

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

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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.

Keywords: Post-harvest R&D, [IDE(I)], Institutional innovation, HORTICULTURE TECHNOLOGY R&D, Agricultural Research.

Research Method:

The research design will be descriptive in nature. The method of data collection will be mainly based on secondary data. However, an effort will be made to collect primary data by taking information from competent persons off and on.

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.

Innovation systems perspectives

The concept an Agricultural Knowledge and Information System (Roling 1986; 1994) makes a similar point. See Clark 2002 for a knowledge market perspective is 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.

- 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.

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

1. Patterns of interaction in research on quality management systems

The research included the development of improved pre-and post-harvest practices at farm and pack house 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. The organizations 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) 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.

2. Working through others: supporting innovation through managing relationships

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 where 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.

- **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.

- **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 cooperative model. 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.

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.

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 facilities using imported technology.

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.

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.

Donor response and a new approach to research management

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. 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. 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.

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 adoption of an explicit capacity development agenda for research.**

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.

- **The delivery of both technical and institutional innovations from research.**

Underlying the 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 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.

Policy implications of post-harvest innovation systems

Flowing from these experiences, 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. The second related point concerns what is the most appropriate partnership grouping? 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. 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 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.

Horticulture Technology R&D Systems in INDIA

The Vijaya mango export project discussed in this paper is a case study of precisely this phenomenon; a technical and policy study of recent developments in the mango sub-sector of the Indian economy involving an institutional marketing innovation, the Vijaya Association of Fruit and Vegetable Growers' Cooperative Societies of Andhra Pradesh (Vijaya). Conceived initially as a purely technical series of projects and interventions, it gradually became clear that the issues were equally about institutions and the need for institutional change. Thus what is interesting about the Vijaya case is not so much its success in integrating small farmers into a wider economic market (including the high value export market) but rather Vijaya's relationships with other stakeholders, in particular those that have been potential sources of technology.

Institutional Learning

The contribution of NSI is that it provides a way of analyzing institutional roles and relationships, and the way these change over time. This is conceptualized in terms of an *innovation system*. This type of analysis is more inclusive than the narrower notion of a *research system*, the distinction being that the latter is a system of predominantly public sector organizations engaged in producing technical innovations. In contrast, an innovation system encompasses all the elements of the system or network of private and public sector institutions, whose interactions produce, diffuse and use economically useful knowledge.

Institutional Roles & Arrangements for Technology Support Agricultural Research

Public sector agricultural research in India is conducted by institutions that can be categorized into two main organizational groups. In the first group are the research institutions that fall under the national agricultural research organization, the Indian Council for Agricultural Research (ICAR). In the second group are the 29 state agricultural

universities (SAU). In addition to these institutions, and less well integrated, are non-agricultural universities and other scientific organizations – notably those under the Council for Scientific and Industrial Research, the Department of Biotechnology and the Department of Science and Technology, all of which conduct research related to agriculture. Similarly under the Ministry of Food there are networks of grain storage research institutes and sugar research institutes.

Horticulture

The Indian Eighth Plan allocation for horticulture sector development increased from US\$ 6 million (Rs24crores) to US\$ 250 million (Rs1000crores). This, coupled with many concessions, subsidies and incentives to producers, was both an important impetus to growth, as well as recognition of its developmental potential. At the macroeconomic level, India has created an increasingly liberal economic policy environment since 1991. This has eased procedures for foreign collaboration and access to international markets. In turn it has precipitated an unprecedented expansion in Indian exports, among which horticultural exports have been important (APEDA, 1998). However the sector has not only witnessed strong growth and policy support.

Relevant Organizations

Box 1 Research institutes related to horticulture in India

ICAR crop/commodity Central Research Institutes

Indian Institute of Horticultural Research, Bangalore, (Southern India)
Central Institute of Sub-Tropical Horticulture, Lucknow (North Central India)
Central Institute of Temperate Horticulture, Srinagar (Far North West India)
Central Potato Research Institute (CPRI), Shimla (Far North India)
Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram (Far South India)
Central Plantation Crops Research Institute (CPCRI), Kasargode (South West India)
Indian Institute of Spices Research (IISR), Calicut (South West India)

Project Directorates

Project Directorate for Vegetable Research, Varanasi (North Central India)

National Research Centres

Citrus, Nagpur (Eastern Central India); Banana, Tiruchirapalli (Eastern Southern India); Grapes, Pune (Western Central India); Arid Horticulture, Bikaner (North West India); Onion and Garlic, Rajgurunagar (Western Central India); Mushroom, Solan (Far North, India); Orchids, Gangtok (North East India); Oilpalm, Elurur; (South Central India); Cashew, Puttur (South West India); Medicinal and Aromatic Plants, Anand (Western India).

Other ICAR Institutes related to horticulture.

Central Institute of Post Harvest Engineering and Technology, Ludiana (North West India)
Indian Agricultural Research Institute, New Delhi
(ICAR complex for North East Region)

Non-ICAR Institutes related to horticulture

Indian Institute of Packaging, Ludiana (North West India)
Central Food Technology Research Institute, Mysore (Southern India).

Private sector organizations

Private organizations are becoming an increasingly important institutional node in the Indian horticultural sector. A notable example of this is the grape growers association of Maharashtra⁷ and the creation of Mahagrapes, a confederation of grape grower's societies (Rasheed Sulaiman and Sadamate, 2000; Hall et al., 1998).

CASE STUDIES

The Vijaya Fruit and Vegetable Growers Association

The Vijaya Fruit and Vegetable Growers Association (Vijaya) was established in 1992 in Vijayawada in southern Andhra Pradesh, India. The association is made up of 16 fruit and vegetable cooperatives (primary societies) spread over three districts around Vijayawada. The primary society membership consists of approximately 500 farmers who between them cultivate almost 3,000 acres of mangoes. Vijaya acts as an apex organization to undertake and coordinate the marketing of mangoes in export and high value domestic markets. Vijaya is ostensibly a private

enterprise established with the initial support of the Andhra Pradesh State Marketing Department. Vijaya's specific goal is to find better prices for farmer members' produce through direct marketing to high value domestic and export markets without the produce being handled by middle men, wholesalers and traders. Vijaya rents pre-cooling and pack house facilities during the mango season (April/May) to process the fruit it purchases from farmer members. It identifies markets, negotiates prices and organizes transport/ shipment of fruit. Farmers receive a premium price for fruit that is of export quality.

The research project

The origins of the recent research project funded by DFID's Crop Post-Harvest Programme (CPHP) can be traced to the activities of the Overseas Development Natural Resources Institute (later renamed NRI). The activities focused on developing a manual on Horticultural Export Quality Assurance (HEQA) to help promote the development of exports of horticultural produce by improvement of quality and achievement of market requirements. The HEQA manual was designed to support producers and exporters targeting European markets. APEDA have developed a scheme that issues a 'Certificate of Registration of Premium Quality Exporter' to pack houses complying with requirements of the manual.

Phase 1: Technical quality parameters

The shape of the new project was not just determined by the fact that APEDA (and Vijaya) viewed the presenting problem as largely technological. Major changes had also taken place at both NRI and within DFID's funding mechanisms, resulting in a stronger physical sciences research mandate than the more developmentally focused initiative of the HEQA manual. This, along with the personalities involved in the UK team, resulted in APEDA and NRI embarking on a predominantly technical research project.

Lessons from Phase 1

APEDA responded in two ways. Firstly, it contracted scientists from NRI to undertake further out-turn assessments in order to monitor the technical validity of the protocols and practices being developed. Secondly, it intensified farmer-training efforts in mango growing areas by devising a more intensive training programme that covered both pre-harvest and post-harvest issues and took an active role in coordinating these efforts (although this was not implemented until 1999).

Phase 2: Technology development and institutional analysis

The second phase of the project took these ideas regarding the institutional environment forward in the form of a pilot action research project, which entailed undertaking a further piece of technical research with Vijaya. This was used as a vehicle to understand the institutional constraints presenting among relevant public agencies; the way these constraints impinged in a practical sense on attempts to solve technical problems; and to identify possible ways of moving forward.

Lessons from Phase 2

The following technical constraints were identified:

- Pre-harvest management constraints, particularly control of pests including anthracnose.
- Size grading – fruit present of mixed and uneven size.
- Maturity indices – the consignment contained fruit of mixed maturity, some over-ripe on arrival, some under-ripe.
 - Post-harvest control of disease – particularly anthracnose and stem end rot developed during storage, suggesting that postharvest treatment for these diseases was also required.
 - Heat damaged fruit – suggesting the need for improved temperature control in the field and during transit to pack house.
 - CA technology – fruit had suffered from chilling injury suggesting that the temperature and possibly gas mixtures had not been correct for the particular variety of mango being shipped.

Phase 3: Combined technology and institutional learning protocols

The third phase of the project concerns undertaking adaptive action research with Vijaya and APEDA to develop

management systems that will allow Vijaya to better access technology suitable for a smallholder production context. The project will allow it to operate more effectively within the overall institutional context of public sector support agencies in India.

Box 2 Institutional constraints identified in Phase Two

1. Professional mandate of scientists:

- Limited opportunities for interactions with farmers or private enterprise;
- Much of the experience of scientists based on the results of laboratory research and literature reviews;
- Little exposure to implementing research findings in either a commercial scale context or the contingencies of servicing the needs of European export markets;
- Absence of any social science expertise among the team members, resulting in a lack of complementary guidance on farmer practice and interaction.

2. Institutional mandates:

- Complementary knowledge and mutually supportive technical expertise locked up in different non-communicating institutes with the responsibility for linking these components left to a third party.

3. Resources and incentives:

- top-down institutional tradition within public sector;
- bureaucratic arrangements often make it difficult to work in new and more useful ways, even where scientists are keen to assist organizations like Vijaya;
- Logistical arrangements and short-term inputs provided limited resources for fieldwork.

4. Client-contractor relationships:

- lack of overall systemic control because APEDA, rather than Vijaya, had contracted and paid for the services of the scientists;
- No contractual recourse on the part of Vijaya to enforce accountability from the service providers;
- Inability of APEDA to play an informed and active management role due to distance from the point of service provision.

5. Institutional capabilities of marketing organization (i.e. Vijaya):

- Not able to facilitate more productive interaction between farmers and scientist, nor articulate farmers' concerns about the inappropriateness of some of the recommendations;
- Lack of awareness of the interrelated nature of many of the presenting problems, putting it in a weak position to press the scientists for the types of technology that would be useful.

CONCLUSION

The paper therefore suggests that henceforth policy analysis for agricultural development should specifically aim to include institutional reform as part and parcel of its recommendations. In addition, project aid must include policy analysis of likely outcomes as an integral component of research design. In this way technical aid may begin at last to have a sustainable impact on developmental possibilities for the world's poor. 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.

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