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Locating research in agricultural innovation trajectories: Evidence and implications from empirical cases from South Asia

T. S. Vamsidhar Reddy[1,*], Andy Hall[2] and Rasheed Sulaiman[3]

[1]*Research Fellow, Research into Use Programme, United Nations University (UNU-MERIT), Keizer Karelplein 19 6211 TC, Maastricht, The Netherlands; Doctoral candidate, The Open University, Milton Keynes, UK; Project Coordinator, AVRDC-The World Vegetable Centre, C/o ICRISAT, Patancheru - 502324, India.*

[2] *Director, LINK Ltd.; United Nations University (UNU-MERIT), Keizer Karelplein 19 6211 TC Maastricht, The Netherlands; Visiting Professor, The Open University, Milton Keynes, UK.*

[3] *Director, Centre for Research on Innovation and Science Policy, 8-2-612/54/1, Gaffar Khan Colony, Road No. 10, Banjara Hills, Hyderabad - 500034, India.*

**Corresponding author. Email: tsvreddy@hotmail.com.*

Agricultural innovation is a process that takes a multitude of different forms, and, within this process, agricultural research and expertise are mobilised at different points in time for different purposes. This paper uses two key analytical principles to establish how research is actually put into use. The first, which concerns the configurations of organisations and their relationships associated with innovation, reveals the additional set of resources and expertise that research needs to be married to, and sheds light on the types of arrangements that allow this marriage to take place. The second, which concerns understanding innovation as a path-dependent, contextually shaped trajectory unfolding over time, reveals the changing role of research during the course of events associated with the development and diffusion of products, services and institutional innovations. This paper examines the efforts of the Research Into Use programme funded by the UK Department for International Development that sought to explore the agricultural research-into-use question empirically.

Keywords: agricultural innovation; value chain innovation; Research Into Use; South Asia; innovation trajectories; Research for Development.

1. Introduction

The context of this paper is the ongoing discussion about how agricultural research can best be used for developmental purposes. The idea that this is simply a question of better transfer of ideas from research to farmers has been largely discredited (World Bank 2006). There certainly are circumstances where this type of technology delivery pipeline arrangement works well, but these circumstances are exceptions rather than the rule. The contemporary understanding of agricultural innovation is that it is a process that takes a multitude of different forms, depending on local circumstances and histories, and presents different challenges and opportunities (World Bank 2006; Rajalahiti et al. 2008; Spielman et al. 2009). And, within this process, agricultural research and expertise are mobilised at different points in time for different purposes. This paper boils these types of issues down to two key analytical principles in order to establish how research is actually put into use. The paper then seeks to use this analysis to derive implications for public policy and its ongoing efforts to add value to research investments.

The first analytical principle used in this paper concerns the configurations of organisations and their relationships

with innovation, as well as the location and role of research within these configurations. This is useful as it reveals the additional set of resources and expertise that research needs to be married to and sheds light on the types of arrangements that allow this marriage to take place.

The second analytical principle concerns understanding innovation as a path-dependent, contextually-shaped trajectory unfolding over time. We argue that this analytical perspective is important, partly because it reveals the changing role of research during the course of events associated with the development and diffusion of products, services and institutional innovations. However, it is also important because this idea suggests that the task of putting research into use is not a post-research task, but is a long-term capacity development task concerned with marshalling resources and expertise to deal with an unpredictable and highly dynamic world in which innovation trajectories play out.

This paper uses these two perspectives to explore the recent efforts of a donor-funded programme that has been established to explore the agricultural research-into-use question empirically (the Research Into Use (RIU) programme funded by the UK's Department for International Development (DFID)). The paper concludes by suggesting new modes of financing to support the undertaking of research and use concurrently and not as sequential steps. It also confirms the importance of the roles played by different types of agencies in the innovation process, which requires adopting capacity building agendas in a system sense rather than technology transfer agendas. The paper then highlights the important roles played by the pivotal agencies of the innovation process—that have pro-poor agendas—to steer innovation trajectories in order to achieve poverty reduction objectives.

The rest of the paper is organised as follows. Section 2 presents a framework for exploring the location of research in agricultural innovation. Section 3 presents the case studies that are then discussed in Section 4 to bring out key issues regarding the nature of agricultural innovation trajectories and the use of research within these. The paper ends with policy implications for putting research into use in Section 5.

2. A framework for exploring the when and where of research in agricultural innovation trajectories

In recent years innovation systems conceptualisation of agricultural development has been based on the importance of multi-actor processes and the institutional context in which knowledge generation, dissemination and use takes place (Hall et al. 2004). This highlights the point that technological, institutional and policy innovations are interlinked. Thus, networking different actors in order to facilitate the sharing of ideas and resources is a critical strategy to enable the process of innovation (World Bank 2006). To support this conceptualisation there is growing evidence to suggest that embedding research in the system of technology users and intermediaries would aid in better use of research products (Hall and Sulaiman 2008). Barnett (2006) provided evidence for a DFID-funded research programme around the notion that organising research as part of a coalition of development, entrepreneurial and policy actors could improve impacts. Experience has also shown that when organisations with varying expertise network together and start engaging in joint activities, it leads to organisational and institutional changes and enhances the application of new knowledge (Spielman et al. 2009). Moreover, the process also raises new and relevant research questions, as well as triggering new demands for technical support (Hall et al. 2009; Sulaiman et al. 2010).

How, then, can these emerging ideas about innovation be used to make sense out of experiments that explore the relationship between research and innovation (such as the case of RIU that this paper is investigating)? It seems that a good starting point might be to try and locate research in space and time.

2.1.1 Locating research in configurations of organisations and their roles. The discussion above clearly points to the importance of the innovation management tasks associated with the development of networks and various configurations of organisations and individuals involved in the innovation process. The logic behind this is that partnerships and other forms of social interaction are the domain in which knowledge (be it from research or elsewhere) is shared and where learning and innovation actually take place (Nelson and Rosenberg 1993: Freeman 2002; Mytelka and Smith 2002; Ekboir 2003; Ayele and Wield 2005; Hall 2005; Kristjanson et al. 2009). Key analytical concerns are about the nature of configurations (range of players involved, different types of arrangements connecting them together, and the roles played by different organisations in these configurations). Analytically the question about roles is important in order to understand the mix of resources, expertise and tasks that need to be combined with research for innovation. It also reveals the differences between organisations that are involved in innovation and have a direct economic or social stake in its outcome and those organisations that have a facilitative role in helping manage innovation—these are the third-party or intermediary organisations that have been referred to as brokers (Klerkx et al. 2009; Rivera and Sulaiman 2009; Klerkx and Leeuwis 2008; Sumberg 2005; Roling and Wagemakers 1998). Examining the nuances of this role provides insights into the types of organisations in any given development arena that may, given adequate financial resources, be able to play a role of this type when they do not have any direct financial stake in the process.

2.1.2 Locating research in different points in the innovation trajectory[1]. Unlike many of the analytical instruments from the neo-classical economics tradition, the evolutionary economic perspective on innovation (Nelson and Winter 1982)—and analytical perspectives aligned to that tradition (notably innovation systems ideas, but also others)—suggests that a sense of history is an integral element of the analysis. The reason for this is that the roles and configurations discussed above evolve over time and play out in an unfolding innovation trajectory, which responds to various economic, social and policy triggers in the wider environment. This evolution arises partially because organisations involved in innovation continuously learn how to do things better and continuously adapt how they do things because the context they operate in is also constantly changing and they need to respond to this. Path dependence and the unpredictable nature of the shaping environment intersect to produce a limitless range of innovation trajectories.

In addition, as specific products and services are brought into use, different skills, resources and expertise are required at different times in the unfolding performance. Research may be more important at a discovery stage and at a troubleshooting stage when second-generation problems occur, but may become less important when diffusion, adaptation and application are taking place. This is not to say that there is a predetermined sequence of events involved in innovation—this would take us right back to end-of-the-pipeline notions of research and technology transfer, which we now know are only effective in a relatively limited set of circumstances. Instead, the analytical insight that comes from exploring innovation trajectories is that it starts to reveal how organisations involved in innovation marshal expertise and resources to meet the challenges of an unpredictable context and how they tackle complex social phenomena, such as poverty, that is itself embedded in its own dynamic context. These concepts, which are now well-founded in the literature, suggest that the task of putting research into use, therefore, does not become a post-research task—an afterthought to make more out of previous research investments. Rather, it suggests that research into use is a capacity building task, where the main organising devices for assistance are not the projects: usually these are conceived as either research- or development-oriented and in reality are always administered and implemented in isolation from each other. Instead, contemporary debates would seem to suggest that it is the innovation trajectory itself that is the organising device for putting research into use. The reason for this is that the innovation trajectory is a domain that brings together both research and development activities (the former aimed at discovery and the latter aimed at social and economic gain) in an integrated way.

We devote the rest of this paper to exploring three of RIU's projects in Asia from the perspective of locating the research within innovation trajectories and within the configurations of organisations existing at different points in that innovation trajectory.

3. The RIU value chain-oriented projects in South Asia

Ten years (1995–2006) of research, funded by the DFID's Renewable Natural Resources Research Strategy (RNRRS), generated new knowledge in the expectation that it would address the needs of poor communities living in Asia and Sub-Saharan Africa. The final evaluation of the DFID programme suggested that although it had generated good scientific research, its developmental impacts have been modest (Spencer et al. 2005; Hall et al. 2010). The DFID then commissioned the RIU programme in 2006. The programme's underlying premise was that an additional set of activities beyond research could help to extract more impact from earlier investments in research. The ideas informing how this might be achieved have matured considerably between the time when the RIU programme was set up and the writing this paper (2010). The projects discussed in this paper were set up in the earlier stages of the programme. At that time the guiding principle was about identifying existing technologies and looking for ways of scaling these out. The operationalisation of this principle, on paper at least, built largely on earlier research project thinking and the understanding of this by research teams. As will be illustrated, however, these projects, when examined through the eye of the analytical principles suggested in Section 2, are proving to be a rich source of insights into the organisation of the innovation process over time.

The present authors were part of the Central Research Team, employed by RIU to generate lessons from the programme's interventions spread across several countries in Africa and Asia. The projects selected for the current paper have all focused on innovation associated with value chain development.

A longitudinal case study method was adopted for understanding the cases. Data was collected during periodic visits to the project locations and through semi-structured interviews with key informants from different stakeholder groups. A review of the literature provided information on the historical aspects of the cases. The agricultural innovation systems analytical framework employed by the World Bank (2006) was used for comparative analysis of the cases.

The three cases presented in this paper involve RIU projects in South Asia (specifically in Bangladesh, Nepal and India) that focused on facilitating wide-scale application of three different knowledge products/processes developed under DFID's RNRRS programme. In Nepal an international development agency, the International Development Enterprises (IDE-Nepal), has put to use the participatory market chain approach (PMCA) to strengthen the vegetable value chain and connect smallholder farmers

to larger markets. The project in Bangladesh, led by the Rangpur Dinajpur Rural Services (RDRS), a non-governmental organisation (NGO) has developed the fish-seed value chain by putting into use the idea of Decentralised (fish) Seed Production (DSP). In India the International Centre for Underutilised Crops (ICUC) and BAIF Development Research Foundation (formerly registered as the Bharatiya Agro Industries Foundation) have built a value chain for underused crops and connected smallholder producers to markets through a multi-pronged approach that was developed by integrating different knowledge products. Table 1 presents some of the key features of these three cases.

3.1 Case 1: Application of the PMCA in Nepal

This project—which is about connecting smallholder vegetable growers to larger markets and other service providers by building configurations of relevant actors in Nepal—is led by IDE-Nepal, an NGO that is well-known for its market-oriented approaches to rural development. IDE-Nepal's long-term efforts to build actor architectures of smallholder vegetable grower groups and to connect them to different agencies and service providers in order to enable better access to markets, received a boost through RIU, under which it adapted and applied the PMCA to move these actor architectures to a higher level of operations. Figure 1 presents the innovation trajectory of PMCA adaptation and application in Nepal.

3.1.1 Development of PMCA in South America. The origins of PMCA can be traced to the efforts of Papa Andina, a regional programme initiative by the International Potato Centre (CIP) with activities covering Bolivia, Ecuador and Peru. Started in 1998, with the aim of improving the livelihoods of low-income potato farmers in the region, Papa Andina's initial activities were focused on improving production through technological solutions. When marketing problems began to impinge upon

Table 1. Key features of value chain-oriented RIU projects in South Asia

Feature	IDE (Nepal)	RDRS (Bangladesh)	CoDI (India)
Assembly of cluster of actors	*At programme level:* Key stakeholder representatives, as members of an advisory committee, supervised project implementation *At field level*: Key actors of existing value chain were brought together through PMCA approach	*At programme level:* Key stakeholder representatives, working as part of a loose network, supported project implementation *At field level:* Value chain developed by creating new roles and strengthening linkages among existing actors	*At program level*: Key stakeholder representatives, organised into a coalition, were involved in programme implementation *At field level:* A multi-pronged approach brought together different actors along agricultural value chain to build a value chain around underutilised crops
Approaches/strategies for putting existing knowledge from RNRRS into use	Proven knowledge was adapted and adopted in a different context for innovation around value chains	Proven knowledge was scaled-up/out in a larger area through innovation around value chains	Different streams of knowledge were appropriately mixed to continuously develop an approach for value chain innovations
Mechanisms/strategies for integration of research into innovation process	Smallholder organisations were enabled to articulate their need for research outputs to research agencies	Research organisations were part of network and there was two-way feedback and information sharing	Research organisations were part of coalition and there was two-way feedback and information sharing
Features and ways of making effort pro-poor	Focus on building capacities of smallholder organisations	Focus on developing smallholder rice field farmers and seasonal pond owners as producers of fish seed	Focus on vegetables and fruit that are mostly cultivated by smallholder farmers on degraded lands
Commodity under consideration	Mainstream fruit and vegetables	Fresh water fish species that are self-recruiting	Underused crops (cereals, fruits and vegetables)
Status of existing value chain (prior to RIU intervention)	Mostly present but with inefficiencies and missing links	Mostly present but with inefficiencies	Mostly absent
Intervention in value chain	Building capacity of smallholder organisations to identify and respond to market opportunities. Building linkages among different components of existing value chain	Creating a role for smallholder farmers in fish-seed value chain and strengthening linkages among existing components of fish-seed value chain	Simultaneously building different components of value chain. Allowing existing components of value chain to participate, in line with their individual business interests

Source: present authors

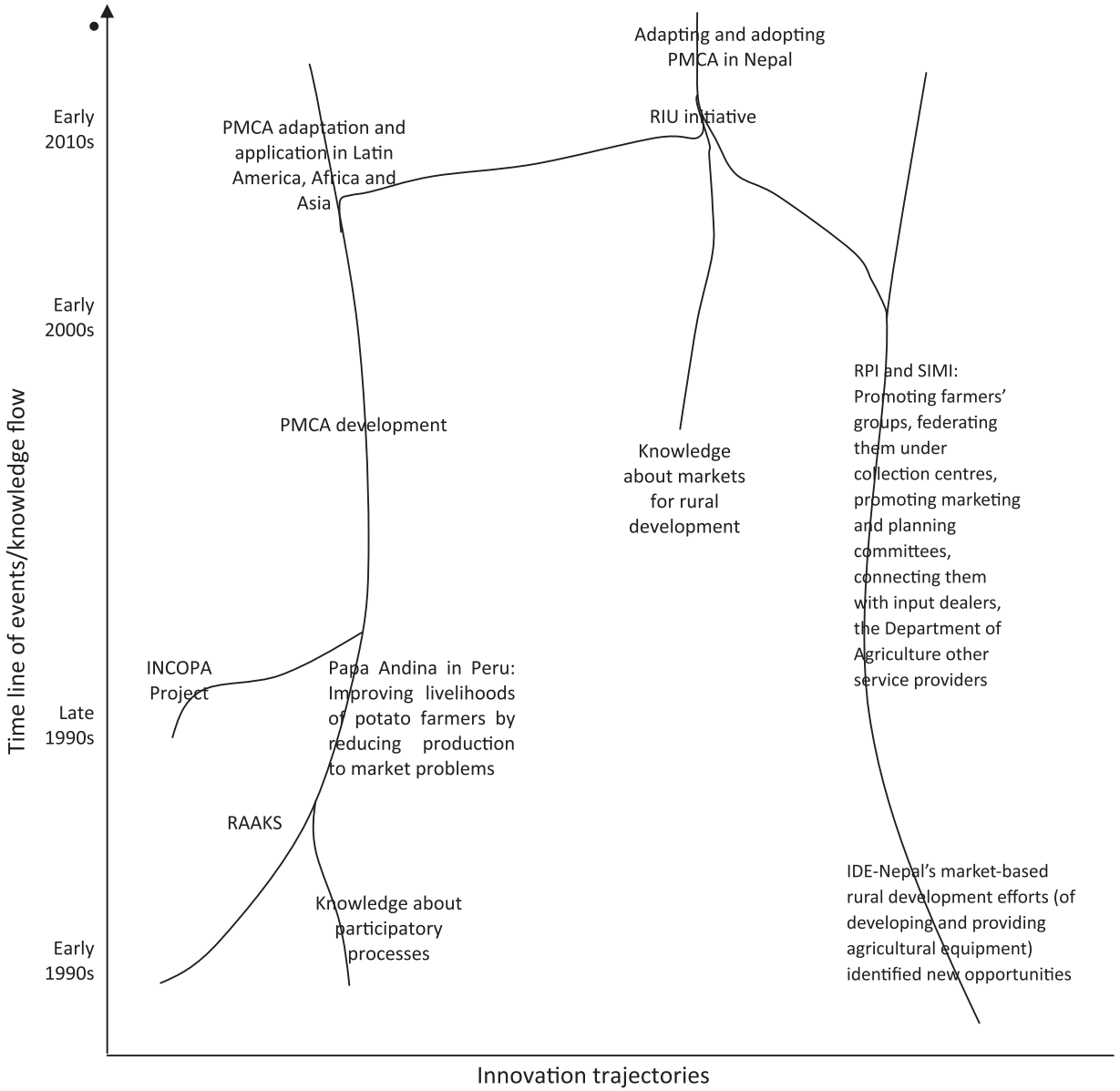

Figure 1. Innovation trajectory of PMCA in Nepal.
Note: INCOPA: Project for Potato Innovation and Competitiveness in Peru; RAAKS: rapid appraisal of agricultural knowledge systems methodology; RPI: Rural Prosperity Initiative; SIMI: Smallholder Irrigation Market Initiative.
Graph is based on date collected during this study.

improvements in production, the programme team began to explore ways to enhance the participation of smallholder farmers in market chains (Horton et al. 2009). To achieve this it worked with another CIP initiative (Project for Potato Innovation and Competitiveness in Peru (INCOPA)) and used the rapid appraisal of agriculture knowledge systems methodology (RAAKS) (Engel and Salomon 2003) together with other participatory approaches. These efforts gradually evolved into the PMCA (Horton et al. 2009).

3.1.2 IDE-Nepal's efforts toward market system-based rural development: Demand for PMCA. Since the early 1990s IDE-Nepal's key activities have involved participatory research to develop and provide appropriate micro-irrigation technologies in Nepal. Later, based on demand, they provided equipment for agricultural production and processing. It was through these activities that IDE-Nepal began to recognise the opportunities for smallholder farmers to rapidly increase their incomes by supplying agricultural produce, especially vegetables, to larger national and international markets. However, realising these opportunities was never easy, given that the farmers were unorganised and only produced small quantities of vegetables. These problems were compounded by the inefficiency in the existing value chains, which were

characterised by missing actors and insufficient connections between the existing ones.

In order to address these constraints and connect farmers to markets, IDE-Nepal facilitated[2] the construction of community managed collection centres at various district blocks, which served as points of accumulation of vegetables to attract local traders. Individual farmers were organised into farmers' groups. These groups from an area were federated and attached to the collection centre of that area. An executive body was appointed for each centre, known as the marketing and planning committee (MPC), to represent the interests of members to different stakeholders. Input dealers who operated in those areas were given resource books on crop production practices and were encouraged to share copies of these with their farmer clients at a nominal cost. These input dealers were also encouraged to attend meetings at the collection centres. Menbers of the MPCs were trained and encouraged to contact the Department of Agriculture and village development committees at the local level to access various programmes and funding schemes. The farmers' groups were registered with the Department of Agriculture, and the MPCs were registered under the Cooperatives Act, with a hope that it would warrant then formalisation and institutionalisation of these organisational structures and thus ensure sustainability.

Such creation of social architectures,[3] under IDE-Nepal's Rural Prosperity Initiative and Smallholder Irrigation Market Initiative, helped the farmers receive better prices, mainly because the MPCs were able to use their bargaining capabilities for the produce at the collection centres. However, despite all efforts, there was an element of mistrust between farmers and traders. This translated into traders not openly sharing prices, farmers complaining about exploitation by traders and traders complaining about the lack of regularity in supplies from farmers. The MPCs lacked the requisite skills to address these issues. The linkages among different agencies that IDE-Nepal created through the collection centres seemed to remain just as formalities and did not deliver the expected outcomes. In many cases, these growing problems started to threaten the entire initiative.

3.1.3 Application of PMCA under the RIU initiative. At this stage, IDE-Nepal came across PMCA as a useful tool to address these problems and move current initiatives to the next level of market operation. IDE-Nepal expected this tool to help them in building the management capacities of the MPCs to enable them to respond to different types of market opportunities and to build trust among different agencies. Given that PMCA was originally developed in a completely different geo-political-cultural-market context, IDE-Nepal decided to adapt it to fit to the local context. For this, it collaborated with PMCA's developers to understand its conceptual underpinnings. While sticking to the broad framework, IDE-Nepal customised the different activities to be undertaken under each of the three stages of the approach. For instance, the thematic groups suggested in the approach were promoted more as mechanisms for different agencies to come together to discuss and jointly plan initiatives. The social architectures established under IDE's previous initiatives, created a demand for the PMCA approach and also formed a base for its successful application.

3.1.4 Post-RIU: Sustainability and scaling up/out. Improved interactions and trust among different actors, created through the application of PMCA, ensured a win–win situation for everyone involved. For example, farmers received better prices, became aware of opportunities in different markets and expanded vegetable growing areas; traders accessed graded and good quality vegetables in large quantities and expanded their business frontiers; restaurant owners and other consumers accessed vegetables in the required quantities and at better prices; input dealers increased their businesses and received feedback on how to improve their operations etc. This newly created trust not only helped the different actors improve their current operations, but also helped them plan for future activities (for example, some groups have plans for organic agriculture, reaching international markets etc.). In this scenario, each of the participating stakeholders in the initiative is striving to sustain it and further expand it, in their own interests.

3.2 Case 2: Application of decentralised seed production in Bangladesh

This RIU project in Bangladesh is focused on setting up a decentralised, micro-enterprise-based supply network to supply fingerlings of an improved breed of tilapia,[4] using an approach known as DSP. The project is led by RDRS, a well-established and well-respected NGO based in northwest Bangladesh (an area of heightened rural poverty where integrated fish and rice production systems are key livelihood strategies). The project builds on an extensive history of R&D activities in Bangladesh and internationally. This innovation trajectory is illustrated in Figure 2.

3.2.1 Developing the DSP approach. Several largely unconnected efforts appear to have contributed to the development of the DSP approach. One stream of efforts was first launched in 1991 by a project known as the Northwest Fisheries Extension Project (NFEP)[5] in northwest Bangladesh. The research-oriented staff of NFEP attempted decentralised common carp seed production through the collection and translocation of spawn deposited by annual floods on aquatic plants in

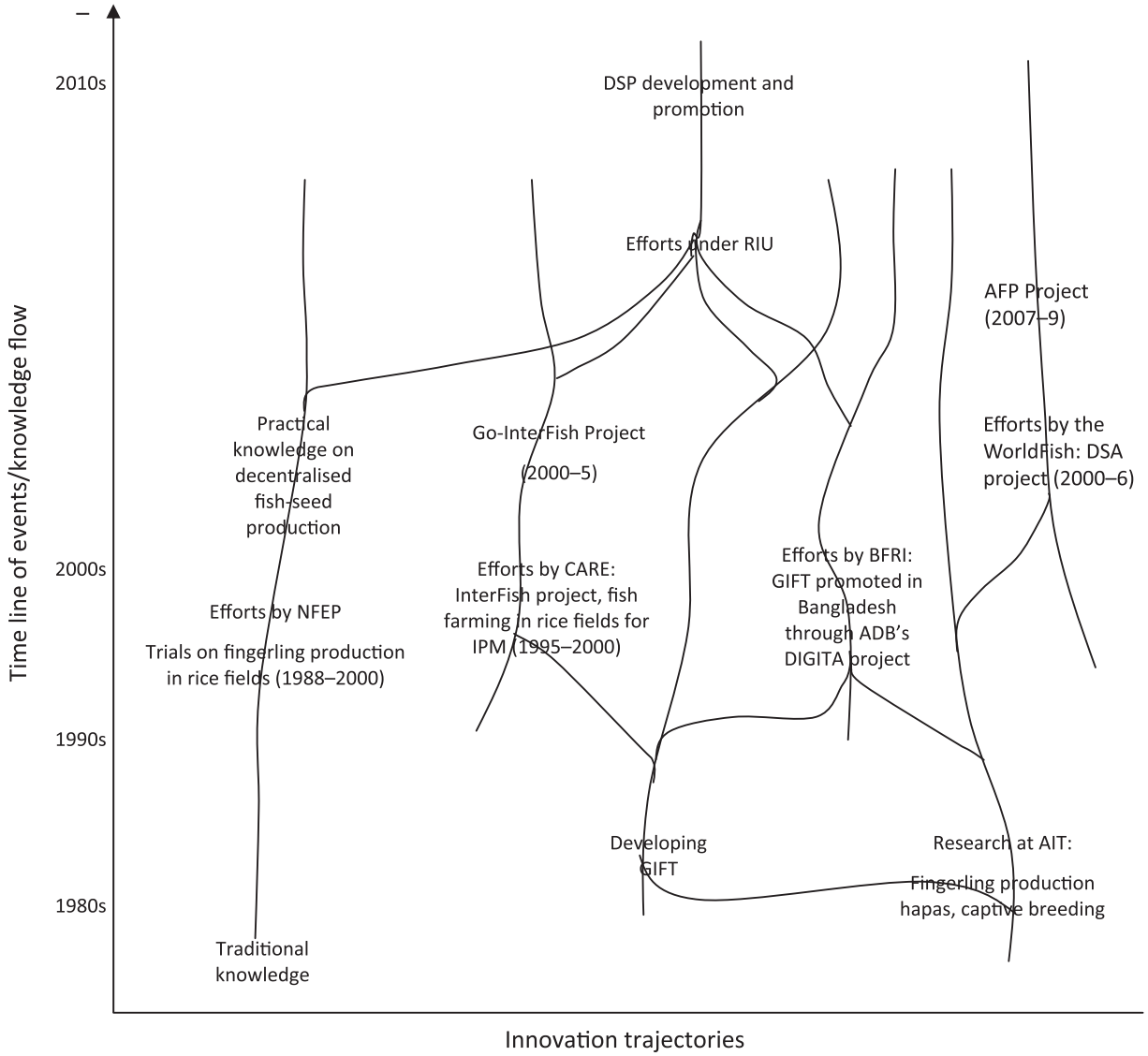

Figure 2. Innovation trajectory of decentralised seed production of GIFT under RIU initiative and its original sources. *Note*: Graph is based on date collected during this study.

household ponds and ditches to rice fields. The encouraging results of this initiative prompted the Integrated Rice Fish (InterFish) Project[6] to promote fish cultivation in rice fields as part of efforts to achieve integrated pest management (fish eat pest larvae). At this early stage efforts were limited to common carp. This, however, changed with the introduction of genetically improved farmed tilapia (GIFT), which had originally been developed by the International Center for Living Aquatics Resource Management (ICLARM)/WorldFish in collaboration with several R&D agencies.[7] Asian Development Bank (ADB) also helped the Bangladesh Fisheries Research Institute (BFRI) to introduce GIFT in 1994, as part of a project on dissemination and evaluation of genetically-improved tilapia in Asia. In 1999, NFEP introduced this improved strain of tilapia as part of a research trial with farmers. The Go-Interfish project, implemented by CARE in the period 2000–5, also further promoted the production of common carp and GIFT in rice-field plots.

Another stream of efforts that contributed to the development of DSP was the result of a collaboration between the Asian Institute of Technology (AIT), WorldFish Centre (a Consultative Group on International Agricultural Research Centre) and the Institute of Aquaculture in the University of Stirling, UK. Financial support for these initiatives came largely from the UK's Overseas Development Administration (ODA, the predecessor of DFID) through its RNRRS programme and the ADB. These partners worked with national government departments and NGOs to advance technical aspects of developing appropriate hatchery systems for low-cost, freshwater fish. As a result, technologies for tilapia

(in both commercial and smallholder situations), small carp and snakeskin gourami[8] were developed or refined. The RNRRS project, 'Aquaculture Outreach project', promoted improved availability of quality fish-seed to farmers and explored different approaches to suit different conditions (AIT 1990). As a result of these efforts, greater numbers of farmers began to produce greater and more improved quantities of seed. Subsequently, a research project on 'improving fresh water seed supply and performance in smallholder aquatic systems in Asia' (funded by DFID through its RNRRS strategy, R-7052 DFID 2002) clarified many earlier perceptions and further advanced knowledge about freshwater fish seed production in Asia. The DSP approach, therefore, evolved by building on knowledge from these different research and development efforts.

3.2.2 Emerging demand for DSP to address problems in freshwater aquaculture. Freshwater aquaculture is very important to the livelihoods of villagers in northwest Bangladesh. Good quality fish seed is critical for the success of freshwater aquaculture. Although there are many public and private sector hatcheries, these exist in clusters and are distantly located. Poor transport facilities (fish-seed is usually transported by seedling traders (*patheelwalas*) in metal pots tied to bicycles) and longer distances result in higher mortality and transportation costs. Monsoon-dependent farming in these areas results in higher demand and higher costs of fish-seed during peak seasons. All these factors act as serious constraints for smallholder farmers when it comes to accessing good quality fish-seed. To address these issues, decentralised fish-fingerling production in rice fields by farmers was suggested as an option, after establishing its feasibility through the efforts mentioned above.

Several attempts were made to popularise this decentralised approach by agencies such as the Department of Fisheries (DoF), BFRI, WorldFish and several NGOs. These included special projects such as the Decentralization of Sustainable Aquaculture Project (DASP)[9] and the Adivasi Fisheries Project (AFP),[10] which demonstrated the usefulness of this approach to farmers — through campaigning on the radio and television and by the efforts of NGOs such as RDRS. Individual farmers who participated directly in these efforts continued to grow fish seed in their rice fields. However, the approach was not taken up widely. The main reason for this was the lack of an appropriate supply chain and support services which could ensure a regular supply of GIFT fingerlings and provide the necessary technical knowledge.

3.2.3 Application of DSP through the RIU initiative. It was at this point that support from RIU entered the picture. To address the constraints discussed above, RDRS led a consortium of NGOs from the northwest region to collaborate with partners with specific expertise. These included the International Development Enterprises-Bangladesh (IDB-Bangledesh) for its market development expertise, the WorldFish Centre for its technical expertise and the Bangladesh DoF for its technical advisory mandate. The consortium built the necessary actor architecture to apply the DSP approach. Rice field farmers, table fish farmers, seasonal pond owners, and fingerling traders were selected and encouraged to be part of the initiative. Roles to be played by each of them were specified and interactions among them facilitated by the project. The farmers and traders were supported with necessary training and finance. A few selected table fish growers (pond owners) in different regions were encouraged to play the role of 'satellite brood rearers' (suppliers of GIFT brood fish to interested rice field farmers). A number of educated and unemployed youth from local areas were selected and trained to play the role of field technicians to provide motivation and technical knowledge, and to clarify any doubts farmers interested in DSP might have had. During the first year, they were paid a nominal honorarium. WorldFish representatives and personnel from the DoF helped these field technicians provided technical support for these field technicians. IDE-Bangledesh, which has extensive expertise in developing rural markets, designed and implemented locally-specific activities to develop markets for fingerlings and build relationships among different actors along the fish-seed supply chain. The DoF promoted and managed a 'brood bank' to ensure a sustainable supply of brood stock to satellite brood rearers. Some individuals (selected from among the fingerling traders, rice field farmers and table fish growers) were promoted as 'local entrepreneurs' and were provided with necessary knowledge and skills to promote the DSP concept, benefiting in the process through increased business. Some of the field technicians were selected to be trained as local entrepreneurs, to ensure continuity of their support to their respective communities. Many locally-relevant ideas were implemented with regards to the composition of fish species to be cultivated, size of the ditch and bunds in the rice fields, feeding patterns, ensuring water supply during dry seasons etc. The tacit knowledge of different functionaries (including the field technicians, rice field farmers, satellite brood rearers, fingerling traders, nursery owners, DoF officials, NGO staff etc.) was utilised to devise these approaches.

What is important to note at this point is that the resources of RIU were mainly used by the project to help bring in partners to an initiative that had, in many senses and in many different forms, been in operation for more than 10 years. The main feature of what the partners actually used RIU resources for was to improve the scope and quality of the relationships and attendant processes necessary for innovation. In this case the innovation was a marketing and institutional innovation that allowed poor

farmers to access and benefit from improved fish breeds. It is also important to realise that RIU did not provide a recipe for managing these processes. That was left to the resourcefulness of the partners involved. A critical element of this was the identification of skill sets required to address emerging issues. For example, the project struggled initially as RDRS had little marketing expertise. This was resolved by bringing in IDE-Bangledesh, which has a strong track record in setting up marketing systems for the poor. This meant that the patterns of partnership evolved considerably as the innovation trajectory of DSP unfolded).

3.2.4 Post-RIU: Sustainability and scaling up/out. Part of the task of selecting and managing an evolving configuration of partners was to create a win–win situation for all participating agencies. In this scenario, rice field farmers benefited from additional income with minimal adjustments to their rice plots and little additional investments. Table fish pond farmers, who acted as 'satellite brood rearers', benefited from additional income by selling brood fish to rice field farmers. They promoted rice field fingerling production as they could sell brood fish to more farmers. Fingerling traders benefited from accessing good quality fingerling locally and at better prices. Thus, they were also keen on promoting rice field fingerling production. The project, therefore, shows great potential for sustainability, given the promotion of DSP by different agencies to further their individual business interests.

3.3 Case 3: Promotion of underused crops through a multi-pronged approach

This RIU project focused on creating actor architectures to develop a value chain for underused crops in India. The ICUC collaborated with BAIF, a reputable national NGO, to achieve this by developing a multi-pronged approach based on several knowledge components that were each successfully tried in different contexts. Figure 3 presents the innovation trajectory of developing and applying this multi-pronged approach.

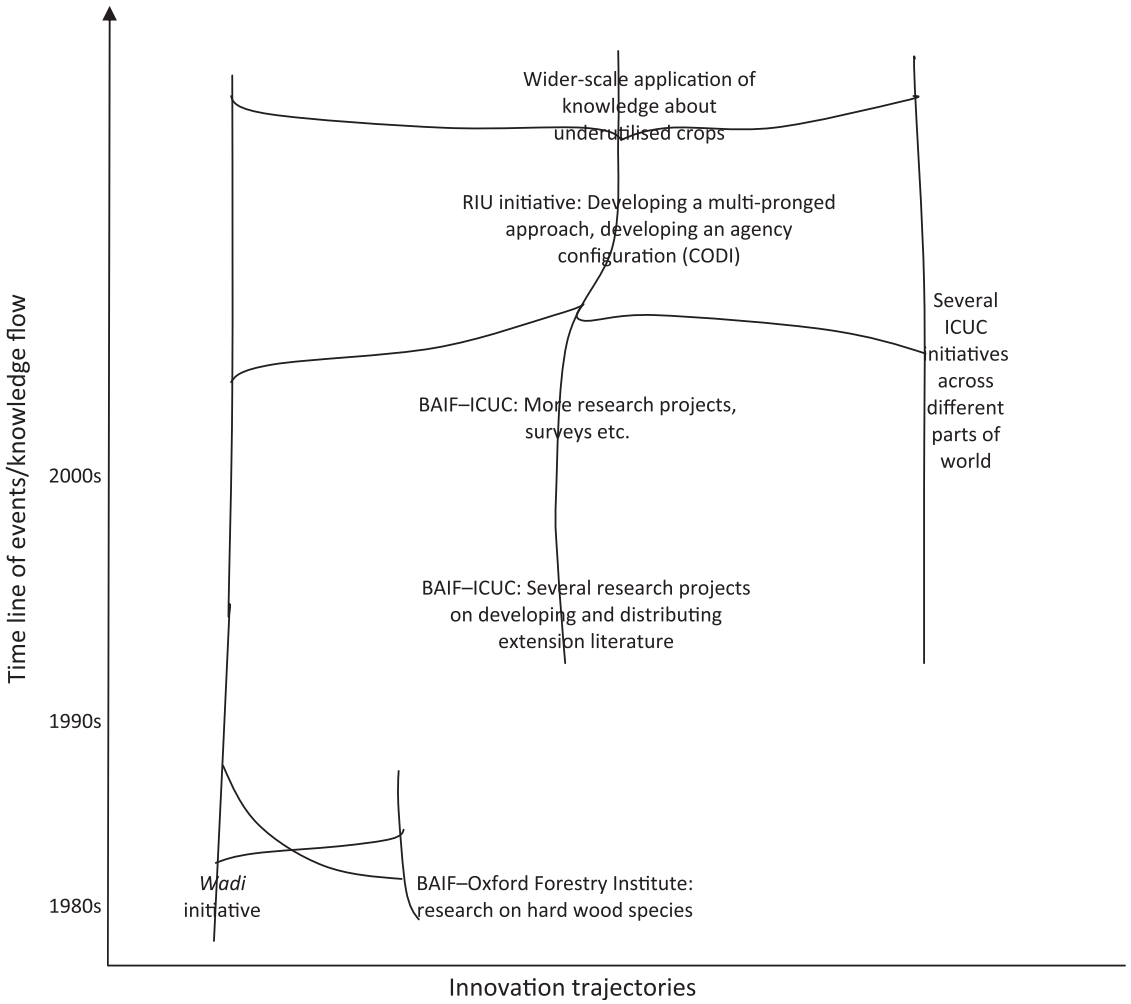

Figure 3. Innovation trajectory of putting UC knowledge into wider-scale use under RIU[3] and its original sources. *Note*: Graph is based on date collected during this study.

3.3.1 Development of the multi-pronged approach to promote underused crops. The multi-pronged approach used by the RIU initiative appears to have emerged from several independent research efforts and experiences. The ICUC led one group of such efforts, which initially focused on collating local and scientific knowledge on production and post-harvest aspects of underused crops into extension literature and promoting the wider dissemination of this material. ICUC collaborated with many research and implementing partners in these efforts. Through projects such as the 'Fruits for the Future Programme' (an RNRRS initiative (R7187), Haq and Hughes 2002), it worked with national research institutes and developmental partners to produce extension literature and organised training programmes to disseminate this. Through reviews of these initiatives, ICUC realised that making this knowledge available only addressed one aspect of the problem. There were other constraints to promoting underused crops such as: the lack of free access to plant propagation material of required species; the unavailability of post-harvest and processing technologies; and a lack of linkages to markets and other service providers. Thus, ICUC realised the need for broader engagement with diverse stakeholders.

Based on these lessons, ICUC subsequently implemented a project on Improved livelihoods through the development of small-scale fruit processing enterprises in Asia (an RNRRS initiative (R8399), DFID 2004), in which capacities of local partners were built in the production and processing of underused crops through training and financial support. These local partners were then expected to identify, encourage and support potential entrepreneurs to set up production and processing facilities, so that producers of underused crops could benefit from these. In India, BAIF, which was ICUC's local partner, established three fruit processing facilities (known as resource centres) through self-help groups of small entrepreneurs. However, these fruit processing enterprises collapsed despite some initial success. It was realised during subsequent reviews that this was mainly because of a lack of business skills among these small entrepreneurs. The lessons from these earlier efforts formed the base for developing a multi-pronged approach.

3.3.2 BAIF–ICUC efforts leading to the application of a multi-pronged approach under RIU. The BAIF Development Research Foundation has been promoting the production and use of underused crops to support rural livelihoods since the late 1980s. Often they collaborated with research agencies, such as the Oxford Forestry Institute, to research on several aspects of underutilised crops in relation to their promotion among rural communities. During the late 1980s, BAIF launched the Wadi programme in the Valsad district of Gujarat state in India. The programme was aimed at promoting agri-horti-forestry plots on degraded lands belonging to resource-poor villagers. The success of the programme in the area encouraged BAIF to promote it in six states in India, covering about 10,000 families and 40,000 hectares. Recognising BAIF's expertise in the area, ICUC collaborated with them on research on underused crops. Together, they implemented several research-cum-developmental initiatives, as mentioned in Section 3 3 1. Learning from them created a demand for developing the multi-pronged approach, under the RIU initiative

3.3.3 Application of the MPA under the RIU initiative. To address the problems in production and use of underused crops, a multi-stakeholder group called the Coalition to Diversify Incomes through Underused Crops (CoDI) was formed,[11] comprising representatives from different organisations. The coalition developed a multi-pronged approach by putting together knowledge generated from various research and developmental initiatives.

The multi-pronged approach was essentially comprised of three components: Community Germplasm Orchards (CGO), Village Crop Fairs (VCF) and Fruit Processing Parks (FPP). The CGO were created to multiply plant material to be supplied to interested growers. Necessary training and financial support was provided to establish these CGO. The VCF were events organized periodically for different agencies connected to the underutilised crops to come together to share lessons and interests. The FPP were the places where necessary facilities/resources concerning post-harvest activities and marketing of underused crops could be accessed. These initiatives were undertaken in areas where BAIF's Wadi programme had already created the necessary social architecture and linkages among relevant agencies. Underutilised crops were planted in the existing Wadi agri-horti-foresty plots. The CGO and FPP helped both the initiatives to benefit. The linkages established with universities and research stations, during the Wadi initiative, helped in extending technical support for underutilized crops. Similarly, the market channels established helped in promotion of these crops. BAIF, which anchored the adoption of this approach in India, played a central role by bringing relevant actors, such as technical experts, market players and community members, together to promote the underutilised crops. They made several adjustments to the approach during the implementation stage, based on feedback after the first round of activities, in order to meet specific local requirements.

3.3.4 Post RIU: Sustainability and scaling up/out. A farmers' producer company, known as the Vasundhara Agri-Horti Producers Company Limited (VAPCOL), which was promoted by BAIF under its Wadi programme, has been spearheading this stage of the initiative. Through

VAPCOL's elaborate network of processing and marketing facilities, underutilised crops are being promoted, and thus ensuring an assured market for them. At the local level, private sector actors, such as those involved in the horticulture/nursery business, are becoming involved in CGO, supplying good quality planting material and, in turn, helping to expand the area under the initiative. The VCF have become mechanisms for different private entrepreneurs to participate in and propagate their businesses and, in turn, promote underused crops. All these actors have been contributing to the sustainability of project initiatives as a result of their own business interests.

4. Discussion: Exploring the when and where of research in agricultural innovation trajectories

This paper set out to understand the nature of agricultural innovation trajectories and the location of research in them. The cases discussed provide useful insights, elaborated below, about the nature of the agricultural innovation process.

- Knowledge products need adaptation to local contexts. This involves a range of partners, going beyond field-level implementers transferring technology. Institutional adaptation (such as new marketing arrangements) may also be needed to help integrate these knowledge products.

The three cases discussed in this paper illustrate that the application of a specific research-derived knowledge product in practice is a complex process, and one that cannot be achieved by simply providing financial resources to an actor to transfer ideas to relevant implementing agencies. This is true even when there was demand for a particular knowledge product, as in the case of all the three cases.[12] At the start of these RIU initiatives, the lead actors involved simply set out to apply specific knowledge products (the DSP approach, PMCA and the multi-pronged approach to promote underused crops) widely by working with relevant field-level implementing agencies. However, along the way they had to facilitate a process of adapting the knowledge product to specific, local contexts. For instance, the DSP approach was developed further by incorporating the basic concept of producing fish-fingerlings in rice fields with other processes/activities (by creating new roles for different fish-seed value chain actors, connecting them in an appropriate way, building relationships, developing markets etc.) in order to ensure large-scale application of the approach. To achieve this project implementers identified different actors to play specific roles, trained and motivated them, and encouraged interactions among them. For example, satellite brood rearers and seasonal pond rearers were identified and supported with technical and financial inputs to maintain regular supplies. Local Entrepreneurs were identified and trained to act as technical backstops, troubleshoot and motivate field-level agencies to continue with the DSP approach even beyond the life of the project. The project team devised compositions of fish species to be cultivated in the rice fields and decided appropriate sizes of ditches and bunds, as well as feeding patterns, based on farmers' preferences and conditions. Different locally specific market development strategies were used. In the end, the actual rearing of fish fingerlings in rice fields—in essence what the DSP approach is all about—is just one component of the many processes and activities of the entire project. Tacit knowledge (for example, on the ways of managing water shortages in ditches during dry seasons or designing feeding strategies etc.) from different sources was important in devising the different initiatives and activities that were combined to promote the DSP approach.

A similar pattern can be observed in the other two cases. IDE-Nepal adapted the PMCA approach to the local context by including locally relevant activities and processes under three stages of the approach. Different actors from the thematic groups set up were encouraged and trained to use meetings and other activities as mechanisms for building interactions and trust among different stakeholders: a key constraint that IDE-Nepal faced in their locations. The multi-pronged approach for underused crops was also one that continuously evolved during the entire process of implementation. Different components of the approach were modified based on emerging lessons. For example, the VCFs were scaled down to village-level activities from the originally planned large regional events.

- Adaptation of knowledge products involves combining ideas with other sources of knowledge from other streams of research.

The three case studies show that the application of knowledge involves further development of the knowledge product and adaptation to specific contexts. For this, many other knowledge products, that themselves resulted from different innovation trajectories, are required. This process involves different agencies coming together into fit-for-purpose configurations, with members having appropriate skills and resources and finding their way forward. The composition of such configurations and the roles played by different members depend on the specific contexts of the area and topic being tackled. Since the context is dynamic, the actor configurations and their strategies are adapted accordingly over time. Significantly, in all the cases studied, it was observed that the conventional research organisations in the actor configurations played a largely supportive role while

other organisations agencies took the lead during this knowledge adaptation stage.

- Non-linearity of stages of innovation means that research can be important at any stage of the innovation trajectory.

The three cases seem to suggest that the innovation trajectory has three distinct stages: the knowledge generation stage, the knowledge adaptation stage and the knowledge application stage. These can either occur simultaneously, sequentially or can overlap. For instance, in the case of the IDE-Nepal-led project, the knowledge generation stage of the approach used took place in South America, where the PMCA was originally developed by the CIP in the period between the late 1990s and early 2000s. The knowledge adaptation stage in this case was facilitated by an actor configuration that was later led by IDE-Nepal under the RIU initiative. The knowledge application stage of this case coincided with the preceding stage, with different entrepreneurs taking the lead in order to further their own business interests. This stage is also currently receiving support from the Nepalese Department of Agriculture, which is mulling over favourable policies to upscale similar initiatives in larger areas, and from other international donors.

In the case of DSP in Bangladesh the knowledge generation stage was led by different research agencies at different periods and in different locations. There appears to have been some amount of sharing of formal and informal knowledge among the actors involved, with each contributing to the development of DSP as a replicable approach. The knowledge adaptation stage under the RIU initiative overlapped with parts of the previous stage. Here, the implementing actors took a lead while the research actors played a largely supportive role. The knowledge application stage occurred at the same time as the adaptation stage, with different entrepreneurs taking the lead in order to further their own business interests. A similar pattern was observed in the case of the multi-pronged approach to promote underused crops in India.

- Knowledge use only takes place within enabling social architectures. Embedding research in these architectures improves its relevance and impact.

The construction of appropriate social architectures (in other words, organising different actors appropriately and building relationships among them) appears to have been critical for putting knowledge into wide-scale use. This appears to have served two purposes: articulating demand for knowledge and creating an enabling environment for putting knowledge into use. DSP was a proven knowledge product with relevance to the area it was developed in. Government departments and other agencies used conventional ways to promote its wide-scale application, but their efforts were largely unsuccessful. Under the RIU initiative, a social architecture was created, consisting of different actors in the fish-seed value chain. The project created new roles (for example, that of satellite brood rearers, seasonal pond owners, local entrepreneurs etc.) to complete this architecture., which seems to have been important for the wider application of DSP.

Similarly, IDE-Nepal's efforts under its previous initiatives had created the necessary architecture of actors. This had helped to articulate demand for elaborate functional interactions embedded with honesty, openness and trust among the actors and enabled the project to move to the next level of operations under RIU. Thus, the PMCA could be successfully applied in this context. The multi-pronged approach for underused crops was also primarily based on the creation of an architecture of different types of actors with functional relationships among them.

5. Conclusions

An analysis of the three case studies examined in this paper provides the following key lessons for putting research into use:

- A two-stage process of knowledge generation and its application does not exist in practice. In fact, there is nothing like a final knowledge product. Each knowledge product needs further R&D to be applied in specific contexts. This effectively blurs the difference between the two components of R&D. In order to be appropriate, research and use should be undertaken simultaneously by building partnerships among researchers and practitioners and embedding this relationship in the wider social architectures that enable innovation. This has significant implications for the way in which agricultural research (and, more broadly, innovation) is funded as it suggests that research should be funded as part of wider development activities. Alternatively, research funds should be made available to support ongoing dynamic trajectories and opportunity-driven circumstances.
- The agricultural innovation process involves a wide diversity of actors, including researchers, NGOs, government departments and market agencies. Each of these actors has a unique and significant role to play to ensure successful and sustainable innovation. It is necessary to recognise this fact and appreciate the strengths and weaknesses of each actor in the architectures. This also suggests that developing networks of relevant actors is a necessary pre-condition for putting research into use. Programme planners should give emphasis to this generalised need to both build up the interconnectedness of different actors, but also to the need to expose actors to the experience and benefits of working in a more joined-up way.

- The cases reviewed all had explicit pro-poor agendas. While the impact on the poor has not been measured, this is where the focus and intent of these initiatives lay. The configurations of the actors observed did not all have explicit pro-poor or even development agendas. However, what is important is that the pivotal actors in these projects had pro-poor agendas and were able to steer innovation trajectories to benefit the rural poor. The flip side of this observation is that agricultural innovation trajectories do not seem to be inherently pro-poor. What is perhaps most interesting, and where policy can play a role, is that the nature of rural development projects observed illustrates the way in which development practice has drawn in entrepreneurial perspectives and is starting to use these in ways that have a likelihood of addressing poverty. This points to the need for policy support to focus on nurturing this emerging mode of enterprise-rich development practice.
- The innovation trajectories explored for each of the RIU projects reveal a process of research, networking, application and change, which, in many senses, has no end point. Perhaps this is a metaphor for the process of development itself—a process of muddling through, using the best ideas available at a given point in time and trying to move forward in a way that addresses certain social, economic and, increasingly, environmental aspirations.
- The RIU cases suggest that these innovation trajectories involve a fluid group of actors who, for a variety of reasons, become aligned with a particular idea or theme. These trajectories are not the property of any particular actor, although they all have (different) stakes in the outcome. Nevertheless these trajectories have a dynamic and are propelled forward. And there are probably many thousands of such identifiable trajectories, continuously merging and branching out.
- Taken together, these observations would seem to have important implications for the way policy tackles the science, technology and development conundrum. Most profoundly, it suggests that the main task of policy is not to fund the generation of new knowledge through research, or to 'do development'—although these activities remain important. Rather, the main task of policy may be to have a capacity strengthening agenda. This capacity strengthening goes beyond developing the technical skills of actors and empowering poor people (again, these remain important). It concerns strengthening the collective dynamic of innovation trajectories and strengthening the orientation of these trajectories towards the development aspirations of policy. For programmes like RIU that are trying to make more effective use of existing public policy tools, such as agricultural research, it means that the starting point should not be the promising technologies themselves. Instead the focus of RIU-like programmes should be on existing innovation trajectories that show promise for achieving developmental goals. Financial, managerial, business and technical support to these trajectories could propel innovation toward policy ambitions and, in the process, put agricultural research to better use.

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Notes

1. This paper uses the term innovation trajectory in the same way it is generally referred to in the literature to a series of events that take place in an innovation process (Prasad 2005).
2. Facilitation involved conceptualisation of the idea, encouraging communities, troubleshooting, and mobilising financial resources and the necessary policy support.
3. The 'creation of social architectures' here refers to the activity of bringing relevant agencies together and developing/strengthening functional relationships among them.
4. The project refers to this as fish-seed.
5. The NFEP was supported by DFID in two phases during the period 1988–2000. The regional focus was the impoverished northwest region of Bangladesh. NFEP trained and used more than 1,000 fish-seed traders and more than 250 secondary school teachers as extension agents. It established more than 200 model villages where more than 9,000 farmers received training in aquaculture.
6. The InterFish Project was implemented by the Cooperative American Relief for Everywhere (CARE) with financial support from DFID.
7. Research efforts to develop GIFT were initiated in 1988 through a collaborative initiative involving ICLARM, the Institute of Aquaculture Research of Norway (AKVAFORSK) and three organizations from the Philippines (the Freshwater Aquaculture Centre of Central Luzon State University, the Marine Science Institute of the University of the Philippines and the Bureau of Fisheries and Aquatic Resources).
8. A type of fish with the biological name *Trichopodus pectoralis*.
9. Implemented by WorldFish in collaboration with about 40 NGOs throughout Bangladesh during the

period 2000–6. Activities focused on creating awareness and training NGO staff on DSP.

10. WorldFish promoted DSP with common carp, GIFT and carp in rice fields through its AFP in the northwest (Rangpur, Dinajpur and Jaypurhat districts) and the north (Sherpur and Netrokona districts) in Bangladesh.
11. CoDI was formed as part of the RIU initiative, with financial support from the programme.
12. The RIU initiatives in all the three cases have been part of the lead agencies' long-term efforts in those locations (villages, areas etc.) to address specific problems. For over a decade IDE-Nepal has been working in those areas with those farmers to improve vegetable production and marketing. When there was demand for an approach such as PMCA they adapted it, as part of the RIU initiative. Similarly in Bangladesh, RDRS and WorldFish were engaged in addressing fish seed availability through promoting GIFT. In their efforts, over a period of time, there was a need for a multi-stakeholder process, which was tried as part of the RIU initiative. In the case of the CoDI, all the efforts of ICUC and BAIF, over a period of time created a demand for a multi-pronged approach, which was tried through the RIU initiative.

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