested, often occurs through coalition building, i.e., associations of people brought together out of the necessity to deal with a specific problem and the shared belief in the choice of approach to solving it. Biggs and Smith go on to suggest that participatory methods will not give farmers a greater role in the research process. This will only happen when participatory methods are accompanied by an acceptance among those conducting and managing research that farmers have a valuable role to play and that their knowledge and perspective are valid and useful. In other words it is the institutional context of research that needs to change and the introduction of new methods will not bring this about on its own.

Increasingly these sorts of ideas are being discussed in terms of the systems that are needed to link research with users needs. For example, Lynam and Blackie (1994) talk of the need for a chain of technologies, institutions and policies that function as an effective system rather than as disarticulated parts. The concept an Agricultural Knowledge and Information System (Roling 1986; 1994) makes a similar point. More recently the notion of an **innovation system** has started to be discussed as a way of about thinking about the institutional context of agricultural R&D (Hall et al. 2001) .[5] The attraction of the innovation system as a policy framework seems to stem from the way it engages with the political, economic, and social dimension of knowledge production and use at a time when these concerns

5. This builds on the idea of a **national system of innovation** (Freeman 1987; Lundvall 1992) developed to examine the differential performance of national economies. Biggs (1990) develops a similar concept in the context of agricultural innovation. See also Clark 2002 for a knowledge market perspective.

are emerging as central to the development debate (Hall 2002). There are a number of valuable features of this framework.

- Firstly, it defines the scope of analysis as the innovation process rather than solely research. The concept of innovation is used in its broad sense of the activities and processes associated with the generation, production, distribution, adaptation, and use of new technical, institutional, and managerial knowledge.
- Secondly, by conceptualizing research as part of the wider process of innovation it helps identify the scope of the organizations and stakeholders (including public, private, research, enterprise, civil society and technology users) involved and the wider set of relationships in which research is embedded.
- Thirdly, because it recognizes the importance of both technology producers and technology users and that their roles are both context-specific and dynamic. It breaks out of the polarized debates of technology–push versus demand–pull theories. Instead that it recognizes that both processes are potentially important at different stages in the innovation process.
- Fourthly, it recognizes that the institutional context of the organizations involved, and particularly the wider environment, governs the nature of relationships, promotes dominant interests, and shapes outcome of the system as a whole. This aspect is enormously important for introducing a poverty focus. The framework provides a lens to examine and reveal which agendas are being promoted, highlighting areas where the agendas of the poor can be promoted.
- Fifthly, it recognizes this as a social system. In other words, it does not just focus on the degree of connectivity between the different elements, but also on the learning and adaptive processes that make this a dynamic, evolutionary system.
- Sixthly, it is only a framework for analysis and planning, and as such it can draw on a large body of existing tools from economics, anthropology, evaluation, management, and organizational sciences and so forth.

One of the most notable points about an innovation system framework is the emphasis it places on learning processes as a way of evolving new arrangements specific to local contexts. There is much empirical evidence to suggest innovation performance is strongly correlated with institutional environments that promote learning.[6] This contrasts with the conventional approach of seeking optimal blueprints for R&D arrangements. The innovation systems perspective instead recognizes the importance of supporting the development of adaptive, evolving arrangements. This in turn suggests that there is likely to be growing diversity in approaches and practices and that this would be an indicator of an effective innovation system. One implication of this is that capacity development becomes a much more important objective of interventions that support to R&D. In other words, research becomes concerned increasingly with establishing relationships and process that will underpin future technology and innovation outcomes. The next section contrasts a number of case studies to illustrate these points.

6. The literature on learning, competency building and innovation performance is very large indeed. Edquist (1997) provides a useful review of concepts in the context of innovation systems.

Case studies of recent developments in the Indian post-harvest innovation system

1. Patterns of interaction in research on quality management systems

Recent studies of efforts to develop quality management protocols for the export of mangoes to the European market illustrates the difficulties of accessing integrated technical backstopping support from clusters of public agencies (for detailed discussion see Hall et al. 2001; 2002a). In these efforts the main research task was to develop a controlled atmosphere (CA) container sea-shipment regime suitable for Indian mangoes. The research, however, also included the development of improved pre-and post-harvest practices at farm and packhouse level in order to improve fruit quality throughout the whole of the supply chain. The focus of this work was Vijaya, a fruit growers' association in Andhra Pradesh. Vijaya received assistance from the Agricultural Processed Products Export Development Authority (APEDA) and an international donor. This support involved APEDA setting up a series of contract arrangements with relevant organizations from the Indian Council of Agricultural Research (ICAR), the Council for Scientific and Industrial Research (CSIR) and the Horticultural Department of the local State agricultural university, Dr Acharya N G Ranga Agricultural University (ANGRAU). These organizations then worked with Vijaya to develop and test the CA protocol along with other supporting pre- and post-harvest quality management measures. The ICAR institute dealt mainly with pre-harvest pest management issues; the CSIR institute undertook experimentation on controlled atmosphere storage regimes; and the university department advised on packhouse management.

Trial shipments took place over a period of 3 years. However, consistent problems encountered with the quality of fruit exported led to an evaluation of the export protocol and technical backstopping provided. Individually the quality management recommendations were technically robust. However limited interaction with farmers and packhouse operators in the development of recommendations resulted in practical difficulties in implementing these recommendations. This was part of a broader concern over the client focus of the contracted agencies. The scientists involved in the work came from organizations where it was unusual to work directly with farmers or in a commercial environment. As a result they had not developed skills in doing this and there were no incentives for them to do so.

Another problem was that quality management measures were not devised and implemented in an integrated way across the supply chain. This resulted from the fact that pieces of useful and mutually supportive technical expertise were located in different organizations that were governed by two different research councils. Scientists from each organization were contracted independently to work on individual components of the quality management problem. Vijaya was then left (unsuccessfully) to ensure that these component technologies and practices operated effectively together. This was particularly apparent with attempts to deal with anthracnose, a quality-related disease that needs to be tackled with an integrated pre- and post-harvest approach.

The notable feature of the Vijaya case is that even where interactions between a farmers' organization and public R&D capability can be created through

contracting arrangements, the ability of individual research organizations to assist is restricted by current institutional arrangements. Not only is there strong disciplinary segregation within ICAR, but different research council affiliation also tends make integration difficult. Normal working practices in these organizations, which tend to be quite rigid, also make the development of more integrated research arrangements difficult. While growers associations have the potential to form the hub of networks of organizations working towards improving post-harvest systems, ways of making scientist accountable in broad-based partnership arrangements such as this is clearly an area that needs much greater attention.

If innovation in a general sense was restricted in this example, what were the prospects for pro-poor innovation? In this case even though mango growers were (rather euphemistically) referred to as 'poor farmers', the reality was that those involved in the export shipment trails were inevitably large-scale, non-poor producers. It was this group that dominated the farmers' association involved, even though the majority of members were genuinely poor households whose livelihoods depended to a large extent on mango production. The key stakeholders in this intervention were willing to continue the rhetoric of pro-poor focus as this was a stipulation of the donor supporting some of the work. Dominant (and perfectly legitimate) stakeholder agendas included: mango export promotion; accessing high-value export markets; accessing technical expertise; developing (and having ownership) of new post-harvest technology and other research products. The staff of the donor agency and scientists implementing research on its behalf did not fully investigate stakeholder agendas until much later in the research process, by which time it was probably too late to make any difference. By ignoring this important institutional context, not only was innovation in a general sense impeded, but more importantly it was almost a forgone conclusion that pro-poor innovation would not take place.

2. Working through others: supporting innovation through managing relationships

This case describes a novel intervention that a non-governmental organization (NGO), IDE India [IDE(I)] has developed to establish technology development, production and supply systems (for detailed discussion see Clark et al. 2003). The approach developed over the last decade involves identifying market demand for technology, identifying and where necessary developing or adapting suitable technology and establishing retail networks to produce, distribute, and sell it to the poor [IDE(I) 2003]. Once the system is established IDE(I) then withdraws. This approach has been applied with great success in the small-scale irrigation sector. This case discusses the application of the approach to the post-harvest sector.

IDE(I) began its work on post-harvest systems by making an assessment of issues relevant to small-scale producers in the Indian hill state of Himachal Pradesh, an area were it was already working. It found that for farm households with limited land, out-of-season tomato production is a critical livelihood strategy. Using family labor, cultivating tomatoes on 0.25 ha can earn each family about US$ 2000 per season. This level of income is far higher than from any other type of farming in the area and has raised farm families well above the poverty line.

However IDE(I) also found that recent changes in environmental policy banning tree felling, while clearly needed, threatened this livelihood option. The reasons for this were that tomatoes were packed in wooden boxes for transport to the lucrative Delhi market. Without an alternative packing technology, tomatoes could only be sold in the local market and IDE(I) estimated that farmers would lose 70% of their income. The focus of IDE(I)'s intervention was therefore to develop an alternative packaging technology for tomatoes and to establish retail systems to supply the technology to farmers.

It was realized at an early stage of the intervention that, other than its expertise in identifying a technology demand, IDE(I) had no relevant skills in the area of post-harvest. As a consequence a decision was taken to implement the intervention by working through others. IDE(I)'s main role then became one of identifying appropriate partners and managing the relationships with and between them. This required some partners who could help in developing alternative packaging technology and others who could help establish packaging production and supply systems. The process of actually doing this was to some extent intuitive, although IDE(I) naturally tended to partner with organizations with shared interests and philosophies. Another important aspect of this partnering process was the way IDE(I) chose to work with organizations with whom it had already established a relationship in the past and whom it felt it could trust.

In this way IDE(I) linked into what turned out to be four different sets or networks of partners that were required to make its intervention succeed.

- **Technology network.** This consisted of scientists from the Indian Institute of Management, Ahmedabad (IIMA) who were working with a cardboard carton manufacturer with a design studio. The scientists and their industry partners had already been developing cardboard carton packaging of horticultural produce and were willing to design and test packaging for tomato transport from Himachal Pradesh to Delhi. This involved a major field and transportation trial. The adaptive development of the carton went through four generations before an appropriate design was arrived at.
- **Local knowledge network.** A local grassroots non-governmental organization (NGO) was identified that had already established a relationship with farmers and self-help groups. These groups formed the focus for the adaptive trials of the cartons. They subsequently took a lead in pre-financing the manufacture of cartons. The local state agricultural university was contacted for information on local crop production systems.
- **Market network.** This included all those linking farmers to the Delhi market, including transporters, commission agents, wholesale traders, and the farmers themselves. This market network was important, as these were the people who would have to accept and use the cartons in their transactions. They had to be willing to promote their use.
- **Production and distribution network.** This consisted of local carton manufacturers in Himachal Pradesh and box traders who originally supplied farmers with wooden boxes. It was important to partner with such organizations as these would form the backbone of the supply and distribution chain for the new carton. A micro-finance institution was also an important part of this network as to establish the first commercial production of cartons a loan was needed to pre-finance local carton manufacture.

By the end of the third year of this intervention 30,000 cartons were produced on a commercial basis and sold to tomato producers. A recent donor-sponsored poverty relevance review (Underwood 2002) of this intervention concluded that: 1. its impact would be inclusive of the poor, i.e., both the poor and the non-poor would benefit from the intervention; 2. it addressed gender concerns in the sense that it recognized that women rather than men suffered the drudgery of existing package technology (making wooden boxes); and 3. it addressed the enabling environment of the poor by reducing their vulnerability to policy changes – in this case environmental policy related to raw materials for packaging.

This case suggests the following principles that seem to have led to changes in post-harvest systems and that have been relevant to the livelihoods of small-scale farmers:

- Recognition that formal R&D was only one of a series of related tasks required to bring about change
- That their range of tasks involved required a group or network of partners each with specific skills. One of the main roles of IDE(I) was to identify these partners and involve them in the intervention
- Choice of partners was important as they needed a perspective and orientation that allowed them to work with and include farmers in the part of the intervention for which that partner assumed responsibility
- IDE(I) relied on partnerships with organizations with whom it had already established a relationship and built up trust. Actively managing and nurturing these relationships was a key part of IDE(I)'s role in this intervention
- The approach IDE(I) adopted was experimental, with lessons learned from establishing technology supply systems in the small-scale irrigation sector being adapted to post-harvest issues.

3. Institutional innovation in response to technology needs

Like the Vijaya case study, the Maharashtra State Grape Growers Association (Maharashtra Rajya Draksh Bagaidar Sangh [MRDBS]) and the linked Mahagrapes concerns a private enterprise that is founded on the farmers' association and co-operative model. However in contrast to Vijaya, MRDBS has been established for over 20 years and approaches to solving some of the technology-input problems experienced by Vijaya have been overcome. The key feature of this case study is the way institutional arrangements have evolved over time in response to market factors and opportunities, and the associated need for new technology that farmer members required to benefit from these opportunities. The sequence of events was as follows.

Phase 1. The growers' association, MRDBS, was established by farmers in the 1960s as a mechanism to support members producing and marketing grapes in the domestic market. During the 1970s MRDBS sought technical advice from scientists from the Indian national agricultural research system (NARS) and from scientists overseas. This allowed the introduction of improved grape varieties that were further developed and selected by the farmers themselves. This combination of prescriptive technical advice from the NARS, and the adaptations and innovativeness of farmers, increased production of grapes to the extent that by 1985 the domestic market was over-supplied and prices were slumping.

Phase 2. In response MRDBS encouraged the formation of co-operatives to assist with marketing. Simultaneously a number of enterprising farmers began to explore export opportunities in the UK and Europe and the Middle East. It was apparent that significant export markets did exist. As a result exports started on an ad hoc basis. From previous experience with the NARS, MRDBS was aware that suitable post-harvest technology was not available in India to allow the shipment of grapes to European markets. Some of the MRDBS farmers imported cool chain technology from USA.

Phase 3. With the potential of significant export markets becoming apparent, grape growers saw the need to create an institutional structure to handle grape exports. The result, Mahagrapes, was created from the grape growers co-operatives already established by MRDBS. Mahagrapes was given the mandate to: locate internationally acceptable quality grapes from growers, identify lucrative foreign markets, and access and develop pre-cooling and storage facilitates using imported technology. Mahagrapes went through a process of learning in export marketing, with initial failure in the Middle East, and subsequent success in European and Far-Eastern markets.

Phase 4. At the same time that the functions of Mahagrapes were being developed (predominately the export and post-harvest aspects), MRDBS was strengthening its arrangements to support farmer members. A well-equipped laboratory was established at Pune, with regional branches, to undertake routine analysis of soil, water, cuttings, etc. These centers also provided advice and demonstrations to members. Subsequently an R&D wing was established mainly to work on grape production problems and matching varieties and grape quality with international market needs.

Phase 5. Having established such facilities in response to gaps in public-sector provision, the public sector itself then began to recognize the importance of MRDBS and its facilities. The R&D wing was formally recognized by the Science and Technology (S&T) Division of the Government of India. The local agricultural university at Rahuri granted affiliated status to MRDBS. The State government allocated land to MRDBS to conduct research. APEDA appointed a full time coordinator for grapes to work within the structure of MRDBS with the role of promoting grape production and export, with a specific focus on technical support. It is interesting to note that APEDA, a public-sector body, chose to implement grape extension and promotion through a private organization rather through its own regional office or through existing state level extension services. The final response of the public sector has been to establish a National Centre for Grape Research under ICAR in the buildings of MRDBS.

The MRDBS case is a story of the way that partnerships form and change in tandem with the institutional arrangement needed to sustain them and the way, in turn, this occurs in response to changing technology needs associated with new markets. MRDBS' initial partnerships were with the NARS. As its technology needs (required for export markets) outpaced those available from the NARS, MRDBS formed new alliances with foreign sources of technology. At the same time it created its own new institutional structure to deal with export markets and the acquisition and application of the required technology. As MRDBS' own technical skills developed it became less reliant on these partnerships with foreign

technology suppliers. The final partnership has once again been with the NARS, presumably as the latter viewed the structure put in place by MRDBS as an effective mechanism for delivering public research and extension services to the grape sector.

Key points here are that the technological developments that led to economic changes (of farmers) were the result of a dynamic process, of which institutional evolution played a fairly significant role. Partnerships were important, but it was the ability of MRDBS to form and dissolve partnerships as circumstances dictated that was key to the whole process. The institutional flexibility, not to mention the foresight to do this, suggests that change and the ability to change is a central component to partnership approaches.

Donor response and a new approach to research management

The case studies described above provide contrasting examples of the way innovation processes can work. In the first case that is probably representative of many interventions, despite the existence of scientific and entrepreneurial expertise, and a clear definition of the main tasks to be achieved, the program was unable to succeed. The reason for this was weakness in the innovation system of which the mango intervention formed part. Partially this weakness resulted from missing or ineffective linkages between different pieces of scientific expertise. But it also concerned the poor integration of this expertise into the broad task of bringing about innovations in the quality management systems of mangoes and the need to work with technology users and other stakeholders. The underlying bottlenecks were institutional in nature – i.e., the behavioral and procedural norms of the organizations involved and the inability to adapt ways of working to match the circumstances associated with establishing a mango quality management system. The endeavor finally failed.

The second case is quite different. Not only does it include a mechanism for forging linkages between the different parts of the innovation systems, it also recognizes the importance of relationships between different partners. In fact IDE(I) go so far as to identify the management of relationships as a key task. Another aspect of this is the explicit choice of partners that have the orientation and perspective to work with small-scale farmers and poor rural communities. As the innovation systems framework would also suggest, these findings point to the importance of engaging with the institutional context of R&D. Such findings also emphasize the need to view R&D as part of a larger set of related activities.

The third case study presents a mature set of developments that have unfolded over a 20-year period. The case is useful as it demonstrates that opportunities emerge and circumstances change and that this often places new technological demands on organizations. Instead of standing still, the case of MRBDS shows how institutional changes have been used to cope with and take advantage of external shocks and opportunities. This has involved new partners, new organizational structures and new operational strategies. The critical point however is that it was the evolutionary, learning-orientated capacity of the organization that allowed it to exploit post-harvest technology in productive ways.

But how can these ideas operate in research management? In the remainder of this section we describe the way these perspectives have been adopted by the UK Department for International Development (DFID) Crop Post-Harvest Programme (CPHP), first in its regional program in South Asia and later across its global program.

Learning and innovation in post-harvest research management and practice

CPHP is one of DFID's 10 centrally managed natural resources research programs. It commissions research on technology development and promotion and policy related to the post-harvest sector. CPHP focuses its work in four regions, namely, East Africa, West Africa, Southern Africa, and South Asia. The discussion below relates principally to developments in the South Asia Regional Program since 1995.

The CPHP (as a global program) began as a fairly conventional post-harvest research initiative. The program commissioned mainly technology development projects relying on disciplinary research on storage, processing, physiology and marketing systems economics. An output to purpose review of the program in 1997 (Altshul 1998) revealed that many of the projects were achieving their technological objectives, but few were making an appreciable impact on the livelihoods of poor people. Around this time CPHP's South Asia program was involved in the mango export work discussed in the earlier case study. As it became increasingly clear that it was the institutional context of research and technology development that was affecting impact and effectiveness, the program began to commission studies to investigate this context. These studies were both empirical and conceptual, developing detailed case histories as well as exploring the innovation systems framework as a way of investigating institutional issues.[7]

Emerging from work in South Asia, and in the other CPHP regions was the recognition that partnerships of various types were becoming important, particularly those involving partners who were not from public-sector research organizations. It seemed that project leaders had responded to the need to focus on the 'uptake' pathways for their findings by involving a wider range of partners in their project. As an initial response, CPHP appointed a consultant to advise on partnership issues. Subsequently CPHP commissioned a formative review to help it develop program strategy on these issues. The review highlighted the central importance of understanding the nature of partnerships and the institutional context that shapes them. As a way of managing this more effectively, it recommended that the innovation systems framework be used as the guiding principle across the whole of the CPHP (Biggs and Underwood 2001). The global CPHP adopted this recommendation and used it as the central theme in the proposal that it presented to DFID explaining how it planned to implement the CPHP in its final phase, 2002–5. CPHP refers to this as the 'coalitions approach'.[8] This new approach has a number of implications.

7. This has produced a large body of literature including: Hall et al. 1998; 2000; 2001; 2002a; 2002b; Clark 2002; Sulaiman and Hall 2002.

- **The adoption of an explicit capacity development agenda for research.** The program and project purpose[9] address changes in the way innovation systems operate. This is stated by CPHP as 'post-harvest innovation systems respond more effectively to the needs to the poor'. This means that the key measure of the success of projects relates to changes in the research and innovation process, rather than direct impacts on the livelihoods of poor people (although these may also take place during the life of the project). There are a number of aspects to this capacity. Partially it relates to the networks of partnerships and relationships and how useful these are – this will be a key indicator to be mapped and monitored in projects to judge progress and make mid-course corrects, and where needed, strengthening links. This capacity also relates to the wider institutional context that governs these relationships (see next point).
- **The delivery of both technical and institutional innovations from research.** Inherent in the stated purpose of changing the way innovation systems operate, is a much greater emphasis in projects on the different sorts of actor involved in projects and on the types of relationship between them. Underlying this emphasis is the belief that innovations relevant to poor people are the result of the learning emerging from the right networks of individuals and organizations working together in certain ways. These 'certain ways' are the rules, norms, or routines that make interaction both productive and pro-poor and which are referred to as institutional arrangements or context. The implication for research projects is that it is important to explore the partners to be involved in projects, the roles played by different actors, the nature of institutional arrangements and the way these are changing. The CPHP views this institutional knowledge of as equal importance to technical knowledge and has asked projects to deliver outputs[10] relating to institutional arrangements.
- **The use of an action research approach.** As implied by the last point above, the emphasis on getting the right partners together and getting them to work in a certain way implies a new research task where the focus of investigation is the nature of the research and innovation process itself. Therefore the **way** of doing things and the **outcomes** of doing these things is unknown and unknowable at the beginning of the project (although such broad aims as supporting the post-harvest systems of poor tomato producers will remain constant, the question is how to achieve it.) Furthermore, because projects are trying to find **ways** of doing things there is iteration between **outcome** and **way**. A project does *x* and *a* happens, therefore the project tries *y* to see if *a+1* will happen. In this way monitoring the cause and effect of **ways** and **outcomes** becomes a central project management tool for evolving new ways of strengthening post-harvest innovation systems. It is for these reasons that an action research orientation has been suggested for CPHP projects so that they can learn, adapt, and evolve en route.

---

8. The term partnerships for innovation is used to describe the program's strategy to implement this approach.
9. The purpose is the overarching objective statement in the logical framework, the main planning tool of the CPHP and its projects.
10. Outputs are the deliverable products of a project that managing partners of projects are responsible for producing.

Policy implications of post-harvest innovation systems

We began this paper by arguing that the idea of an innovation system provides a useful conceptual framework for understanding the institutional context of R&D as part of the larger process of innovation. We went on to suggest that that this is particular relevant to the post-harvest sector where relationships, roles and agendas are often complex and contested. Our case studies illustrate how this analysis can reveal the reasons for failure; how managing the institutional environment as part of total systems concept can lead to success; how learning and evolutionary process can be a central elements of the capacity of innovation systems; and the implications for implementing this in research programs. Flowing from this experience, are a number of broad principles that seem to be relevant to post-harvest research in developing countries, particularly where poverty reduction concerns are paramount.

Firstly, success of research projects seems closely related to the characteristics of the partnership grouping or coalition that emerges or is developed around a particular problem area. Almost by definition this coalition needs to be predominantly made up of local partners. Only in this way can projects understand and respond to local institutional contexts. Assumptions about the roles of partners in the coalition have to be made explicit from the start and reassessed as the project proceeds. Similarly, roles will evolve as projects evolve. Revealing and managing the historical and institutional context of these partnerships is an important element of project design and implementation.

The second related point concerns what **is** the most appropriate partnership grouping? We would argue that this is an empirical question that cannot realistically be answered at the outset of a project, at least not in a definitive sense. The implication of this is that projects would benefit from an action research orientation allowing partners to join during the project when it becomes necessary. Currently, projects often have no systematic ways of assessing the types of partnerships and relationship require either at the project design stage or during the life of the project. The mango case was an example of this deficiency, whereas the grape case demonstrated the usefulness of creating new partnerships to deal with emerging circumstances.

The related implication of an action research orientation is that the process and institutional lessons associated with technological success in projects are valid project outputs and are often innovations complementary to the new technical knowledge that projects produce. The NGO case study on tomato packaging is a very clear example of this – it had developed and evolved an approach that could be used elsewhere. Furthermore this approach is developing and evolving along the way in its new area of application. Disseminating these institutional innovations must surely be as important as disseminating their technological counterparts.

Thirdly, where a poverty focus is paramount, stakeholder analysis is needed to ensure that this agenda is promoted within the coalition. The mango case typifies how easily the competing agendas of different stakeholders can subsume a poverty focus. The relationship of the coalition with the wider institutional context, the effects this has on patterns of relationship and the way agendas and priorities are identified and promoted needs to be made explicit from the start of the project.

The fourth point relates to the way projects are monitored. Monitoring projects for direct impact makes little sense from a day-to-day project management perspective. A useful alternative is monitor behavioral changes during the life of the project that support such implementation goals as poverty relevance, effective partnerships, and consensual and inclusive processes.

The implication of this need to focus on behavioral changes in post-harvest innovation systems is that much greater emphasis needs to be placed on the capacity-development effect of research projects. By this we do not only refer to building up stocks of research infrastructure and trained scientists, but also to the development of the collective capacity of networks or systems of organizations to learn and innovate in ways that support the current development agendas. It is perhaps this last point that forms the critical message for development assistance agencies seeking to exploit post-harvest R&D in the cause of poverty reduction. Building up institutional knowledge on how to do this will only take place when R&D becomes more fully integrated into the broader task of innovation, and when policies and practices are in place that supports learning and institutional change.

Although these ways of thinking about the progress of 'scientific' projects may be new to those working in the conventional post-harvest research arena, a well developed set of tools that can help scientists deal with the contextual setting of their work already exists. Examples include, stakeholder analysis (see Grimble and Wellard 1997) and the actor linkage matrix (see Biggs and Matseart 1999). Such tools could help introduce an innovation systems orientation into research projects.

Conclusions

Post-harvest innovation is a critical area of international development that could support the poor in many ways through: production, employment, value addition, and cheaper, safer food. This will only happen, however, if post-harvest innovation systems are strengthened. In part this concerns encouraging linkages, connections, and learning processes, but it also concerns ensuring that the institutional context of these endeavors is managed in ways that ensures that innovations are pro-poor. These linked tasks are challenging but essential. The innovation systems framework could be a useful starting point in this task.

Endnote

This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID [R7502: Crop Post-Harvest Programme]. A shorter version will be published as Hall A J, Rasheed Sulaiman V, Yoganand B, and Clark N G. 2003 (in press). Post-harvest innovation systems in South Asia: research as capacity development for pro-poor impact. Outlook on Agriculture 32(2): 19–26.

References

Altshul H. 1998. Output to purpose review of DFID's Crop Post-Harvest Programme. Chatham, Kent, UK: Natural Resources International Limited. 54 pp.

Biggs S D. 1990. A multiple source of innovation model of agricultural research and technology promotion. World Development 18:1481–1499.

Biggs S D, and **Smith G.** 1998. Beyond methodologies: coalition-building for participatory technology development. World Development 26: 239–248.

Biggs S D, and **Matseart H.** 1999. An actor oriented approach for strengthening research and development capabilities in natural resource systems. Public Administration and Development 19: 231–262.

Biggs S D, and **Underwood M P.** 2001. Review of the Crop Post-Harvest Research Programme: partnerships and innovation systems. Aylesford, Kent, UK: Natural Resources International Limited. 20 pp.

Clark N G. 2002. Innovation systems, institutional change and the new knowledge market: implications for third world agricultural development. Journal of the Economics of Innovation and New Technology 11(1–2): 353–368.

Clark N G, Hall A J, Rasheed Sulaiman V, and **Guru Naik.** 2003. Research as capacity building: the case of an NGO-facilitated post-harvest innovation system for the Himalayan Hills. World Development 31(11) (in press).

Edquist C. (ed.) 1997. Systems of innovation approaches: technologies, institutions and organizations. London, UK: Pinter, Cassell Academic.

Freeman C. 1987. Technology and economic performance: lessons from Japan. London, UK: Pinter.

Grimble R, and **Wellard K.** 1997. Stakeholder methodologies in natural resource management: a review of principle, contexts, experiences and opportunities. Agricultural Systems 559(2): 173–179.

Hall A J. 2002. Innovation systems and capacity development: an agenda for North-South research collaboration? International Journal of Technology Management and Sustainable Development 1(3): 146–152.

Hall A J, Sivamohan M V K, Clark N, Taylor S, and **Bockett G.** 1998. Institutional developments in Indian agricultural R&D systems: the emerging patterns of public and private sector activity. Science, Technology and Development 16(3): 51–76.

Hall A J, Clark N G, Rasheed Sulaiman V, Sivamohan M V K, and **Yoganand B.** 2000. New agendas for agricultural research in developing countries: policy analysis and institutional implications. Knowledge, Technology and Policy 13(1): 70–91.

Hall A J, Sivamohan M V K, Clark N, Taylor S, and **Bockett G.** 2001. Why research partnerships really matter: innovation theory, institutional arrangements and implications for the developing new technology for the poor. World Development 29(5): 783–797.

Hall A J, Clark N G, Rasheed Sulaiman V, and **Taylor S.** 2002a. Institutional learning through technical projects: horticultural technology R&D Systems in India. International Journal of Technology Management and Sustainable Development 1(1): 35–48.

Hall A J, Rasheed Sulaiman V, Clark N G, Sivamohan M V K, and **Yoganand B.** 2002b. Public–private sector interaction in the Indian agricultural research system: an innovation systems perspective on institutional reform. Pages 156–176 *in* Agricultural research policy in an era of privatization: experiences from the developing world (Byerlee D, and Echeverria R G, eds). Wallingford, Oxon, UK: CAB International.

Hayami Y, and **Ruttan V W.** 1981. Agricultural development: an international perspective. Baltimore, USA: Johns Hopkins University Press.

IDE(I). 2003. Annual Report 2002. New Delhi, India: International Development Enterprises, India [IDE(I)].

Lundvall B A (ed.) 1992. National systems of innovation and interactive learning. London, UK: Pinter. 161 pp.

Lynam J K, and **Blackie M J.** 1994. Building effective agricultural research capacity: the African challenge. Pages 106–134 *in* Agricultural technology: policy issues for the international community (Anderson J R, ed.). Wallingford, UK: CAB International.

Rogers E M. 1983. Diffusion of innovations. 3rd ed. New York, USA: The Free Press. 142 pp.

Roling N. 1986. Extension science: increasingly preoccupied with knowledge systems. Socilogica Ruralis 25: 269–290.

Roling N. 1994. Agricultural knowledge and information systems. Pages 56–67 *in* Extension handbook: processes and practices (Blackburn D, ed.). Toronto, Canada: Thompson Educational Publishing.

Sulaiman R V, and **Hall A.** 2002. Beyond technology dissemination – can Indian agricultural extension re-invent itself? Policy Brief no. 16. New Delhi, India: National Centre for Agricultural Economics and Policy Research (NCAP).

Underwood M P. 2002. Annual poverty relevance review of DFID's Crop Post-Harvest Programme projects in South Asia – 2002. Patancheru 502 324, Andhra Pradesh, India: CPHP South Asia Regional Co-ordination Office. 37 pp.

The evolving culture of science in the Consultative Group on International Agricultural Research: concepts for building a new architecture of innovation in agri-biotechnology

A J Hall,[1] B Yoganand,[2] and J H Crouch[2]

Abstract

The Consultative Group on International Agricultural Research (CGIAR) needs to respond to the wider implications of biotechnology in the way it conducts its research. This involves an evolving role and important institutional developments. Critically the CGIAR needs to forge a new relationship with the private sector, to gain access to proprietary technologies, and as a delivery mechanism for its own research products. This in turn suggests the need to build intellectual property management skills and business-orientated perspectives, previously under developed in most CGIAR centers. At the same time the CGIAR must visibly engage in and promote a debate that helps quell public unease concerning the use of new technologies in the production of food crops. And this must all be achieved within the loudly proclaimed mandate of poverty reduction and development. Using the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) as an illustration, this paper explores recent innovation systems thinking and associated planning tools as possible ways of helping the culture of international agricultural science evolve in useful ways. While institutional change has certainly begun, there is still much distance to travel.

Introduction

Innovations and impacts from research in the life sciences and from biotechnology in particular, are increasingly dependent on new groupings, alliances, and relationships both within science, and between science and business. In Europe and the USA, for example, the boundaries between public and private sectors are becoming increasingly blurred as both private companies and national governments recognize the economic importance of knowledge and the need for greater collaboration in its production and use. This new architecture of innovation has emerged in the developed world for a number of interrelated reasons:

- Advances in the biosciences that have both economic and social relevance, particularly in health and agriculture
- The new possibilities that this presents for ownership of biological materials and processes, coupled with strengthening intellectual property regimes
- The changing role of the state and the emergence of the market as a major decision-making institution
- A growing understanding of the importance and role of new knowledge and innovation in economic development
- An increasing focus on innovation policy and the associated need to encourage greater connectivity between scientific and entrepreneurial elements in national innovation systems.

1. University of Greenwich, UK, seconded to International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India
2. ICRISAT

These same issues and possibilities are starting to increasingly impinge on developing countries. While there is little doubt that biotechnology has enormous potential to make a significant contribution to poverty reduction, this will not happen through market mechanisms alone. As Byerlee and Fischer (2002) point out, while the private sector is the major global player, investing US$ 2.6 billion in agricultural research and development (R&D), only modest private investments are taking place in the developing world. Furthermore, these investments tend to be in such niche areas as hybrid vegetables and cereals plus spill-overs from their investments in major global commodities such as soybean and cotton. Social commentators such as Scoones (2002a) suggest that the political economy of the biotechnology industry in developing countries – both local start-up companies and multinational corporations – is such that the poor are unlikely to benefit from biotechnology unless there is specific public policy intervention in this arena.

Other groups fear that the risks from biotechnology are unacceptable and that the public should not be exposed to technologies and products that are derived from it, particularly genetically modified organisms (GMOs). Innovation analysts such as Clark et al. (2002a) suggest that biotechnology will fail to impinge in developing countries unless biotechnology capacity is developed locally. This often has less to do with numbers of trained scientific personnel and instead concerns greater connectivity within national innovation systems including partnerships within science, between science and public policy, between the public and the private sectors, and between science and society in general.

The emerging view is that the public sector must simultaneously continue to invest in R&D while seeking alliances with the private sector. At the same time it must engage in policy and regulatory issues that protect and promote the agendas of the weaker sections of society. The international community and particularly the Consultative Group for International Agricultural Research (CGIAR),[3] has a unique role in this process in its operational countries. However, it must first give careful consideration to the ways in which it approaches this task bearing in mind its own research-for-development goals. For example:

- How does the CGIAR initiate and evolve relationships with, the private sector and advanced research organizations?
- How does it ensure public access to proprietary (privately owned) technologies and processes?
- How does it maximize the public good nature of innovations jointly owned with the private sector?
- How does it negotiate new partnerships that ensure that all stakeholders including the poor stand to gain?
- How does it constructively engage in issues of public acceptance of biotechnology, simultaneously promoting new technology and protecting society from the unknown?
- How does it reach consensus with stakeholders on research priorities?
- How does it engage and build capacity in national and international policy processes relevant to exploiting biotechnology for pro-poor development?

3. The CGIAR (established in 1971), is an informal association of public and private sector members that supports a network of 16 international agricultural research centers. It is managed and core funded by the World Bank.

These questions are part of the wider issue concerning how to integrate the CGIAR's work and agenda into that of others working across the science – development continuum. Byerlee and Fischer (2002, quoting Morris and Hoisington 2000) make the point that while the CGIAR has focused on biotechnology R&D capacity development (its own and in its public partners in developing countries) it has paid less attention to the operating environment necessary to nurture the use of biotechnology. So, for example, the CGIAR has invested little in strengthening capacity in policy and regulatory issues related to the deployment of biotechnology products, and has shied away from active participation in public dialog surrounding transgenics (Byerlee and Fischer 2002), (although more recently a system-wide Biotech Awareness and Biosafety Support Unit have been established). It is clear that not only do these challenges need to be faced, but that there is also a strategic value to knowledge that deals with ways of enabling innovation in these new, dynamic, and complex relationships and institutional environments.

What conceptual and policy tools does the CGIAR have to assist it in its struggle with the policy and implementation questions associated with biotechnology? In the main the answer is very little. What it has are scarcely more than the neoclassical tools of research priority setting and rather simplistic notions of public and private goods and services. This lacuna is made all the more remarkable by the fact that there is a well developed set of concepts and tools available to help guide thinking on these issues. For inspiration one only needs to look at contemporary science and technology (S&T) policy as practiced in many of the Organization for Economic Co-operation and Development (OECD) countries. There, as the old world order of public-sector, science-led economic growth has been eclipsed by more complex circumstances, so too the approaches to S&T policy have changed. Our main argument is that ICRISAT and the CGIAR could usefully draw from this other, parallel policy paradigm. Of specific relevance is the ongoing analysis of innovation processes and the systems that support these processes (Hall et al. 2000). Not only has this allowed the debate to break out of the old linear paradigm of science-led innovation, it has also allowed a greater analysis of the institutional context that shapes research and innovation. In turn this has shed light on ways of planning this as an embedded process – i.e., a process that is specific to and shaped by context, task, stakeholders, and institutional arrangements.

This paper reviews some of this parallel policy literature and reflects on the developments and challenges that face ICRISAT and the CGIAR in general. In the empirical section the evolving of the culture of science at the Institute is discussed. The main argument here is that cultures and norms in science do change, and ICRISAT is adapting to the contingencies of the pervasive importance of biotechnology and the institutional and policy implications of this. In essence this is a story about the way CGIAR science is coming to terms with a new more interactive way of working with partners, particularly the private sector; the way new business and legal competencies are becoming essential to public science; and the way the role of organizations like ICRISAT is changing. Challenges lie ahead. These include the need for new governance structures with wider stakeholder participation and, closer to home, new incentive structures to encourage scientists to work in teams where conventional disciplinary and

institutional boundaries and hierarchies need to be replaced by new disciplinary groupings and working relationships required to exploit biotechnology effectively. The discussion section of the paper explores concepts and tools that may assist in this task. The paper begins by providing an overview of some of current issues in the biotechnology for development debate.

Biotechnology and international agricultural research

Promises and threats

Biotechnology and its potential to contribute to the developmental agenda of agricultural research has been widely debated for nearly two decades (see Sasson 1988; Klopenburge 1988). It has a number of technical and institutional features which distinguish it from conventional agricultural technology which means that its raises specific policy, ethical, equity, and scientific questions. There are four broad technical areas of biotechnology intervention for plant breeders:

1. **Genomics.** Diagnostic techniques that use an understanding of molecular biology to improve the speed, efficiency and precision of plant breeding while promising to address new goals not possible through conventional means.
2. **Tissue culture.** Multiplication techniques that allow rapid multiplication of disease-free planting material, embryo rescue techniques that facilitate the recovery of hybrids from crosses between different species, and, gamete culture techniques that allow rapid development of inbred material.
3. **Transgenics.** Genetic manipulation techniques that allow the transfer of genes from a wide range of sources, including across species. This can be used to introduce desirable characteristics that are either not possible through conventional means or with a greater degree of precision. This could be disease or drought tolerance, or such traits as herbicide resistance. This has been the subject of the greatest controversy in the eyes of the public particularly in view of the ability of these techniques to transfer genes into our food from exotic plant species, animals and even bacteria.
4. **Bioinformatics.** Computer-based techniques for structuring, accessing and analyzing huge collections of genomics data (primarily sequence-based data). It is these tools that are linking many biological disciplines that were previously somewhat isolated and thereby driving a paradigm shift in the way biological research and product development are carried out.

The majority of techniques for gene transfer, and many of the most widely used genes in current transgenic varieties, are owned by private companies, mostly the few large multinationals that dominate the field. The reasons for this relate both to the high research costs of biotechnology which are often beyond the resource of the public sector and, of course, the novel possibilities for profitable business ventures that the private sector perceives to be possible as a result of the new technologies. Almost all transgenic varieties are privately owned, again mainly due to the extremely high cost of the biosafety testing required prior to government approval for commercial production. Public research organizations, including the CGIAR are, however, developing transgenic material using genes from a variety of sources: licensed, donated or acquired from the private sector, or generated through publicly funded research.

Risk, uncertainty and the public debate

While the arguments concerning the ability of biotechnology to provide agricultural technology for the world's poorest are well rehearsed in the specialist literature, there are also well recognized risks and uncertainties that are rarely given much air time in scientific conferences. These include both those associated with the contained use of biological processes and intermediate products in laboratories, as well as the risks and uncertainty of the impacts of products when released into the environment (Essebgey and Stokes 1998).

The real difficulty is that quite often there is scientific uncertainty of potential outcomes, i.e., there is not enough prior knowledge to determine the probability of an outcome or impact. While it has always been recognized that technological interventions are associated with a certain degree of risk, conventional ex-ante methods of assessing this risk, such as social cost/benefit analysis, are less useful in the case of biotechnology. This is because scientific uncertainty, brought about by rapid technological and institutional change of the evolutionary type associated with biotechnology does not have the stable parameters required to make ex-ante judgments dependant on a set of reliable assumptions and probabilities.

This may seem a rather esoteric point, but its implications are at the heart of current public controversy over, for example, GMOs. It means that the concept of objective scientific risk assessment no longer necessarily holds true. Furthermore, a number of high-profile incidents that have called into question scientific objectivity, have further undermined public trust (Tait 2001). Another perspective in this debate maintains that the public in general has little comprehension of the relative risk of, for example, walking down the road, or catching malaria whilst on holiday as compared to developing a life-threatening condition from eating transgenic food. This line of reasoning maintains that powerful lobbies with wide media coverage have convinced the public that they must be given absolute guarantees regarding the safety of transgenic food. Interestingly, if the same biosafety testing was applied to conventional foods, a very large proportion would probably be banned.

While some of the public debate has also been ignorant of existing scientific evidence, it has raised ethical objections which quite reasonably need to be factored into the decisions of risk and acceptability.

This concern over risk and uncertainty is embodied in the precautionary principle of the Rio Earth Summit Declaration (ref principle 15, the World Summit on Sustainble Development, 26 August – 4 September 2002, Johannesburg, South Africa). Little advice, however, is provided on ways of implementing it. Clark et al. (2002a) argues that specific decision tools are unlikely to play a useful role. Alternatively support is growing for the solution proposed by Tait (2001) who calls for a constructive dialog among all interested parties so as to clarify issues and reach a social consensus on all the underlying problems. While this is a useful suggestion ways of finding a common language to communicate issue in mixed groups of scientists and non-scientists remains a significant challenge.

The whole concept of risk is highly contextual, with society or groups in that society choosing what it wishes to identify as risk. This is further complicated by the presence and effectiveness of organized lobbying groups generating awareness of different risks and promoting different agendas based on various ideological

positions and other motivations. Examples of this in other contexts in North America include the tobacco lobby and the Pro-Life anti-abortion lobby. The Dark Green movement and the multinational corporations play a similar role in the context of biotechnology.

The way forward is therefore to help negotiate the choice societies make when facing uncertainty in response to the perceived risk to biotechnology. There will still be a need to manage the competition between different groups of stakeholders in their efforts to define risk according to their own world-views and to build trust in the regulatory process (Newell 2002). Instead of abandoning science, this consensus-building approach implies the need to recognize the limitation of science (as a decision tool) in a technological field that is evolving very rapidly. In addition, there is a need to define a more facilitative role for public policy in the regulatory process, strengthening links between science, society and the policy process. To make the same point differently there is no magic bullet solution to these dilemmas. What is required instead is a public policy response that creates a process which builds consensus between groups with different view points, and helps make transparent choices that can accommodate the diversity agendas that exist.

Winners and losers

There is a long history of analyzing the equity implications of technologies from international agricultural research (reviewed comprehensively by Lipton and Longhurst 1988). The debate surrounding the Green Revolution pivoted around those who saw the main task as one of increasing food production and those that saw the task as one of better access to that increased production and the contribution of agriculture to wider livelihood goals. Tripp (2000) argues that opponents of agricultural biotechnology for development have mainly been NGOs. The core of their opposition concerns their perception that: (i) there is a need for more emphasis on distribution of resources (mainly food) rather than creating better production technology; (ii) potential environmental and health risks associated with transgenic material through gene escape, toxicology and allergenic problems, and the potential increase in the use of agri-chemicals (through herbicide resistance for instance); (iii) an increased dependence on seed companies and a threat to farm-saved seed through new intellectual property regimes; and (iv) an abandonment of traditional techniques and biodiversity that have served farmers well in the past. Tripp argues that NGOs have little evidence to support their advocacy for low-input agricultural techniques, nor its appropriateness to evolving livelihood aspirations. Furthermore the advocacy on both sides of the debate seems to be founded on little empirical evidence of farmers' and consumers' perception about biotechnology in developing countries – although this is changing. A citizen's jury approach recently used in India (see Pimbert and Wakeford 2002), that purported to demonstrate farmer resistance to GMOs was dismissed by the director of one of the (UK) organizations involved as methodologically flawed.

Public–private sector partnerships

There are a number of credible concerns over the equity implications of the dominant private sector involvement in biotechnology (see for example Scoones

2002b). It is, for the reasons of prominence and ownership of technologies that the public sector will have to increasingly court private partners. This is particularly so for public plant breeding research which must increase interactions with the private sector in sharing biotechnology techniques and materials, most of which have been developed in the private sector (Tripp and Byerlee 2000). Hall et al. (2002) and many others argue that the public sector's relationship with the private sector needs to expand on a number of fronts that include, but go beyond, access to technology. This will include a range of relationships including: private distribution of public technologies; private purchase of public research services and technologies; public use and purchase of private materials, methods and services; and public–private research collaboration involving cost and resource sharing, including genes and protocols, business incubation, and various kinds of product and profit sharing. The complementary nature of the two sectors' assets is summarized in Table 1.

Table 1. Assets of public and private sectors in agri-biotechnology research

	Public sector	**Private sector**
National level research organization	National agricultural research systems (NARS)	Local seed companies
Key assets	Local diverse germplasm Local knowledge Breeding and evaluation programs and associated infrastructure Access to delivery systems including extension Upstream capacity (in more-effective NARS only)	Local knowledge Breeding programs and infrastructure Seed delivery systems Marketing network
Regional and global level organizations	CGIAR international centers	Global life science companies
Key assets	Diverse germplasm Breeding and evaluation programs and associated infrastructure Global germplasm exchange and evaluation networks Economies of market size Up-stream capacity in a few centers Mostly positive public image	Biotechnology tools, genes, and know-how Access to capital markets Economies of market size Skills in dealing with regulatory agencies Flexibility and speed in decision making

Source: Byerlee and Fischer 2002

Capitalizing on complementary assets and new types of arrangements will require new capabilities in partnering to help rapidly develop a range of public–private sector partnerships. Fischer (2000) suggests that regional networks of public research organizations may be required to strengthen their bargaining position and skills. These developments also raise a series of questions concerning the changing role of public research organizations and ways of ensuring that the developmental mandate of the international agricultural research centers (IARCs) is maintained. Tripp and Byerlee (2000) caution that while there is significant pressure to partner with the private sector as a resource mobilization strategy, this in itself will not improve the effectiveness of agricultural research unless it is guided by specific and relevant opportunities that private partners can provide.

Intellectual property management

The combination of the proprietary nature of much agricultural biotechnology and the related need to engage in new forms of partnership with the private sector means that public research organizations are going to have to deal with intellectual property (IP) issues. For example, Cohen et al. (2002) in a survey of CGIAR centers recorded 166 applications of proprietary research inputs. These included: selectable markers (44); promoters (35); transformation systems (29); insect-resistance genes (19); disease-resistance genes (11); genetic markers (10); diagnostic probes (3); others (15). The CGIAR as a whole adopted guiding principles in 1996 reaffirming that resources maintained in gene banks should be freely available and that legal protection (so called defensive patenting) of innovations would only be used where necessary to ensure that developing countries have access to new technology.

IP management expertise was established in the late 1990's on a system-wide basis within the CGIAR through the creation of the Central Advisory Service on IPR. Around the same time individual centers began to develop similar in-house expertise, with each center developing its own policy governing its products and the use of those of others. This is an area in which the CGIAR recognizes it will need to invest more resources as a response to the growing importance of legal issues in agricultural science (Tripp and Byerlee 2000). While Cohen et al. (2002) argue that the costs involved in developing a management capacity suggest a systems-wide approach there is evidence that individual centers are developing their own capacities and purposing a range of IP strategies to suit their own contexts and agendas. It is quite clear that IP is set to become an integral component of the use of biotechnology for development.

Capacity development in biotechnology

IARCs have historically played a large role in capacity-development efforts in their counterpart programs at the national level. This has included research infrastructure development and particularly training and human resource development. A capacity-building agenda also needs to accompany biotechnology. However these efforts need to be different in three respects. Firstly, biotechnology is likely to be more generic than previous scientific paradigms, where basic research capabilities will be relevant in both health and agriculture sectors. Secondly, capacity will be in both the public and the private sectors (currently more so in Asia, less so in Africa) and will involve both national companies and multinational corporations and NGOs. This raises challenges for conventional approaches that relied heavily on advanced training (often in developed countries) for public scientists.

The third difference concerns more fundamental questions about capacity-building approaches and the desirable characteristics of technological competence in national and international settings. Arnold and Bell (2002) and Velho (2002) argue that increasingly capacity development in development assistance programs needs to be thought of in total systems terms. That is to say that what is important is not the individual blocks of scientific expertise per se, but rather the way this links together and integrates with users of technology, including consumers,

markets, private industry, and policy processes in specific national contexts. This approach suggests that South–South partnerships will be an increasingly important aspect of capacity building – i.e., networking together local scientific, technical and entrepreneurial resources. The East African Bio-Sciences Initiative – a cross-sectoral clustering scientific organization related to agriculture and health – is an emerging example of this model. Developing total system capacity has its own challenges – even within individual organizations. Haribabu (2000), arguing that the problem can be as basic as getting molecular biologists to interact with plant breeders, suggests that divergent cognitive empathy is to blame.

Clark et al. (2002b) exploring a case of agricultural biotechnology capacity development in India, demonstrate the way these systemic capacities build up slowly over time. The role of the donor in this successful case was to provide the professional space to allow scientists and others to experiment with new institutional arrangements that promote learning and innovation in the area of biotechnology. In another exploration of this theme, Clark et al. (2003, in press) argues that developing countries often have well trained scientists, but lack the links with the policy process causing biotechnology policy in many countries to be extremely weak. Consequently enabling frameworks such as bio-safety and IP regimes develop slowly. This is revealed in the unduly cautious approach of some countries and this is restricting the rapid deployment of biotechnology advances (Paarlburge 2000).

Again this suggests that stronger connectivity between science and research users including policy makers is required. But it also requires an expansion of the professional mandate of both scientists and administrators in ways that promote a broader understanding of science. This needs to be tackled at many levels starting with the curriculum of tertiary education so that disciplinary expertise is coupled with an appreciation of the wider context of science in society. The CGIAR centers could play an important role in this more holistic vision of capacity development.

Frameworks for promoting new architectures of innovation

Linear and systems architectures of innovation

At the heart of the challenges that the CGIAR and ICRISAT face with respect to biotechnology is the implied need to embed technology and capacity development in a much broader set of relationships and contexts. The CGIAR is no longer the primary source of new knowledge in this field. Neither can it continue to rely on old architectures wherein which it independently develops research products that can then be usefully transferred to others. The challenge facing the CGIAR is to find new architectures to structure its relationships with a range of novel and conventional partners and stakeholders. And to do so in ways that best exploit frontier science for the good of society and particularly the poor.

This challenge is not unique to the CGIAR. Science and technology policy in many sectors around the world has faced the need to redraw conventional approaches to promoting economic and social development in an era of rapid technological and institutional change and increasingly complex techno-economic

systems. In response an important policy shift has been an increased emphasis towards promoting innovation rather than focusing on research alone. As distinct from research and invention, innovation is a much more complex process often requiring technical, social, and institutional changes, and involving the interaction of organizations across the conventional knowledge producer–user divide. Emerging as a useful way of thinking about this is the concept of an **innovation system** (Table 2 presents the way innovation systems thinking has emerged and the way the innovation policy with its focuses on the systems and processes of change has overshadowed the earlier science and technology policy preoccupations of resource allocation).

Innovation systems thinking

The origin of innovation systems thinking can be traced to the idea of a **national system of innovation** proposed by Freeman (1987), and Lundvall (1992). The concept brings together thinking from a broad set of theoretical debates[4] that view development and change in systems terms. More importantly it is based on empirical observations of 'good practice' in different countries and technology sectors. At its heart lies the contention that change – or innovation – results from and is shaped by the system of organizations and institutions (in the rules, norms and conventions sense) in particular locations and points in time. This system includes organizations involved with research and the application and adaptation of research findings, as well as intermediary organization that promote knowledge transfer. Lundvall (1992) identifies learning and the role of institutions as critical components of these systems. He considers learning to be an interactive and thus socially embedded process, which cannot be understood without reference to its institutional and cultural context, usually in a national setting.[5]

This has many analytical implications: the need to consider a range of activities and organizations related to innovation and how these might function collectively as a system; and the need to locate research planning in the context of the norms, culture and political economy in which it takes place, i.e., the wider institutional context. Similarly it is no longer useful to think of institutional and organizational arrangements for research and innovation as fixed or optimal – clearly these must evolve to suit local and changing circumstances. In the same way, the evaluation of innovation performance also becomes much more context-specific relating to the perspective of stakeholders and current imperatives, rather than either scientific peer review or economic justification alone. Douthwaite (2002) believes that these types of perspective hold true in technological contexts ranging from rice drying in South Asia to wind turbines in Europe and North America. He shows how innovative success is a complex process of learning and adaptation. The innovation systems concept is now widely used in the policy process in developed countries, but has only recently started to be employed in relation to research policy in the South (see for example, Hall et al. 2001; Byerlee and Alex 2003).

---

4. Edquist (1997) provides a useful review.
5. Gibbons et al. (1994) makes a broadly similar point in their much cited discussion of **mode one** and **mode two** production of knowledge.

Table 2. Innovation systems under changing paradigms

Period/ paradigms	Conception of science	Who produces scientific knowledge	Model of technological change	Policy framework and policy tools	Policy analysis and research evaluation tools	Model of North/South Cooperation[1]
Post-war period until beginning of 1960s Science as an engine for progress	Historically and socially neutral, follows its own internal logic	The Scientists (Republic of science)	Linear relationship: basic research, applied research, technological development, innovation, diffusion, economic progress and social welfare (science push)	Focus on science policy: large-scale science funding; allocation of resources through institutional normative mechanisms, scientific merit	Peer review (sooner or later the good science finds out its practical application. Input indicators	Problem-solving phase: find quick solutions to development problems through the use of human and financial resources of the Northern countries
1960s and 1970s Science as solution for problems (and also as cause of problems)	Disputes about the neutrality of science	The scientists (but they must be directed and put in contact with the demand)	Linear relationship (the same as above, but demand–pull)	Science policy and technology policy emphasis in resource allocation in terms of priorities (often by sector of activity) Science had to find a way to be used by technological development	Peer review plus output indicators (basically bibliometric) studies: role of S&T in economic growth; history of technology innovation at firm level	Developing indigenous capacities of **individuals** (problem-solving and research capacities) in the recipient countries
1980s and 1990s Science as a source of strategic opportunity	Science wars (dispute between realism and relativism/ constructivism)	Scientists directly influenced by a complex network of actors and its interests	Complex –includes several actors, a diversity of institutions and processes (Technological trajectory subjected to lock-in – somewhat deterministic)	Emphasis on resources administration and allocation to strategic programs, interdisciplinary and collaborative research (national, institutional and disciplinary level) alliances Technology policy	Intensification of the peer review process, program assessment (concern with the impacts), prospective and foresight	Generate new collaborative partnerships that benefit both sides, from supply-driven to demand-oriented (involvement of stakeholders by using participatory methods)
21st Century Science for the benefit of society (back to the Baconian ideal)	Socially and culturally constructed, national styles	Actor network composed by scientists and non-scientists-configuration varies according to each event	Complex multifaceted (technological trajectories reversible according to social choice)	Emphasis in co-ordination and management. Accountability, maintenance of an independent scientific basis. Innovation policy	Peer review + direct public participation (emphasis given to the process), scenario building with ample social participation - foresight	Learning in a sytems of innovation (SI) framework Co-ordination of donors, competitive funds for research and technology development (RTD)

1. This periodization is based on Gaillard (1998)
Source: Vehlo 2002

Applying innovation systems concepts

The innovation system concept therefore provides a framework for: 1. exploring patterns of partnerships; 2. revealing and managing the institutional context that governs these relationships and processes such as learning and change; 3. understanding research and innovation as a social process of learning; and 4. thinking about capacity development in a systems sense. On this last point, Velho (2002) observes that national systems of innovation, made up of actors that are not particularly strong, but where links between them are well developed, may operate more effectively than another system in which actors are strong but links between them are weak.

Increasingly emphasis is being placed not only on knitting together different elements of national innovation systems, but also on embedding the planning of such endeavors in a wider constituency than only key scientific stakeholders. While these undoubtedly do include the private sector both as an entrepreneurial agent as well as an R&D player, it also includes stakeholders representing wider society. As a result the innovation systems approach treats such issues as biotechnology not only as an issue of nurturing technical and entrepreneurial innovation, but also as developing an institutional and policy environment that mediates between or regulates the potentially conflicting agendas of the constituent stakeholders including society at large. While one could argue that national governments in developed countries have not always been entirely successful in their innovation policy efforts – witness the continuing polarization of the transgenic debate in western Europe – there is also evidence that such approach have potentially large economic advantage (OECD 2000).

Institutional learning and change and organizational culture

One of the important points that the innovation system concept makes is that institutional learning and change are key characteristics of organizations in effective innovation systems. This allows systems to reconfigure in an iterative way as organizations and their partners build up knowledge about ways of dealing with constraints or exploiting new opportunities. The emergence of biotechnology is a good example of an instance where institutional learning and change are required to reconfigure the relationship between different players in the innovation system – particularly between public and private sectors, but between science and society more generally.

Institutional contexts and cultures within organizations are an important determinant of the ability of organization to respond effectively to emerging challenges. Research managers planning the transition to new technological fields where multidisciplinary and partnership modes of working are required – such as biotechnology – need to pay much greater attention to the culture of their organization and the incentives it provides for the change process and new ways of working (Feller 2002). A key challenge is lowering barriers between disciplinary units, particularly where these have been the focus of measures of professional performance. Often the primary shift required is that from an inward-looking hierarchical mode of management that emphasizes administrative control, to one

characterized by 'adhocracy' that emphasizes flexibility in reporting relationships and external orientation (Cameron and Quinn 2000). Feller (2002) provides a useful typology (see Table 3) to help research managers assess their organizational culture and the possible changes required.

In the next section we shall see how the organizational culture of the CGIAR and the values that it implies have been a critical area of concern during its attempts to reconfigure itself into a new architecture of innovation more suited to the contemporary context of international S&T.

The evolution of international agricultural science

The history of the emergence of organized agricultural sciences in the form of national research programs and subsequently in the form of the international centers is well known. However the main points from this history are repeated because the patterns of institutional development explain many of the issues we are facing today.

To a very large degree the establishment of the early CGIAR centers reflected the prevailing political and ideological context of the time.[6] Anderson's (1991) discussion of the establishment of the International Rice Research Institute (IRRI) usefully demonstrates this. The origins of IRRI (and the International Wheat and Maize Improvement Center [Centro Internacional de Mejoramiento de Maíz y Trigo, CIMMYT]) stemmed from the funding of agricultural research by The Rockefeller Foundation and later the Ford Foundation. It was closely associated with an America foreign policy that saw that food security problems, particularly in Asia, could lead to political instability and the spread of communism.

The Rockefeller Foundation took the decision that the drive to increase food supply should be technology-led with yield per hectare as the key dependent variable. Complex issues associated with farm size, access to inputs, applicability and socio-economic relevance were placed to one side in order to focus thinking and resources on the one key objective, transforming agricultural productivity by means of improved germplasm. The focus was on so-called **isolable** technical problems[7] – **isolable** in the sense that they could be isolated from the socio-economic context of farmers and the political context of target countries. This dictated to large degree the central strategy of the early CGIAR centers. The strategy was science-led, with mission success depending on narrow-goal specification combined with rigid adherence to the best technological means of achieving the goal as quickly as possible.

The other notable feature of the of CGIAR centers was that they were set up at a time when it was quite reasonable to assume that the public sector would play the dominant role in supplying developing-country farmers with yield-enhancing technologies embodied in improved crop and livestock varieties. Indeed this belief was implicit in the relationship that many of the centers had with the NARS in the countries in which they were hosted. The CGIAR's primary partner was seen

6. For detailed discussion see Anderson (1991); Anderson et al. (1991); Reece (1998).
7. Anderson (1991) quotes the term **isolable** from contemporary Rockefeller Foundation archive material.

Table 3. The organizational culture profile

Flexibility and discretion

Internal focus and integration

External focus and differentiation

Clan Culture

A very friendly place to work where people share a lot of themselves. It is like an extended family. The leaders, or heads of the organization, are considered to be mentors and perhaps even parent figures. The organization is held together by loyalty of tradition. Commitment is high. The organization emphasizes the long-term benefit of human resources development and attaches great importance to cohesion and morals. Success is defined in terms of sensivity to customers and concern for people. The organization places a premium on teamwork, participation and consensus.

Adhocracy Culture

A dynamic, entrepreneurial and creative place to work. People stick their necks out and take risks. The leaders are considered innovators and risk takers. The glue that holds the organization together is commitment to experimentation and innovation. The emphasis is on being the leading edge. The organization's long-term emph-asis is one of growth and acquiring new resources. Success means gaining unique and new products of services. Being a pro-ducer or service leader is important. The organization encourages individual initia-tive and freedom.

Hierarchy Culture

A very formalized and structured place to work. Procedures govern what people do. The leaders pride themselves on being good coordinators and organizers who are efficiency-minded. Maintaining a smooth-running organization is most critical. Formal rules and policies hold the organization together. The long-term concern is on stability and performance with efficient, smooth operations. Success is defined in terms of dependable delivery, smooth scheduling and low cost. The management of employees is concerned with secure employment and predictability.

Market Culture

A results-oriented organization whose major concern is with getting the job done. People are competitive and goal-oriented. The leaders are hard drivers, producers and competitors. They are tough and demanding. The glue that holds the organization together is an emphasis on winning. Reputation and success are common concerns. The long-term focus is on competitive actions and achievement of measurable goals and targets. Success is defined in terms of market share and penetration. Competitive pricing and market leadership are important. The organizational style is hard-driving competitiveness.

Stability and control

Source: Feller 2002

(appropriately at that time) as the national public sector and the relationship conformed to a linear hierarchy by which research led to technology, which in turn was passed down from the international centers to national programs, then extension services and finally to farmers. This greatly restricted the diversity of partners involved in CGIAR research notably farmers, private industry and NGOs. Furthermore, as these assumptions replicated themselves over the years, the organizational culture of the CGIAR centers continued to reflect some of the institutional hangovers from the earlier years (Hall et al. 2000). While slowly over the intervening years things did start to evolve, a stereotype of this organizational culture at that time might include the following:[8]

8. Based on the authors' experience, this would have probably been typical 5–6 years ago.

- The main task was increasing food production. This could best be achieved by focusing on increasing yield per unit area under optimum conditions and this was the central criteria for judging success
- Public good research should be undertaken by the public sector unsullied by any commercial interest. The corollary being that interaction with the private sector is highly suspect and should be avoided
- Technologies developed were good and that it is the failure of others to transfer these to farmers that was the cause of weak farm level adoption
- The NGO sector was at best scientifically suspect and perhaps even anti-science particularly latterly in its attitude to biotechnology
- Research priorities should be set, with the help of economists, by scientist themselves. Analysis of economic rates of return to research investment being the method of choice for assessing research performance
- Impact on the poor and development more generally, is a presentational problem and that main role of social scientists is to legitimize through impact assessment the good work done by scientists.

We deliberately polarize these points for illustrative purposes. Organizations and their cultures have changed. It is important to recognize, however, that it is this broad position from which many CGIAR centers are moving forward. It is also the stereotype carried around by many of CGIAR's critics and potential partners, including the private sector and NGOs. The centers are thus double-burdened as they strive towards a new architecture of innovation.

The evolving culture of science at ICRISAT

Historical perspectives on organizational culture

ICRISAT, established in 1972, with a mandate for crops of the semi-arid tropics was typical of the second wave of CGIAR centers. Although it clearly had a very strong eco-regional focus it was established primarily as a commodity improvement center for its five mandated crops – sorghum, pearl millet, chickpea, pigeonpea, and groundnut. The institutional model of ICRISAT was very much of its time. In India the partner organization was the Indian Council of Agricultural Research (ICAR), which was also the main conduit for technology transfer and access to farmers. The private sector (input supply and food and feed industries) was seen to operate in a separate domain in which it had comparative advantage. The Institute adhered, at times quite strictly, to the role distinctions that this design implied – often encourage by the Governing Board who felt the need to conform to memoranda of understanding with host governments.

It can therefore be seen that organizational culture of ICRISAT conformed to a linear model of innovation whereby technology is developed and then passed to others for further development and transfer. An area of discourse in the organization that illustrates this is the perennial references to the technology

shelf – the mythical repository for research products that are yet to be adopted.[9] In 2001, Hall et al. (2001) found that despite the continued discussion of this concept as the rationale for establishing new partnerships, interviews with private-sector seed companies revealed that they were less interested in partnering to gain access to technology alone, but instead wanted access to expertise and research infrastructure. In their words it highlighted that there was a need to match what ICRISAT had to offer with what its new partners wanted. This implied the need for a totally different type of relationship that was more consensual and where agendas and priorities were negotiated bilaterally.

Early partnerships with the private sector

Indeed it was against this backdrop of a rather conservative public-research sector organization that in 1997 a new Director General[10] joined the Institute with mission to introduce a much more entrepreneurial forward-looking culture. The new Director General, found, however, a number of institutional restrictions to implementing new ideas and, frustrated by the slow process of change, he left. During his short time as Director General, this visionary character had seeded the need for change in the organization, although there was still a long distance to travel before this vision could be implemented. Thus in 1998 two of the Institute's plant breeders, encouraged by the then Head of the Genetic Resources and Enhancement Program, began their 2-year struggle to establish the first research initiative funded by the private sector. The two breeders knew that the Institute had to move on from the paternalistic support that it had been providing to the emergent private-sector seed industry and that a type of contract research was the way forward. However what they found was that not only were there uncertainties over intellectual property rights (IPR), but that there was also an uncertainly as to whether the Institute was actually allowed to enter in to such an arrangement at all. As such there was hesitation on both the part of the private-sector seed companies and the Institute.

The seed companies' main concern was that of gaining exclusive rights on the products they were to fund ICRISAT to develop – improved inbred parental lines of sorghum and pearl millet for production of commercial hybrid varieties. ICRISAT IP policy allows free access to all germplasm through a materials transfer agreement, thus disallowing an exclusive arrangement. This was finally resolved in two ways. Firstly, the funding was organized through a consortium, thus lowering costs for companies involved, making exclusivity less of a concern. Secondly, the companies were assured that although there would be public access to improved hybrid breeding lines, the companies could take ownership of subsequent materials that came from crossing these with their own lines.

The next hurdle was to get this arrangement approved by ICRISAT management and Governing Board. The details of this process clearly indicate that there was a great deal of uncertainty over whether this was something that was appropriate for the Institute (see Reddy et al. 2001). It was passed on to ICAR for their comment

9. The origins of this terminology may have emerged from an External Programme and Management Review that commented on unadopted technologies.
10. Dr Shawki Barghouti

before being passed back to ICRISAT where it was rejected – mainly because the sums of money where felt to be insignificant. Possibly one of the most significant points of departure in this story was the change in attitude that took place with the assignment of an Acting Director General[11] who quickly pushed the issue through, commenting that the financial magnitude of the seed consortium was less important than the value of the partnerships it was establishing. It is the vision and conviction of this one individual that marked the beginning of ICRISAT's liberalization with respect to developing partnerships with other organizations. His decision was fully endorsed by the incoming Director General who signed the agreement with the private consortium.

A more recent hurdle that the Institute has faced concerned the principle of partnerships with the private sector, involved creating joint ventures with the private sector and hosting commercial companies within a proposed Agri-Biotech Park (ABP). The new Director General is firmly behind this concept, but there were difficulties in doing so in relation to the Institute's founding agreement with the Government of India. However, a shift has taken place via interest from the local State government for ICRISAT to host the agri-biotech wing of the state-sponsored Genome Valley Science Park, thereby legitimizing the Institute's desire to work intimately with a wider array of private-sector partners through an income-generating model.

Institutional changes and opportunities associated ICRISAT's applied genomics facility

While ICRISAT had been working on a number of aspects of molecular biology since the mid-1990s, the Institute's biotechnology capability was substantially increased through US$ 1 million dollar capital investment in genomics during 2000–02. The Institute was given a substantial grant from the Asian Development Bank to establish marker-assisted selection systems in sorghum, groundnut and chickpea in collaboration with the NARS of Bangladesh, China, India, Pakistan and Vietnam. A scientist from the commercial plant-breeding sector in Europe was recruited to establish and manage this facility and the integration of its activities into plant breeding programs in Asia and Africa. Three internationally recruited post-doctoral fellows were also employed to coordinate the high throughput genotyping facility. The manager of the facility began a series of initiatives (with mixed success) that involved developing a new relationship with the private sector, including out-sourcing, collaboration, and joint ventures.

The first innovation was to initiate out-sourcing of research to biotech companies in India and Europe. The rationale for out-sourcing was to save time and to free up ICRISAT staff to concentrate on more conceptually challenging genomics research; to evaluate a range of national and international service providers in a consistent manner and to relay this information to the plant breeding community. While it was recognized that in the beginning, out-sourcing may not offer substantial time and cost/benefits, it was considered an important contribution to capacity-building in the region. A similar initiative has also been

11.The then Head of the Genetic Resources and Improvement Program

established for alternative suppliers of training such that ICRISAT staff could become trainers of trainers and thereby release more time for intensive research activities.

Again this was the first time that this type of arrangement had been used at ICRISAT and perhaps not surprisingly it took around one year (during 2000–01) to pass through the Institute's approval system and finalize the contractual terms. The scientists driving this initiative bore the brunt of the work, preparing contracts and negotiating with the company (mainly on IPR issues) and, later on, monitoring and backstopping the progress of the research. However, one of the outcomes was that ICRISAT learned a lot about contracting the private sector that it had not previously known. This in turn led to a broadening of private-sector interaction and an appreciation within the Institute of the need to establish dedicated in-house capacity for IP issues; and thus, in 2002, an IP Management Office was created in ICRISAT.

A full-time administrator is coordinating the IP Management Office with technical backstopping from the Deputy Director General and the Global Theme Leader for Biotechnology To help him adapt to the new role he followed a part-time diploma in patent law. At the time of writing, the Institute is now investigating means of recruiting a full-time lawyer to lead this Unit. A great deal of specific legal activities can be effectively out-sourced in India. Nevertheless, the presence of a minimum critical mass of in-house expertise is considered essential to enable the Institute as a whole to evolve a much more strategic perspective toward IP management. In addition, as most legal experts focus entirely on legal issues from a commercial perspective, it is critical to establish an institutional capacity to approach these issues from the perspective of a non-profit institution. Part of a longer-term vision here is that IPR may become one of series of expert services, along with bio-safety support, innovation, and partnership policy and strategy, which the Institute can offer to others – either with a view to capacity building under donor support or on a cost-recovery basis. These skills are clearly co-products of current institutional developments taking place at ICRISAT, emerging as the Institute's role and competencies evolve.

ICRISAT's Technology Innovation Center

The Technology Innovation Center (TIC) at ICRISAT is part of the overall vision associated with enhanced linkages and capacity development of the Indian national agricultural industry. Initially, in 2001, it was envisaged to establish an Agri-Biotech Incubator, however, the Indian Department of Science and Technology (DST) approached ICRISAT with a proposal for a broader initiative that was subsequently named Agri-Business Incubator (ABI). Although the ABI has several potential biotech components, it is also involved in many other agricultural technology issues (see next section for further details). On this basis, the ICRISAT's emphasis in turn moved to a bigger initiative for biotech that is now encapsulated in the Agri-Biotech Park (ABP) which has gained favor with the State government who plan to include it as a wing of the spatially decentralized Genome Valley Science Park (see section on ABP below for further details). With such a rapid evolution in initiatives driven both internally and externally, it was decided that an umbrella structure should be created to form a single point of access and vision for all private sector partnership initiatives at ICRISAT.

In order to handle the anticipated cluster of partnership arrangement that the ABI is expected to bring with it, ICRISAT has established what it refers to as a Technology Innovation Center (TIC). In fact, not only ABI activities will be handled through the TIC, but also a number of other partnership-based initiatives ranging from biotechnology to rural development. In time this will also include the science park initiative. The purpose of the TIC is two-fold. Firstly, to provide a special-project institutional environment where such different working norms as income generation can be pursued independently of the rest of ICRISAT. Secondly, to act as a clearing house for proposals and establishing principles – and to this end a committee has been constituted in ICRISAT.

Agri-Business Incubator (ABI). The related idea of an ABI has, crystallized. Whereas the science park mainly concerns capacity development and collaboration on pre-competitive research,[12] the ABI sits firmly in the domain of commercialization. The rationale here is that ICRISAT and its public partners have a range of existing technologies that can be exploited by private companies if the combined efforts of entrepreneurial and scientific skills are incubated. The origin of this initiative was an approach by the DST requesting ICRISAT to apply for a scheme under its National Science and Technology Entrepreneurial Development Board. The scheme provides a grant that ICRISAT had to match. This grant is then used to support private companies in their attempts to develop and commercialize promising technologies.

The ICRISAT scientists involved in making the application (a molecular biologist and a bioinformatics specialist with extensive previous experience in physiology and agronomy) had for a number of years seen the need for and opportunities associated with working with the private sector. However in the past they had found that there was no framework for negotiating a working arrangement with the private sector. The ABI provided that framework, normalizing an arrangement whereby the Institute could recover costs associated with a joint venture that promotes the development and uptake of ICRISAT science, while at the same time provides a profit-making opportunity for the private sector. The framework also makes provision for ICRISAT to have equity holding in the companies involved. Bureaucracy has been kept to a minimum, with the Director General of ICRISAT having authority to approve any new initiative he sees fit under the ABI.

An example of this arrangement was a gene gun developed at ICRISAT. The equipment had a lower performance than commercially available equipment, but could be made for a fraction of the cost. An ex-ICRISAT employee (previously a technician involved in the gun's development) has set up a company to manufacture this equipment. Under the ABI ICRISAT scientists helped modify the design and made it a viable and cost-effective choice for the Indian market. ICRISAT was paid for the additional research expenses and it also gains goodwill from its involvement.

The ABI is still at an early stage, having had funding approved at the time of writing. Once again, this is new territory for ICRISAT and will require new tasks and norms to make it work. One new task will be to match technologies with

12. Research in which the private sector alone may not invest, either because of entry costs or because research products initially may not sufficiently 'near market'

private-sector partners wishing to commercially exploit them. ICRISAT is approaching this with two innovations. Firstly it plans to recruit a manger for ABI. This will be somebody with a business management background whose task will be to identify partners, negotiate terms, develop business plans, assess viability of product options, and provide support to the company during the incubation phase. While ICRISAT has done some of these things before, it has never employed a professional in this area. This is therefore another important departure in the evolution of science culture at ICRISAT – specifically, that it (formally) recognizes the complimentary importance of science, business acumen, and skills relating to negotiation and relationship building.

Agri-Biotech Park (ABP). Biotechnology-based companies in India are being encouraged to establish ventures at ICRISAT. A primary driving force was the substantial excess of capacity currently available at ICRISAT headquarters in India. At the same time it was realized that almost no plant breeding programs in India can muster capital investment to the level dedicated at ICRISAT for high throughput genotyping in support of plant breeding. Indeed, ICRISAT had invested in capacity beyond its own immediate need, in order to be able to lease this excess capacity to NARS and private-sector breeding programs to provide a low-cost entry point in to this new paradigm of plant breeding.

The idea here was that a broad range of companies would be attracted to establishing biotech activities at ICRISAT. These might be start-up biotech companies, breeding companies wishing to move into biotech activities, or international companies interested in expanding their out-sourcing activities. The availability of laboratory, greenhouse and field facilities and ready access to ICRISAT expertise were expected to be a major points of attraction to all these ventures.

An organizational culture in transition: decisions on the road ahead

The organizational culture of ICRISAT has quite clearly changed in recent years, with an increasingly liberal policy towards partnerships with the private sector. A variety of fundamental changes in the way science is conducted have flowed from this policy shift. For example, there has also been an expansion in the legitimate professional skills that need to be part of modern scientific endeavor. This has particularly been so in the area of legal and business development issues. But also in terms of the type of relationship scientists have with the private sector and others from outside the Institute.

The change process

Implicit in many of these developments has been the recognition that the culture of the organization had to change to accommodate new ways of working. So, for example, underlying the idea of the agri-science park was the hope that the presence on campus of young dynamic professionals from the bio-/agri-enterprise sector would expose ICRISAT scientists to different perspectives on science and way of working. This in turn was viewed as supportive of agricultural technology development in an emerging paradigm of R&D that involved much greater collaboration between public and private sectors.

As part of its wider agenda of change, ICRISAT believed that it could also support the positive evolution in national programs through opening its doors to three-way partnerships (ICRISAT–NARS–private sector). This approach has been cautiously received by scientists within ICRISAT and the international donor community. However, the very positive response from private-sector companies and State government suggests that it may be successful if appropriate and sufficient changes in public-sector mindsets can be achieved in a short time. For this reason, pilot projects with limited IPR concerns have been chosen for proof-of-concept initiatives.

Viewing the private sector as an important partner and critical conduit for impact has not always been readily accepted by all stakeholders from national public research programs. Thus the need for an international public goods organization to be involved in capacity building in the private sector becomes an even more daunting prospect. Finally the catalytic value of proximity and intimate relationships with product-driven researchers has been a particularly difficult rationale for some stakeholders to appreciate.

The learning process

The creation of the TIC at ICRISAT has been a powerful learning by doing process for the Institute's Governing Board, management, scientists and stakeholders. Again this learning process as been part of the task of changing the culture of the organization. Perhaps one of the most pervasive lessons that have been learned during this time, is the critical importance of process and the great difficulty that scientific organizations experience if institutional change is not driven and reinforced at the right level, in the right order, and at the right pace. However, not only are these issues highly intangible, they are also highly contextually specific. Inevitably this means that a successful process can rarely be designed (beyond a standard framework) but must evolve through a dynamic iterative process that is both time and emotionally intensive for all concerned. Thus although the rewards may be substantial, the investment is equally significant. Clearly scientific organizations and their staff must be entirely convinced of the need and value of this investment if their collective goal is to have a reasonable probability of success.

The transition process

The transition in ICRISAT has not been easy for anyone – too slow for some yet too fast for others. The time delays discussed above reflect the degree to which change has been contested. But note also that change is gathering pace as scientists and administrators become more comfortable with the new organizational culture that is emerging. Of course this acceptance has not been evenly spread across the staff at the Institute, with some disjunction between the Institute's professed policies and the personal attitudes of some of its scientists and administrators. Some view the private sector as the 'smash and grab' partner overly concerned about exclusive agreements, while others feel reluctance to enter the rapidly changing world of the private sector and the complexities of, among other things, negotiating IP issues. What is clear is that as biotechnology becomes a more pervasive force for change, ICRISAT will be increasingly drawn into relationships

with new partners, not just those in the private sector but with a range of developmental stakeholders. New skills gained through building relationships with the private sector will be equally valuable for building partnerships with NGOs and civil society groups.

Decisions on the road ahead

Discussions with scientists reveal many opportunities and challenges. For example, stemming from the recent approval of *Bt* cotton in India, many smaller seed companies have recognized the importance of value-added products in a highly competitive market and are approaching ICRISAT for transgenic services. In turn, with greater investment there is an increasing eagerness to protect the value return and new interest in DNA fingerprinting services and strengthening of variety protection regulations. Thus companies are approaching ICRISAT for molecular fingerprinting services for plant variety protection (PVP). It is expected that in due course they will move on to needing molecular fingerprinting services for distinctness, uniformity and stability (DUS) testing and marker-assisted selection (MAS).

Should ICRISAT pursue these opportunities to develop a cost-recovery service that could perhaps cross-subsidize core research while at the same time bringing them closer to the end-users? As mentioned earlier ICRISAT is building up new types of expertise in IPR and partnership development and management. How can it best take advantage of this? This dilemma will not go away and in the future the private sector will continue to approach ICRISAT with an increasingly diverse array of demands. While this offers opportunities, these will be only exploited if both sides develop the skills needed to build partnerships. Scientists observe that it is difficult to establish dialog, often because there is little understanding of what either side wants, or is able to do. Here definitive contract development, although initially time-consuming, becomes critically important to offset subsequent wasted time or complete collapse of the partnership.

Frameworks for choices

Over and above these concerns, however, in an increasingly scarce funding environment it is all too easy to lose sight of the reasons the Institute is pursuing these new types of relationship. Resource mobilization alone cannot be the deciding factor. What is the framework for making decisions on these matters, particularly in terms of setting priorities that abide by the overarching goals of poverty reduction espoused by ICRISAT and the CGIAR in general? The science park and perhaps to a lesser extent the ABI raise these question most profoundly. So while the Institute faces the challenge of developing ways of partnering with unfamiliar players, it also has the task of establishing new mechanisms to govern such arrangements and provide a framework for making informed choices relevant to the Institute's mission. In other words it needs a way of identifying those new opportunities that truly strengthen its position and unique mission and filtering out those that don't.

The fact that the main thrust of these partnerships will be in the area of biotechnology also suggests that existing mechanisms for setting research priorities by scientists and economists will be inadequate. The reason for this relates to the

on-going tensions between advocates and critics of biotechnology. While much of the debate is ill- informed, scientific defensiveness is likely to confound consensus building and agreement on ways to move forward. Developing broader acceptance of biotechnology, defusing public concerns, and building trust in the decision-making processes of ICRISAT will be needed if ideas such as a science park are to gain the widespread legitimacy they deserve. The key question therefore concerns how this can be achieved and what are the implications for the evolving culture of science at ICRISAT?

From patronage to partnership: towards a new architecture of innovation

In order to discuss ways to move forward we now review some of the international experience in dealing with some of the issues that ICRISAT is facing. We focus on the two main questions: how to build linkages, and how to develop consensus across a broad range of scientific and non-scientific stakeholders. Returning to our earlier discussion of innovation systems, it can be seen that the desirability of viewing technology development and diffusion on a broader canvas of partners and institutions is a mainstream concern in many of the OECD countries. We will explore two mechanisms and comment on their implications for ICRISAT. Firstly, science parks, an idea already widely discussed at ICRISAT. Secondly, foresight, a concept new to ICRISAT but one that we believe has much to offer.

Science parks

The concept of science parks originated in United States of America where the first science park, i.e., Stanford Research Park, was established in 1952. Industry soon realized the advantage of site proximate to a university, and so we see the pattern emerging in the late 1970s and 80s. The flurry of building research parks in the 1980s represented the second wave of interest in the concept.[13] MacDonald (1987) lists the following defining features:

- A facility that allows businesses to locate in close proximity to (usually) public science
- Formally and operationally there must be at least one 'reservoir' of technology and expertise, usually universities or research institutions
- An organization which provides management support for its tenant companies.

Westhead (1997) claims that science parks reflect an assumption that innovation requires a catalytic environment that occurs when those involved in research interact both formally and informally with those involved in business and profit. Many of the science parks have incubators either separately managed or managed as an integral part of the park. An incubator is defined as a property with small work units providing a supportive environment for entrepreneurs and

13. There is no uniformly accepted definition of science parks and there are several terms used to describe similar development such as research park, technology park, business park, business innovation, 'technopoles', science centers, center for advanced technology, technology business incubators and similar versions of the same concept (Monck et al. 1988). The terms 'science park' and 'technopole' are used most commonly in Europe, while the term 'research park' is preferred in the USA and Canada.

investors during the start-up stage of their business. But an incubator should be much more than just the premises; it should seek to build a culture of entrepreneurship by providing access to a wide variety of facilities, equipment, and expertise (if possible on a lease basis so as to off set the high capital costs barrier for biotech start-ups). Businesses are encouraged to leave the incubator when they have established sufficient market strength, and frequently relocate to a science park proper where relationships may be looser and of a long-term nature.

It is difficult to appraise the effectiveness of science parks because the objectives of the different partners in the parks may differ considerably (Monck et al. 1988). However, the general consensus seems to be that by virtue of its positive effect on the economy the science park has been variously employed by different investors, for example, by universities for transferring and commercializing technology, by the private sector for profit (as a type of real-estate business), by governments for: job creation, building technological capability in the private sector, or accelerating economic growth, etc.

The concept of a science park addresses many of the issues with which ICRISAT and the CGIAR are dealing, namely the disjunction between research and private enterprise between technology developers and technology users. This concept is probably more suitable for scenarios where the private sector has an under developed R&D capability but a good understanding for the market demand for products. A business incubator idea may also be appropriate where it is felt that ICRISAT and its NARS partners have potentially commercializable technologies that the private sector could adapt, refine and promote. However any initiative of this type needs to be approached bearing in mind two major caveats.

- Firstly, neither of these ventures can be entered into lightly as significant financial and human capital investment is required for such ventures to work effectively
- Secondly, the concept is seductively appealing to those who view this as a relatively simple task of transferring technologies from the 'shelf' to the waiting private sector. The real significance and power of such arrangements is that they establish long-term relationships with the entrepreneurial sector. In turn, this opens up the possibility of jointly identifying research priorities and helping facilitate research–client iteration that is such a crucial element of the innovation processes. This closer relationship also holds the promise of such further institutional innovations as joint public–private ventures and other hybrid organizational types. While this may sound far-fetched, the close working relationships that science parks offer opens up a space for the discussion and negotiation of new working arrangements and related institutional innovations.

From the perspective of an international agency such as ICRISAT, partnership with the private sector is not necessarily a good thing per se. The question therefore remains as to what would be the most appropriate framework for governing such an arrangement in the light of ICRISAT's wider developmental goals.

Technology foresight

Technology foresight is an increasingly widely used mechanism for linking science and technology more closely to the nations' economic and social goals (needs).

Martin (1996) argues that with the increasing pressure on government spending, there is a move towards greater public accountability, leading to an increasing need for alternative mechanisms to make choices effectively with the limited resources available in science and technology. While these themes reflect national concerns, they are familiar issues for CGIAR centers such as ICRISAT.

Yuthavong and Sripaipan (1998) state that technology foresight is a process of looking forward, and involves interaction between scientists and technologists, responsible for the science and technology push, and sociologists, economists, other professionals, and laymen providing the market-pull, to produce a balanced perspective for the planners and policy makers. They further state that it focuses on the prompt identification of emerging technologies, still in the pre-competitive stage of development and often requiring government support because they have not yet reached the market stage. Technology foresight is therefore concerned with being able to maximize the foreseen benefits and minimize losses in the context of future societies.

The approach relies on establishing working committees and expert panels[14] from a broad range of scientific and non-scientific stakeholders to make predictions about future technology and society scenarios. It thus provides decision-makers in both public and private sectors with the background intelligence on long-term trends needed for broad direction-setting. By relying on broad-based participation to develop future scenarios – and note that it concerns multiple futures not a single vision – foresight has both product and process outcomes. Product outcomes in the sense that the approach provides working plans that enable technology planning to be based on wide consensus. Process outcomes not only in the sense that they promote consensus and trust, but also because they build linkages between different elements in the innovation system. It is in this sense that technology foresight is a collective learning process leading to building of new networks and 'wiring up' of national systems of innovation (Martin 1996).

Towards a consultative foresight process in the CGIAR

How does this concept have relevance to ICRISAT in particular, and the CGIAR in general. In particular, how can it contribute to the CGIAR need to focus its partnership-based initiatives for poverty reduction as a guiding principle? One possibility is that a consultative foresight process is attached to the range of public–private sector partnership activities clustered under, for example, ICRISAT's TIC. Foresight stresses the need to canvas the opinion of what is in essence a constituency of stakeholders. For ICRISAT this constituency would certainly include national and international scientific partners from both the public and private sectors. But it would also include donor representatives, NGOs and civil society organizations, farmer's federations, and farmer-operated organizations such as co-operatives. It could also include social commentators including the advocates and critics of biotechnology. In other words it would bring together the whole spectrum of interest related to science, agriculture, rural development,

14. Most foresight exercises such use techniques as expert panels, brain-storming, scenarios, or commissioned studies from consultants rather than the Delphi surveys that were classically used in the pioneering efforts of the Japanese (Martin 1996).

and poverty reduction. The outcome of any discussion by such a diverse group would undoubtedly be a compromise, but that would be the objective – i.e., to try and make decisions about research and technology policy that were based both on informed discussion and on consensus between science, business, and society.

While foresight in these terms could be viewed as a governance structure dealing with accountability to stakeholders and a more consensual approach to priority setting, the process of foresight is equally important. For ICRISAT it would provide a mechanism for networking with a wider set of organizations than those with whom it would normally interact. Not only would this be valuable for developing scientific and business alliances, but it would also help breakdown barriers and build trust with critics and adversaries. There are convincing arguments that suggest demonstrating a shift to a culture of science that was truly driven by stakeholder consensus would be attractive to the more skeptical donors, as well as to private-sector sources of funding. While a foresight approach might sound both fanciful in its conception and painful in its execution, this is a practical approach to operationalize the rhetoric of partnership, consensus-building and poverty-reduction that is now so widespread in the CGIAR system.

Conclusion

As a result of the new age of biotechnology, and probably as never before, the CGIAR centers are having to revisit the underlying principles that govern the way international agricultural research is conducted. While inevitably we are all prisoners of our own institutional histories, the culture of science in the CGIAR centers is evolving in valuable ways. The core of the dilemma is that while biotechnology has much to offer, this international public goods endeavor has to strike a new bargain with both private industry who owns much of the technology, and society at large who remains cautious and often ill-informed. Individual CGIAR centers such as ICRISAT are operating in specific contexts with their own threats and opportunities. In this paper we have seen the way the approach of the Institute is unfolding and the way the culture of science is gradually changing. The broad message that we would like to underline is that there is no blueprint on ways to proceed. There are, however, well established conceptual principles, particularly regarding process, that can provide a framework for planning innovation and change – particularly the innovation systems framework. From this school of thought come such practical tools as the consultative foresight approach. We recommend that scientists, administrators, and policy-makers give these concepts and principles due consideration whilst planning the future of CGIAR science.

Endnote

This paper is a joint the output from a research project funded by the United Kingdom Department for International Development (DFID) and funding from ICRISAT under Global theme 6 Biotechnology for the poor. The views expressed are not necessarily those of DFID [R7502: Crop Post-Harvest Programme] or ICRISAT. The authors would like to express their thanks to valuable comments provided by Dr Rodomiro Ortiz on an earlier draft of this paper. They would also like to thank ICRISAT scientists for providing their views on recent development at the Institute. Any errors or misinterpretations are the responsibility of the authors alone.

References

Anderson R S. 1991. The origins of the International Rice Research Institute, Minerva, Spring: 61–89.

Anderson R, Levey A, and **Morrison W.** 1991. Rice science and development politics: research strategies and IRRI's technologies confront Asia's diversity (1950–1980). Oxford, UK: Clarendon Press.

Arnold E, and **Bell M.** 2001**.** Some new ideas about research for development. Pages 279–319 *in* Partnerships at the leading edge: a Danish vision for knowledge, research and development. Report of the commission on development-related research funded by Danida. Copenhagen: Ministry of Foreign Affairs/Danida.

Byerlee D, and **Alex G.** 2003. National agricultural systems: recent developments and key challenges. Note prepared for the Interim Science Council of the Consultative Group on International Agricultural Research (CGIAR). 8 pp.

Byerlee D, and **Fischer K.** 2002. Accessing modern science: policy and institutional options for agricultural biotechnology in developing countries. World Development 30(6): 931–948.

Cameron K S, and **Quinn R E.** 1999. Diagnosing and changing organizational culture. Reading, UK. Addison-Wesley Longman. 365 pp.

Clark N G. 2002. Innovation systems, institutional change and the new knowledge market: Implications for third world agricultural development. Journal of the Economics of Innovation and New Technologies 11(4–5): 353–368.

Clark N, Stokes K, and **Mugabe J.** 2002a. Biotechnology and development: threats and promises for the 21st century. Futures 32(9–10): 785–806.

Clark N, Yoganand B, and **Hall A J.** 2002b. New science, capacity development and institutional change: the case of the Andhra Pradesh–Netherlands Biotechnology Program (APNLBP). International Journal of Technology Management and Sustainable Development 1(3): 195–212.

Clark N G, Hall A J, Rasheed Sulaiman V, and **Guru Naik.** 2003. Research as capacity building: the case of an NGO-facilitated post-harvest innovation system for the Himalayan Hills. World Development. 31(11) (in press).

Cohen J I, Falconi C, Komen J, and **Blakeney M.** 2002. Propriety biotechnology inputs and international agricultural research. ISNAR Briefing Paper no. 39. The Hague, The Netherlands: International Service for National Agricultural Research (ISNAR). 15 pp.

Douthwaite B. 2002. Enabling innovation. London, UK: Zed Books. 238 pp.

Edquist C. (ed.). 1997. Systems of innovation approaches: technologies, institutions and organisations. London, UK: Pinter, Cassell Academic. 432 pp.

Essegbey G, and **Stokes K.** 1998. Building capacity for biosafety policy in Ghana. Issues and options for policy-makers. Science, Technology and Development 16(2)

Feller I. 2002 New organisations, old cultures: strategy and implmentation of interdisciplinary programs. Rsearch Evaluation 11(2): 109–116.

Fischer K. 2000. Access to modern science: issues and opportunities for the public sector agricultural research systems. Washington, USA: Rural Development Department, World Bank (draft).

Freeman C. 1987. Technology and economic performance: lessons from Japan. London, UK: Pinter.

Gibbons M, Limoges C, Nowotny H, Schartzman S, Scott P, and **Troww M.** 1994. The new production of knowledge. London, UK: Sage. 192 pp.

Gaillard J. 1998. Donor models for strengthening research capacity building in developing countries. Pages 37–74 *in* Basic sciences and development (Garret M J, and Granqvist C G, eds.). Aldershot, UK: Ashgate.

Hall A J, Sivamohan M V K, Clark N, Taylor S, and **Bockett G.** 2001. Why research partnerships really matter: innovation theory, institutional arrangements and implications for the developing new technology for the poor. World Development 29(5): 783–797.

Hall A J, Yoganand B, Rasheed Sulaiman V, and **Clark N G. (eds.).** 2001. Sharing perspectives on public–private sector interaction: proceedings of a workshop 10 April 2001, ICRISAT, Patancheru, India. Library Avenue, Pusa, New Delhi 110 012, India, and Patancheru 502 324,

Andhra Pradesh, India: National Centre for Agricultural Economics and Policy Research (NCAP) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). 48 pp.

Hall A J, Clark N G, Rasheed Sulaiman V, Sivamohan M V K, and **Yoganand B.** 2000. New agendas for agricultural research in developing countries: policy analysis and institutional implications. Knowledge, Policy and Technology 13(1): 70–91.

Hall A J, Rasheed Sulaiman V, Clark N G, and **Yoganand B.** 2001. Shared perspectives: a synthesis of obstacles and opportunities. Pages 35–40 *in* Sharing perspectives on public–private sector interaction: Proceedings of a workshop 10 April 2001, ICRISAT, Patancheru, India (Hall A J, Yoganand B, Rasheed Sulaiman V, and Clark N G, eds.). Library Avenue, Pusa, New Delhi 110 012, India, and Patancheru 502 324, Andhra Pradesh, India: National Centre for Agricultural Economics and Policy Research (NCAP) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Hall A J, Rasheed Sulaiman V, Clark N G, Sivamohan M V K, and **Yoganand B.** 2002. Public–private sector interaction in the Indian agricultural research system: An innovation systems perspective on institutional reform. Pages 155–176 *in* Agricultural research policy in an era of privatization: experiences from the developing world (Byerlee D, and Echeverria R G, eds.). Walingford, Oxon, UK: CAB International.

Haribabu E. 2000. Cognitive empathy in interdisciplinary research: the contrasting attitudes of plant breeders and molecular biologists towards rice. Journal of Biological Science 25(4): 323 330.

Kloppenburg J R. (ed.). 1988. Seeds and sovereignty: the use and control of plant genetic resources. Durham, North Carolina, USA: Duke University Press. 11 pp.

Lipton M, and **Longhurst R.** 1989. New seeds and poor people. London, UK: Unwin Hyman. 275 pp.

Lundvall B A (ed.). 1992. National systems of innovation and interactive learning. London, UK: Pinter. 161 pp.

MacDonald S. 1987. British science parks: reflections on the politics of high technology. R&D Management Journal 17(1): 25–37.

Martin B R. 1996.Technology foresight: capturing the benefits from science-related technologies. Research Evaluation 6(2): 158–168.

Monck C S P, Porter R B, Quintas P, Storey D J, and **Wynarczyk P.** 1988. Science parks and the growth of high technology firms. London, UK: Croom Helm.

Morris M, and **Hoisington D.** 2000. Bringing the benefit of biotechnology to the poor: the role of the CGIAR Centers. Pages 327–355 *in* Agricultural biotechnology in developing countries: towards optimizing the benefits for the poor (Qaim M, Krattiger A F, and von Braun J, eds.). Boston, Massachusetts, USA: Kluwer Academic Publishers.

Nelson R R, and **Winter S G.** 1983. An evolutionary theory of economic change. Cambridge, Massachusetts, USA: The Belknap Press of Harvard University Press. 452 pp.

Newell P. 2002. Biotechnology and the politics of regulation. IDS Working Paper 146. Brighton, UK: Institute for Development Studies (IDS).

OECD. 2000. Donor support for institutional capacity development in environment: Lessons learned. Paris, France: Organization for Economic Co-operation and Development (OECD). 125 pp.

Paarlberg R L. 2000. Governing the GM crop revolution: policy choices for developing countries, Washington DC, USA: International Food Policy Research Institute (IFPRI).

Pimbert M P, and **Wakeford T.** 2002. 'Prajteerpu': food and farming futures for Andhra Pradesh. A citizens' jury/scenario workshop. Economic and Political Weekly (6 Jul): 2778–2787.

Reddy B V S, Hall A J, and **Rai K N.** 2001. The long road to partnership: private support of public research on sorghum and pearl millet. Pages 27–34 *in* Sharing perspectives on public–private sector interaction: proceedings of a workshop 10 April 2001, ICRISAT, Patancheru, India (Hall A J, Yoganand B, Rasheed Sulaiman V, and Clark N G, eds.). Library Avenue, Pusa, New Delhi 110 012, India, and Patancheru 502 324, Andhra Pradesh, India: National Centre for Agricultural Economics and Policy Research (NCAP) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Reece J D.1998. Agricultural research practice for environmental management reduction: The case of CIAT, PhD Thesis, The Open University, Milton Keynes, UK.

Sasson A. 1988. Biotechnology and development. Paris, France: United Nations Educational, Scientific and Cultural Organization (UNESCO).

Scoones I. 2002a. Biotech science, biotech business current challenges and future prospects. Economic and Political Weekly (6 Jul): 2725–2733.

Scoones I. 2002b. Science, policy and regulation: challenges for agricultural biotechnology in developing countries. IDS Working Paper 147. Brighton, UK: Institute for Development Studies (IDS). 32 pp.

Tait J. 2001. More Faust than Frankenstein: the European debate about risk regulation for genetically modified crops. Journal of Risk Research 4(2): 175–189.

Tripp R, and **Byerlee D.** 2000. Public plant breeding in an era of privatization. Natural Resources Perspectives no. 57. London, UK: Overseas Development Institute (ODI).

Tripp R. 2000. GMOs and NGOs: Biotechnology, the policy process, and the presentation of evidence. Natural Resources Perspectives no. 60. London, UK: Overseas Development Institute (ODI).

Vehlo L. 2002. North-South collaboration and systems of innovation. International Journal of Technology Management and Sustainable Development 1(3):195–212.

Westhead P. 1997. Inputs and outputs of technology-based firms located on and off science parks, R&D Management Journal 27(1): 45–62.

Yuthavong Y, and **Sripaipan C.** 1998. Technology foresight as a tool for strategic science and technology planning and policy development. Prepared for ASEAN Fifth Science and Technology Week (Feb 1998), Hanoi. 12 pp.

(Source: http://www.apectf.net/pubprofile.cfm?pub=20 (accessed on 12 May 2003)

Institutional learning and change: towards a capacity-building agenda for research. A review of recent research on post-harvest innovation systems in South Asia

A J Hall,[1] R V Sulaiman,[2] B Yoganand,[3] R S Raina,[4] N G Clark,[5] and Guru C Naik[6]

Abstract

Reviewing recent research on partnerships in the post-harvest sector this paper explains the way the innovation systems framework was developed and used to gain insights into the institutional context of R&D with a view to promoting good practice. Emerging from this research is the recognition of the central importance of institutional learning and change as a way of creating the constantly shifting links, partnerships, and approaches that underpin innovation. Based on what is now known about the process of innovation and institutional change, it is suggested that the next task for research is to explore institutional learning and capacity building in greater detail. The recommended approach is an interactive policy research methodology that ensures an action research orientation, placing the work in real life (and real time) interactive post-harvest innovation contexts. This needs to be linked to the development of a community of practice that will promote consensus on the need for and direction of institutional change.

Introduction

This paper reviews recent innovation policy research in the post-harvest sector and outlines future plans for research in this area. A joint Indian and British research team undertook the work reviewed with support from the Crop Post-Harvest Programme (CPHP) of the Department for International Development (DFID). The significance of the research was that it examined the importance of partnership in post-harvest research at a time when partnership approaches were starting to be recognized as useful, but when little was know about promoting such an approach in ways that strengthened pro-poor innovation. The research focus on innovation was also significant because innovation was explored in the broad sense of the activities and processes associated with the generation, distribution, adaptation and use of new technical, institutional, and managerial knowledge. This distinction is made to emphasize that the research was not about innovation in the narrow sense of the invention of new technology in research

1. University of Greenwich, UK, seconded to International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India
2. National Centre for Agricultural Economics and Policy Research (NCAP), Library Avenue, Pusa, New Delhi 110 012, India
3. ICRISAT
4. National Institute of Science Technology and Development Studies, K S Krishnan Marg, New Delhi 110 012, India
5. Graduate School of Environmental Studies (GSES), Wolfson Centre, University of Strathclyde, Glasgow G4 0NW, UK
6. O-450, Jalvayu Vihar, Sector 30, Gurgaon 122 001, Haryana, India

and development (R&D) laboratories – although R&D is clearly important. Rather the research was about how R&D needs to be viewed as part of a larger process that brings about changes in post-harvest systems.

Among the many findings of this work has been the growing realization that innovation happens when arrangements are in place that support learning and institutional change among groups of partners and stakeholders. This means arrangements whereby those involved in research and rural development reflect with their partners on their successes and failures and adapt approaches and procedures in order to achieve success. This process is referred to in a number of ways – 'learning by doing', 'failing forward', 'participatory learning and action'. The term 'institutional change' is used here as shorthand for this concept and by this we simply mean changing the norms, routines, and conventions associated with the way post-harvest innovation is approached. This might mean reconsidering who is involved in research or implementation activities; who decides priorities and approaches; how successes are judged and by whom.

During the 3 years over which the research was conducted it was observed that this combination of cycles of learning and institutional change is a powerful way of bringing about post-harvest innovation that supports the livelihoods of poor people. While we have realized the importance of institutional learning and change, we know far less about how to encourage and promote this process in organizations and clusters of partners. The purpose of this paper is to provide a synthesis of the past work that has led us to these conclusions. We then go on to discuss further avenues of research that could build on this work.

We begin with a brief discussion of the emerging importance of these types of policy study.

The need for policy research on innovation and institutional issues

The need for this type of policy research in a technology domain such as post-harvest stems from widespread recognition that the institutional environment or context of R&D plays a major role in the outcome of such efforts, governing their success not just in terms of technical performance, but also in terms of relevance and impact on the livelihoods of poor people (Biggs 1990; Rajeswari 1995; Hall et al. 2001a). Blaikie et al. (1997) make similar comments in the context of efforts to incorporate the knowledge and values of poor people into rural innovation processes (Box 1 defines the institutional context of R&D).

By way of introducing the interrelatedness of technology, policy and socio-economic outcomes, Box 2 presents an example of how the institutional context of post-harvest research affects project progress and impact. The case described highlights the nature of partnerships, as well as the rules governing partners and their relationship with each other, as a critical area of policy that is integral to post-harvest innovation. What is notable in the case in Box 2 is that failure to engage with critical institutional and policy contexts of the project not only led to failure in establishing improved post-harvest management systems (the main technical focus of the research), but also allowed the project to proceeded for a number of years with little hope of helping the groups of poor people that it assumed were its key stakeholders.

Box 1. Institutional context of R&D

The institutional context of R&D concerns the rules, norms and conventions that govern research. In practice this means the rules and norms governing:

- How research priorities emerge, are promoted and executed
- The role of various actors involved in the production, transfer, and use of knowledge
- The relationship between these different actors and the factors that affect their relationships
- How research performance is evaluated and rewarded (incentives), and by whom
- How R&D is held accountable to different interest groups and society as a whole
- How knowledge is built up, shared, and used
- How organizations reflect and learn.

Other aspects of the institutional context concern the wider institutional environment. For example, it concerns the way national culture embeds in the norms of individuals and organizations and the way this affects how they operate, interact, and relate to each other, and how they learn and use knowledge. Therefore there can be different national cultures of science, with norms of acceptable behavior, review, and validation. There are also different organizational cultures and traditions in different sectors. For example, government agencies (sometimes unfairly) are thought of as top-down bureaucracies, whereas NGOs are usually (sometimes incorrectly) presumed to have flatter management structures. These are all illustrations of institutional contexts that impact on the way decisions are made, whose voice is heard, and the dynamics of relationship with partners – all factors that impinge on the direction and outcome of R&D.

In fact, it was the experiences of working on the projects described in Box 2 that laid the foundations for the research discussed in this paper. The research discussed was ambitious in its scope and the donor, CPHP, was courageous and farsighted in its decision to fund it. The original proposition of this work was that often the institutional context of R&D was a major restriction to innovation and thus socio-economic impact. However, it was postulated that the emergence of a series of new types of relationship between the public and private sectors in India was starting to alter the institutional context of innovation. Furthermore, there was some hope that this would bring about institutional changes that were pro-poor, the hypothesis being that these developments would build links between the poor and sources of technology.

A critical novelty of this research was that it conjectured (probably prematurely) that a new non-linear paradigm of innovation was starting to emerge as a result of these partnerships. By this it was meant that the research–extension–farmer model of technology development and transfer was starting to be supplemented by networks of organizations and individuals with two-way flows of information and technology. The research proposed that the **national systems of innovation** conceptual framework could provide a way to understand this new paradigm and explore ways in which it could be capitalized on and promoted.

The main attraction of the innovation systems framework was that it brought into the analysis of R&D project performance the broad range of actors and institutional contexts that shape research and techno-economic change. It also recognized that learning was important in dynamic systems and thus introduced this as an issue to be investigated. These were all clearly important dimensions for post-harvest research as it spans the interests of many research, development,

Box 2. Interaction among multiple agencies in the horticultural supply chain in India

Between 1996 and 2001 CPHP supported the development of mango exports by Vijaya, a Fruit Growers Association and the Agricultural Processed Products Export Development Authority (APEDA). The main focus was on the development controlled atmosphere (CA) container sea-shipment protocols. APEDA set up a series of contract arrangements with relevant organizations from both the Indian Council of Agricultural Research (ICAR) and the Council for Scientific and Industrial Research (CSIR) as well as with the Horticultural Department of the local State agricultural university. These organizations then worked with Vijaya to develop and test the CA protocol. The ICAR institute dealt mainly with pre-harvest pest management issues; the CSIR institute undertook experimentation on CA storage regimes; and the university department advised on packhouse management.

Trial shipments took place over a period of 3 years. However, consistent problems with the quality of fruit exported led to an evaluation of the export protocol and technical backstopping provided. Individually the quality management recommendations were technically robust. However it was observed that there was limited interaction with farmers in the development of recommendations and this was part of a broader concern over the client focus of the contracted agencies. Typical of their organizations, the scientists involved had little experience in working with farmers or in a commercial environment, and were usually not encouraged to do so. It was also observed that quality management measures were not devised and implemented in an integrated way across the supply chain. This resulted from relevant technical expertise being located in organizations governed by two different research councils, with scientists contracted independently to work on components of the quality management problem. Vijaya was then left (unsuccessfully) to ensure that these component technologies and practices operated effectively together. This was particularly apparent with attempts to deal with anthracnose, a quality-related disease that needs to be tackled with an integrated pre- and post-harvest approach.

The notable feature of the Vijaya case is that even where interactions with the public sector can be developed through contracting arrangements, the ability of individual research institutes to assist is limited by current institutional arrangements. Not only is there strong disciplinary segregation, but different research council affiliation also tends make integration difficult. The nature and rigidity of organizational culture – a key institutional arena – also makes the development of more integrated and responsive working practices amongst scientists difficult.

But if innovation in a general sense was restricted, what were the prospects for pro-poor innovation? In this case even though mango growers were (rather euphemistically) referred to as poor farmers, the reality was that those involved in the export shipment trails were inevitably large-scale, non-poor producers. It was this group that dominated the farmers' association involved, even though the majority of members were genuinely poor households whose livelihoods depended on mango production. The key stakeholders in this intervention were willing to continue the rhetoric of pro-poor focus, as this was a stipulation of the donor supporting the work. Dominant (and perfectly legitimate) stakeholder agendas included: mango export promotion; accessing high-value export markets; accessing technical expertise; developing (and having ownership) of new post-harvest technology and other research products. Stakeholder agendas were not investigated until much later in the research process, by which time it was probably too late to make any difference. By ignoring this important institutional context, not only was innovation in a general sense impeded (different agendas and roles were never negotiated and resolved), but more importantly it was almost a forgone conclusion that pro-poor innovation would not take place.

Source: Hall et al. 2003b.

marketing, and production actors. In addition, it is an arena where the poverty focus is always going to be contested by a large number of stakeholders with diverse and competing interests and hence institutional issues are of central importance. When this policy research approach was proposed (see Hall et al. 1998) and adopted in 1999 it was the first application of the national systems of innovation framework in the agricultural sector of developing countries – bar none.

The origins and features of the innovation systems framework

The attraction of the innovation systems framework stems from the way it engages with the political, economic, and social dimensions of knowledge production and its use at a time when these concerns are occupying a central position in development practice. Current debate is broader than research as a basis for scholarship and the development of new technologies – although both ultimately remain important. The term **innovation** – used in the sense of new creations of wider socio-economic significance – helps us to break away from these confines, and allows a more nuanced discussion of the process of development and change.

The origin of innovation systems thinking can be traced to the idea of a 'national system of innovation' proposed by Freeman (1987) and Lundvall (1992). At its simplest, this concept states that innovations emerge from evolving systems of actors involved in research and the application of research findings. Lundvall identified learning and the role of institutions as the critical components of these systems. He considers learning to be an interactive and thus socially embedded process, which cannot be understood without reference to its institutional and cultural context, usually in a national setting. The innovation systems concept is now widely used in the policy process in developed countries, but has only recently started to be employed in relation to research policy in the South (see for example, Hall et al. 2001a; 2001b).

Another way of making a similar point is proposed by Gibbons et al. (1994) in their much-cited discussion of 'mode one' and 'mode two' production of knowledge. In mode one, knowledge is generated, often with government assistance, by a research community accountable to its disciplinary peers. The Gibbons' thesis is that institutional changes in western societies (particularly where the market has started to eclipse the state as the primary decision-maker) have forced science to become more socially embedded and less hierarchical, thus defining the mode two type. The important point is that as societies and economic systems become ever more complex, the mode one type of production of knowledge becomes less able to respond to rapidly changing user contexts. Only by assuming the features of mode two production of knowledge can systems be designed to cope with complexity and rapid change.

The innovation system concept therefore provides a framework for: 1. exploring patterns of partnerships; 2. revealing and managing the institutional context that governs these relationships and processes; 3. understanding research and innovation as a social process of learning; and 4. thinking about capacity development in a systems sense. On this last point, Velho [2002] observes that national systems of innovation, made up of actors which are not particularly

strong, but where links between them are well developed, may operate more effectively than another system in which actors are strong but links between them are weak.

Six principles of the innovation systems framework

- Firstly, it focuses on innovation (rather than research) as its organizing principle. The concept of innovation is used in its broad sense of the activities and processes associated with the generation, production distribution, adaptation, and use of new technical, institutional, and organizational or managerial knowledge
- Secondly, by conceptualizing research as part of the wider process of innovation it helps identify the scope of the actors (including public, private, research, enterprise, and technology-users sectors) involved and the wider set of relationships in which research is embedded
- Thirdly, because it recognizes the importance of both technology producers and technology users and that their roles are both context- specific and dynamic, it breaks out of the polarized debates of 'technology-push' versus 'demand-pull' theories. Instead that it recognizes that both processes are potentially important at different stages in the innovation process
- Fourthly, it recognizes that the institutional context of the organizations involved and particularly the wider environment governs the nature of relationships, promotes dominant interests, and shapes the outcome of the system as a whole. This aspect is enormously important for introducing a poverty focus. The framework provides a lens to examine and reveal which agendas are being promoted, highlighting the arena in which the voice of the poor can be promoted
- Fifthly, it recognizes this as a social system. In other words, it does not just focus on the degree of connectivity between the different elements, but also the learning and adaptive process that make this a dynamic evolutionary system
- Sixthly, it is only a framework for analysis and planning, and as such it can draw on a large body of existing tools from economics, anthropology, evaluation, management and organizational sciences and so forth

Overview of work to date

Where have the last 3 years lead us, and what have been the outcomes? The research conducted under the project has firstly given us confidence that the innovation systems framework is a valuable way of conceptualizing the institutional context of post-harvest research and innovation. A great deal of time has been spent in thinking about what the concept means in terms of its application to agricultural innovation in a developing-country context and how it might be used.

The research has also used the innovation system framework to analyze a series of case studies of partnerships initiatives related to post-harvest innovation, including some of the CPHP's portfolio of projects in South Asia (Box 3 lists the case studies that have been conducted). Part of the work has concerned general analysis of the nature of Indian agricultural innovation systems (see Box 4). This empirical work has lead to a number of broad conclusions.

Firstly, our initial announcement of the death of the old linear technology

transfer paradigm was exaggerated! Our case-study work has certainly given us examples of instances where institutional change is starting to take place as a result of new forms of partnership. But, time and time again we found that in many areas, particularly (but not exclusively) in the public-sector research system, much institutional change is required before systems approaches to innovation

Box 3. Case studies of partnership and post-harvest innovation

CPHP projects

- Developing a quality assurance system for mango export in India. (Experiences of trying to develop export protocols through the collaboration of the export development authority, public research organizations and a framers' association)
- The sustainable retailing of post-harvest technology in India. (Experiences of developing and supplying a new packaging technology for tomatoes using a partnership-based approach)

Others

- Contrasting research arrangement in the public, private, and co-operative sectors using the illustration of the sugar sector in India
- Kerala Horticultural Development Programme, an example of a learning-based approach to developing research partnerships and linking farmers to markets
- Public–private sector partnership in the Indian seed industry
- Partnership-based approaches to commercialization of sorghum and pearl millet in southern Africa
- New institutional arrangements for developing pro-poor biotechnology capability in Andhra Pradesh
- Agro-processing and local markets through People's Technology Initiatives In India
- Mango processing by tribal communities in Gujarat
- The pomegranate innovation system in Maharashtra
- Building local capacities for traditional agro-processing: the case of indigo in Andhra Pradesh
- Food system innovations and the role of civil society organizations: the case of *Spirulina* technology in India.

can be adopted. Partially this is an issue of integrating and linking research organizations into the wider context of other sector stakeholders including the private sector, non-government and community-based organizations (Boxes 4 and 5). With this task in mind, our research has led to a number of lessons on the nature of the partnership process and ways partnerships and linkages could be promoted (see Box 6).

While the creation of new partnerships will be needed if innovation systems are to be strengthened, the institutional change required also concerns changing the 'rules of engagement' that would govern this integration and the relationships that stem from it. In particular conventions and arrangements that put poverty-reduction criteria firmly on the agenda of innovation efforts are still an area that needs much greater attention in many parts of the innovation system. Similarly the need to break down many of the hierarchies that currently characterize agricultural research and rural development interventions need to be replaced by more consensual approaches with broad-based (and genuine) participation of the diverse range of stakeholders involved in the sector.

Box 4. India's agricultural innovation system and challenges its faces

In India it is apparent that many of the elements of an effective agricultural innovation system are emerging. There is a strong and extensive public research system. There is a vibrant private sector. There are large numbers of skilled and committed rural development agencies in both the public and non-governmental centers and increasing efforts been made to foster linkages between different sectors. However the system is challenged, particularly with regard to the way that scientific organizations relate both to each other and to user sectors including the poor. The result is that scientific expertise remains locked up in research organizations. This will not be resolved until all the elements of the innovation system are able to work effectively together. This will require significant institutional reform.

Some of the issues to be addressed:

- Disciplinary segregation between different research areas relating to cross-cutting economic themes such as post-harvest
- Administrative segregation of research relating to agriculture and research relating to industrial development, including food science
- Hierarchical cultures within science, between science and social science, between research and knowledge transfer and use, leading to linear flows of information and technology, restricting joint learning and consensus building
- Organizational cultures in research establishments that discourage learning and only encourage the reporting of 'successes'
- Co-opting of participatory methods to camouflage existing behaviors and roles of scientist and poor technology users
- Research priority setting and evaluation by scientists and economists using principles of excellence in science and economic efficiency criteria. Weak accountability to society
- Lack of wide stakeholder participation in the agricultural research planning and implementation process
- A disconnect (underpinned by professional hierarchies) between the learning from science and development initiatives in the civil society sector and the priorities and practices in the formal research establishment
- A disconnect between research and policy, including a disconcert between policy advocacy for poverty reduction and policy advocacy for agricultural research, but also weak linkages between science, society, and policy in such regulatory areas as food safety, IPR, and biotechnology.

Our research suggests that partnerships, while making an important contribution towards this goal, need to be accompanied by the recognition that institutional change is needed in some of the fundamental areas that relate to the governance of agricultural science and technology. Our research has also shown that without institutional change the relevance of formal research organization reduces over time as they have no way to adapt their focus and activities to match the constraints and opportunities faced by technology users and society as a whole. It is for this reasons that institutional learning assumes such importance in strengthening innovation system performance (see Box 7 for definition of institutional learning). Table 1 provides a comparison between old and new, system-friendly institutional arrangements for research using an example from ICRISAT's partnership-driven approach in South Africa. Table 2 contrasts technology transfer and innovation systems models of innovations, illustrating

Box 5. Public–private interaction in India's agricultural innovation system

Private distribution of public technologies. The seed industry benefited from earlier policy liberalization and a successful private seed industry has emerged. Strong and positive interaction exists between the public sector and small-scale private seed distribution companies. However larger-scale seed companies, now an important source of new varieties and hybrids, feel that they suffer from a more competitive relationship with the public sector.

Private purchase of research services. In the horticultural sector contract research is starting to increase interaction between public and private sectors. However there are still significant institutional constraints that need to be addressed before such arrangements can become more widespread. These constraints concern contractual accountability, bureaucratic procedural norms, and institutional segregation among public agencies. Case studies of the sugar industry demonstrate how such concerns not only act as a disincentive for the private sector to engage with the public sector, but also how they greatly reduce the relevance of the technology and related services that the pubic sector can provide.

Public–private research partnerships. Collaborative research partnerships between the public and private sectors are still uncommon. The reasons why such patterns have yet to become widespread include a long history of separation and mutual mistrust between the sectors. Underpinning this problem are sharply contrasting views on the role of science and the way to apply it in a problem-solving context. This is made worse by a public administration system designed for a centrally-planned state where delays are frequent and the possibility of sudden policy changes can cause much uncertainty. This institutional environment is poorly suited to commercial working styles. Case studies also suggest a basic misunderstanding on the part of the public sector about the demand of the private sector. Whereas the public sector feels that its 'shelves' of un-adopted technologies are its greatest asset, the private sector is equally interested in public research expertise and infrastructure. This suggests that the nature of partnerships to exploit this synergy needs to involve knowledge sharing and developing technologies jointly, rather than simply transferring public products to the private sector

Source: Hall et al. 2002a.

the institutional issues that need to be analyzed when assessing the nature and effectiveness of innovation systems.

The task at hand is therefore two-fold, concerning: 1. the need to link up parts of the innovation system; and 2. ensuring that institutional arrangements allow the different parts to work in a systems fashion that is simultaneously pro-poor, provides incentives for broad based participation from diverse stakeholders and responsive to evolving development priorities and opportunities.

In terms of enhancing post-harvest innovation and its poverty relevance, a number of generic points emerge from our work over the last 3 years.

On the nature of post-harvest innovation

- Innovation in the post-harvest sector involves dealing with issues in complex systems that have both technical and socio-economic parts and often involve producers, market chain actors and consumers (Hall et al. 2003b)
- Both technical and institutional innovations are important (Hall 2002b)

Box 6. A dozen things we know about partnerships

1. Partnering is a pragmatic response to the need to accomplish complex tasks that cut across disciplinary, organizational, and sectoral mandates. Joint task identification and definition builds partnership. Forced partnerships and ritualistic partnerships have no value and will not be sustained
2. Partnerships should only last as long as there is a shared task to be accomplished and should not be viewed as a permanent linkage
3. Not all organizations have the appropriate skill to be good partners
4. While the clear definition of roles for all partners is important, it also needs to be recognized that the roles of partners change during the innovation process, with different partners assuming greater importance at certain times
5. Partnering helps sharing of resources, skills, and knowledge and thus is critical to learning and innovation. Not all organizations have a culture of learning. This restricts both their ability to partner and generate institutional innovations
6. Rigid institutional and organizational structures, particularly those with hierarchical designs tend to stifle learning and the development of iterative relationships with broader sets of partners
7. While it is easy to stereotype public–private and NGO organizations, and the organizational culture that goes with them, there is a need to examine these more closely in the analysis of project partnership viability
8. Successful partners have intuitive ways of identifying each other that relate to shared values, trust and complementarity. Shared history built up over previous partnerships obviously contributes to this. To promote partnership it is necessary to provide opportunities for this trust to develop
9. Partnership skills are part of a range of capabilities that help organizations innovate, and that are learned through interaction with partners and networks
10. How organizations learn and build up these skills is not yet entirely clear
11. The strengthening of learning processes in project partners appears to be a key area of capacity development
12. Activities that widen the interaction of organizations with other partners and networks are likely to be an important way of building up innovation capabilities, both in individual organizations and in wider national systems.

Box 7. Institutional learning

The concept of institutional learning concerns the process through which new ways of working emerges. It concerns learning how to do things in new ways. It asks the question 'what rules and norms have to be changed to do a new task or to do an old one better?' (e.g., how has our research approach changed in response to the need to improve the poverty relevance of our work and what else needs to change? What can we learn from activities that did not have expected outcomes?). A key aspect of this learning may involve learning how to learn better, a concept that the management and organizational theory literature refers to as 'double-loop' learning. The learning process is very context-specific and consequently institutional learning can lead to great diversity in approaches, partnerships, and strategies. Institutional learning is an inevitable and intuitive process, a fundamental property of all social systems. Where programs have explicit, systematic learning objectives and procedures, research management strategies can evolve and progress rapidly.

Source: Hall 2003a; Horton 1999

Table 1. Key features of the research management and technology promotion in contrasting institutional settings: SMIP[1] task networks and conventional agricultural research arrangements

	Conventional agricultural research arrangements	SMIP task network
Guiding agenda	Scientific	Developmental
Relationships involved	Narrow, hierarchical	Diverse, consultative
Partners	Scientists in other public agencies	Scientist, entrepreneurs, and development workers, from the public and private sectors
Selection	Predetermined by institutional roles defined by the arrangement of the research system	Coalitions of interest. Determined by the nature of task, national institutional context and skills and resources available
Role	Fixed. Predetermined by institutional roles defined by the arrangement of the research system	Flexible. Determined by the nature of task, national institutional context and skills and resources available
Research priority setting	Fixed. By scientists	Consensual. By regional stakeholders and by needs of task network
Work plans and activities	Fixed at beginning of project	Flexible, iterative
Mandate for research/task approach adopted	Fixed by institutional norms of the research system	Negotiated through coalitions of interest
Technology development and transfer approach	By scientists and extension staff	Participatory technology testing with farmers and agro-processing enterprises. Use of farmer groups for technology promotion
Knowledge produced	Technical/ scientific	Technical/scientific and institutional
Performance indicators	In scientific terms to other scientist	In development terms to donors. In terms of fulfilling role in task network to other partners
Responsibility for achieving impact	Other agencies dedicated to extension and technology promotion	SMIP scientists and their partners in task networks
Capacity building	Trained scientists and research infrastructure	Collective capacity of task networks, social capital, partnership skills

1. SMIP is the Sorghum and Millet Improvement Program of ICRISAT. This 20-year program has aimed to develop sorghum and millet improvement capabilities in southern Africa and promote the uptake of research products.

Table 2. Opposite end of the continuum: Models of agricultural innovation compared

Features	Transfer of technology	Agricultural innovation system
1 System features		
1.1 Actors involved	Mainly public research and extension organizations	Diverse combinations of actors from public, enterprise, NGO and CBO sectors
1.2 Patterns of relationship	Hierarchical arrangements with linear flows of information	Flatter more consultative relationships to exploit complementary resources and joint learning. Partnerships and alliances important
1.3 Sources of institutional innovation and learning	Centrally generated, blueprint model Static	Through experimentation by partners Evolving and dynamic
2 Role of different actors		
2.1 Technology users/farmers	Technology adoption	Source agro-ecological and socio-economic knowledge Undertaking research and adaptive testing Technology adoption Identifying research priorities and evaluating research performance
2.2 Private enterprise	Technology transfer	Technology transfer Knowledge of inputs and output markets and demands of technology users Source of research funding In-house research expertise Advocacy for policy change Evaluating research performance
2.3 NGOs	Technology transfer	Technology transfer Implementing research and development initiatives Market studies, enterprise development. Facilitating linkages between farmers and other agencies Facilitating the development of farmer organizations Advocacy for policy change Evaluating research performance Identifying research priorities
2.4 CBO	Technology transfer	Technology transfer Community based research and development initiatives Agro-ecological and socio-economic knowledge Evaluating research performance Identifying research priorities
2.5 Public research organizations	Conducting research. Identifying research priorities and evaluating research performance Passing technologies to specialist technology transfer organizations	Partner providing research services, technology and technical backstopping Creating regulatory framework Linkage with international scientific community

Table 2. continued....

2.6 Policy bodies	Resource allocation. Passive recipient of policy research recommendations	Strengthening the enabling environment of innovation systems Active partner in the research process
2.7 Donors	Sources of funds	Clients and partners in the research process
2.8 International agencies		Program management and oversight Linkage to source of funds Technology supply Research services Linkage facilitation
3 Governance of R&D		
3.1 Scope of participation	Limited	Consultative with many partners, including farmers and technology users
3.2 Accountability	Limited to peer review	Collective and to society and technology users directly
3.3 Scope of vision and goals	Scientific	Developmental focusing on livelihood security
4 Wider context		
4.1 Relationship with wide institutional and political context	Disconnected	Embedded
5 Capacity building		
5.1 Focus	Research capacity of the existing research organization	Evolutionary capacity of entire agricultural innovation system
5.2 Composition of capacity	Research personnel and their scientific skills, research infrastructure, level of research funding	Individual capacities of different organizations collective capacity of temporary coalitions and alliances Longer term capacity arising from development of partnering skills and joint learning
6 System performance impact		
6.1 Criteria	Scientific and economic outcomes	Developmental outcomes and institutional or behavioral changes in the system
6.2 Method of evaluation	Peer review by scientists and economists	Expert review by public and private sectors, science and non-science stakeholders
6.3 Indicators	Citation analysis, technology adoption rates Economic rates of return to research investments	Changes in livelihoods and other socio-economic outcomes Evidence of new partnerships, consensual approaches and other processes that promote pro-poor innovation

- Formal R&D is only one of a series of related tasks required to bring about post-harvest innovation. It requires collaboration between different scientific disciplines, between researchers and technology users and between public and private sectors. It is sometimes useful to involve an organization to act as a catalyst facilitating this pattern of broad-based collaboration. (Hall et al. 2001a; Rasheed Sulaiman and Hall 2002; Clark and Mugabe 2003)
- The institutional context of these collaborations or partnerships is a key determinate of their direction and outcome (Hall et al. 2001)

On institutional change

- There is a generic concern relating to the need to build stronger and more consultative linkages between public-sector science and other actors in the innovation system. There is a need to address a broad range of institutional features of the current agricultural innovation systems that prevent these linkages developing. Static and compartmentalized roles, combined with a poorly developed learning culture are institutional issues that need specific attention (Hall et al. 2000; 2001a; 2002a)
- Supporting institutional change requires long-term commitment on the part of donors and policy agencies. This is particularly so because successful institutional change is observed to emerge indigenously, through trial and error in response to local circumstances (Clark et al. 2002; Hall and Yoganand 2003)
- Transferred institutional models or blueprints rarely succeed (Hall et al. 2000; Rasheed Sulaiman and Hall 2002).

On partnerships

- Successful projects have been those that have focused specifically on establishing coalitions of local actors around a particular problem area or task. These actors include scientific ones, but not exclusively so and not necessarily as the leading actors. Similarly, roles may evolve over time (Reddy et al. 2001; Clark et al. 2003, in press; Hall 2003; 2002)
- The selection of the most appropriate grouping of partners is very often an empirical question that cannot realistically be answered at the outset of a project. Projects should allow for this with inception phases and mechanisms that allow the introduction of new partners or replacement of old ones (Rasheed Sulaiman and Hall 2002; Hall 2003; 2002; Clark et al. 2003, in press).

On institutional learning

- There is a tendency, reinforced by the output-oriented, problem-solving framework of the conventional project cycle, to under report process or institutional innovations and lessons associated with technological success (or failure.) These lessons are often complementary innovations to the new technical knowledge and its application. This institutional learning should be part and parcel of technical projects and their outputs (Hall et al. 2002b; 2003a)
- If institutional or process lessons and innovations are to be fostered as a research output, an action research approach should be used. To implement

this approach self-reflection and process monitoring and documentation skills will need to be developed in project teams. This is particularly so where team members come from formal scientific research organizations where the learning culture is poorly developed (Hall and Rasheed Sulaiman 2003; Hall et al. 2003a; 2003b)
- Institutional learning and change is often highly contested. It rarely succeeds if it is driven by only one or two individuals, particularly if they are relatively junior in an organization. Institutional change can be prevented or legitimized depending on the support or otherwise of key senior figures, particularly directors of organizations, or senior bureaucrats in donor and policy bodies (Reddy et al. 2001; Clark et al. 2002a; Hall et al. 2003a)
- Organizations that are willing to experiment and learn are the ones that succeed. Often successful approaches develop and evolve along the way. Projects and organizations that encourage continuous institutional learning seem more likely to succeed (Clark et al. 2003, in press; Hall et al. 2003b)
- Research approaches that support institutional learning and change (as arguably all do to varying extents) need to be recognized for their contributions to developing the capacity of innovation systems. This needs to be considered when planning monitoring and evaluation procedures, as it is behavioral changes within the innovation system that will indicate progress towards such longer-term goals as poverty reduction. (Hall 2002; Clark et al. 2003, in press).

On poverty focus

- The relative degree of poverty focus is related to the agendas of different project partners and the dynamic that determines how these agendas are promoted in the project. To succeed projects often have to introduce specific institutional changes or arrangement to achieve this poverty focus; for example, deciding to work only with landless groups or tribal communities (Rasheed Sulaiman and Hall 2002; Hall and Rasheed Sulaiman 2003; Abrol 2003)
- Needs assessment and participatory approaches, while valuable, have been much less important in ensuring a poverty focus than the agendas of the stakeholders involved in a given project These stakeholders include both members of the research team as well external individuals and organizations (Underwood 2002)
- Revisiting during the project key assumptions about, for example, roles of partners and technology users, relevance of project outcomes to livelihoods, and the changing agendas of different stakeholders, helps maintain a poverty focus in projects (Underwood 2002)
- There are still unanswered questions about the way organizations build up skills that allow them to participate in the innovation process in pro-poor ways and how these types of behavior and practices can be introduced into innovation systems (Hall 2002).

Emerging issues

During the course of the research it became apparent that the question of how organizations engage in institutional learning, and how this can be promoted

was central to developing post-harvest innovation systems capacity. Take, for example, the case of the IDE(I) tomato packaging project (see Clark et al. 2003, in press for detailed discussion). This project had developed an important institutional innovation in technology identification, adaptation, and supply using a market-based total-systems approach that was relatively pro-poor. The project was particularly notable for the way it developed a range of partnerships with different organization during the course of the project. The roles of the different partners evolved over time (see Table 3), with IDE(I) playing facilitative role allowing the project and its partnerships to evolve in useful ways. The project was very successful in establishing a pilot commercial system to supply 30,000 cardboard cartons to small-scale tomato producers by the end of the third year of the project.

At best the only way to describe the learning (and implementation) process was as 'intuitive' and it was unclear what practical advice could be given to other organizations or groups of partners who wanted to evolve their own approach through a similar process of institutional learning and change. This does not

Table 3. Who does what and when: Multiple partners and evolving roles from the case of IDE(I)

Partners/ roles in each phase	Problem definition	Technology and partners search	Technical development and testing	Establishing product and supply system
Lead organization	Consulting, collating, negotiating	Identifying technology and facilitating partnership development	Coordinating activities of different partners and managing relationships	Coordinating activities of different partners and then withdrawing
NGO	Facilitating local consultation		Facilitating farmer participation in adaptive testing	Facilitating farmer groups' access to credit to pre-finance technology production
Scientific research organization		Advising on available knowledge and technology	Researching technology performance	Publishing
Farmers' groups	Advising on problem definition		Testing technology advising on technology performance	Pre-financing of technology production Adoption of technology
Market actors	Advising on marking systems		Testing technology advising on technology performance	Distributing new technology
Manufacturers		Advising on available knowledge and technology	Modifying technology	Producing technology

detract from what IDE(I) achieved, it just highlights that there is obviously much more that needs to be known about how R&D organizations learn through their activities and through the partnering process. Another case examined was the Kerala Horticultural Development Programme and its efforts to link producers with both markets and technology (see Rasheed Sulaiman and Hall 2002 for detailed discussion). Again a learning approach underpinned its success and informed its partnership strategy, but how it actually did this is less clear.

A similar example can be found with the case of the efforts of Dastkar Andhra, a civil- society organization attempting to reintroduce production, processing and use of indigo to weaving communities in Andhra Pradesh (see Box 8). In the Dastkar Andhra's own words, it developed an approach through experimentation, failing and learning, recognizing that there was an important formative role for organizations that were willing to fail. What is less clear is precisely the nature of the process through which the organization learned and built up its learning skills and what practical tips another organization could borrow from this example.

Emerging from this is the conclusion that while institutional learning and change has clearly underpinned the successes of some of our successful examples of post-harvest innovation, ways of promoting this remains an empirical question. Before we discuss ways of approaching this question it is useful to pause and reflect on what has been the outcome or impact of this work on post-harvest innovation systems and the novel application of the national systems of innovation framework. We reflect on this is at this point because our success to date in promoting institutional change through our work holds lessons for future ways of exploring this issue.

What has been achieved

The research reviewed in this paper has lead to a significant number (approximately 30) of publications. Almost half of these are peer-reviewed articles, the rest being policy briefs, network papers, book chapters, international conference papers, and workshop proceedings. We point out this achievement, as it was an import component of our strategy of making innovation systems analysis of post-harvest R&D a credible and visible approach. In addition to publishing this material we have mailed hard copies to an Indian and international audience. But what has been the impact of all of this? Have we actually changed research management strategies? One of our targets was the DFID research programs (of which CPHP is one). While acknowledging the efforts of others we feel that our research on innovation systems played an important role in paving the way for the adoption of innovation systems as a core principle of the coalitions approach of CPHP (this is discussed in detail in Hall and Sulaiman 2003). We also had success with DFID's Livestock Production Programme (LPP) and we were set to use the innovation systems approach to explore the design of LPP's 'dissemination' strategy in India – but this was unfortunately thwarted by the diversion of funds within DFID.

In the Indian agricultural science community, and notably among agricultural economists, the innovation systems term has entered the lexicon of policy debate. For example, a recent conference of the prestigious Indian Academy for Agricultural Science convened to discuss agricultural research policy, not only concluded with

Box 8. The re-introduction of indigo: a case of experimentation and learning

This case involves the reintroduction, over a 10-year period, of indigo production and processing technology. Central to this was the role played by Dastkar Andhra (DA), a civil-society organization providing research and consultancy services to the artisanal sector. The intention has been through three distinct phases. The first concentrated on introducing the indigo crop. This was generally viewed as unsuccessful. It revealed, however, that information on indigo, indigo processing, and its quality and price, while widely documented in the specialist literature, was almost nil amongst weavers. DA learned that an indigo-growing project needed to be formulated as an experiment as well as a commercial feasibility study. Similarly, the process needed to be driven by an independent interest group emerging around indigo products and that this would require the intervention to be rooted in strong local partnerships.

The next phase took place a number of years latter. Through its role of marketing the handloom products of a number of cooperative societies DA recognized that there was a demand for indigo-dyed cloth. Building on past experience DA realized that growing indigo would need to be supported by other activities. A key intervention was seen as the introduction of indigo dying vats amongst weavers who never dyed their yarn and had become separated from the dyeing process. A dyer with knowledge of the vats was brought to live in a weavers' village in order that he could set up a vat. A series of village-level seminars was subsequently held as a way of disseminating the technology in context. The seminars brought together a number of different groups, among who were indigo growers, indigo traders, weavers, designers, natural dyeing experts and buyers of the final product – indigo-dyed cloth.

The third and more recent phase approached the tasks in a much more integrated fashion building on the lessons from the earlier experiment with indigo growing which was seen as having failed primarily due to the lack of strong partnerships at the field level. The project entitled, 'Action Research in Indigo in Andhra: Growing, Processing and Dyeing' involved three components: 1. the use of archival research to reintroduce practices of indigo cultivation, 2. to fuse this with experimentation in the field, which would demonstrate cultivation, processing and dyeing of indigo is a viable occupation, and 3. to link these activities with weavers and to establish a market for end products, i.e., indigo cakes and indigo fabric. In other words an interest group for the product was developed simultaneously with activities on indigo production and processing. Re-forging links between growers of indigo, dyers, and weavers was an important aspect of this project.

DA recognizes the following key lessons:

- The first phase while unsuccessful was important because it was an experiment that nobody else was willing to make and the only knowledge that existed resided either in books or amongst few individuals of communities who were no longer producing indigo. The insights gained and the ideas developed laid the foundation for subsequent steps and placed the private knowledge of a few in the public domain
- In order to take the first steps beyond identification of needs and begin addressing them through experiments or programs, strong partnerships in the field are needed
- While the NGO can initiate the process of knowledge or innovation rooting in local contexts the success or failure of this attempt seems to depend on the participatory networks that it is able to create and sustain. The same is true for the dissemination phase where networks and partner are seen as key
- There is an apparently value to DA's role of linking various players – farmers, traders, weavers, the market, government agencies, and research organizations.

A generic point is that none of this could take place without DA approaching this task experimentally, while undertaking learning jointly with stakeholders thus determining what would be the next step. In other words to make the intervention successful it was necessary for the external agencies to engage in an evolutionary process where the way of approaching the reintroduction of an agro-processing activity was the central empirical question that needed to be pursued over many years.

Source: Seemanthini Niranjana 2003

an expression of the need for institutional change, but it also recognized that the innovation systems approach is a suitable way to proceed. We presented our work on partnerships and innovation systems in the post-harvest context (Hall et al. 2002c) and our participation in this conference had a significant impact on this debate and its outcome (see Raina and Abrol 2002).

Those of us working in the Indian agricultural research system are increasingly receiving requests for information on innovation systems. The concept has been presented at a number of important conferences and workshops and is again attracting attention, particularly among mid-career professionals to whom it is all too clear that a practical way of engaging with institutional issues is the need of the hour. As part of the India science community, with our intimate knowledge of this institutional context, we believe that the institutional edifice is starting to crumble. There are people with alternative perspectives on innovation, but they lack a collective voice and mutual support systems.

We have also had some impact on the Consultative Group on International Agriculture Research (CGIAR) system. An external review of economics and policy research at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) concluded that the work on innovation systems was one of only three significant methodological developments to have been achieved by ICRISAT in the last 5 years. Our work on innovation systems has created interest at a series of CGIAR international conferences. It is starting to have an impact on the way impact assessment work in the CGIAR is being discussed (for example see IFPRI 2003) and our research team has been closely involved an proposal to attract donor support for institutional learning and change backstopping for a number of the CG centers.

Its also important for us to acknowledge that the emergence of the innovation systems debate in the agricultural research sector has had a number of sources, but we are clearly one of those sources (Coincidently, DFID has used the innovation systems approach in its recent research policy review). Similarly, innovation systems are one of the key themes on which the reformed International Service for National Agricultural Research (ISNAR) will focus its work. Our work may not yet be impacting on the conduct of post-harvest innovation directly in a general sense (nor would it be expected to have done so by this stage), but it has certainly impacted on the debate surrounding agricultural innovation policy.

Where we have failed and what we have learned

We also acknowledge the shortcomings in the work we have conducted so far. In this regard we are grateful to Dr Stephen Biggs (University of East Anglia, UK), who pointed out to us that we failed to heed the advice we were promoting as policy researchers, i.e., the need to develop our own coalition of partners around the promotion of the innovation systems framework as an alternative approach to post-harvest R&D in India. The idea of developing an informal network or community of practice is an approach that has been used to great effect elsewhere – a good example is the advocacy associated with participatory approaches to development and the subsequent spread of these. A similar case is the way powerfully placed agricultural economists within the CGIAR system have managed to advocate the use of certain types of impact assessment methodology despite

the existence of other forms of evaluation preferred by other professional groups.

We now recognize that without the creation of such a network of support and advocacy, a policy research project stands little chance of creating a new consensus that can challenge the normative organizational culture of R&D establishments and the institutional context that this implies. This is particularly true with regard to large public agencies responsible for post-harvest and other areas of agricultural R&D, but the same applies to other organizations and stakeholders in the innovation system who need to be part of the institutional change process. We also now realize how important it is that the coalition or community of practice advocating systems approaches will require the involvement of poor people if the system approach is going to lead to institutional change for pro-poor innovation. Exploring ways of engaging in local knowledge systems is an important element of this task.

A rationale for interactive policy research approach to institutional learning and change

Flowing from the above are three major concerns that further research in this area must address. Firstly, and as already stated, the main thrust of enquiry needs to be on understanding how institutional learning and change takes place, and how it can be strengthened and promoted. Secondly, ways of exploring how learning takes place is an empirical question in itself. Furthermore, a research question of this type would lend itself to an action research approach whereby ways of building learning and change capabilities are investigated in real time and supplemented with case histories from wider experience. Thirdly, the research and capacity-building action research activities need to be embedded in a bigger task of developing a community of practice that simultaneously builds consensus and advocacy as well as linking research into the range of stakeholder interests (farmer to policy-makers) associated with how innovation is organized and promoted. To make the same point differently, this suggests an approach whereby research is used to feed training and facilitated institutional learning and change activities which themselves then form the basis for the development of a network or community practice. This is very much a shift in direction away from the formal policy research that we conducted in our earlier work, where the approach was to develop broad principles and recommendations for research managers and planners.

This mixed approach to policy research that we suggest should be referred to as **interactive policy research** signifying the iterative, systems nature of the approach and distinguishing it from the conventional linear policy approach critiqued by, for example, Sutton (1999). In addition to the conclusions we draw from our earlier research, advocacy for such an approach can also be seen in recently published reviews of the organizational development literature (Ticehurst and Cameron 2000) and the evaluation and capacity development literature (Horton 2002; Horton and Mackay 2002; Stein 1997). These sources stress the need to design, negotiate, and implement change (e.g., new policies and institutional arrangements) with the full participation of the stakeholders involved. Beijer and Holland (2001), for example, provide an example of how this interactive

policy approach has been used to develop agricultural extension policy in Albania. Horton (2002) provides a useful definition of capacity development that highlights the reason we give such importance to an interactive policy research perspective: 'the process by which individuals, groups, and organizations improve their ability to perform their functions and achieve the desired results over time.'

This institutional learning and change agenda also concerns the need for research teams to learn how to operationalize this interactive policy approach. This in itself will be a key source of institutional and methodological lessons. The perspective of removing the (notional) distinction between the researched and the researchers is emerging as central to much of the debate about good practice in development (e.g., Abbot and Guijt 1998; IDS 1998; IDS 2001) and there is considerable literature on ways of pursuing such approaches (Lusthaus et al. 1995; Bainbridge et al. 2000; Lawrence et al. 2002). Of course, the innovation systems framework attaches similar importance to these learning mechanisms. Indeed, as this perspective notably recognizes, relationships and interactions between agents have to involve non-price relationships and that while the transaction costs theory of institutions (for example North 1990) cannot explain the dynamics of such systems, an interactive learning theory of institutions can (Lundvall et al. 2002).

Practical considerations

How could these ideas be operationalized in the practical sense of a research project? The conventional case-study methods will still be important in understanding learning. The novelty of the interactive policy research approach that we are suggesting here, however, is in the use of this case-study material to illustrate in training and capacity development exercises the different ways of supporting pro-poor, post-harvest innovation. The form of this capacity development is a well recognized approach. Again we draw on a recent review of several decades of work on capacity development (Horton 2002) that concludes that **learning by doing, or experimental learning,** lies at the heart of capacity development. Horton suggest that a balanced approach that includes small amounts of formal training should be accompanied by facilitating change processes in pilot-case organizations and using the learning from this pilot work to feed a network generating and applying knowledge on institutional innovation.

Conclusions

By way of conclusion we would like to make three points. Firstly, policy research on institutional change and innovation has to be at the heart of efforts to exploit, in pro-poor ways, such technology domains as post-harvest. The involvement of the poor as part of the social process of learning and innovation requires complementary streams of technical and institutional knowledge that not only tell what can be done, but also how this **doing** can be achieved.

Secondly, the progress and outcomes of our research to date demonstrate that policy research can make an impact on the praxis of post-harvest innovation, although we acknowledge that there is much work still to be done. A significant task in this regard is to strengthen ways of developing capacity for pro-poor

innovation through institutional learning and change.

Thirdly, based on our research findings and what we now know about the process of institutional change, we suggest that the next task for research is to explore institutional learning and capacity development in greater detail. We also suggest that an interactive policy-research methodology should be employed to ensure an action research orientation, placing the work in real life (and real time), interactive, post-harvest innovation contexts. This needs to be linked to greater efforts in developing a community of practice promoting consensus and change.

Endnote
This paper is the output from a research project funded by the United Kingdom Department for International Development (DFID). The views expressed are not necessarily those of DFID [R7502: Crop Post-Harvest Programme].

References

Abbot J, and **Guijt I.** 1998. Changing views on change: participatory approaches to monitoring the environment. Sustainable Agriculture and Rural Livelihoods Discussion Paper 2, London, UK: International Institute for Environment and Development (IIED).

Bainbridge V, Forester S, Pasteur K, Pimbert M, Pratt G, and **Arroyo I Y.** 2000. Transforming bureaucracies. Institutionalising participation and people centred processes in Natural Resource Management. An Annotated Bibliography. London, UK: International Institute for Environment and Development (IIED) and the Institute of Development Studies (IDS). 209 pp.

Beijer W, and **Holtland G.** 2001. Pro-active policy and organisational development. Paper presented at the 15th European Seminar on Extension Education (ESEE) meeting, 27–31 August. Wageningen, The Netherlands: ESEE.

Biggs S D. 1990. A multiple source of innovation model of agricultural research and technology promotion. World Development 18: 1481–1499.

Blaikie P K, Brown M, Stocking L, Tang P, Dixon P, and **Sillitoe P.** 1997. Knowledge in action: local knowledge as a development resource and barriers to its incorporation in natural resource research and development. Agricultural Systems 55(2): 217–237.

Clark N G, and **Mugabe J.** 2003. Strengthening science and technology in the field of environment and development: the case of the African Centre for Technology Studies Capacity Development Programme. Pages 65–67 *in* Post-harvest innovations in innovation: reflections on partnership and learning. DFID Crop Post-Harvest Programme, South Asia, Patancheru 502 324, Andhra Pradesh, India, and Natural Resources International Limited, Aylesford, UK.

Clark N, Yoganand B, and **Hall A J.** 2002. New science, capacity development and institutional change: the case of the Andhra Pradesh–Netherlands Biotechnology Programme (APNLBP). International Journal of Technology Management and Sustainable Development 11(3): 195–212.

Clark N G, Hall A J, Rasheed Sulaiman V, and **Guru Naik.** 2003. Research as capacity building: the case of an NGO-facilitated post-harvest innovation system for the Himalayan Hills. World Development 31(11) (in press).

Freeman C. 1987. Technology and economic performance: lessons from Japan. London: Pinter. 342 pp.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, and **Troww M.** 1994. The new production of knowledge, London, UK: Sage. 192 pp.

Hall A J. 2002. Innovation systems and capacity development: agenda for North–South research collaboration? The International Journal of Technology Management and Sustainable Development (December special edition) 1(3): 146–152.

Hall A J. 2003. New patterns of partnership in agricultural research in Africa: Recent experiences from SADC/ICRISAT Sorghum and Millet Improvement Program (SMIP), Phase IV. Socioeconomics

and Policy Working Paper Series. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (in press).

Hall A J, and **Rasheed Sulaiman V.** 2003. Post-harvest innovation systems in South Asia: research as capacity development and its prospects for pro-poor impact. Outlook on Agriculture (under review).

Hall A J, and **Yoganand B.** 2003. New institutional arrangements in agricultural R&D in Africa: concepts and case studies. Pages 97–104 *in* Proceedings of the international conference on Targeting Agricultural Research for Development in the Semi-Arid Tropics of Sub-Saharan Africa, 1–3 July 2002, Nairobi, Kenya. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Hall A J, Clark N G, Rasheed Suliaman V, Sivamohan M V K, and **Yoganand B**. 2000. New agendas for agricultural research in developing countries: policy analysis and institutional implications. Knowledge, Policy and Technology 13(1): 70–91.

Hall A J, Sivamohan M V K, Clark N G, Taylor S, and **Bockett G**. 2001a. Why research partnerships really matter: innovation theory, institutional arrangements and implications for the developing new technology for the poor. World Development 29(5): 783–797.

Hall A J, Yoganand B, Rasheed Sulaiman V, and **Clark N G. (eds.)** 2001b. Sharing perspectives on public–private sector interaction. Proceedings of a workshop, 10 April 2001, ICRISAT, Patancheru, India. Library Avenue, Pusa, New Delhi 100 012, India, and Patancheru 502 324, Andhra Pradesh, India: National Centre for Agricultural Economics and Policy Research (NCAP) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). 48 pp.

Hall A J, Rasheed Suliaman V, Clark N G, Sivamohan M V K, and **Yoganand B**. 2002a. Public–private sector interaction in the Indian agricultural research system: an innovation systems perspective on institutional reform. Pages 156–176 *in* Agricultural research policy in an era of privatization: experiences from the developing world (Byerlee D, and Echeverria R G, eds.). Wallingford, Oxon, UK: CAB International.

Hall A J, Clark N G, Rasheed Sulaiman V, and **Taylor S.** 2002b. Institutional learning through technical projects: horticultural technology R&D systems in India. The International Journal of Technology Management and Sustainable Development 1(1): 25–39.

Hall A J, Rasheed Sulaiman V, Yoganand B, and **Clark N G.** 2002c. Partnerships in the Indian agricultural innovation system: lessons and ways forward. Paper for workshop on Agricultural policy: redesigning R&D to achieve the objectives. Sponsored by National Academy of Agricultural Sciences (NAAS), co-sponsored and organized by Centre for Advancement of Sustainable Agriculture (CASA), National Institute of Science, Technology and Development Studies (NISTADS), National Centre for Agricultural Economics and Policy Research (NCAP), 10–12 April 2002.

Hall A J, Suliaman R V, Clark N G, and **Yoganand B.** 2003a. From measuring impact to learning institutional lessons: an innovation systems perspective on improving the management of international agricultural research. Agricultural Systems (in press).

Hall A J, Sulaiman R V, Yoganand B, and **Clark N G.** 2003b. Post-harvest innovation systems in South Asia: research as capacity development and its prospects for pro-poor impact. Outlook on Agriculture 32(2): 97–104.

Horton D. 1999. Building capacity in planning, monitoring and evaluation: lessons from the field. Knowledge, Technology and Policy 11(4): 152–188.

Horton D. 2002. Planning, implementation, and evaluating capacity development. ISNAR Briefing Paper No. 50. The Hague, The Netherlands: International Service for National Agricultural Research (ISNAR).

Horton D, and **Mackay R.** 2002. Evaluating organizational capacity development in the area of planning, monitoring and evaluation. The Hague, The Netherlands: International Service for National Agricultural Research (ISNAR). 13 pp.

IDS. 1998. Participatory monitoring and evaluation: Learning from change. IDS Policy Briefing issue no. 12 (November). Brighton, UK: Institute of Development Studies.
www.ids.ac.uk/ids/bookshop/briefs/breif12.html (accessed 10 Dec 2000)

IDS. 2001. The new dynamics of aid: procedures and relationships. IDS Policy Briefing issue no. 15 (August). Brighton, UK: Institute of Development Studies.
www.ids.ac.uk/ids/bookshop/briefs/brief15.html (accessed 15 Nov 2002)

IFPRI. 2003. Institutional learning and change in the CGIAR: Summary record of workshop held at IFPRI, Washington, USA, 4–6 Feb 2003. Washington DC, USA: International Food Policy Research Institute (IFPRI). 59 pp

Lawrence T B, Hardy C, and **Philips N.** 2002. Institutional effects of interorganisational collaborations: the emergence of proto-institutions. Academy of Management Journal 45: 281–290.

Lusthaus C, Anderson G, and **Murphy E.** 1995. Institutional assessment : a framework for strengthening organizational capacity for IDRC's research partners. Ottawa, Canada: International Development Research Centre (IDRC). 88 pp.

Lundvall B A. (ed.) 1992. National systems of innovation and interactive learning. London, UK: Pinter.

Lundvall B, Johnson B, Andersen C, and **Dalum D.** 2002. National systems of production, innovation and competence building. Research Policy 31(2): 213–231.

North D. 1990. Institutions, institutional change and economic performance. Cambridge, UK: Cambridge University Press.

Raina R S, and **Abrol P.** 2002. Learning to change. Current Science 83(5): 547–548.

Rajeswari S. 1995. Agricultural research effort: conceptual clarity and measurement. World Development 23(4): 617– 635.

Rasheed Sulaiman V, and **Hall A J.** 2002. An innovation systems perspective on the restructuring of agricultural extension: evidence from India. Outlook on Agriculture 30(4): 235–243.

Reddy B V S, Hall A J, and **Rai K N.** 2001. The long road to partnership: private support of public research on sorghum and pearl millet. Pages 27–34 *in* Sharing perspectives on public–private sector interaction. Proceedings of a workshop, 10 April 2001, ICRISAT, Patancheru, India. (Hall A J, Yoganand B, Rasheed Sulaiman V, and Clark N G, eds.). Library Avenue, Pusa, New Delhi 100 012, India, and Patancheru 502 324, Andhra Pradesh, India: National Centre for Agricultural Economics and Policy Research (NCAP) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Seemanthini Niranjana. 2003. Trajectories in the indigo story. Dastkar Andhra (Draft manuscript). 11pp.

Stein J. 1997. How institutions learn: a socio-cognitive perspective. Journal of Economic Issues 31: 729–740.

Sutton R. 1999. The policy process, an overview. ODI Working Paper no. 118. London, UK: Overseas Development Institute (ODI).

Ticehurst D, and **Cameron C.** 2000. Performance and impact assessment: emerging systems among development agencies. NRI Policy series 8. Chatham, UK: Natural Resources Institute. 6 pp.

Underwood M P. 2002. Annual poverty relevance review of DFID's Crop Post-Harvest Programme projects in South Asia – 2002. Patancheru 502 324, Andhra Pradesh, India: CPHP South Asia Regional Co-ordination Office. 37 pp.

Velho L. 2002. North-South collaboration and systems of innovation. International Journal of Technology Management and Sustainable Development 1(3): 195–212.

Institutional learning and innovation: origins and implications for future research and capacity building

A J Hall,[1] R V Sulaiman,[2] and R S Raina[3]

Abstract

There is a growing realization in the Consultative Group on International Agriculture Research (CGIAR) that impact assessment approaches need to expand their scope to include an institutional learning and change (ILAC) perspective. This paper summarizes a presentation made at a recent workshop to discuss how these perspectives might be promoted. It is suggested that an innovation systems conceptual framework is a useful starting point for thinking about the institutional context of research and the process of change. This context is often overlooked and there are many examples of hidden histories of research where valuable institutional lessons are not learned in a systematic fashion. A broad implication of this way of thinking is that ILAC will need to be supported by action research approaches and that this will involve a large degree of capacity development with scientists developing new skills and ways of working. The scope of these activities should not be confined to CGIAR centers alone, but rather to the whole range of actors relevant to contemporary agricultural innovation systems.

Introduction

This paper summarizes a presentation made at a recent Consultative Group on International Agriculture Research (CGIAR) workshop held at the International Food Policy Research Institute (IFPRI) in February 2003 to discuss the need for institutional learning and change and to consider options for taking this agenda forward. The context is a growing appreciation that while impact assessment exercises have a useful accountability function, the approach is not an appropriate way to stimulate learning and/or institutional and organizational changes, and thus improve impacts on poverty. This realization stems from a number of sources, particularly a recent poverty impact assessment exercise conducted by the International Food Policy Research Institute (IFPRI) and its partners. This study was novel in that it examined poverty rather than economic impact and that it employed tools to explore the wider livelihood context of the poor. These so-called **wave I** studies not only revealed the complexity of rural livelihoods to the research teams, but also that the issue of technology impact was related to process and to institutional issues associated with research and technology promotion procedures. The preliminary findings of this work presented at a CGIAR conference in January 2002 in Costa Rica had many parallels with a series of presentations

1. University of Greenwich, UK, seconded to International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India
2. National Centre for Agricultural Economics and Policy Research (NCAP), PO Box 11305, Library Avenue, Pusa, New Delhi 110 012, India
3. National Institute of Science, Technology, and Development Studies, K S Krishnan Marg, New Delhi 110 012, India

by another small group of CG scientists who had concerns about the effectiveness of impact assessment as a way of strengthening the poverty impact of research.

The outcome of these events was that a decision was made by IFPRI to refocus its second wave of poverty impact studies, adopting an institutional learning and change (ILAC) orientation. Over the last 12 months support from the Rockefeller Foundation has been used to organize and hold a 3-day workshop to explore what an ILAC orientation might mean in a second wave of studies, and how these could be implemented and supported.

This paper outlines some of the concepts and origins of ILAC and draws some preliminary conclusions about the impactions of adopting such an approach. We begin with some definitions.

Institutional learning and change (ILAC)

Definitional clarity

The terms **institution** and **organization** are sometimes used to mean different entities and sometimes refer to the same entity. Different meanings are assigned to these concepts in different professional and disciplinary contexts, but there is a tendency within the CGIAR to use them interchangeably. This inconsistency can lead to misunderstandings. The term **institution** in this paper is being used to mean norms, routines, habits, ways of doing things, or behavior and not as a synonym for **organizations.**

Learning is used here to refer to adaptive, interactive processes of changing norms through new knowledge on ways of doing things. Learning is viewed as a way of creating new behaviors as well as new knowledge.

Institutional learning is about the process through which new ways of working emerge. It is therefore central to any discussion about ways of improving the impact of agricultural research.

It would be helpful to the advancement of ILAC within the CGIAR if the current ambiguous or loose use of terms were addressed, thus allowing greater clarity in the communication of concepts and approaches.

Multiple disciplinary origins

There is a long and disciplinary-diverse history associated with the theory and practice of learning. Some of the influences come from:

- Evolutionary economics (implicit in pre-neoclassical economics and remerging in the 1980s)
- Organizational learning (1970s)
- Systems thinking (1930s, but remerging in the 1980/90s through the work of Checkland[4] and others)
- Action research (1960/70s)
- Capacity development (1980s)
- Program evaluation (1970s)

4. Checkland P. 1983. System thinking and systems practice. Chichester, Sussex, UK: John Wiley and Sons

- Participatory learning and action and participatory monitoring and evaluation (1980/90s)
- Agricultural research management perspectives that recognize the multiple sources of agricultural innovation (1990s)
- Innovation systems (1980/90s)

All of these perspectives implicitly and explicitly recognize the evolutionary nature of social systems. These systems are characterized less by the pursuit of an optimal blueprint or model and more by adaptive behavior and slow, cumulative change. Learning is therefore not only a fundamental property of such systems, but it is also the driving force for dealing with changing circumstances and improving performance and effectiveness.

Innovation systems perspectives

Since our perspective as presenters is that of **innovation systems,** we will explain in brief how this conceptualization deals with institutional learning and change. We believe its value to the ILAC initiative in the CGIAR is that it deals directly and explicitly with the institutional context of research and recognizes the evolutionary nature of the systems in which research is embedded. It thus provides a more-nuanced, fine-grained account of the way techno-economic change takes place, providing insights into ways of improving this as a process. The following 7 points provide a useful introduction to the principles of innovation system thinking.

1. It focuses on innovation (rather than research) as its organizing principle. The concept of innovation is used in its broad sense of the activities and processes associated with the generation, production, distribution, adaptation, and use of new technical and institutional and organizational or managerial knowledge.
2. By conceptualizing research as part of the wider process of innovation it helps identify the scope of the actors (including public, private, research, enterprise, civil-society organizations, and technology-users sectors) involved and the wider set of relationships in which research is embedded.
3. Because it recognizes the importance of both technology producers and technology users and that their roles are both context-specific and dynamic, it breaks out of the polarized debates of technology–push versus demand–pull theories. Instead it recognizes that both processes are potentially important at different stages in the innovation process.
4. It recognizes that the historical and institutional context of the organizations involved and particularly the wider institutional environment governs the nature of relationships, promotes dominant interests, and shapes outcomes of the system as a whole. This aspect is enormously important for introducing a poverty focus. The framework provides a lens to examine and reveal which agendas are being promoted, highlighting the arena in which the voice of the poor can be promoted.
5. It recognizes this as a social system. In other words, it does not just focus on the degree of connectivity (partnerships) between the different elements, but also on the learning and adaptive processes that make this a dynamic evolutionary system. Institutional learning (learning to do things in new ways, or learning to do things more effectively) is therefore a central process that policy and practice interventions can focus on strengthening.

6. Collective learning among partners or by coalitions of interest breeds a cycle of advocacy (about new ways of doing things), the emergence of new demands or priorities and new learning (new practices or methods). Learning and change, therefore, must take place concurrently at the innovation system level and at the level of the organizations that make up the system.
7. The innovation system concept is only a framework for analysis and planning, and as such it can draw on a large body of existing tools from economics, anthropology, evaluation, management, and organizational sciences and so forth.

ILAC: the concept

There is no hard and fast definition of ILAC. The concept emerges from a number of policy and practice fields including innovation policy, participatory approaches, and modern evaluation procedures, all of which stress the importance of learning and change. ILAC encompasses both output **and** process elements – i.e., information and behaviors that promote an ongoing process of reflection, learning and change as a way of better achieving goals. It is premised on a number of widely acknowledged observations:

- Those involved in research do not necessarily have adequate information and perspectives concerning the livelihoods of poor people and the agendas of other actors in the innovation process
- There are norms and routines (institutions) and structures (organizations) that shape research procedures in ways that can make it difficult for the perspectives of the poor and other actors to contribute to, for example, problem definition, technology development and testing, the evaluation of outcomes, or to be part of a collective learning process associated with innovation
- Innovation requires a continuous process of learning whereby method, and institutional and organizational arrangements can adapt to deal with changing contexts, demands, and opportunities. This learning has to be interactive and driven by self-reflection
- Research that includes capacity development in terms of strengthening learning skills can contribute to institutional change, thus enhancing research effectiveness. Modern evaluation procedures give the same emphasis to learning
- Experience with participatory approaches to development practice more generally is suggesting the importance of mutually supportive changes in personal and professional behavior, attitudes and methods, and in organizational and institutional arrangements.

Hidden histories of science and the legitimate narrative

Technical and institutional innovations co-exist, but whereas the former are generally reported, the latter tend not to be. This practice of selective reporting can lead to **superstitious learning.** Such is the case with the reporting of the Green Revolution in India being about improved varieties of rice. In practice, the links between Indian research programs and international NGOs such as The Rockefeller Foundation also played very a important role and represented a new way of doing science in India. Similarly institutional innovations in marketing

systems, input subsidization and price support and procurement arrangements, were a major change that helped promote the new varieties.

We raise this point in the context of ILAC partly to draw attention to the importance of more holistic accounts of innovation and the perspective this gives of the role of research and new technology in this wider process. But we also raise this point because scientists and social scientists are learning, developing new competencies, and innovating with new approaches as a routine outcome of their research and their interaction with partners and colleagues. The question then arises as to why these learnings and institutional innovations do not spread, diffuse, and influence wider practice.

Two stories serve to illustrate this learning process:

1. **International Crops Research Institute for the Semi-Arid Tropics' (ICRISAT's) Sorghum and Millet Improvement Program in southern Africa.** This 20-year program was established to build capacity in sorghum and millet research in public agencies in southern Africa and to develop and release new varieties. The scientists' own concerns about the effectiveness of this public agricultural research and extension driven model led them to experiment with partnerships with private enterprises and civil society organizations. Even when this approach was (successfully) employed more widely to achieve the impact targets specified by the donor, monitoring and reporting of the achievement of the program neglected to explore and report the underlying institutional changes that were taking place. Success tended to be reported (partly at the instance of the donor) in terms of spread and adoption of varieties. Only relatively recently has ICRISAT invested in an investigation of the institutional learning emerging from this experience.
2. **Watershed research at ICRISAT.** The narrative discussing this work in formal settings in ICRISAT concentrated on disciplinary details of soil, water science and agronomy, but it substantially ignored the institutional learning that took place in and around partnerships. Triggering this was the need for scientists to move their on-station work to a more participatory on-farm approach. This forced them to seek new partners and to engage in the realities and complexities of rural situations. The presenter suspects that the scientists involved hold enormous amounts of knowledge on processes and approaches that have relevance to improved impact, but which rarely see the light of day in a scientific organization.

These stories help to illustrate what might be called **clandestine learning** about institutional change – changes in the norms and routines governing research and inter-organizational relationships – as opposed to those sanctioned by the **legitimate narrative** which is about the technical and scientific aspects of projects. Similarly it concerns the way project outcomes are reported and what is viewed as a legitimate (variety adoption rates and so forth) and the perceived value outputs concerning intuitional innovations.

Impact to learning: the road traveled and the baggage we bring

The history of impact assessment in the CGIAR has caused us to focus on a particular type of impact assessment. This type of impact assessment is arguably more about measuring than it is about learning; more about accountability than

changing the way things are done. A pertinent question is 'For whom and why is impact assessment carried out?' These questions are all the more pertinent because even scientists agree that the credibility of impact assessment is not high. In light of that limited credibility, we need a more nuanced account of impact. Beyond measuring outcomes to research we need to focus on learning how impacts are brought about by the interaction of research and production technologies **and** changes in institutional behavior. Moreover, all the impacts need to be examined – not just those on the poor, but those that affect the scientists involved as well. The stories above amply demonstrate that scientists are impacted by the research they do and by the relationships they build in this process, and that this causes them to learn and innovate in the way they conduct research.

We believe the agenda of impact assessment is moving on to raise new and important challenges. The fundamental question facing us is: How can the impact assessment process be made more pro-poor, and how can we go about gaining a better understanding of how learning and change take place? The **technology pipeline** – where all that is believed to matter is how much comes out of the end of the research pipe – does not correspond to reality. We need a different mental set. To continue the metaphor, we need to ask: 'What is the pipe made of?' and 'How does the pipe change during the innovation process?' Ultimately, we are all part of the pipe! And therefore we need to reflect back upon our own norms and procedures and how we conduct our research.

Where are the scientists? and the new role of social scientists

In the past, social scientists, particularly economists, have been assigned the role of legitimizing scientific practice and behaviors. The new focus on learning about how agricultural research can contribute better to poverty alleviation suggests a change in this role. It encourages social scientists to examine the nature of the research and innovation process. However it also suggests that if this is a task concerning learning and devising new ways to work effectively towards impact on the poor, the social scientists cannot act as surrogates for the scientists who will actually have to change their professional behavior. The role of the social scientists therefore needs to expand to including facilitating learning, i.e., a much more proactive role in the ILAC agenda.

The authors' own personal experience is that writing research papers on institutional change while perhaps important for a disciplinary audience, cuts very little ice with the day-to-day practice of science. The authors' other experience is that scientists from his own organization actively seek his assistance to help them think about partnerships and ways of making their own research more relevant. The authors' richest professional experiences have emerged from these types of interactions.

While this all suggests that all scientists in CGIAR organizations need to be part and parcel of any ILAC initiative rather than the social scientists alone, the innovation systems concept introduced earlier suggest that learning has to include others from outside our home organizations. Ways have to be found to reflect and learn in consensual ways with our partners. It clearly makes no sense to reflect on ways of working with the private sector without including the private sector in the discussion. Equally, discussing ways of making research more pro-poor without

involving representatives from poor communities stands little chance of success. Social scientists have an important role in ensuring that learning activities take account of different perspectives, agendas, and interpretations of what is effective, useful, and desirable.

Real-time learning and the need for an interactive methodology

To summarize some of the impactions for ILAC that emerges from this paper:

1. ILAC marks a distinct departure from impact assessment as it is generally conceived in the CGIAR. It implies a different conceptualization of the innovation process that is characterized by broad-based partnerships and evolutionary process. It concerns learning to change and do things in new ways in response to changing circumstances and demands. And it is not another form of accountability to donors. A central implication is that institutional lessons that routinely emerge from the research process, but are often not exploited, recorded, synthesized, or promoted, have been under-valued as a way of improving the impact of agricultural research.
2. There is a role for documenting institutional innovation as one way of promoting institutional learning. Important questions exist about how partnerships emerge and evolve and how learning takes place through these arrangements. Answering these questions through research on the research and innovation process is valuable both for our disciplinary understanding of how learning takes place, as well as in helping develop general principles that can promote institutional learning and change.
3. However, there is a caveat and indeed a fairly fundamental one. Namely that being taught is not a substitute for learning. Learning is a real-time event arising though the **process of becoming,** through **learning by doing.** Certainly it can be facilitated. And certainly there are skills, policies, and institutional arrangements that will promote learning and change. It needs, however, to be highly contextual – organizations and groups of partners need to work out how to change to suit local circumstances, histories, skills and opportunities. Pro-forma organizational change, e.g., structural changes in the organization, can camouflage the perpetuation of old behaviors so we need to pay attention to broad principles and beware of 'magic bullet' blueprints.

There are three critical implications of this for initiatives that seek to pursue and promote ILAC in the CGIAR.

- Firstly, research and other ILAC initiatives need to be carried out in such a way that there is a strong capacity-development emphasis. In particular such initiatives should strengthen the individual and organizational process of **learning to learn,** and monitor this capacity development through behavioral change indicators.
- Secondly, these ILAC initiatives need to take place not just within organizations in isolation, rather learning capacities have to be developed at the innovation system level. In practical terms this means that any learning and reflection exercises need to include the participation of all the stakeholders relevant to the conduct of a research and innovation task, including those involved in its outcomes.

- Thirdly, traditional approaches for information dissemination are probably less valuable to ILAC initiatives as it is the learning process that needs to be promoted along with lessons and principles. We would argue that a more useful way of promoting ILAC is through networking and the development of coalitions of interest around new forms of behavior and practice. Clearly conventional information dissemination is still important. However one advantage of networking or building a community of practice is that it builds momentum, it broadens the constituency of ILAC, increases ownership of new practices and approaches, and, if managed effectively can aid the communication of these ideas between practice and policy. This last point might be particularly important in legitimizing ILAC in a system such as the CGIAR where institutional and organizational changes have tended to be driven from the top. An ILAC philosophy suggests something quite different!

Endnote

This paper, an output of DFID [R 7502:crop post harvest programe] was originally presented at a Workshop on Institutional Learning and Change in the CGIAR held at the International Food Policy Research Institute (IFPRI), Washington DC, 4–6 Feb 2003. A J Hall acknowledges the financial support of IFPRI and The Rockefeller Foundation to attend the workshop and make this presentation. The opinions expressed are those of the authors alone.

Appendices

Appendix 1. Workshop participants

Dinesh Abrol
Scientist
National Institute of Science, Technology and Development Studies (NISTADS)
K S Krishnan Marg
New Delhi 110 012, India
Tel: +91 11 25773181
Fax: +91 40 25754640
E-mail: ap1966@hotmail.com

Daniel Anand Raj
Programme Officer–Farming Systems
Integrated Pest Management
Agriculture Man Ecology (AME)
368, IV Cross, III Phase, J P Nagar
Bangalore 560 078
Karnataka, India
Tel: +91 80 6582303/6582835
Fax: +91 80 6583471
E-mail: amebang@giasbgol.vsnl.net.in

Mohammad Arif Ali
Consultant–Social Anthropologist
Flat 402, B Block, Premier Enclave
Humayun Nagar
Hyderabad 500 028
Andhra Pradesh, India
Tel: +91 40 23535677
E-mail: arifalimd@hotmail.com

T Balaguru
Acting Director
National Academy of Agricultural Research Management (NAARM)
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24015020
Fax: +91 40 24015915
E-mail: bala@naarm.ernet.in

N G Clark
Professor of Environmental Studies and Director, Graduate School of Environmental Studies (GSES)
Wolfson Centre
University of Strathclyde
Glasgow G4 0NW
UK
Tel: +44 141 548 4078
Fax: +44 141 5572 5498
E-mail: n.g.clark@strath.ac.uk

V K Dixit
Programme Coordinator
International Development Enterprises, India [IDE(I)]
C5/43, Safdarjung Development Area
New Delhi 110 016, India
Tel: +91 11 26969812/813
Fax: +91 11 26965313
E-mail: dixit@ide-india.org

Archana J Godbole
Applied Environmental Research Foundation
G-2, Hill View, 46/4
Erandwan Paud Road
Pune 411 038
Maharashtra, India
Tel: +91 20 4004233
Fax: +91 20 4004255
E-mail: aerf@vsnl.com

K S Gopal
Vice-President
Centre for Environment Concerns (CEC)
3-4-142/6, Barkatpura
Hyderabad 500 027
Andhra Pradesh, India
Tel: +91 40 27564959
Fax: +91 40 27563017
E-mail: cenvicon@hd2.vsnl.net.in

Sue Hainsworth
Consultant Editor
Editorial and Publishing Services
Plot 200, Road 14, Jubilee Hills
Hyderabad 500 033
Andhra Pradesh, India
Tel: +91 40 23544367
E-mail: suehainsworth@vsnl.net

V K Jayaraghavendra Rao
Senior Scientist (Agricultural Extension)
Information, Communication and Management Unit (ICM)
National Academy of Agricultural Research Management (NAARM)
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24015394
E-mail: vjer@naarm.ernet.in

Dayanath Jha
Indian Council of Agricultural Research (ICAR)
National Professor, National Centre for Agricultural Economics and Policy Research (NCAP)
PO Box 11305, Library Avenue, Pusa
New Delhi 110 012, India
Tel: +91 11 25766421
E-mail: djha_ncap@iasri.delhi.nic.in

Dinabandhu Karmakar
Programme Director
Professional Assistance for Development Action (PRADAN)
Lalmohan Trivedi Lane
Nilvuthi Danga
Purulia 723 101
Orissa, India
Tel: +91 03252-23144
E-mail: bku-prdanbl@sancharnet.in

Rama Devi Kolli
Principal Director
Society for Transformation, Agriculture and Alternatives in Development (STAAD)
58/101, Totem Pradham Apartments
Flat 1, Street 2, Abids
Hyderabad 500 001
Andhra Pradesh, India
Tel: + 91 40 23200905/23200344
E-mail: ramadevi@hd2.dot.net.in

T Krishna Prasad
Research Associate
APCESS Project on Management of Agricultural Education
National Academy of Agricultural Research and Management (NAARM)
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24015394
Fax: +91 40 24015912
E-mail: krishnaprasad@naarm.ernet.in

Guru C Naik
Freelance Consultant
O-450, Jalvayu Vihar, Sector 30
Gurgaon 122 001
Haryana, India
Tel: +91 0124 2382232
E-mail: guru@livelihoodsolutions.com

Sanjiv J Phansalkar
Amul Management Consultant
G-2 Lakshmikrupa Apartments
T-7 Lakshminagar
Nagpur 440 010
Maharashtra, India
Tel: +91 7122 41272
E-mail: sanjv@nagpur.dot.net.in

Mohan Pillai
Consultant, Income Generation Activity
Attapadi Hill Area Development Society (AHADS)
Agali PO, Aplacad 678 581
Kerala, India
Tel: + 91 492 2454202
Fax: +91 492 2454489
E-mail: ahads@sancharnet.in

G V Ramanjaneyulu
Scientist
Directorate of Oilseeds Research (DOR)
Indian Council of Agricultural Research (ICAR)
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24015345
Fax: +91 40 24016979
E-mail: gvramanjaneyulu@rediffmail.com

K V G K Rao
Water Management Specialist
Water Concentration Mission
V Floor, Government Insurance Building
Tilak Road, Abids
Hyderabad 500 001
Tel: +91 40 6782326
E-mail: kvgkrao@hotmail.com

N H Rao
Principal Scientist
National Academy of Agricultural Research and Management (NAARM)
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24015394
Fax: +91 40 24015912
E-mail: nhrao@naarm.ernet.in

M Sashi Kumar
Consultant
Thinksoft Consultants Pvt Ltd
3-4-142/6, Barkatpura
Hyderabad 500 027
Andhra Pradesh, India
Tel: +91 40 27563831
Fax: +91 40 27566655
E-mail: tsoft@eth.net

P Sateesh Kumar
Director
Prabhat Agri Biotech (Pvt) Ltd.
3-6-168/7, Hyderguda
Hyderabad 500 034
Andhra Pradesh, India
Tel: +91 40 23227537
E-mail: puligun@yahoo.com

A Satyanarayana
Director of Extension
Dr Acharya N G Ranga Agricultural University (ANGRAU)
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24015326
Fax: +91 40 24015326
E-mail: angrau@ap.nic.in

Girja Sharan
Professor
Indian Institute of Management (IIM)
Vastrapur, Ahmedabad 380 015
Gujarat, India
Tel: +91 79 6307241
E-mail: gsharan@iimahd.ernet.in

P M Shingi
Professor
Indian Institute of Management (IIM)
Vastrapur, Ahmedabad 380 015
Gujarat, India
Tel: +91 79 6324858
E-mail: prakashshingi@rediffmail.com

M V K Siva Mohan
Visiting Scientist
International Water Management Institute (IWMI) India Office
c/o International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Patancheru 502 324
Andhra Pradesh, India
Tel: +91 40 23296161
Fax: +91 40 23241239/23296182
E-mail: m.sivamohan@cgiar.org

O N Srivastava
Director
Centre for Natural Resource Management (CNRM)
National Institute of Rural Development (NIRD)
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24015767
Fax: +91 40 24015767
E-mail: ons@apnrc.kp.nic.in

R V Sulaiman
Scientist
National Centre for Agricultural Economics and Policy Research (NCAP)
PO Box 11305
Library Avenue, Pusa
New Delhi 110 012
India
Tel: + 91 11 25743036
Fax: +91 11 25822684
E-mail: nagma@bol.net.in

S P Tucker
Project Coordinator
Andhra Pradesh Rural Livelihoods Project
c/o Andhra Pradesh Academy of Rural Development
Rajendranagar
Hyderabad 500 030
Andhra Pradesh, India
Tel: +91 40 24001954
Fax: +91 40 24001953
E-mail: sptucker@rediffmail.com

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Patancheru 502 324
Andhra Pradesh, India
Tel: +91 40 23296161
Fax: +91 40 23241239/23296182
E-mail: icrisat@cgiar.org

J H Crouch
Principal Scientist and Global Theme Leader, Harnessing Biotechnology for the Poor

W D Dar
Director General

A J Hall
Special Project Scientist
[seconded from University of Greenwich, UK]

P Parthasarathy Rao
Scientist

Belum V S Reddy
Scientist

B Yoganand
Scientific Officer

Appendix 2. Acronyms

ABP	Agri-Biotech Park
ABI	Agri-Business Incubator
ACTS	African Centre for Technology Studies
AgREN	Agricultural Research and Extension Network (ODI)
AHADS	Attapadi Hill Area Development Society (India)
AME	Agriculture Man Ecology (India)
ANGRAU	Dr Acharya N G Ranga Agricultural University (India)
APEC	Asia-Pacific Economic Cooperation (Thailand)
APEDA	Agricultural Processed Products Export Development Authority (India)
APNLBP	Andhra Pradesh–Netherlands Biotechnology Program
APRLP	Andhra Pradesh Rural Livelihoods Project
CA	controlled atmosphere
CAPART	Council for Promotion of Application of Rural Technologies (India)
CASA	Centre for Advancement of Sustainable Agriculture (India)
CCC	corrugated cardboard carton
CBD	Convention on Biological Diversity
CBO	community-based organization
CDP	Capacity Development Programme (ACTS)
CEC	Centre for Environmental Concerns (India)
CERD	Centre for Ecology and Rural Development (India)
CFTRI	Central Food Technology Research Institute (India)
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo
CMERI	Central Mechanical Engineering Research Institute (India)
CNRM	Centre for Natural Resource Management (NIRD)
CORE	Core Emballage Ltd. (India)
CPHP	Crop Post-Harvest Programme (DFID)
CSIR	Council of Scientific and Industrial Research (India)
CSR	Centre for Social Work and Research (India)
CSSTD	Centre for Studies in Science, Technology and Development (India)
CTD	Centre for Technology and Development (India)
DA	Dastkar Andhra (India)
DFID	Department for International Development (UK)
DOR	Directorate of Oilseeds Research (ICAR)
DST	Department of Science and Technology (India)
DUS	distinctness, uniformity and stability
ERP	enterprise resource planning
ESSE	European Seminar on Extension Education (The Netherlands)
EU	European Union
FOSET	Forum of Scientists, Engineers, and Technologists (India)
FRC	Faculty Research Committee (KAU)
GMO	genetically modified organism
GSES	Graduate School of Environmental Studies (UK)
HESCO	Himalayan Environmental Studies and Conservation Organization (India)
HVM	Haryana Vigyan Manch (India)
ICAR	Indian Council of Agricultural Research
ICM	Information, Communication and Management Unit (NAARM)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre (Canada)
IDE(I)	International Development Enterprises, India

IDS	Institute for Development Studies (UK)
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development (UK)
IIMA	Indian Institute of Management, Ahmedabad
IIP	Indian Institute of Packaging
ILAC	institutional learning and change
IntNGO	international non-governmental organization
IPR	intellectual property rights
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
IUCN	International Union for the Conservation of Nature
IWMI	International Water Management Institute
JTN	Jan Taknik Network (India)
KAU	Kerala Agricultural University (India)
KHDP	Kerala Horticulture Development Programme (India)
KWS	Kenya Wildlife Service
MAS	marker-assisted selection
MERADO	Mechanical and Engineering Research and Development Organization (India)
MoU	memorandum of understanding
MRDBS	Maharashtra Rajya Draksh Bagaidar Sangh (Maharashtra State Grape Growers' Association) (India)
MTRM	Mid-Term Review Mission (KHDP)
NAARM	National Academy of Agricultural Research Management (India)
NAAS	National Academy of Agricultural Sciences (India)
NARS	national agricultural research system
NCAP	National Centre for Agricultural Economics and Policy Research (ICAR)
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organization
NIRD	National Institute of Rural Development (India)
NISTADS	National Institute of Science, Technology and Development Studies (India)
NORAD	Norwegian Agency for Development Co-operation
ODI	Overseas Development Institute (UK)
OECD	Organization for Economic Co-operation and Development
PRADAN	Professional Assistance for Development Action (India)
PTD	participatory technology development
PTI	People's Technology Initiatives (India)
PVP	plant variety protection
R&D	research and development
RDD	research, development and design
RTD	research and technology development
RUCHI	Rural Centre for Human Interest (India)
SADC	Southern African Development Community
SAT	semi-arid tropics
S&T	science and technology
SHG	self-help group
SI	systems of innovation
SMBE	small- and medium-scale biotechnology enterprises
SMIP	Sorghum and Millet Improvement Program (SADC/ICRISAT)
SRL	sustainable rural livelihoods (DFID)
SSA	sub-Saharan Africa
STAAD	Society for Transformation, Agriculture and Alternatives in Development (India)

STD	Society for Technology and Development (India)
STVO	science and technology voluntary organization
TCI	Technology Innovation Center (ICRISAT)
TG	technology-generating group
TMOP	Technology Mission on Oilseeds and Pulses (India)
TPD	tonne per day
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VC	venture capital

Appendix 3. About the authors

Dinesh Abrol has been working as a Research Scientist in the field of science, technology and society for last 20 years at the National Institute of Science, Technology and Development Studies (NISTADS), New Delhi, India. He has to date over 20 research publications to his credit, 15 research reports, and 3 books in the area of S&T policy and management. He has also contributed to the field through his active involvement in action research on technology implementation in rural settings for the weaker sections.

Norman G Clark is Professor of the Environmental Studies, and Director of the Graduate School of Environmental Studies (GSES), University of Strathclyde, Glasgow, UK. He has worked on issues dealing with science and technology policy in developing countries for more than 30 years. This work has included research, advisory and capacity-building activities in Asia, Africa, and Latin America. The main theme of his research has concerned the nature of technical and economic change in evolution systems.

Jonathan H Crouch is a Principal Scientist at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) where he is Global Theme Leader for Harnessing Biotechnology for the Poor. A plant breeder and biotechnologist, trained at the University of Reading and the John Innes Institute, UK, he has worked for the public sectors in Africa and Asia and the private sector in Europe.

Andrew J Hall is a Reader in Innovation Systems for Development at the University of Greenwich, UK. For the last 6 years he has been on secondment in the SAT Futures and Development Pathways theme at ICRISAT in India. His main area of interest is agricultural research policy. In recent years he has worked on the development and application of the innovation systems concept as a way of exploring partnerships and institutional arrangement in agricultural research and development.

John Mugabe is Executive Director of the Commission of Science and Technology for New Partnership for Africa's Development (NPAD). He holds a doctorate degree in environmental policy from the University of Amsterdam, The Netherlands, and was a Research Fellow at the United Nations University Institute for New Technologies, Maastricht. He is a member of the Board of Directors of the Biofocus Foundation of the World Academy of Arts and Sciences, the African Conservation Centre, Kenya, and the Board of Biotechnology and Development of the University of Amsterdam. He founded and directed the Biopolicy Institute, African Centre for Technology Studies (ACTS). His research interests include technology policy and institutional issues related to environmental management in general, and the conservation of biological diversity in particular.

Guru Charan Naik is a development consultant in the areas of promotion of income-generation opportunities (appropriate technology, marketing, micro-enterprise, business development services and commercial horticulture) for the rural poor and is the Founder Director of 'Livelihood Solutions', a development support and consulting firm. He trained in agriculture and business management at the Indian Institute of Management, Ahmedabad (IIMA) and has 18 years of

experience in the development sector; including managing development projects at grassroots, state, and national levels. He has organizational experience of working with both national and international NGOs and has been consulting for the past 2 years.

Sanjiv J Phansalkar studied management at IIMA, where he completed his PhD, after which he taught at the Institute of Rural Management, Anand. He has published three books and several papers and written scores of cases and case studies. He currently works as a freelance consultant specializing in issues related to rural livelihoods and is a board member of International Development Enterprises, India [IDE(I)].

Mohan Pillai is qualified in agriculture and management, and has been working in the agricultural sector for the past 18 years. He started his career as a planter and went on to hold such senior management positions as Profit Centre Head in a commercial agriculture organization. His skills have been honed in industry where success is measured through customer satisfaction. He joined the Commission of the European Communities as a consultant to provide support to the Kerala Horticulture Development Programme (KHDP) in field implementation. KHDP has been judged one of the best European Union-aided projects in India, it is now a successful, sustainable organization providing services to the farming community of Kerala. Presently, he is working with a rural development project in Pallakkad as a consultant on developing sustainable livelihood options for the local community, especially the tribal population.

Rajeswari Raina is an Economist with NISTADS. With an inter-disciplinary training in the agricultural sciences and economics, her publications address the history of and institutional reforms in agricultural science, the evaluation of agricultural research, and the organization and measurement of agricultural research effort.

Rasheed Sulaiman V is a Senior Scientist at National Centre for Agricultural Economics and Policy Research, New Delhi, India. He holds a doctorate in agricultural extension policy. In recent years he has studied institutional innovation in extension, including privatization models as well as exploring extension as part of broad-based development interventions in the agricultural sector. In this work he has increasingly used the innovation systems concept as a way of thinking about technology transfer in a more holistic sense.

Yoganand B is a Scientific Officer at ICRISAT. He was originally trained as an agricultural economist, but has latterly worked on science and technology policy issues. His main area of interest is the innovation policy implication of recent advances in biotechnology.

About the Crop Post-Harvest Programme (CPHP), South Asia

CPHP South Asia is one of four regional offices of the UK Department for International Development's (DFID's) Crop Post-Harvest Programme. The CPHP is one of DFID's 10 renewable natural resources research programmes. These programmes commission research on the natural resources systems that support the livelihoods of poor people. The CPHP geographic focus is on South Asia and Western, Eastern and Southern Africa. CPHP projects are implemented by scientific and developmental organizations from partner countries, often in collaboration with counterpart organizations in the UK. In the South Asia region CPHP works in India, Bangladesh, and Nepal.

CPHP South Asia Mission

CPHP South Asia seeks to support the livelihoods of poor people by promoting the development of post-harvest innovation capabilities through partnership based research, networking and strengthening relevant communities of practice.

For further details contact:

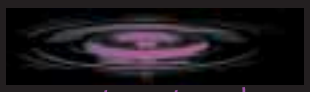
Andy Hall
South Asia Regional Co-ordinator
Crop Post-Harvest Programme (CPHP)
c/o International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Patancheru 502 324
Andhra Pradesh
India
E-mail: a.hall@cgiar.org
Phone +91 (0) 40 23296161 ext. 2522

CROP POST-HARVEST PROGRAMME

DFID Department for International Development

CPHP
South Asia

Crop Post-Harvest Programme, South Asia
Patancheru 502 324, Andhra Pradesh, India
Tel : +91 (40) 23296161 ext 2522 Fax: +91 (0) 40 23241239
Email: a.hall@cgiar.org www.cphpsouthasia.com



nr international

Natural Resources International Limited
Park House, Bradbourne Lane, Aylesford, Kent ME20 6SN, UK
Tel: +44 (0) 1732 878686/7 Fax: +44 (0)1732 220497
Website: www.nrinternational.co.uk and www.cphp.uk.com Email: info@nrint.co.uk

ISBN 0-9539274-8-2