Postharvest innovation systems in South Asia: research as capacity development and its prospects for impact

Andy Hall[1,*] *and Rasheed V. Sulaiman*[2]

[1]Regional Co-ordinator for DFID's Crop Post-harvest Programme, South Asia, c/o ICRISAT, Patancheru, Andhra Pradesh 502 324, India

[2]National Centre for Agricultural Economics and Policy Research, PO Box 11305, Library Avenue, Pusa, New Delhi 110 012, India

Abstract

Postharvest research and development 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 research and entrepreneurial and technology user sectors. Similarly, if pro-poor postharvest innovation is to be encouraged, greater attention will need to be given to the wider institutional context in which innovation takes place. As a way of exploring these issues, this paper presents the concept of a postharvest innovation system and explains the capacity-development view of research that this perspective brings. Examples of postharvest innovation systems are presented to illustrate the critical importance of partnerships and institutional contexts. Ways of implementing this in research programs are then discussed.

Introduction

IT is recognized increasingly that efforts to strengthen postharvest systems in developing countries are going to need to pay much greater attention to the institutional environment in which innovation takes place (Hall et al. 2002a). It is all too evident that technological innovation, although necessary, is not sufficient to bring about changes in food and marketing systems, particularly for poor rural communities. On the other hand, there is growing evidence that appropriate innovations can be made to have impact through partnerships between organizations from the research, enterprise, implementation, farming and market sectors, particularly where institutional conditions support consensus building, synergy and learning. It is not just technological innovations that can emerge in this way—institutional innovations connected to research and management also emerge as a co-product of technological change. The key challenge for improving the impact of postharvest research would therefore seem to rest on developing research and implementation procedures that address the need to develop partnerships and institutional arrangements that support learning, innovation and change. As a way of exploring these issues, this paper presents the concept of postharvest innovation systems; we discuss the status and evolution of these in India; and describe the way a donor research program is seeking to strengthen such systems.

Innovation systems perspectives are rooted in a growing realization that, in many production sectors, it is useful to blur the distinction between organizations responsible for research, application and entrepreneurial activity. Postharvest innovation exemplifies this situation, as issues and opportunities are frequently embedded in a wider set of relationships and contexts than is implied by the conventional research–extension–farmers model of research and development (R&D). In this model, not only is a rather narrow range of actors deemed to be important, but also this conceptualization of R&D implies that a linear, hierarchical relationship exists between research, technology devel-

* Corresponding author. Email address: <a.hall@cgiar.org>.

opment and transfer. The reason that such arrangements exist (and persist) relates to the historical patterns of institutional development associated with agricultural R&D in many countries and the philosophical positions that have informed (and continue to inform) these arrangements.

In contrast, the innovation systems analysis recognizes that innovations tend to emerge from a much wider set of relationships and that these are often iterative and evolving. It also recognizes that innovation is rooted in and shaped by its historical, political and institutional context. In practice, this means stronger patterns of connectivity between different elements of the innovation system, shaped by local norms and imperatives. From a policy perspective, this provides a much more holistic appreciation of the institutional and organizational conditions conducive to technical change and impact. Such perspectives clearly have resonance with the postharvest arena, characterized as it is by linkages and relationships between producers and consumers, between rural and urban areas, and between private enterprise and public policy. The main theme of this paper is an explanation of, on the one hand, what can go wrong when the linear, disconnected model of R&D prevails; and, on the other, the results that can be achieved when systems concepts of innovation inform policy and practice and hence encourage greater connectivity.

The paper illustrates this with some recent examples from India where, following economic liberalization, opportunities exist to encourage the participation of a broader spectrum of actors in the postharvest innovation system—particularly the private sector. The first case study discusses experiences in developing quality management systems for the export of mangoes. This case not only illustrates the opportunities that are emerging, but also highlights some of the difficulties of making different scientific elements of the systems work effectively together. A second case study discusses the experiences of introducing improved packaging technology through an approach that relied entirely on managing and facilitating a series of relationships with a wide range of research, non-government organization (NGO), market, and credit agency actors. The intervention was enormously successful. The paper then goes on to discuss the way in which the United Kingdom Department for International Development's (DFID's) Crop Post-harvest Programme has used the innovation system principle to develop a new approach to research management and implementation. The paper discusses the implications of these concepts and approaches for postharvest research and ways of increasing its impact on poor rural households in developing countries. A critical conclusion is that research needs to give more attention to developing the capacity of postharvest innovation systems, particularly in the area of institutional innovations, and that this needs to be emphasized in planning and evaluation processes.

To give conceptual context, we begin by introducing some of the contemporary debate on the innovation process in the renewable natural resources sector.

Innovation systems perspectives in natural resources R&D

THE debate about ways of improving the effectiveness and impact of natural resources research (including postharvest) is not a new one. However, the influence of institutional arrangements and the dynamics of the innovation process are issues that many theories of agricultural innovation 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 the decision over how and to whom they are promoted—a **technology-push** theory.

Another branch of this debate concerns the role of farmers in the research process. This has found expression in 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 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—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 the participatory approaches that evolved in this way were associated more with institutional innovations rather than new methods *per se*, and that transferring the methods element of the approach to new and often unreceptive institutional and organisational contexts stands little chance of success.

Such systems ideas can be seen elsewhere; 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 of an 'agricultural knowledge and information system' (Roling 1994) makes a similar point. More recently, the notion of an innovation system has started to be discussed as a way of thinking about institutional arrangements in agricultural R&D (Hall et al. 2001).[1] The attraction of the innovation systems 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 are emerging as central to the development debate (Hall 2002). There are several valuable features of this framework.

- 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.
- It conceptualizes research as part of the wider process of innovation, and thus it helps identify the scope of the actors (including public, private, research, enterprise, and technology user sectors) involved and the wider set of relationships in which research is embedded.
- It recognizes the importance of both technology producers and technology users and that their roles are both context specific and dynamic. In this way, 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.
- It acknowledges that the institutional context of the organizations involved, and particularly the way 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.
- It recognizes this as a social system. In other words, it does not focus simply on the degree of connectivity between the different elements, but also the learning and adaptive process that makes this a dynamic, evolutionary system.
- It is only a framework for analysis and planning, and can draw on a large body of existing tools from economics, anthropology, evaluation, management and organizational sciences, and so forth.

From a planning and intervention perspective, the innovation systems framework places particular emphasis on the importance of learning processes as a way of evolving new arrangements specific to local contexts. This draws from a very large body of thinking on innovation performance, where learning and the ability to build up new competencies, often through interaction with others, are central analytical concerns[2]. This contrasts with the conventional approach of seeking 'optimal' blueprints, and instead recognizes the importance of supporting adaptive systems and the value of the growth of diversity in approaches and practices.

One implication of this emergent perspective is that capacity building—in a total systems sense—becomes a much more important objective. In other words, research interventions become concerned increasingly with establishing relationships and processes that will underpin future technology and innovation outcomes. The advocates of the approach suggest that its use for the evaluation and planning of technology development and promotional activities is a useful way to build locally adapted, collective operational capacities where institutional concerns such as a poverty focus and other policy agendas can be monitored and sustained (Biggs and Smith 1998; Hall et al. 2002a). It is precisely these perspectives that would seem to be at the heart of current debates concerning improving the effectiveness and impact of postharvest research and food and marketing systems. The next section contrasts two case studies to illustrate these points.

Case studies of recent development in the Indian postharvest innovation system

Interaction among multiple agencies in the horticultural supply chain

Recent studies of public–private interaction in the horticultural sector illustrate the difficulties of accessing integrated technical backstopping support from clusters of public agencies (Hall et al. 2001, 2002). This is particularly apparent in the horticultural supply chain where quality management—the key technical constraint—requires a combination of production, harvesting, handling and processing elements that show a high degree of interdependence. In contrast, public-sector research institutes in India

[1] 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) developed a similar concept in the context of agricultural innovation.

[2] 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. See also for debate on competency building.

tend to be segregated along disciplinary lines. Even where the services of these different public agencies can be accessed successfully, integrating the different pieces of technical assistance can be difficult.

The efforts to export mangoes to the European market by Vijaya, a fruit growers' association in Andhra Pradesh, with the assistance of the Agricultural Processed Products Export Development Authority (APEDA) illustrate precisely this problem. A critical need was to develop controlled atmosphere (CA) container, sea-shipment protocols to access the new export market. This required significant adaptive research to develop the gas and temperature regimes for shipment specific to the characteristics of Indian mangoes. The protocol also included improved pre- and postharvest practices at farm and packinghouse level. To achieve this, APEDA set up a series of contract arrangements with relevant institutes from both the Indian Council of Agricultural Research (ICAR) and from the Council for Scientific and Industrial Research (CSIR) as well as with the horticultural department of the Andhra Pradesh State Agricultural University. These organizations then worked with Vijaya to develop and test the CA protocol with its associated quality management measures. The ICAR institute dealt mainly with preharvest pest management issues, the CSIR institute undertook experimentation on CA storage regimes, and the university departments advised on packinghouse management.

Trial shipments took place over a period of three years. However, persistent 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. But there were several institutional constraints that 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. The organizational culture (and mandate) of scientists involved meant that not only did they have little experience in working with farmers or in a commercial environment, but also there were few incentives to do so.

However, the major obstacle was that quality management measures were not devised and implemented as a package across the supply chain. This resulted from the fact that pieces of useful and mutually supportive technical expertise were located in the different organizations, falling under two different research councils. The 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 postharvest 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 highly circumscribed by current institutional arrangements. Not only is there strong disciplinary segregation within ICAR, but different research council affiliation also tends make integration difficult. The nature and rigidity of organizational culture—a key institutional arena—also make the development of more integrated and responsive working practices amongst scientists difficult. While growers' associations have the potential to form the hub of task-related networks, ways of making scientists accountable in broad-based partnership arrangements such as this is clearly an area that needs much greater attention.

But if innovation in a general sense was restricted, what were the prospects for pro-poor innovation? What emerged in this case was that 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 postharvest 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 (different agendas and roles were never negotiated and resolved), but more importantly it was almost a foregone conclusion that pro-poor innovation would not take place.

Working through others: supporting innovation through managing relationships

This case study describes a novel intervention that an NGO, International Development Enterprises (IDE) India (IDEI), has made to establish technology development production and supply systems. The approach developed over the last decade involves identifying market demand for technology, identifying suitable technology and establishing networks to produce,

supply and sell it to the poor (IDE 2002). It combines both entrepreneurial and technology development and requires locally specific technological and institutional innovation. This approach has been applied with great success in the context of small-scale irrigation/water resources technology. A recent expansion of activities concerned applying this approach to postharvest technology in the context of small-scale producers of vegetables supplying the Indian domestic market.

The case study illustrates the way in which the integration of technology development and promotion into market arenas requires a wider range of partnerships than would normally be considered in a conventional technology R&D initiative. The case is particularly interesting because IDEI realized at an early stage that, other than its expertise in identifying a technology niche using market analysis principles, it had no relevant skills in postharvest issues. As a consequence, a decision was taken to implement the initiative by 'working through others', with IDEI viewing its role as one of managing relationships with its partners and coordinating innovation.

IDEI first identified that environmental policy changes in the area in which it was working—Himachal Pradesh—were making the wooden packaging used for tomatoes an obsolete technology. The task then was to establish a network of partners around the development and supply of an alternative packaging technology—cardboard boxes. In fact, this involved identifying and accessing four existing informal networks and establishing partnership with them. These networks are illustrated in Figure 1 and were as follows.

- **Technology network.** This consisted of scientists from the Indian Institute of Management, Ahmedabad, and a box manufacture with a design studio with whom they had previously worked on packaging development. The scientists and their industry partners were willing to design tomato boxes.
- **Local knowledge network.** A local grass-roots NGO in the focus area was identified that had already established a relationship with farmers in a network of different communities. The communities formed the focus for the adaptive trials of the new boxes. It also included a partnership with the local agricultural university for information on local crop production systems.
- **Market network.** This consisted of the actors 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 actors who would have to accept and use the cardboard boxes in their transactions. They had to be willing to promote their use.
- **Production and distribution network.** This consisted of local box manufacturers in the focus area and box traders. Obviously it was important to partner with such organizations as these would form the backbone of the supply and distribution chain.

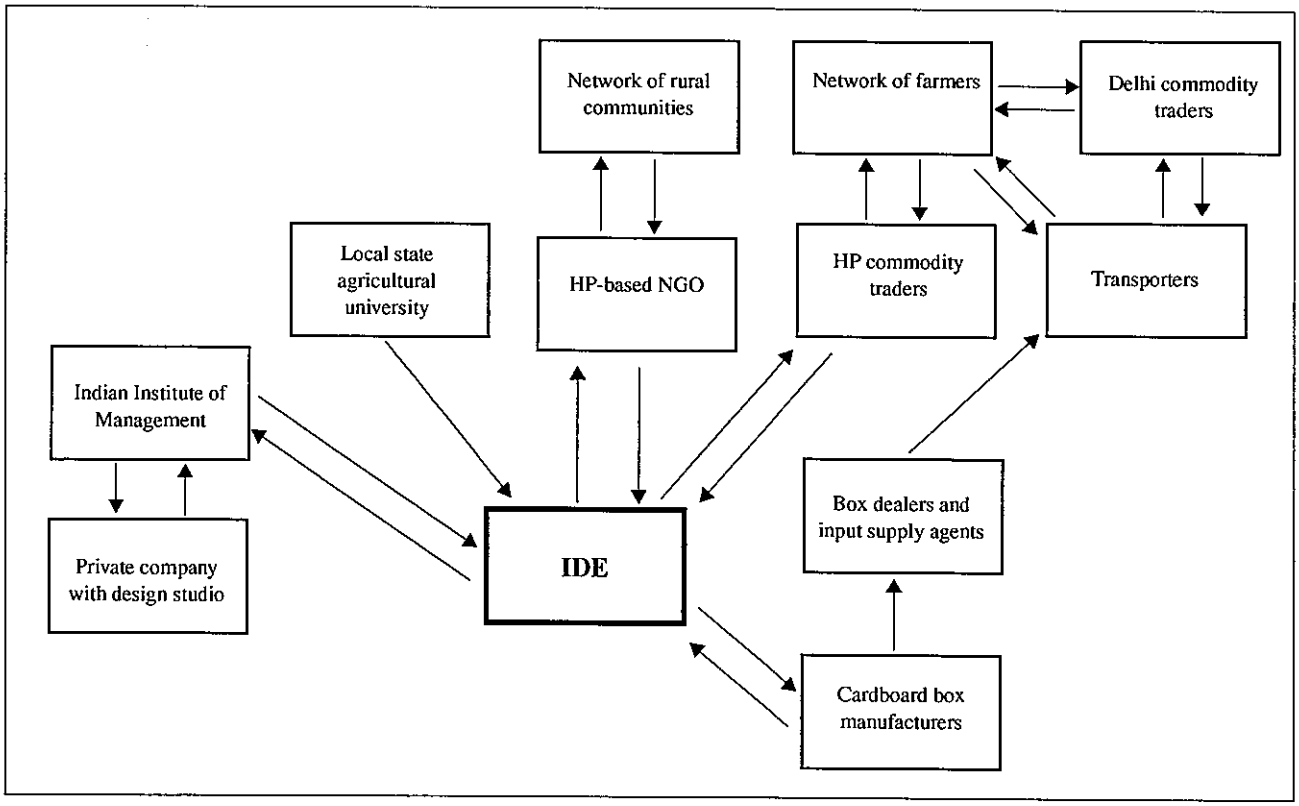

Figure 1. Partnerships associated with the development and supply of packaging technology.

IDEI efforts to introduce an alternative packaging technology to the small-scale tomato production sector in Himachal Pradesh are still continuing, with commercial production of boxes set to start in 2002. IDEI used an intuitive process to identifying partners it could work with. It also established relationships that appear not only to have been productive in terms of establishing a technology development production and supply system, but also to have done so in a way that focuses on the needs of the small-scale production sector.

Donor responses and new approaches to research management

THE case studies described above provide two contrasting examples of the way innovation processes can work. In the first case, which 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 related to the inability of different elements of the innovation system to interact and respond to each other. Partially, this concerned linking together different elements of scientific expertise. But it also concerned integrating this expertise with technology users and their environments. The underlying bottlenecks were institutional in nature, i.e. the behavioral and procedural norms of the organizations involved and the inability to adapt this institutional framework to the contingencies of establishing a mango quality management system. The endeavor finally failed, wasting enormous resources and missing an important market opportunity for Indian mango producers.

The second case is quite different. Not only does it include a mechanism for making the linkages between the different elements of the innovation systems—and these are clearly quite diverse—but also it recognizes that managing these relationships and ensuring that research is integrated into production and marketing operations, is critical for an innovation to take place in the postharvest system. As such, it is identified as a key task for the managing partner—IDEI in this case. In other words, instead of ignoring the institutional context in which these activities are taking place, in this example, this context is both recognized and managed. Furthermore, this has been an intervention that has created a postharvest innovation that has poverty, gender and environmental sustainability relevance (Underwood 2002) as well significant economic importance in terms of the tomato subsector in the region.

These findings certainly suggest that the innovation systems perspective has much to offer as a way of engaging with the institutional context of R&D and technology intervention. But how can these ideas be operationalized in research management, planning and policy? In the remainder of this section we describe the way these perspectives have been adopted by the DFID Crop Post-harvest Programme (CPHP), first in its regional programme in South Asia and later across its global program.

Learning and innovation in postharvest research management and practice

CPHP is one of DFID's 10 centrally managed natural resources research programs. It commissions research mainly on technology development and promotion related to the postharvest 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.

CPHP (as a global program) began as a fairly conventional postharvest research initiative. The program commissioned mainly technology development projects relying on disciplinary research related to 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 broader development goals that they purported to address. Around this time, the 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 the institutional context of research and innovation.[3]

Emerging from work in South Asia, as well as 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. These developments started to take place in response to the need for projects to focus on the 'uptake' pathways for their findings and the need to somehow embed these mechanisms into research design. As an initial response, the CPHP program appointed a consultant to advise on partnership issues. Subsequently, CPHP commissioned a formative review to help it develop a program

[3] This has produced a large body of literature including Clarke 2002; Hall et al. 1998, 2000, 2001, 2002a,b; Sulaiman and Hall 2002.

strategy with respect to partnerships. 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 research program (Biggs and Underwood 2001). The global CPHP adopted this recommendation and used it to underpin the technical proposal that it presented to DFID, explaining how it planned to implement CPHP in its final phase, 2002–2005. CPHP refers to this as the 'coalitions approach'.

This new approach has a number of implications, including:

- the adoption of an action research methodology
- a shift to mainly locally led projects
- a greater emphasis on facilitated project development
- a project design covering both technical and institutional aspects of research themes
- a greater emphasis on institutional learning, i.e. lessons about research and innovation processes
- an explicit capacity-building development agenda, with a program *purpose* (at global and regional levels) addressing the strengthening of national postharvest innovation systems and their ability to respond effectively to the needs of the poor.

In practical terms, this meant that instead of releasing a call for research proposals, the program's regional coordinators became responsible for developing coalitions of actors around a limited number of technical or policy research themes. These nascent partnerships would then form the basis for the negotiation of action research projects. This approach recognizes that coalitions need to be established in-country around a particular theme identified and defined by in-country partners based on their technical and institutional understanding of the research task. The membership of the coalition and the role (or roles) of the actors will then be determined by the nature of the theme and the wider (perhaps national) institutional context in which the coalition is being developed. This implies a greater degree of accountability (to the coalition) for research partners.[4]

[4] The case of CPHP and the larger questions concerning north–south research collaboration are explored in detail in the December 2002 special edition of the International Journal of Technology Management and Sustainable Development (Hall 2002).

The policy implications of postharvest innovation systems

We began this paper by arguing that the idea of a postharvest innovation system provides a useful conceptual framework for understanding the institutional context of innovation. We went on to suggest that this is particularly relevant to the institutional and organizational context of the postharvest sector because 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; and the practical implications for implementing this in research programs. Flowing from this experience are several broad principles that seem to be relevant to postharvest 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 institutional roles of the actors in the coalition have to be made explicit from the start and reassessed as the project proceeds. Similarly, roles will evolve as projects evolve.

A 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. The implication of this is that projects would benefit from an action research orientation. For example, our evaluation of case histories suggested that, in general, the research procedures and reporting structures often create much determinism in projects, often persisting with partners and technology trajectories, even when it was apparent to all involved that changes in direction were needed. 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 discussed in the previous section is a very clear example of this—it had developed and evolved an approach that could be used elsewhere.

Thirdly, where a poverty focus is paramount, stakeholder analysis is needed to ensure that this agenda is promoted within the coalition. The relationship of the coalition within the wider institutional context, the effects this has on patterns of relationship, and the way

agendas and priorities are identified and promoted need to be made explicit from the start of the project.

The fourth point relates to the way projects are monitored. Monitoring projects for direct poverty impact makes little sense from a project management perspective. This is because of the limited time-frame problem; the attribution problem; and, most importantly, the complex systems phenomenon (i.e. livelihoods are complex systems in which future outcomes of current initiatives are unknown and unknowable). However, a useful alternative is to track poverty relevance through the project cycle. For example, are the institutional elements of the project pro-poor? Have process innovations allowed better pro-poor governance of the project? Are there institutional bottlenecks that need to be addressed?

The conceptual message from the innovation systems framework is that rather than worrying about monitoring the inputs and outputs of research, it would be more useful to monitor process change, particularly the way relationships between actors are changing and leading to improved innovation performance. The same applies to the near obsession that some agencies have with measuring economic rates of return to research investment—often as a way of justifying past investment decisions.

Instead of this input–output orientation to monitoring and impact analysis, the innovation systems perspective suggests that what are important are behavioral changes in the system that is generating and applying new knowledge. So, for example, in the case of the mango project, of importance would be the development of the types of relationships and institutional arrangements appropriate to dealing with a complex production/marketing chain containing a range of stakeholder contexts and agendas. Again, institutional changes—for example, who and how problems are defined and who and how progress is evaluated—are an important 'indicator' of progress. Although these ways of thinking about the progress of 'scientific' projects may be new to those working in the conventional postharvest research arena, there is already a well-developed set of tools that can help scientists deal with the contextual setting of their endeavors—examples include stakeholder analysis (see Grimble and Wellard 1997) and the actor linkage matrix (Biggs and Matseart 1999).

The implication of this view of the importance of process is that much greater emphasis needs to be placed on the assessment of the capacity-development effect of projects, i.e. capacity development, not in the conventional sense of building up stocks of research infrastructure and trained scientists, but rather in the sense of the collective capacity of networks or systems of actors interactively linked with the view to innovate.

It is perhaps this last point that forms the critical message for development assistance agencies seeking to exploit postharvest R&D in the cause of sustainable development and poverty reduction. Technological innovation will emerge and find receptive contexts only when it is accompanied by the necessary institutional innovations to integrate research into the activities and agendas of a broad set of stakeholders in the innovation system. Building up institutional knowledge on how to do this will take place only when R&D planning and evaluation adopts a sufficiently holistic framework for analysis and learning.

Conclusions

POSTHARVEST 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. However, this will happen only if postharvest innovation systems are strengthened. In part, this concerns strengthening linkages, connections and innovation processes, but it also concerns ensuring that the institutional context of these endeavors is managed in ways which ensure 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.[5]

References

Altshul, H. 1998. Output to purpose review of DFID's Crop Post-harvest Programme. Chatham, United Kingdom, Natural Resources International, 54 p.

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

Biggs, S.D. and Underwood, M.P. 2001. Review of the Crop Post-harvest Research Programme: partnerships and innovation systems. Aylesford, Natural Resources International, 20 p.

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), Spring 2002.

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Edquist, C., ed. 1997. Systems of innovation approaches: technologies, institutions and organisations. London, Pinter, Cassell Academic, 253 p.

Freeman, C. 1987. Technology and economic performance: lessons from Japan. London, Pinter, 227 p.

Grimble, R. and Wellard, K. 1997. Stakeholder methodologies in natural resource management: a review of principle, contexts, experiences and opportunities. Agricultural Systems, 55(9), 173–179.

Hall, A.J. (ed.) 2002. Innovation systems and capacity development: an agenda for north–south research collaboration? International Journal of Technology Management and International Development, 1(3) 146–152.

Hall, A.J, Clark, N.G., Sulaiman, R.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, 70–91.

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

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

Hall, A.J., Sulaiman, R.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. In: Byerlee, D. and Echeverria, R.G., ed., Agricultural research policy in an era of privatization: experiences from the developing world. Wallingford, UK, CAB International, 300 p.

Hayami, Y. and Ruttan, V.W. 1981. Agricultural development: an international perspective. Baltimore, John Hopkins University Press, 261 p.

Lundvall, B.A., ed. 1992. National systems of innovation and interactive learning. London, Pinter, 161 p.

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

Rogers, E.M. 1983. Diffusion of innovations, 3rd edition. New York, The Free Press, 142 p.

Roling, N.G. 1994. Agricultural knowledge and information systems. In: Blackburn, D.J., ed., Extension handbook—process and practices, 2nd edition. Toronto, Thompson Educational, 26–51.

Sulaiman, R.V. and Hall, A. 2002. Beyond technology dissemination—can Indian agricultural extension re-invent itself? Policy Brief No. 16. New Delhi, National Center for Agricultural Economics and Policy Research, 4 p.

Underwood, M.P. 2002. Annual poverty relevance review of DFID's Crop Post-harvest Programme projects in South Asia—2002. Patancheru, India, Crop Post-harvest Programme (CPHP) South Asia Regional Co-ordination Office, 37 p.