



The World Bank

Agriculture and Rural Development Discussion Paper 38

Agricultural Innovation Systems: From Diagnostics toward Operational Practices



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The World Bank

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Acronyms and Abbreviations

AET	Agricultural education and training
AIS	Agricultural innovation systems
AKIS	Agricultural knowledge and information systems
ANGOC	Asian Non-Governmental Organization Coalition
ARD	Agriculture and Rural Development Department, World Bank
ASARECA	Association of Strengthening Agricultural Research in Eastern and Central Africa
ATPS	African Technology Policy Studies, Kenya
CATIE	Centro Agrónomico Tropical de Investigación y Enseñanza
CIAT	International Center for Tropical Agriculture
CIP	International Potato Center
CGIAR	Consultative Group for International Agricultural Research
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
COFUPRO	Coordinadora Nacional de las Fundaciones Produce
CRISP	Centre for Research on Innovation and Staff Policy
CSIR	Council for Scientific and Industrial Research
CSO	Civil society organization
CTA	Technical Center for Agricultural and Rural Cooperation
DFID	Department for International Development
EMBRAPA	Brazilian Agricultural Research Corporation
ESSD	Environmentally and Socially Sustainable Development, World Bank
IADB	Inter-American Development Bank
ICT	Information and communications technology
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IICA	Inter-American Institute for Cooperation on Agriculture
ILAC	Institutional Learning and Change
IPGRI	International Plant Genetic Resources Center
ISNAR	International Service for National Agricultural Research
KIT	Royal Tropical Institute
NAADS	National Agricultural Advisory Services, Uganda
NCAP	National Center for Agricultural Policy

NGO	nongovernmental organization
NRI	Natural Resources International Ltd., UK
OECD	Organisation for Economic Co-operation and Development
PMCA	Participatory market chain approach
PPP	public-private partnerships
R&D	research and development
RNRRS	The Renewable Natural Resources Research Strategy
S&T	science and technology
SASKI	Sustainable Agriculture Systems Knowledge Institutions
SIDA	Swedish International Development Agency
UK	United Kingdom
UNU/INRA	United Nations University, Institute for Natural Resources in Africa
UNU/INTECH	United Nations University, Institute for New Technologies
USAID	United States Agency for International Development
USMEFAN	Union of Small and Medium Scale Farmers of Nigeria
WES	Workforce Education System

Preface

The International Workshop on Enhancing Agricultural Innovation Systems was organized by the Agriculture and Rural Development Department of the World Bank and held during March 22–23, 2007, in Washington, DC. This Discussion Paper presents the converging views of workshop participants and the emerging agenda for an agricultural innovation systems approach. It incorporates views and content from the Economic and Sector Work Report, *Enhancing Agricultural Innovation: How to Go beyond Strengthening Research Systems* (World Bank 2006b), case studies of the innovation systems approach in different contexts, as well as other material on AIS.

The Innovation Systems Workshop was the key follow-up to the International Workshop on Development of Research Systems to Support the Changing Agricultural Sector, organized by the World Bank in 2004. A primary conclusion of the 2004 workshop was that stronger research systems may increase the supply of new knowledge and new technologies, but stronger research systems may not necessarily correlate very well with the capacity to innovate and adopt innovations throughout the agricultural sector or with economic growth. The 2007 Innovation Workshop took a closer look at innovation systems for agriculture through a set of case studies and other material.

The authors would like to thank all of the presenters and participants for their time and contributions during the Innovation Workshop. Particular thanks are extended to the Department for International Development in the United Kingdom, the Secretariat of the Consultative Group on International Agricultural Research, and the World Bank's SASKI Sustainable Agriculture Systems Knowledge and Institutions Thematic Group for their financial contributions. Regina Birner (International Food Policy Research Institute) and André Devaux (International Potato Center) are acknowledged for helpful comments on the proceedings. We also thank Kelly Cassaday for editorial support and Lisa Li Xau for logistical support associated with publishing.

Executive Summary

Agricultural development depends to a great extent on how successfully knowledge is generated and applied, and indeed knowledge intensiveness has featured prominently in most strategies to promote agricultural development. Yet the changing context for agricultural development has highlighted a strong need to understand and adopt innovation systems thinking.

An innovation system can be defined as a network of organizations, enterprises, and individuals that focuses on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance. The innovation systems concept extends beyond the *creation* of knowledge to encompass the factors affecting *demand* for and *use* of knowledge in novel and useful ways. Innovation systems not only help to create knowledge; they provide access to knowledge, share knowledge, and foster learning.

Given the diversity and context-specificity of innovation systems approaches, in March 2007 the World Bank organized a workshop in which about 80 experts (representing donor agencies, development and related agencies, academia, and the World Bank) took stock of recent experiences with innovation systems in agriculture and reconsidered strategies for their future development. This paper summarizes the workshop findings and uses them to develop and discuss key issues in applying the innovation systems concept. The workshop's recommendations, including next steps for the wider innovation systems community, are also presented.

Enhancing Agricultural Innovation

The agricultural information systems (AIS) approach presented in the workshop's introductory session draws on information from *Enhancing Agricultural Innovation* (World Bank 2006b). The AIS concept has been applied to agriculture in developing countries only recently, and *Enhancing Agricultural Innovation* analyzes eight case studies to assess the utility of the AIS concept and develop an operational framework for agriculture. The case study analysis illuminates two important contextual factors affecting the innovation process: (1) the actors that start the process can come either from the public or private sector and (2) the factors that trigger innovation are either policy or market triggers. Thus two distinct scenarios emerge. In one, a sector can develop because entrepreneurs identify new market opportunities and innovate to gain market access. In the second, research interventions promote innovation when they are organized in ways that promote interaction or when they are part of integrated sector support.

Four key findings emerged from the introductory session. First, AIS is a response to the increased speed at which the farming and rural community

must move to remain competitive/productive in a rapidly changing world. Second, an innovation systems approach recognizes the importance of technology but focuses on innovation, widens the scope of actors, highlights the institutional context and the environment that promotes dominant interests, and emphasizes that innovation systems are social systems. Third, the AIS approach should be expanded to rural innovation, because aside from agriculture, production, and commodities, related issues of natural resource management, off-farm employment, and overall rural development require attention. Fourth, an innovation system can operate at multiple levels and for different purposes, including poverty alleviation, economic growth, and agricultural development.

Technology, Research, and Advisory Services in the Innovation Process

Most innovations arise in response to the potential for added value. In the case studies, that value was often associated with niche opportunities exploited after the harvest (quality, processing, storage, packaging, and marketing); with social or environmental niche opportunities (fair-trade or organic food); or with more traditional opportunities to add monetary value (increasing the volume, value, or size of an operation). An easier and quicker avenue for accessing and dealing with this kind of innovation may come from information provided by actors outside of research agencies, such as advisory services and the private sector. The workshop consensus is that research and technology development are required but constitute only part of the innovation process. The key challenge in most successful cases of innovation has not been the creation of new inventions but the adaptation and use of existing ones.

Obviously the shift from thinking about research as being the central actor in an innovation system to being one important part of the system has implications for researchers and research systems. There is a heightened need to learn how to involve a range of other activities and processes, including strengthening of and learning from networks with other actors. There is also increased pressure on advisory services to play a new role as knowledge brokers among the diverse innovation actors.

The Importance of Incentives, Partnerships, and Coordination

The economic or social performance of a country depends on the participation of many innovative agents that foster the emergence of an innovation system. Although innovations frequently arise in the search for added value, a market opportunity alone is often not sufficient to encourage collaboration and partnerships. Coordination mechanisms and/or organizations can play an important role in establishing networks when the market is not sufficiently developed to provide incentives to do so.

The case study evidence on partnerships points to several common features. Most successful partnerships are typically dynamic, multistakeholder partnerships that offer concrete benefits for all partners. Partnering requires recognition of shared principles of partnership as well as specific skills,

including the ability to identify shared values, negotiate, and find common ground among partners. Partnerships usually require active coordination and facilitation, often with the public sector playing a key role. The capacities of the weakest partners may need to be improved to enable full and fair participation, and it may be useful to provide specific funds that address the transaction costs involved in forming and maintaining partnerships. Learning alliances and stakeholder platforms have proven effective for facilitating partnerships and collaboration.

Empowering Smallholders and Engaging the Private Sector

Asymmetries (in power, resources, and capacity) among the actors in an AIS, or the application of an AIS approach through rural development activities that focus on commercialization, may exclude some actors or benefit them unequally. The AIS approach needs to take account of the economic and social heterogeneity that is common to rural areas and, as noted, address such issues as natural resource management, staple crop production, subsistence farming, and overall rural development and employment, including rural nonfarm activities. Not only is it important to enhance and emphasize the role of smallholders as the engine for innovation; it is important to implement measures that maximize the inclusion of all groups who are typically disadvantaged and maximize the positive impact on their livelihoods.

The importance of agroindustries, postharvest technologies, and the development of small- and medium-sized rural enterprises for successful innovation is increasingly clear. It is essential to attract the private sector to participate in innovation networks and innovation clusters rather than to focus on innovative farmers working on their own. The organization of rural stakeholders is a common element of value chain approaches. The public sector can coordinate and facilitate interaction among partners—and/or create opportunities for other impartial groups, such as civil society, to facilitate the interaction—and ensure that poor people's interests are taken into account.

How to Nurture Innovation Capacity

Two important findings from the workshop center on innovation capacity. First, the actors must be capable of learning and innovating in a changing environment. Second, this dynamic adaptive capacity is often associated with local institutions possessing sufficient organizational and technical capacity.

To create enough human capital to meet the needs of the agricultural sector and a supportive AIS, the appropriate training organizations, including universities, must be engaged and strengthened. Although a greater understanding of agricultural education and training's (AET's) role in promoting innovation and development is needed, some key principles have been identified: develop new educational programs that are more strategically attuned to the needs of social and productive actors; develop new curricula that instill the capacity to deal with complexity, change, and multiactor processes in rural innovation, in addition to permitting greater specialization;

and strengthen the innovative capabilities of AET organizations and professionals.

To enhance innovation capacity, it is necessary to invest in learning and capacity building, provide incentives that allow actors to put new skills into use, and also nurture new attitudes and practices. Programs that encourage greater openness in organizations to collaborating with diverse formal and informal actors, introduce organizational and managerial innovations within organizations, or strengthen individual and organizational incentives to develop innovative capacity, should be considered. The organizational or collective innovative capabilities, however, reside in individuals, in the information and technology used by an organization, and in an organization's structure, routines, and coordination methods. Besides nurturing individuals who act as change agents within organizations, the case studies highlight the power of: collective action within and among organizations; flexibility (to allow self-organization); building self-confidence and trust; fostering preparedness for change; stimulating creativity; and the enabling environment, particularly the policy and funding incentives that permit these characteristics to develop. Policy capacity thus needs to be strengthened to build innovation capacity.

Enabling Environment

The economic or social performance of a country depends on a set of enabling conditions that foster the emergence of innovative agents. The conditions include infrastructure, effective governance of input and output markets, and a supportive policy and fiscal framework for science, technology, legal, advisory, and trade issues. Most developing countries lack an optimum enabling environment and must choose among the many options to improve it.

Given that the enabling environment often influences how the actors in a sector can use their knowledge, the enabling environment is an important promoter of innovation capacity. Policies are integral to forming an enabling environment, but there is no single "innovation policy." A set of policies is needed to work together to shape innovation. The evidence suggests that policy interventions to create an enabling environment for innovation may remain ineffective unless they are accompanied by efforts to change prevailing attitudes and practices.

The evidence also indicates that the ability to agree on the innovation challenges within a sector is much greater when effective value chain coordination is in place. Improvements in the enabling environment will thus be more effective if they are combined with activities to strengthen other aspects of innovation capacity, particularly the patterns of interaction among the main actors, and if the efforts to improve the enabling environment focus on identified needs for innovation and address the need for sector coordination.

Recommendations

In attempting to implement an AIS approach, a number of **general recommendations** should be kept in mind:

1. AIS is an evolving framework and its application requires flexibility and learning. No blueprint exists.
2. AIS can be seen as part of a government's national science and technology policy and strategy. The overall national agriculture-rural development agenda and aspirations should also guide AIS activities, particularly their long-term prioritization and investments into innovation capacity.
3. Communicate the potential benefits and challenges of an AIS approach effectively to stakeholders throughout design and implementation. It is important for this communication to stimulate political will and provide relevant economic arguments to ministries and the private sector.
4. Launch a consultation and discussion phase (and maintain it throughout the implementation), perhaps by facilitating multistakeholder platforms that support the identification and planning of activities, including the assessment and analysis of existing AIS and the identification of AIS-related needs, particularly the prioritization of AIS framework needs.
5. Understand the critical factors, actors, and conditions for innovation in a given context and therefore map and analyze the status of the innovation system.
6. Systematically explore innovation capacity and institutional issues at the outset and develop a capacity-building plan.

Investments in an innovation system require integrated programs that address science, private sector investment, the financial system, the policy and regulatory environment, and stakeholder participation. These investments may be divided roughly into two categories: innovation capacity and enabling environment. The recommendations on investment relate primarily to innovation capacity—that is, the skills and capacity needed for AIS (education and training, research system, and advisory services), partnerships and collaboration, and becoming a learning organization.

An effective innovation system requires a cadre of professionals with a **specific skill mix**. Besides increasing scientific capacity, capacity-building efforts should target the different actors in an AIS to initiate behavioral and organizational change, to build learning organizations, to enable collective action and coordination for building innovation networks and linkages, and to build the social skills of mediators, extension service agents, and others. The engagement and strengthening of appropriate training organizations, including universities, is needed to create this human capital. It is important to realign the visions and mandates of **agricultural education and training** organizations with national development aspirations by promoting new types of educational programs that are more strategically attuned to the different needs of social and productive actors.

The innovation systems concept values the capacities and processes emphasized in the national agricultural **research system** and agricultural knowledge and information systems frameworks, including well-resourced and up-to-date scientific research and training organizations and channels that give farmers access to information. However, support to research systems must focus more on developing the interface with the rest of the sector and the society and engage universities, private sector research, farmers, and civil society in the process. The AIS approach also has significant implications for **advisory services**. The primary emphasis of extension should shift away from technology transfer and toward creating connections to outlets, institutions, and people. Extension needs to perform a wider range of services and provide a wider range of support to a diverse clientele to improve their capacity to access, adapt, and use knowledge, inputs, and services. Extension agents should see their main role as being intermediaries and knowledge brokers. The only way forward is through partnering with other actors.

Because the AIS approach is essentially multisectoral, it is essential to promote the cooperation of different ministries, departments, and units and cooperation among various stakeholders. A system to **facilitate collaboration and synergies** among the agencies, ministries, and stakeholders is needed. Engagement with the poor requires capacity building to address potential asymmetries in capacity and resources. Other actions should address a joint exploration of needs and opportunities, facilitation of access to assets and other resources, and particularly the engagement of other stakeholders. Public-private partnerships for innovation development may be particularly useful in agrichains characterized by outdated knowledge and technology and limited research capacities and funding.

Efforts to induce organizational change are typically a gradual process that builds self-confidence and trust, fosters preparedness for change, and stimulates creativity by promoting attitudes that encourage dynamic and rapid responses to changing circumstances. Investments in learning and in becoming a **learning organization** are crucial, as is investment in knowledge management and sharing practices.

One of the key issues for **science and technology policy** is to contribute to establishing an enabling environment for innovation. Ways to address this need include: establishing institutions and mechanisms to implement and enforce an enabling environment; promoting stakeholder engagement and collaboration through foresight activities, innovation platforms, adequate incentives for actors, and the development of interaction rules (related to intellectual property rights, research funding, agent roles, and so on); and strengthening knowledge management capacities and collaboration arrangements that will lead to a better use of available information, knowledge, and technologies at the national, regional, and global level, both in the public and private sector.

Next Steps

The participants agreed that further steps and initiatives are needed to address the challenges identified during the workshop, especially:

- **Improve the understanding of the AIS concept.** Although the AIS approach is gradually moving toward an operational framework with certain characteristics, success factors, operational implications, and analytical/operational tools, it remains an evolving concept that requires better understanding and analysis.
- **Communicate the potential of the AIS approach.** Additional evidence is crucial for communicating the rationale and presenting evidence on the impact of an AIS approach. The AIS community needs to identify how to communicate AIS and its potential benefits and challenges effectively to different stakeholders, such as decision makers and investors. Well-chosen, practical pilot projects and other experiments are usually powerful ways to convey this message. An important goal of communication is to stimulate political will and to provide relevant economic arguments to ministries and the private sector.
- **Develop tools for studying and evaluating impact.** Most of the partnerships analyzed have not paid sufficient attention to monitoring and evaluation. Monitoring and evaluation requires the development of suitable, partnership-specific innovation indicators. Indicators can be used for diverse purposes. For example, the development and communication of agricultural innovation indicators can be a powerful tool to facilitate policy dialogue and guide agricultural innovation policy. One of the next steps is a study that develops a national-level benchmarking tool for AIS. This tool allows the strengths and weaknesses of an AIS approach to be compared across countries and can be valuable for guiding investment in sustainable agricultural innovation systems.
- **Establish a community of practice.** The above-mentioned challenges (developing a better understanding of the AIS concept, tools for studying and evaluating impacts, and communicating evidence on the effectiveness of AIS), which currently constrain the development of operational AIS activities, may be better addressed through the AIS community. It is proposed that a global community of practice in agricultural innovation be established to enable the widest possible sharing of experiences and encourage further operationalization of the AIS approach.

1 Workshop Context and Objectives

Agricultural development depends to a great extent on how successfully knowledge is generated and applied, and indeed knowledge-intensiveness has featured prominently in most strategies to promote agricultural development. Although many of these strategies have been successful, they may no longer be sufficient in many countries, where agriculture is increasingly subject to rapid and unpredictable change. Amid such change, it is perhaps inevitable that ideas about innovation and its sources should also change. The perceptions of what constitutes “research capacity” and how innovation occurs are being transformed, along with approaches for investing in the capacity to innovate. It is now clear that investing in the creation of stronger research systems—the primary focus of agricultural research investment in the 1980s and 1990s—may increase the *supply* of new knowledge and technology, but it may not improve the wider capacity for innovation throughout the agricultural sector (Rajalahti, Woelcke, and Pehu 2005). More recently, attention has focused on the *demand* for research and technology and on the development of innovation systems. An “innovation system” is a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect the system’s behavior and performance (World Bank 2006b).

Can new perspectives on the sources of innovation yield practical approaches that may be more effective for agricultural development? How can the innovation systems concept be used to guide investments that support the development of agricultural technology? These are the central questions explored in a recent World Bank publication, “*Enhancing Agricultural Innovation: How To Go beyond Strengthening Research Systems*” (World Bank 2006b) and in the workshop reported on in this paper.

Given the context-specificity and diversity of agricultural innovation system approaches, in 2007 the World Bank organized a workshop to take stock of recent experiences with innovation systems and reconsider strategies for the future development of agricultural innovation systems. Specifically, workshop participants (about 80 experts representing donor agencies, development and related agencies, academia, and the World Bank) sought to:

- Take stock of and gain a better understanding of the agricultural innovation systems approach.
- Identify how the agricultural innovation systems approach contributes to growth, development, and poverty reduction.
- Identify how the agricultural innovation systems approach has been and can be further operationalized.
- Explore the desirability of forming a community of practice.

This proceedings discusses the workshop findings, case study evidence, converging views from the working groups (community of practice, science and technology policy, investments in research and development), education and training, pro-poor innovation, organizational and management culture, innovation system indicators, and advisory services) and other material on agricultural innovation systems. Some of the insights discussed here may have been presented in previous publications.

The 21 case studies for the workshop¹ were selected to provide examples of either market-driven or public innovation systems (defined in World Bank 2006b) and also to reflect the experiences of diverse innovation systems “communities.” The studies focused primarily on commodities rather than staple crops and natural resource management, reflecting the fact that, to date, most of the experience with innovation systems in agriculture has been with commodities.

To orient the discussion, this proceedings begins with a brief review of the agricultural innovation systems approach (chapter 2) detailed in World Bank (2006b). Subsequent chapters discuss key themes and workshop findings related to agricultural innovation systems:

- Chapter 3 explores the role of research and research systems in the innovation process.
- Chapter 4 concentrates on partnerships and linkages between actors in innovation systems.
- Chapter 5 addresses the asymmetry in capacity, power, and resources among potential actors in innovation systems. More specifically, it discusses ways of empowering smallholders and engaging the private sector for successful innovation.
- Chapters 6 and 7 examine ways of stimulating the capacity for innovation and of fostering an enabling environment within the agricultural innovation system framework.

Chapter 8 summarizes the findings and presents recommendations; potential next steps for the wider innovation systems community are described in chapter 9.

2 Enhancing Agricultural Innovation

What Is an Innovation System?

An innovation system² can be defined as the network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect the system's behavior and performance. Innovation systems help to create knowledge, provide access to knowledge, share knowledge, and foster learning. *The innovation systems concept embraces not only the science suppliers but the totality and interaction of actors involved in innovation.* In other words, the concept extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways (World Bank 2006b).

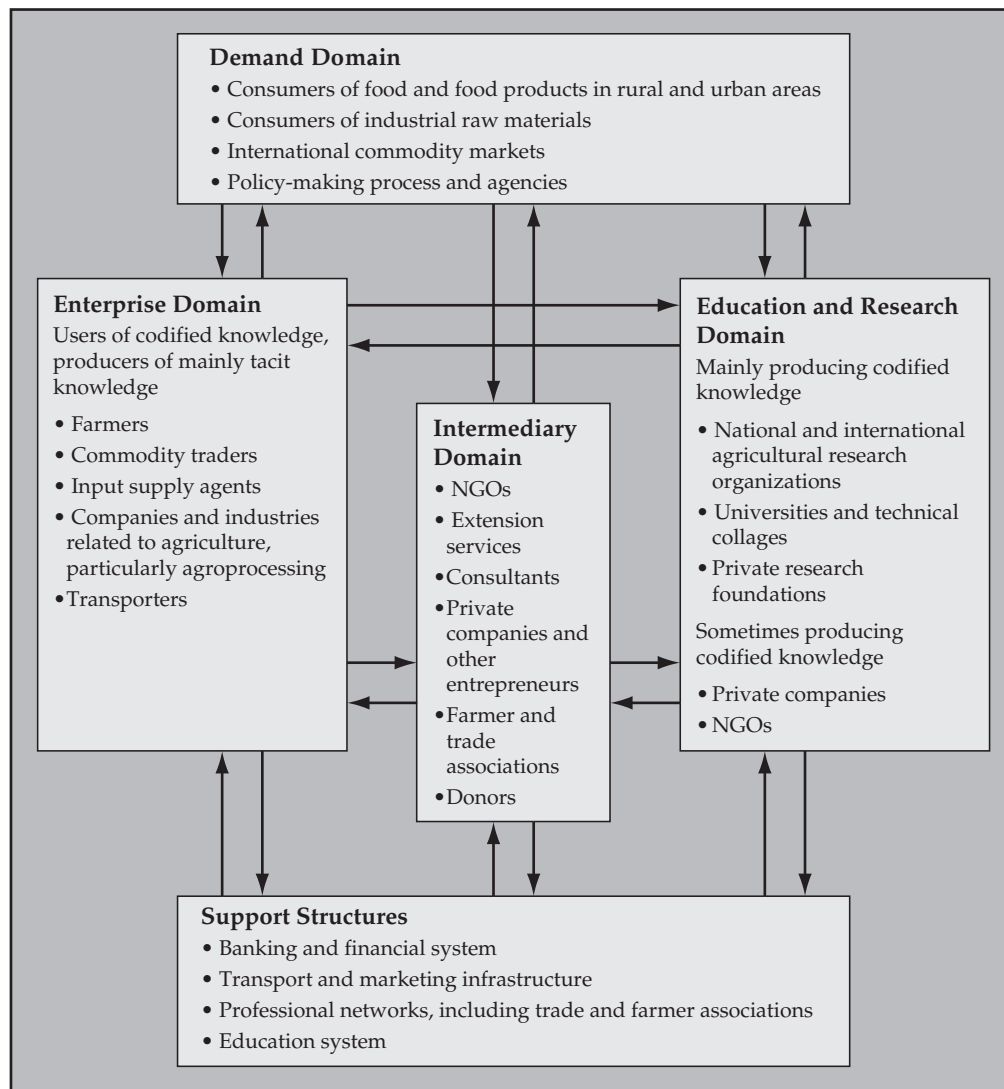
The innovation systems concept is derived from direct observation of countries and sectors with strong records of innovation. The concept has been used predominantly to explain patterns of past economic performance in developed countries and has received far less attention as an operational tool. It has been applied to agriculture in developing countries only recently, but it appears to offer exciting opportunities for understanding how a country's agricultural sector can make better use of new knowledge and for designing interventions that go beyond research system investments.

The last 40 years have witnessed substantial debate over the best way for science and technology (S&T) to foster innovation. The first view to emerge regarded scientific research as the main driver of innovation; research created new knowledge and technology that could be transferred and adapted to different situations. This view is usually termed the "linear" or "transfer of technology" model. The second and later view was termed the "agricultural knowledge and information system" (AKIS) concept in the 1990s and (more recently) the "agricultural innovation systems" (AIS) concept. Although acknowledging the importance of research and technology transfer, the second view explicitly recognizes *innovation as an interactive process*. Innovation involves the interaction of individuals and organizations possessing different types of knowledge within a particular social, political, policy, economic, and institutional context (World Bank 2006b).

In innovation systems theory, the importance of investing in S&T is well recognized, but the focus is on the *additional insights* and *types of interventions* that can be derived from an innovation systems perspective and that can influence the generation and use of S&T for economic development.

Figure 1 presents a conceptual framework that captures the main elements of an AIS (the education and research, enterprise, demand, and intermediary domains), the linkages between its components, and the institutions and policies that constitute the enabling environment for innovation.

Figure 1 Elements of an Agricultural Innovation System



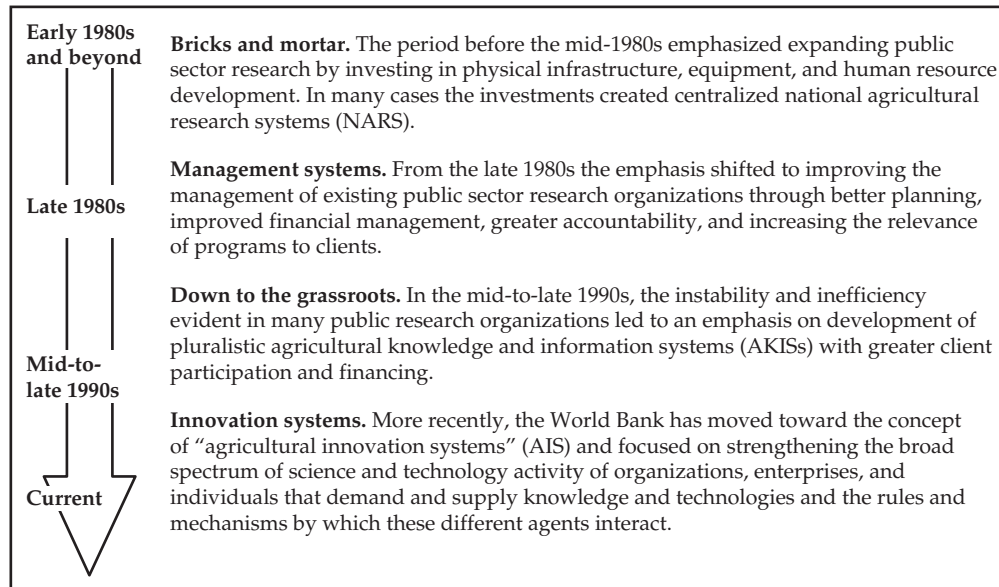
Source: Adapted from Arnold and Bell 2001: 292.

Why Is Innovation Systems Thinking Needed Now?

Six major changes in the context for agricultural development heighten the need to reexamine how innovation occurs in the agricultural sector:

1. Markets, not production, increasingly drive agricultural development.
2. The production, trade, and consumption environment for agriculture and agricultural products is growing more dynamic and evolving in unpredictable ways.
3. Knowledge, information, and technology increasingly are generated, diffused, and applied through the private sector.
4. Exponential growth in information and communications technology (ICT) has transformed the ability to take advantage of knowledge developed in other places or for other purposes.

Figure 2 Changing Approaches to Investing in Innovation Capacity



Source: World Bank 2006b.

5. The knowledge structure of the agricultural sector in many countries is changing markedly.
6. Agricultural development increasingly takes place in a globalized setting (in contrast to a setting characterized predominantly by national and local influences and interests).

At the same time, approaches to investing in research systems and innovation capacity have evolved, as described in figure 2 and table 1.

Scope	Approach	Focus	Actors
Activity based	National Agricultural Research Systems (NARS)	Technology generation and transfer	Research organizations, universities
Output based	Agricultural Knowledge and Information Systems (AKIS)	Knowledge and Technology dissemination	Research organizations, universities, extension services, nongovernmental organizations
Outcome based	National Agricultural Innovation Systems (NAIS)	Technological and institutional innovation	All economic actors that actively use or generate knowledge

Source: Willem Janssen (personal communication).

It can be argued that innovation systems approaches are receiving attention because they provide valuable insights into the theory and increasingly the practice of innovation. An innovation systems approach very explicitly recognizes that the use of knowledge is a social process that occurs in a rapidly evolving context, and thus it is essential to *think about* the capacity to innovate in a more holistic manner. It has also become *feasible* to foster the development of innovation systems because of: (1) existing investments in research and development (R&D) infrastructure; (2) the emergence of new sources of knowledge; and (3) greater access to information through ICT.

Moving from Analysis to Intervention

Can new perspectives on the sources of agricultural innovation in fact yield practical approaches to agricultural development? The utility of the innovation systems concept has been assessed and an operational framework developed for agriculture (World Bank 2006b; see box 1 for details on the methodology). The assessment, which was based on eight case studies, highlighted two important contextual factors that affect the innovation process: (1) the type of actors that start the process (broadly speaking, either public or private actors) and (2) the factors that trigger innovation (either policy or market triggers). Two distinctive scenarios appear: (1) a sector can emerge because entrepreneurs identify new market opportunities and innovate to gain market access and (2) research interventions promote innovation when they are organized in ways that promote interaction or when they are part of integrated sector support.

Box 1. The Analytical and Intervention Frameworks to Assess and Develop an Innovation Systems Approach

The analytical framework

A central insight of the innovation systems framework is that partnerships and linkages must be analyzed in their historical and contemporary context, for that context greatly defines the *opportunities* and *necessities* for innovation, especially where rapid change is occurring. The context includes policy, market, and trade conditions and the challenges they present, as well as other factors, such as the sociopolitical environment and the natural resource base. A description of the changing context reveals any divergence between the innovation system and its practices on the one hand and the changing demands imposed by the context on the other. The four main elements of the analytical framework include:

1. *Key actors, the roles they play, and the activities in which they are involved*, with an emphasis on the diversity of public and private sector actors and on the appropriateness of their roles.
2. *Attitudes and practices of the main actors*, with an emphasis on ways of working, views on collaboration, traditional roles, potential inefficiencies, patterns of trust, risk taking, and the existence of a culture of innovation.
3. *The effects and characteristics of patterns of interaction*, with an emphasis on formal and informal networks, links, and partnerships, inclusion of the poor, and the existence and functions of potential (sector) coordination and stakeholder bodies.

Box 1 (Continued)

4. *The enabling environment (policies and infrastructure)*, with an emphasis on the role of policies related to science, technology, and fiscal concerns; the role of farmer and other organizations in defining research and innovation challenges; and the significance of legal frameworks.

Case studies and comparative analysis

The analytical framework was applied in eight case studies. Four criteria were used to select case studies that would capture elements of the dynamic agricultural context: (1) niche sectors that had shown strong patterns of growth, (2) sectors that were strongly integrated into global markets, (3) traditional sectors that are being transformed by the growth of activities further up the food chain and that can highlight implications of the industrialization of the food chain, and (4) sectors that provide large employment opportunities for the poor. The case studies included medicinal plants and vanilla production in India; food processing and shrimp production in Bangladesh; cassava processing and pineapple production in Ghana; and cassava processing and cut flower production in Colombia. For details on the case studies, see World Bank (2006b).

The intervention framework

Based on the analysis, an intervention framework was developed for (1) assessing innovation systems, as understanding is a key to successful interventions, and (2) identifying potential interventions to match local settings and to provide examples of ways to strengthen innovation capacity.

The assessment has two elements:

1. *A typology of agricultural innovation environments*, which helps the user rapidly assess the characteristics of an innovation system and capacity in a particular context. The typology described in World Bank (2006b) is based on the *origins of sector development* and the *phases of development* of the sector.
2. *Diagnostic features* for each phase of innovation system development, to help explain why certain features are likely to impede innovation and identify promising arrangements that could be built upon. These diagnostic features are derived from the analysis of four key elements of the innovation systems concept used in the analytical framework: the actors; attitudes and practices; interaction patterns; and the enabling environment.

The intervention has two elements:

1. *Principles for intervention*. The diagnostic features are associated with a set of distinctive intervention principles to address the characteristic weaknesses of innovation capacity in each phase of sector development. *Principles* rather than *prescriptions* are emphasized, because the specific features of interventions must match local institutional and policy settings.
2. *Options for intervention*, based on the case study examples, are provided.

Source: Adapted from World Bank 2006b.

These initial conditions shape two distinct innovation trajectories or systems: an *orchestrated trajectory* and an *opportunity-driven trajectory*. These trajectories/systems can be divided into several phases of development: the pre-planned, foundation, and expansion phases in the orchestrated trajectory and the nascent, emergence, and stagnant phases in the opportunity-driven trajectory (described in annex 1). The ultimate phase of development in orchestrated and opportunity-driven systems is a dynamic system of

Table 2 A Typology of “Leadership” and “Maturity” Derived from Eight Case Studies of Agricultural Innovation Systems					
Development phase					
	Opportunity driven	Nascent	Emergence phase	Stagnation phase	Dynamic system of innovation phase
Private			Medicinal plants, India	Shrimp, Bangladesh	Cut flowers, Colombia
			Pineapple, Ghana	Vanilla, India	
			Food processing, Bangladesh		
Public	Orchestrated	Pre-planned	Foundation phase	Expansion phase	Dynamic system of innovation phase
				Cassava processing, Ghana	Cassava processing, Colombia

Source: “Towards an Intervention Framework for Strengthening Agricultural Innovation Capacity,” an unpublished workshop paper by Willem Janssen.

innovation, which can be established with the right type of support. The sector is neither publicly nor privately led but characterized by a high degree of public and private interaction and collaboration in planning and implementation. It is agile, responding quickly to emerging challenges and opportunities and delivering economic growth in socially inclusive and environmentally sustainable ways. The case studies and matching development phases are presented in table 2.

Intervention Options

The innovation systems concept places great emphasis on the context-specific nature of arrangements and processes that constitute a capacity for innovation. For this reason, principles of intervention rather than prescriptions are the key. Interventions in advanced phases of development typically can build on interventions from earlier phases; the more advanced the phase, the more varied interventions can take place simultaneously. Options include:

- *Initiating interventions* (for example, that build trust or improve the ability to scan and reduce risk for new opportunities) allow the transition from the pre-planned phase to the foundation phase.
- *Experimental interventions* (for example, that support partnerships on emerging opportunities or develop attitudes, practices, and financial incentives) allow the transition from the foundation phase to the expansion phase.

- *Interventions that help build on or nurture success* (for example, that expand proven initiatives, strengthen good practices, and address weaknesses) allow the transition from the expansion or emergence phase to a dynamic system of innovation.
- *Remedial interventions* (for example, that build coherence and links between the research system and the sector, support coordination bodies, and strengthen or redesign existing organizations) help resolve the weaknesses of innovation capacity in the stagnation phase.
- *Maintenance interventions* (for example, that maintain agility and the ability to identify new opportunities and challenges, enhance collaboration across actors and sectors, and contribute to the maintenance of an enabling environment) help ensure that dynamic systems of innovation do not deteriorate.

Summary of Innovation Systems Analysis

Generic observations about innovation and innovation capacity in the eight case studies are summarized in box 2. The case studies (World Bank 2006b) yielded a number of operationally relevant findings on the nature of innovation and innovation capacities:

- Research is important, but not always central, to innovation.
- An agricultural sector's competitiveness depends on the ability to collaborate effectively within the sector.
- Social and environmental responsibilities are integral to economic success and must be reflected in interventions.
- The market is not sufficient to promote interaction. The public sector has a key role to play.
- Capacity building to strengthen learning and collaboration is key to fostering innovation, as learning and collaboration enable a sector to respond to continuous competitive challenges.
- The organization of rural stakeholders is central to innovation performance, just as it is central to numerous agricultural and rural development efforts.
- Intermediary organizations are crucial for innovation but are often overlooked or not included in interventions.
- An innovation culture requires trust and appreciation of other perspectives. Often a change in attitudes and practices is required.
- Innovation thrives in a proper enabling environment—for example, where there is value chain coordination.

Box 2. Generic Observations about Innovation and Innovation Capacity in Eight Case Studies

Observations about innovation

- Innovation combines technical, institutional, organizational, and other sorts of change.
- Innovation is neither science nor technology but the application of knowledge of all types to achieve desired social and economic outcomes.
- Innovation is not about global novelty but often about local creative imitation.
- Innovation can involve radical changes but more usually involves many small improvements and a continuous process of upgrading.
- Innovation can be triggered by the market (most often), policy changes (sometimes), and research (rarely).
- Considerable value is being added in nontraditional agricultural sectors.

Observations about innovation capacity

- Linkages and interaction are often weak or absent.
- Current attitudes and practices are major obstacles. Even where competition requires collaboration, for example, it does not take place.
- New policies are needed to promote interaction; the usual policies (for example, to strengthen research) are often not the bottleneck.
- Lack of interaction causes:
 - Limited access to new knowledge.
 - Weak articulation of demand for research and training.
 - Weak technological and institutional learning.
 - Weak integration of social and environmental concerns.
 - Weak access to sources of financing for innovation.

Source: Adapted from "Enhancing Agricultural Innovation: Framework and Principles," an unpublished workshop presentation by Andy Hall; World Bank 2006b.

Value Added of the Innovation Systems Approach

The innovation systems approach adds value for the following reasons:

- Through its explicit attention to development outcomes, the innovation systems approach helps to identify systemic strengths and weaknesses for sector development, beyond research strengthening.
- The approach is not a blueprint, but it can be adapted to specific phases of development and to local conditions. The approach itself will evolve and contribute to a learning process, similar to the process that occurs in building innovation capacity in a sector.
- The approach promotes the integration of poverty and environmental issues into sector development planning by altering the roles and interactions of actors in the public sector, the business community, and civil society. However, more experience is required before a truly pro-poor, pro-environment, and pro-market innovation system can be fully defined.

- The approach invites the joint investment of private and public sector skills and funds. Interventions thus should not focus first on developing research capacity and only later on other aspects of innovation capacity. Instead, research capacity should be developed so that, from the beginning, it nurtures interactions between research, private, and civil society organizations.
- The approach opens up the space for linking parallel development efforts that build capacity—for example, linking community-driven development efforts and self-help groups with research and extension investments. Recent discussions of innovation capacity have argued that capacity development in many countries involves two sorts of tasks. The first task is to create networks of scientific actors around research themes such as biotechnology and networks of rural actors around development themes such as dryland agriculture. The second task is to build links between these networks so that research can be used in rural innovation.

Key Findings from the Introductory Session

The emergence of AIS is a response to the speed at which the farming and rural community must move to remain competitive and productive amid rapid change (as seen, for example, in the economic, political, technological, and environmental spheres).

An AIS approach is important because:

- It is essential to ensure that both existing and new knowledge will be used more effectively for the livelihoods of the rural poor.
- Research and researchers are not the only contributors to innovation and change—rather, innovation and innovation systems require different sets of actors.
- Improved communication, information, and interaction through the Internet and other channels allow the use of new ideas and knowledge from various sources. It is imperative to identify ways for this kind of knowledge to be brought into the change process.

In summary, the innovation systems approach recognizes the importance of technology but focuses on innovation, widens the range of actors involved, highlights the institutional context and the environment that promotes dominant interests, and underscores that innovation systems are social systems.

In particular, with respect to rural development:

- The *agricultural* innovation systems approach should be expanded to *rural* innovation. Aside from agriculture, production, and commodities, rural issues include natural resource management, off-farm employment, and overall rural development.
- The innovation system can operate at multiple levels and for different purposes (poverty alleviation, economic growth, agricultural development, and so forth). Also, agricultural/rural innovation systems can

operate at the individual, farm, community, regional, national, or international level.

- Innovation may arise anywhere. It is not the preserve of formal research organizations or processes, and it can be of a technical, social, managerial, and/or institutional (or other) nature. Innovation addresses both the generation and use of new or existing knowledge and information. In fact, innovation in agriculture may come from institutions that do not consider themselves part of the agricultural sector, such as ICT, biotechnology, natural resource management, systems modeling, and S&T organizations.

3 The Role of Technology, Research, and Advisory Services in the Innovation Process

Most often innovations arise in response to the potential for added value. In the case studies presented in the workshop,³ added value was often associated with niche opportunities exploited after the harvest (through quality, processing, storage, packaging, and marketing); with social or environmental opportunities (such as fair-trade or organic foods); or with more traditional opportunities to add monetary value (such as increasing the volume, value, or size of an operation). Many of these opportunities were realized through small, gradual changes. Notably, opportunities of this type may be more easily and rapidly grasped and managed through actors other than research organizations, such as advisory services and private entrepreneurs. Most innovations, especially with respect to postharvest niche opportunities, require applied research or technical support, a need that emphasizes the importance of technical advisory services in applying existing knowledge to local situations (Authors).⁴

Putting the Role of Research and Technology into Perspective

The consensus from the workshop is that research and technology development are definitely required for innovation but constitute only a part of the innovation process. In the case studies, research was a major trigger for innovation in only a few instances. In most cases it played a relatively small role. The key challenge in most successful innovation cases has not been to create new inventions but rather to adapt and use existing ones, typically to deal with a market demand or specific problem. Research traditions driven by disciplinary orientation are often unsuited to meeting contemporary innovation demands (World Bank 2006b).

Moving Beyond Commodities and Market Development

The AIS approach has been particularly successful in addressing issues associated with commodity and market development, but as noted previously, it must also address issues related to natural resource management, subsistence farming, and overall rural development and employment. In addressing this broad group of agricultural and rural issues, it is essential to enhance the role of farmers and other rural people as the engine for innovation—for example, by organizing and empowering rural stakeholders.

The relative priority given to different types of research is another consideration. For example, shifting toward an AIS approach stimulated changes in the research programs under the Renewable Natural Resources

Box 3. From Research to Innovation Systems

The Renewable Natural Resources Research Strategy (RNRRS) of the Department for International Development (DFID) has evolved significantly over the years. For example, the focus shifted from producing research and scientific publications to emphasizing the impact of research on poverty. The focus also shifted from outputs to outcomes and long-term impacts. At the same time, interdisciplinary research, policy, and the livelihoods of the poor received more attention.

The evolution of RNRRS research programs resulted in an increased share of social science research, a reduction in natural sciences research, and a shift from basic to applied research. It also involved a number of decisions about how research programs would be developed and undertaken:

- Research was organized around beneficiary groups.
- Priority was given to impact rather than to the generation of knowledge for its own sake.
- Participatory processes were emphasized to establish demand and prioritize research needs.
- There was greater follow-up and clustering of projects to allow for continuity of research themes.
- More emphasis was given to dissemination and promoting uptake.
- “Southernization” increased—more work was done with southern partners and more funds were spent in southern countries (up to 70 percent of project budgets, in some cases).
- Explicit capacity-building activities were developed.
- Links were made with private sector stakeholders as partners and research users.

Source: Turrall 2006.

Research Strategy of the Department for International Development (DFID) (box 3 summarizes these changes). Although an AIS approach, given its relevance to commodity, market, and overall rural development, appears particularly suited to an adaptive research agenda, it is important to balance applied, strategic, and maintenance research priorities (World Bank 2008).⁵ Investments to build the capacity for planning and foresight⁶ activities are useful to support priority setting and resource allocation, especially if an AIS approach is being introduced.

The shift from research being in a central position to being an important part of an innovation system has implications for researchers and research systems. Researchers must acquire skills in negotiation and facilitation to perform as effective partners in the incremental process of innovation and development. Organizations need to provide funding and incentives to promote partnerships and enforce partnering as a way of working. These added activities and demands will require resources that traditionally have not been available to research organizations.

Box 4 summarizes the findings of the working group on research systems. For further discussion of capacity issues, see chapters 4, 6, and 8.

Box 4. Challenges and Requirements for Research Systems Operating within an Agricultural Innovation System

Research systems face a dual challenge. They must respond to more immediate, demand-driven priorities—regional, national, or local—and at the same time develop global public goods that anticipate future needs. Several issues require attention if research systems are to meet these challenges:

- *Support to public research systems must focus more on developing the interface with the rest of the sector and society.* Aside from their important role with respect to public goods, *public research organizations* are increasingly viewed as essential for coordination, facilitation, standard setting, and regulation of competition. *Universities*—where research often is underfunded—must reengage with the wider research system, perhaps through inclusion in business parks and through training and skills development to use diverse funding schemes effectively.
- *Private sector involvement* is essential for research systems to remain relevant to stakeholders. The private sector may be induced to participate in research linked to long-term business development rather than short-term profit (perhaps to address consumers' concerns over fair trade and fair prices for farmers). Partnerships could be formed to enhance private research outside of areas where complete market capture is possible. Some companies may decide to fund development activities to enhance their reputations and further the interests of smallholders at the same time.
- The roles of *farmers* and *civil society* are important. Farmer research groups, farmer-to-farmer exchanges, and multistakeholder action research may facilitate wider participation, priority setting, implementation, and evaluation of results, eventually leading to better research outcomes.
- *Shifting to an AIS approach requires greater attention to research system governance and the ability to form partnerships.* Highly pluralistic partnerships require shared priority setting, research, and innovations that go beyond agriculture and into nontraditional research areas. They also require facilitation, coordination, team-building, problem-solving, and negotiating skills, as well as clarity on the division of labor among the partners. Research institutions may serve such partnerships in diverse ways: as leaders, contractors, facilitators, or trainers.
- The engagement of diverse partners, particularly of smallholders and the private sector, places more emphasis on the need to *balance short- and long-term research results*. It is essential to accommodate research with short timeframes with clear benefits to participants. As private sector involvement becomes more important, the funding and use of pilot projects to evaluate potential research investments becomes more important.
- *Funding must be flexible.* Conventional loans (over four or five years) to the public sector often take a long time to materialize. For this reason, trust funds and partners are vital to fund startup research. Evidence also points to the usefulness of grants as a key incentive mechanism to foster a variety of outcomes at a wide variety of scales (local, regional, and international).
- Where there is a conservative national research system, *competitive grant programs* with conditions that require the building of multistakeholder partnerships can be effective in changing practices and attitudes among some researchers. Despite the fact that competitive grants have not worked in some cases (particularly where there was not wide stakeholder representation on the bodies awarding the grants), they remain the best means of funding research under loan projects, when given according to strict criteria and monitored using appropriate indicators.^a *Matching grants*, which combine the managerial,

Box 4 (Continued)

infrastructure, and mobility inputs of the private sector, the land and labor of farmers, and the monetary contribution of the loan, are particularly suitable for local innovation systems development. *Microfinance* is another option that allows beneficiaries to adopt innovations. The factors conferring success in savings and loan schemes and revolving funds are well known but difficult to achieve simultaneously. Yet in remote areas where the banking sector is absent or operates on highly restrictive terms, such mechanisms remain useful.

Source: Authors; workshop working group on research systems; World Bank 2006a; Heemskerk and Wennink 2005.

^a For further information on grants and other funding mechanisms for research and partnerships, see World Bank 2006a and Heemskerk and Wennink 2005.

A Significant and Revised Role for Advisory Services

The AIS approach, with its strong emphasis on how relationships influence innovation, has especially strong implications for actors who serve as mediators. Advisory-extension services should play a significant albeit revised role in the innovation process. Key issues from the findings of the working group on advisory services, as well as other material on extension in the AIS process, are summarized in box 5.

Box 5. Implications of Innovations Systems Thinking for Advisory Services

Because the success of the agricultural innovation systems approach often depends on coordination and partnerships, mediators play a critical role. Advisory services can fill this important role if their mandates and roles are revised.

A revised mandate for extension. The primary emphasis of extension should shift toward creating connections to outlets, institutions, and people. Extension needs to provide a wider range of services to a more diverse clientele to improve their capacity to access, adapt, and use knowledge, inputs, and services. Extension systems must be flexible, user-driven, and focused on local problems. Developing better habits and practices that promote wider interaction and learning is perhaps the greatest challenge for extension organizations.

A changed role as a knowledge broker. As potential intermediaries and knowledge brokers, extension services are ideally placed to lead the local innovation agenda by scouting for needs and opportunities among smallholders and other actors. Additionally, extension can serve as a bridge among the actors in an innovation system and facilitate partnerships, building coalitions of different stakeholders by linking farmers with other farmers, research, agribusiness, exporters, training, investors, and financial services. Essential activities and mechanisms include: organizing forums and supporting establishment of producer organizations; promoting information flows; and experimenting with new approaches to facilitate access to knowledge, skills, and services from a wide range of organizations. Specific attention must be given to empowerment, capacity building and teaching (particularly among smallholders), the organization of producers and the rural poor, and the identification, articulation, and building of demand through financing and capacity building.

Partnering with other actors is the only way forward. Capacity-building and incentive structures aimed at reforming extension services should support the revised functions of extension. Extension organizations require a wider range of skills and partners to address the increasingly complex rural innovation agenda. Partnerships have generally been weak in public extension services. The weak links between extension and research remain a matter of great concern. Independence is emphasized at the expense of interdependence.

Box 5 (Continued)

Institutional innovations. Technical innovation is not necessarily the starting point for extension. Institutional innovations are going to be equally or more important in dealing with the complex challenges facing agriculture and rural development. Institutional innovations may include new ways of organizing production, input management, marketing, or sharing common resources. It may include the development of a new producer company or a new way of providing extension support. Flexible funding and governance arrangements are needed as centralized funding, implementation, monitoring, and evaluation have proven ineffective in fostering locally relevant institutional innovations.

Source: Authors; workshop working group on advisory services; Sulaiman V, Hall, and Raina 2006.

Evidence from the Case Studies

A number of case studies explored potential new roles for research organizations and advisory services in innovation systems.

A “new role” for research

The “Convergence of Sciences” case studies⁷ emphasize a “new role” for research, which entails seeking value-added opportunities and meeting the needs of users through a process that addresses technical, social, and organizational change. The studies, which focus on Benin and Ghana, indicate that the bottleneck in West African agriculture is not so much the lack of innovation and productivity at the farm level, but their lack *within* the very small windows of opportunity that currently exist to improve farmers’ livelihoods. These windows can be expanded to allow room for innovation and change by ensuring that research relates to the needs and opportunities of resource-poor farmers; that academic excellence is based on socially relevant concerns; and that ex ante impact assessments are carried out with technology⁸ and diagnostic studies.

The studies conclude that trying to foster agricultural development through technology alone, when the necessary institutional conditions are absent, will probably not succeed. A combination of issues must be assessed: “hardware” issues (technologies such as new varieties, better agronomic practices, or soil improvement measures), “software” issues (changed mindsets and goals, such as a shift in focus from yield improvement to farmer empowerment); and “orgware” issues (different organizational arrangements and institutions, such as better market outlets, different labor arrangements, and adding value to products). A few examples of successful interventions (in addition to research inputs) include:

- An increase in the producer price for cocoa in Ghana from 2001 to 2004 increased cocoa production by an astounding 80 percent.
- Setting up a task force resolved corrupt and extractive cheating with weighing scales by the Licence Buying Companies for cocoa in Ghana.
- New tenure arrangements broke up patrimonial networks impeding investments in soil fertility, such as tree planting, which is a covert claim to land ownership.

- In sorghum production for the brewery industry in northern Ghana, creating a dynamic relationship between the private sector, farmers, scientists, and nongovernmental organizations (NGOs) in contract farming under market-driven conditions can improve access to markets.
- Cotton in Benin can be produced more sustainably by stopping rent seeking by private organizations, which impedes the delivery of inputs needed for integrated pest management.

The case studies conclude that it is important to (1) enlarge the socioeconomic and institutional space, as this allows technological improvements to be made; (2) strengthen farmer-based organizations; (3) decentralize; and (4) facilitate stakeholder negotiation. Institutional development results when actors enter into stable relationships and configurations based upon negotiated and agreed rules.

Technology uptake pathways vary and require flexible arrangements

The three case studies⁹ for Afghanistan, Nepal, and Tanzania are concerned with the partnerships and institutional frameworks needed for effective and sustainable uptake of technologies and processes. In each case the technology or process arose from a different source, and each case is based on different objectives, exposing the need for flexibility in defining the appropriate actors and conditions for any given situation.

In Nepal, technologies were identified by research organizations through conventional research. The breakthrough from conventional research to an innovation systems approach was brought about by insisting (through the conditions of a competitive grant fund) that public, private, and civil society elements work together to test new technologies in the real world of markets and inputs. The example of low-cost water tanks suggests that there are researchable constraints on the demand side as well as on the supply side of technology, and it also demonstrates the value of having a single organization that coordinates both the demand and supply sides.

In Tanzania, technologies were identified by community-based farmer research groups. The innovation partnership evolved over time as needs (such as inputs, credit, and training) became apparent. The flexibility of the facilitating NGO enabled unforeseen needs to be met in a sustainable way.

In Afghanistan, the process under investigation was introduced from another country, where it had evolved into a “package of practices” that needed to be questioned during its introduction into a new situation. The institutional, cultural, and security situations are very different in India (the country of origin of the self-help group model) and remote, Islamic, postconflict Afghanistan. The cost of facilitation (particularly if women’s groups are included on an equal basis) is comparatively high, owing to social conflict, opposition from local power bases, a lack of literacy and technical knowledge, weak government institutions, and poor logistics.

The cases in Nepal and Afghanistan influenced significant institutional change at the national level (in the way research is funded and managed in Nepal, and in the rural financial institutions of Afghanistan).

In conclusion, the three cases highlight important considerations in shifting research systems toward an innovation systems approach:

1. In all cases, a pilot project has expanded or is likely to expand. In all cases the public sector is taking on this scaling-up. However, the public sector does not have a good record in managing projects that require a large amount of flexible, sensitive facilitation, coupled with trust that local organizations can take their own decisions and work in diverse ways toward self-reliance.
2. Partnerships have developed in a flexible way, with organizations being brought in as the understanding of the requirements evolves. Public research and extension can play only a limited role in the generation and uptake of technology, and therefore the integration of other players has been crucial, along with clarity in defining their roles.
3. In two of the cases, the facilitating organizations empowered local institutions (Farmer Research Groups and Self-Help Groups) to develop autonomously and provided platforms for sharing their different experiences. It was necessary to build capacity in the groups to organize their own affairs, identify their own priorities, and carry through activities that addressed those priorities.
4. In all three cases, the development of links to input suppliers, markets, and technical assistance was important. In some cases, these services were provided by government, but more often they were provided by the private sector. The Farmer Research Groups are also linked to national and international training and research institutions.
5. Facilitating group formation, capacity development, and linkages is a skilled activity, and the skills of researchers working with multiple stakeholders will need to be enhanced if this way of working is to be widely adopted. However, these cases clearly prove that research systems can accommodate AIS as needed.

Observations on the changing role of advisory services

Most case studies acknowledge the importance of advisory services, but discussion of their role was limited at the workshop, with the exception of the Uganda National Agricultural Advisory Services (NAADS) program.¹⁰ This program promotes an extension system that is fundamentally different from previous systems in Uganda. It focuses on providing market-oriented services by contracted service providers based at the subcounty level and controlled by farmers. The emphasis is on the empowerment of farmers as key stakeholders, and therefore this program is discussed more fully in chapter 5.

It has become clear that researchers and research systems need to be interact continuously with other elements of the innovation system and that advisory services are ideally placed to facilitate such interaction. However, it is less clear how to implement this role and what capacities need to be strengthened. Above all, this change requires a very flexible and evolutionary approach to building skills, bringing in other actors, and managing and financing innovation processes. Chapter 4, which focuses on partnerships, provides further evidence on the merits of these arrangements.

4 The Importance of Incentives, Partnerships, and Coordination

The economic or social performance of a country depends on the *participation* of many innovative agents that foster the emergence of an innovation system. Particularly important to this notion is the emergence of effective interactions between a country's scientific base and its business community (Powell and Grodal 2005; OECD 1999; Rycroft and Kash 1999; Nelson and Rosenberg 1993). The case studies also indicate that successful AIS approaches nearly always feature (1) multiple sources of knowledge and information and (2) stakeholder engagement and partnerships that allow this knowledge to be used effectively. As pointed out in chapter 2, innovations often arise in the search for added value, perhaps because the potential for value addition is also an important incentive to bring partners together (Authors). A market opportunity alone is often not sufficient to encourage collaboration and partnerships, however. For this reason, coordination mechanisms and/or organizations can be essential for establishing networks when the market is not sufficiently developed to provide incentives to do so.

Establishing Networks and Partnerships

Although the right "configuration" and maintenance of a partnership or network is highly context-specific and evolves over time (as the actors' needs evolve), intangible factors can be decisive in the creation and maintenance of innovation networks among organizations and firms, and they underline the need for persistent and active network management (Marques, de Carvalho Alves, and Saur 2005). These intangible factors are related to expectations raised around a specific cooperative arrangement and are influenced by the profile of the members, in terms of their reputations, their institutional visibility, and the existence of a shared vision and inspiring ideal. The development and consolidation of the network depends on a number of factors, which can be grouped into the actors involved, the way relationships occur within the network (structure), and network management. Common principles and lessons on the essential aspects of building networks can be found in annex 2.

Marques, de Carvalho Alves, and Saur (2005) also argue that it is essential to have or invest in establishing both local and multisectoral networks. Local networks are well suited to most agricultural contexts because of the physical proximity of network members (Authors). This proximity facilitates the exchange of knowledge rooted in individuals. Common practices and shared culture, norms, and values help communication processes (Marques, de Carvalho Alves, and Saur 2005). Because rural issues go well beyond agriculture and commodity development issues,

however, most rural settings and development paradigms require a multisectoral approach (Authors). Although multisectoral networks are challenging to establish and maintain, participants benefit from collaborating across disciplines and perspectives as well as from an important creative potential.

Evidence from the Case Studies

Most case studies feature partnerships and linkages between actors. For the sake of brevity, five examples are discussed here.

Learning alliances

A learning alliance is a process undertaken jointly by research organizations, donor and development agencies, policy makers, and private businesses. The process involves identifying, sharing, and adapting good practices in R&D in specific contexts. These practices can be used to strengthen capacities, generate and document development outcomes, identify future research needs or areas for collaboration, and inform public and private sector policy decisions (Lundy, Gottret, and Ashby 2005). A learning alliance focuses explicitly on answering questions in a collective fashion. Other multistakeholder platforms focus on coordination or joint programs but rarely have a clear central focus on knowledge generation and management. To answer shared questions, the learning alliance incorporates knowledge and experiences from a range of sources and recombines this content into a shared prototype to test and improve. To this end, the alliance has four key functions: (1) identifying knowledge gaps; (2) recombining experience among partners and from the literature into a prototype tool/approach; (3) applying the prototype in a variety of sites and conditions, with technical and peer-based backstopping; and (4) conducting a peer evaluation of the prototype to assess what worked well (and should be shared) and what did not. Another key difference of a learning alliance is an explicit focus on influencing the behavior of partner agencies and others. The learning alliance contributes to improved development practice, greater shared knowledge on specific topics, and inputs for lobbying and policy advocacy by partner agencies (Mark Lundy, personal communication).

A case study on learning alliances¹¹ provides details on a process of multistakeholder innovation focused on rural enterprise development in Latin America. The learning alliance, led by the International Center for Tropical Agriculture (CIAT), seeks to identify, innovate, and disseminate effective practices related to rural enterprise among the partner agencies and to specific external groups, including policy makers, donors, and private firms. The alliance seeks to engage partners in a processes of double loop learning, inviting participants to reflect on their underlying assumptions; identify knowledge gaps; jointly develop innovative prototypes of approaches, methods, and tools; test these in diverse contexts; and reflect collectively about what works where, with whom, and why. The learning alliance rests upon several common principles (table 3).¹² Lessons learned from the implementation are summarized in box 6.

Table 3 Key Shared Principles for an Effective Multipartner Learning Alliance	
Principle	Description
Clear objectives	Multiple stakeholders have different objectives and interests. A learning alliance is based on the identification and negotiation of common interests, needs, and capacities of participating organizations and individuals. What does each organization bring to the alliance? What complementarities or gaps exist? What does each organization hope to achieve through the collaboration? How can the alliance add value to partner activities?
Shared responsibilities, costs, and benefits	Organizations and individuals participate in learning alliances when: (1) they perceive that they will obtain benefits from this association, (2) the transaction costs are lower than the expected benefits, (3) benefits are perceived to be higher than those obtained by working individually, and (4) results do not conflict with other key interests. As learning alliances seek to benefit all parties, the interaction costs and responsibilities, as well as the benefits and credit for achievements, need to be shared among partner agencies in a transparent fashion.
Outputs as inputs	Rural communities are diverse; hence there is no universally applicable recipe for sustainable development. Learning alliances view research and development outputs as inputs to processes of rural innovation that are specific to a given place and time. Methods and tools developed by researchers will change as users adapt them to their needs and realities. Understanding why adaptations occur, the extent that they lead to positive or negative changes in livelihoods, and documenting and sharing lessons learned are key objectives.
Differentiated but linked learning mechanisms	Learning alliances have a diverse range of participants. Identifying each group's questions and willingness to participate in the learning process is critical to success. Flexible but connected learning methods are needed.
Long-term, trust-based relationships	Rural development processes stretch over many years or decades. To influence positive change and understand why that change has occurred requires long-term, stable relationships capable of evolving to meet new challenges. Trust is the glue that cements these relationships, but it develops gradually as partners interact with each other and perceive concrete benefits from the alliance.
<i>Source: "Learning Alliances: Building Multi-Stakeholder Innovation Systems in Agro-Enterprise Development," an unpublished workshop paper by Mark Lundy and Maria Verónica Gottret.</i>	

Box 6. Learning Alliances: Lessons Learned

- **Individuals are important.** Experience highlights the importance of individuals as opposed to organizations, as well as the need to avoid organizational standard bearers who feel threatened by open systems where “the competition” also participates. It is critical to connect and engage individual people in a transparent fashion with sufficient information and under the aegis of an honest broker to build trust.
- **Strive for clarity and realism.** Clear and shared objectives, applicable results, personal commitment, and flexibility are key elements for successful learning alliances. An effective innovation system adds value to individual participants in diverse ways by leveraging a collective motivation to work smarter.
- **The facilitation of an innovation system is an art in itself.** The learning alliance has identified the value of diversity of opinion and tension as a crucible of creative ideas.
- **Many essential interventions center on communication and information.** Specific interventions highlighted by partner agencies to support innovation systems projects or programs focus on connectivity and information. Key interventions in connectivity include face-to-face exchanges and trust building. Once a minimum level of trust exists, other technical tools such as e-mail, voice over Internet protocol, and web-based applications are useful. Trust is the basic building block; without it, technical fixes are of limited use. A second key intervention is to increase information access and flow. Participants in the learning alliance value new ideas about how to resolve constraints, short case studies illustrating the application of these ideas in diverse contexts, access to people with experience using these tools, and feedback mechanisms to share their experiences with others. Investments in simple process documentation (contracting local reporters), knowledge-sharing fairs, web-based platforms, as well as support for writing to make sense of outcomes, are useful here.
- **Challenges.** Several critical issues and/or errors can be taken from experience with learning alliances. First, it is difficult to sell a process in a project- and outcome-driven context. Second, a lack of causality in many of the results makes evaluation and reporting difficult in more formal channels. Third, an initial excessive emphasis on shiny, web-based tools is misplaced; what seems to work best is face-to-face exchanges that build trust and innovation. Fourth, ongoing funding can be difficult to obtain for what is, admittedly, a fuzzy, demand-driven process. Fifth, it is necessary to proactively involve more members of the overall food system (such as public policy makers and the private sector) from the outset. Finally, there must be buy-in from key decision makers in the organizational “home” of the innovation system.

Source: Adapted from “Learning Alliances: Building Multi-Stakeholder Innovation Systems in Agro-Enterprise Development,” an unpublished workshop paper by Mark Lundy and María Verónica Gottret.

Opportunities and challenges for research in multiple stakeholder partnerships

Another case study¹³ also recognizes that multiple stakeholder partnerships are a prerequisite for innovation. The study specifically assesses the challenges and opportunities for research and the potential role of researchers in enabling innovation through stakeholder partnerships. The authors identify several key principles for such partnerships (box 7). They emphasize that, to operate and

thrive, partnerships require recurrent, multiple-focus, realistic negotiations as well as appropriate operational and governance mechanisms and innovative funding. Potential asymmetries among partners (over power, for example) need to be taken into account and efforts made to build capacity of the weakest partners. Researchers are particularly able to serve as honest brokers in this process, if they are willing to learn the new skills that make AIS work.

Box 7. Key Principles for Enabling Innovation Through Stakeholder Partnerships

Identify common ground for innovation by negotiating on values and goals

Shared values are extremely important for innovation to take place, yet shared values must be identified through negotiation. It is important to understand what brings people together or drives them apart. Initial, multiple focus negotiations are essential, and negotiation skills need to be learned. Recurrent negotiations are key for partners to understand each other and maintain fruitful relations over time. These activities can help identify the link between attitudes/practices and underlying values and perceptions. They can also help participants identify “enough” common ground to ensure lasting collaboration. A number of factors encourage partners to develop trust among themselves, such as openness about one’s own values and interests and the perceivable consistency between one’s values and actions.

Build the devices necessary for meaningful interaction among partners

The term “device” refers to the activities, resources, rules, relationships, and mechanisms through which a set of actors agree to work together toward a shared goal. Devices include governance devices (decision making, coordination, and so forth) and operational devices (implementation of activities). In designing devices and effective partnership management, it is essential to:

- Formalize rules and define the ethical framework.
- Build flexibility to allow for adjustments and unpredictable, nonlinear evolution.
- Devise robust mechanisms for tension/conflict resolution.
- Monitor and evaluate results and the process.
- Facilitate empowerment of the weakest partners.

Deal with asymmetries among partners

Asymmetries among partners with respect to power, knowledge, resources, institutional strength, negotiation skills, and other assets may prevent a true partnership from developing. Small-scale farmers and farmer organizations frequently constitute the weakest link in multistakeholder partnerships, as these groups can be limited by loose organization, dispersed membership, leadership issues, and the limited availability of human and financial resources, among other constraints. In strengthening farmers and their organizations, it is valuable to remember that:

- The process must be gradual, long term, and paced according to the absorption capacity of the groups involved.
- Capacity-building should be a key ingredient (for example through community-driven development).
- A learning-by-doing approach is essential.
- Interpersonal relationships are of great significance.

Box 7 (Continued)**Understand the implications for research partners**

In multistakeholder partnerships, research partners often have the opportunity to serve as neutral brokers, but to fulfill this role well they must:

- Learn and play new roles and functions.
- Conduct research while strengthening the weakest partner.
- Assess the efficacy and efficiency of research in partnership (for example, through case studies).
- Put the correct motivations or signals in place within their research institutions.
- Negotiate with donors for adequate funding.
- Become properly educated and trained in agricultural innovation system concepts and practices.

Source: Adapted from "Nurturing Innovation Processes by Building Multiple Stakeholder Partnerships: Opportunities and Challenges for Research," an unpublished workshop paper by Bernard Triomphe, Henri Hocdé, and Guy Faure.

Stakeholder platforms for pro-poor innovation and market development

The International Potato Center (CIP), through its regional Papa Andina Initiative,¹⁴ has facilitated interaction and collective learning among public and private partners to promote pro-poor innovation to develop and exploit niche markets for native potatoes in Bolivia, Ecuador, and Peru. The basic premise is that supplying niche markets can contribute to the incomes and well-being of small-scale Andean farmers. The Initiative has a few central tools: a participatory approach to promoting market chain innovation, stakeholder platforms, coordination time, capacity-building, and development of an exit strategy (box 8; Devaux et al. 2007). This experience has yielded valuable lessons:

1. **A multistakeholder platform is an attractive entry point for "newcomers."** Newcomers, be they researchers, donors, politicians, farmer groups, or entrepreneurs, can use the platform to discuss and set up new R&D projects or new businesses.
2. **Collective action is not automatic; it needs good facilitation.** The Papa Andina experience reveals that opportunities for information exchange and collective action must be actively created, especially when bringing together actors along the market chain, who compete in their daily business and whose time has a high opportunity cost. Good process facilitation, by highly competent (social and technical) facilitators, can help guarantee active participation of key actors and generate tangible benefits for those who get involved.
3. **Commercial innovation can drive subsequent technological and institutional innovation.** Constraints identified among actors at the consumer end of market chains can stimulate technological innovation with producers at the other end of the chain. In Papa Andina, the need for technological innovation created linkages between the more market-minded development organizations and agricultural research organizations. As new commercial products came on stream, it became

apparent that institutional innovation was needed to create a more permanent space for market chain actors to come together and address constraints in the market chain for native potatoes.

4. **Biodiversity and cultural identity can add value to collective action for innovation and market access.** Focusing on native potatoes created a “pro-poor filter” for developing high-value niche markets for which small-scale farmers residing in the highlands have a comparative advantage. Products from native potatoes give them more opportunities to link with other actors, participate in these niche markets, and participate in a way that enhances their local culture. These products also have good potential in external markets because they are seen as exotic and come from a well-recognized region, the Andes. Native potatoes can add value to collective action, making small-scale farmers and small agroenterprises more competitive in potato market chains.

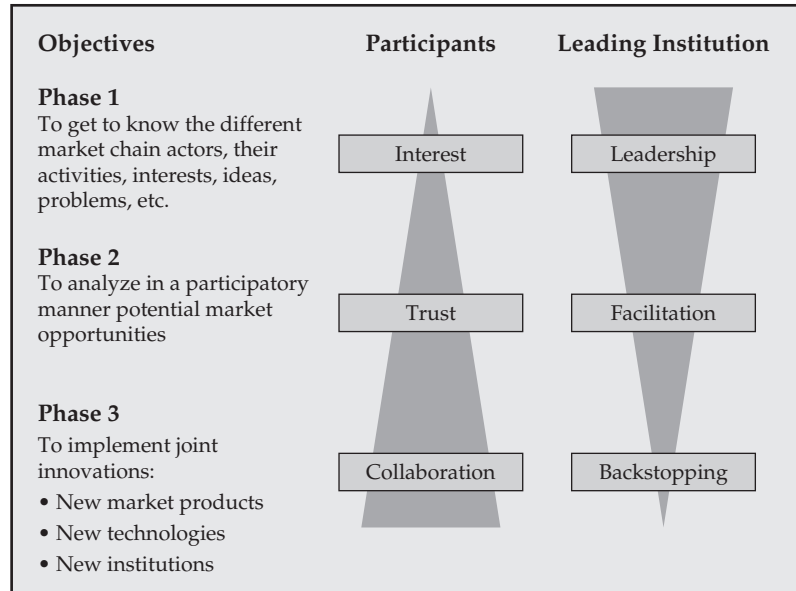
Box 8. The Papa Andina Initiative: Pro-Poor Innovation Through Stakeholder Platforms and a Participatory Market Chain Approach

Since 1998, the Papa Andina Initiative has operated in Bolivia, Ecuador, and Peru to encourage technological, commercial, and institutional innovation throughout the potato sector. Papa Andina and its partners have developed two complementary approaches to engage public and private organizations in pro-poor innovation: the participatory market chain approach (PMCA) and stakeholder platforms.

The PMCA^a engages market chain actors, researchers, and other service providers in identifying and analyzing potential business opportunities that benefit the poor, by stimulating market-driven innovation. An initial qualitative diagnostic identified the main actors along each segment of the potato market chain. The PMCA's three phases, usually implemented over several months, begin with planning, coordination, and facilitation, initially led by a research and development organization. As the process advances, market chain actors take on more responsibility and the research organization shifts to a supporting role (see figure). The process essentially builds a platform for stakeholders to partner and innovate.

Phase 1 of the PMCA begins with a rapid market survey and ends with a workshop at which market chain actors meet supporting research organizations to discuss possible innovations. *Phase 2* involves a series of group meetings and applied research to analyze market opportunities. A key goal of this phase is to build trust among participants. *Phase 3* involves joint activities that seek to develop concrete innovations, which might be technical (new products, production practices, or packaging) or institutional (farmer associations, stakeholder platforms, or business arrangements such as contract farming agreements). The PMCA formally ends with a large public event where market chain actors and service providers present their innovations and meet national policy makers, donor representatives, the media, and other “VIPs.” After the formal closure, the research organization may be called on by specific actors or asked to backstop new institutions.

For Papa Andina, the PMCA cycle was financed by the research organization, but other participants contributed to the implementation of the innovation by investing in development of the new products.

Box 8 (Continued)

Source: Adapted from "Stimulating Pro-Poor Innovation within Market Chain of Native Potatoes: The Case of Peru," an unpublished workshop paper by André Devaux, Miguel Ordinola, Kurt Manrique, Gaston Lopez, and Graham Thiele.

^a For a full description of the PMCA cycle, see Bernet, Thiele, and Zschocke 2006.

Setting up an effective coordination body may make the difference

A number of the case studies illustrate how the presence or absence of coordination significantly affects a sector's success or failure. The Ghana case study¹⁵ emphasizes that when a sector has not yet taken off, the critical factors above all include visionary leadership, political will, and effective public sector coordination of the actors within the sector. Other critical elements are the influence of end-market demand (expressed as consumer demand) and overall involvement of market actors, along with the strengthening of actor linkages, donor support for technologies, and organizational innovation.

A case study from India¹⁶ illustrates the importance of coordination in the export and domestic trade of medicinal plants as well as in the local health-care system. The medicinal plants industry has a multitude of players (large and small), with conflicting as well as complimentary agendas. Policy related to the industry is diffused across many sector and ministerial portfolios. Clearly the central challenge is to bring better coherence and coordination to this very large and diverse industry. The coordination efforts that are underway must address the divides between business and rural development and between science and traditional health care, by promoting interaction between clusters of diverse actors. The governance mechanism needs to be inclusive and reside outside government. Major new research and training initiatives are required; they must be guided by the need to explore and exploit the interface and synergy between traditional medicine and scientific medicine, irrespective of whether the research topics relate to the cultivation of medicinal plants, conservation of biodiversity, drug discovery, or drug efficacy and safety. Such initiatives will

require governance and financing structures that include the public sector, private sector, and civil society. Box 9 provides details on two (successful and less successful) coordination approaches. One of the key ingredients for success (trust) is central to developing relationships that help innovation develop, integrate economic, social, and environmental concerns, and at the same time allow the sector to grow.

Other case studies, on shrimp in Bangladesh¹⁷ and vanilla in India,¹⁸ also emphasize the value of coordination, especially when a crisis heightens the rapidity of change and the demand for innovation. A lack of strong coordination and partnerships may provoke an ad hoc “fire-fighting” response to the crisis, however, hampering innovation and sector development. Both case studies recommend building collaboration, establishing an autonomous sector-coordinating body with a diverse membership, and investing in the ability of a sector and its many actors to adapt and learn in a changing environment.

Box 9. Two Coordination Units for the Medicinal Plant Industry in India

The Foundation for Revitalization of Local Health Traditions

The Foundation for Revitalization of Local Health Traditions is a coordinating body established as a nongovernmental organization with government and donor support. It engages in a range of activities, including: ex situ and in situ conservation; conservation research; the development of a database on medicinal plants and traditional knowledge; research on strengthening local health cultures; laboratory studies on quality standards for traditional herbal materials, products, and processes; the development of educational material; and training and capacity building.

The Foundation recognizes the need to strengthen supply chains and at the same time add value by implementing new conservation measures and quality standards for herbal materials. It has tried to integrate different types of knowledge—for example, scientific knowledge and traditional systems of medicine. This process has not been without problems, but dialogue between stakeholders is helping to build the trust needed to sustain collaboration and innovation. The Foundation’s intervention has been relatively successful, thanks to certain attitudes and practices, including:

- An experimental approach of learning by doing.
- Continuous evaluation of program performance.
- Openness to new strategies and wide participation of staff at all levels in decision making.
- A commitment to research and implementation.
- An ideological commitment to safeguarding Indian health-care traditions.
- The adoption of a partnership approach.
- A commitment to pro-poor development.
- Excellent leadership that has shaped the Foundation’s vision, attitudes, and practices and largely determined how the Foundation has articulated and implemented its mission.

The National Medicinal Plants Board

The National Medicinal Plants Board became India’s apex body for coordinating and implementing policies related to medicinal plants at the central and state level

Box 9 (Continued)

in 2001. The Board is mandated to facilitate interministerial, interstate, and interinstitutional collaboration on all matters related to medicinal plants, including drawing up policies and strategies for conservation, proper harvesting, cost-effective cultivation, research and development, and processing and marketing. Most Board members are senior government officers, although some members represent the medicinal plant industry. The Board has established five committees to look after cultivation, research, demand and supply, patents and other intellectual property rights, and export and import. These committees are chaired by senior officers of government departments.

The Board has provided financial assistance to improve the supply of 32 medicinal plants in great demand but has been unable to meet its main mandated objectives, largely owing to: a lack of freedom to take independent decisions (on staffing, compensation, and programs, for example) without government approval; more bureaucratic and less professional management; time constraints; and a lack of expertise, experience, and intellectual leadership to coordinate the sector.

Source: Adapted from "Innovation Challenges in the Medicinal Plants Sector in India," an unpublished workshop paper by Rasheed Sulaiman V.

Regional research collaboration through partnerships and communication

Coordination and active promotion of partnerships are particularly important when attempting regional partnerships among multiple organizations with varying visions and objectives.¹⁹ Box 10 summarizes the plan to increase the impact of agricultural research in Africa through collective action by 15 research centers (supported through the Consultative Group on International Agricultural Research, CGIAR) and other partners.

Box 10. Promoting Institutional Innovation in Eastern and Southern Africa: The Regional Plan for Collective Action

The Regional Plan for Collective Action in eastern and southern Africa is the declared intention of the 15 research centers within the Consultative Group on International Agricultural Research (CGIAR) and partners to increase the impact of agricultural research in eastern and southern Africa. The Regional Plan is an institutional innovation that has evolved in step with the rapidly changing regional and sub-regional context.

The Regional Plan seeks to achieve its goals through (1) better alignment of research among all partners and (2) the joint development of a set of flagship programs in which the gains of better collaboration are achieved through reduced transaction costs. It aims to provide a framework for innovation in which research is better aligned with regional needs and to improve the integration of research through information, coordination, and realization of economies of scale and scope. The keys to success are expected to be:

- Support of the alliance of CGIAR research centers and adherence to their principles and procedures.
- Facilitation by a distributed unit that creates incentives through information and flexible support. Information is a key incentive for collaboration, but

Box 10 (Continued)

current information is inadequate for regional planning. Incentives to participate are essential: The intention of the Regional Plan is to attract collaboration rather than challenge bilateral arrangements between the research centers and partners.

- Effective nodes that gain from participating in the activities of the Regional Plan.
- An evolutionary approach that accommodates change in the Sub-Regional Office for southern Africa.
- Favorable donor and national agricultural research system environments.
- Scientific review by the CGIAR Science Council to ensure quality and compatibility of regional and CGIAR priorities.
- Good communication with respect to scientific excellence, solving problems identified by the CGIAR Sub-Saharan Africa Task Force, and (more generally) facilitating CGIAR reform more widely. An understanding of the process and pathways to achieve objectives is essential for progress.

The Regional Plan can be promoted in several ways. Opportunities for investors include:

- Create an information system in the CGIAR to support regional planning.
- Support the hub unit as a facilitator of innovation in program content and in reforming CGIAR links with partners.
- Finance “quick wins” from collaborative efforts.
- Respect both CGIAR priorities and regional priorities.
- Retain flexibility in interpreting partners’ “agreed agenda.”
- Support capacity building through partnership programs that help to eliminate competition, overburdening of national research systems, and crowding out and that make it possible to focus on the agreed agenda.

The Regional Plan’s evolutionary approach offers the potential for partners to develop research together and reform the relationships among partners as envisaged by the Task Force on Sub-Saharan Africa. The Regional Plan does not preclude deep-seated structural change but concentrates on building the relationships needed for any reorganized research system to function.

Success is not guaranteed, but the Regional Plan’s approach and focus are achieving many of the key intentions of the Alliance that mandated the Plan and the partners that have given it a chance to effect change.

Source: Adapted from “The Regional Plan for Collective Action in Agricultural Research in Eastern and Southern Africa: An Institutional Innovation in Progress,” an unpublished workshop paper by Howard Elliott and Ravi Prabhu.

Conclusions from the case studies on partnerships

The case studies highlight common features of successful partnerships:

1. **Most successful partnerships are typically dynamic, multistakeholder partnerships.** Partners are drawn from many types of organizations, including government, community-based organizations, NGOs, and the private sector. They include numerous formal, informal, and individual representatives at different levels (local, regional, national, and international).

2. **The cases on learning alliances and on the opportunities and challenges for research illustrate the principles of partnership and the skills required among partners (including negotiating skills, a capacity to share values, and the ability to find common ground).** Typically there may be initial resistance to forming partnerships (owing to distrust, poor awareness of benefits, and other factors) or difficulties in collaborating (owing to distance, transaction costs, language, culture, bureaucracy, and other barriers).
3. **Active coordination and facilitation are often central to successful partnerships (as well as linkages and collective action).** The public sector often has a key role to play in coordinating and facilitating the partners and/or creating opportunities for other impartial organizations to do so.
4. **Partnerships must offer concrete benefits for all partners, not just “shop-talk.”**
5. **Often it is necessary to build capacity in the weakest partners to reduce actual or perceived asymmetries** (for example, in power, voice, resources, and benefits) and explore common ground. Chapter 5 develops this point.
6. **Funding must be available to compensate for the transaction costs of forming and maintaining partnerships.** Facilitation/coordination skills as well as flexibility (in activities, budgets, partners, and timetable) are also needed across the different organizations involved.

Innovation systems typically depend on intermediary organizations to facilitate interaction or access to technology and information, and they also depend on coordinating bodies to help integrate the activity of different actors in a sector and foster its development. The Papa Andina and medicinal plants cases illustrate these points. When coordinating bodies function effectively, initial public support for their activities can be superseded by financing from the sector they support, for example through a levy or contribution system (World Bank 2006b).

Aside from coordinating and improving patterns of interaction between players, the public sector has other important roles in facilitating AIS: supporting small-scale farmers in becoming partners in innovation systems and adding value to their assets and skills (see chapter 5); helping to strengthen innovative capacity (chapter 6); and providing and enforcing an enabling environment for investments and innovation, ranging from innovation policies (chapter 7) and regulatory frameworks for differentiated product markets to infrastructure investments.

5 Empowering Smallholders and Engaging the Private Sector

Although interaction and partnerships are clearly “the bread and butter” of innovation, it is also evident that asymmetries among actors and the application of an AIS approach through rural development activities that emphasize commercialization may benefit some actors unequally or exclude others. It is important to implement measures that maximize the inclusion of those who typically are disadvantaged, such as the poor, women, and smallholders, and that maximize the positive impact on their livelihoods (Authors).

The private sector features more prominently than ever in the value-added opportunities that encourage innovation. Yet to foster engagement between the private sector, small-scale farmers, and the poor, it is necessary to look beyond basic supply and demand issues and identify needs, opportunities, common ground, and benefits. The innovations and innovation processes of greater interest to the poor versus other groups are often neglected or undermined (Berdegúe 2005). This exclusion will not be resolved by establishing partnerships among the poor. Closed networks of poor people rarely yield useful and sustainable innovations. The workshop findings indicate that networks must involve partners with different resources and capabilities, which in totality meet the needs and contribute to the common goal of the partners. At the same time, asymmetries in capacity, power, and resources must be addressed. Building capacity among the weakest is a prerequisite for reducing asymmetries and exploring common ground (Authors).

Economic and social heterogeneity is a defining characteristic of rural areas and has implications for public policy that supports agriculture as a catalyst for economic development and poverty reduction (World Bank 2008). The AIS approach needs to take account of this heterogeneity and address the wide range of agricultural and rural issues, such as natural resource management, staple crop production, subsistence farming, and overall rural development and employment. Expanding innovation to rural nonfarm activities will be essential, given that rural nonfarm economic activities account for 40 to 45 percent of rural income in Sub-Saharan Africa, Latin America, and South-East Asia and 30 to 40 percent in South Asia (DFID 2002).

How Can Different Groups of Farmers and Rural Poor Be Engaged and Empowered?

To answer this question, it is first helpful to identify *who* are the farmers and the rural poor. Rural people include those with a good asset base and access to markets, those with limited assets and/or capacity but good access to markets and finally those with a very low asset base residing in unfavorable environments for agriculture and market development. Interventions to support pro-poor innovations should be adjusted to these different contexts (box 11).

Box 11. Pro-Poor Interventions in Different Contexts

Specialized farmers with assets

In most market-driven environments, innovation is typically enhanced owing to a favorable context and asset positions. Agriculture tends to be profitable, and few farmers are poor to begin with.

- Farming communities with a good asset base and access to markets often are more inclined to associate with highly specialized, large-scale, intensive staple crop or livestock production systems or with innovation systems for high-value products driven by agribusiness interests.
- Farmers with little land but good links to markets are interested in diversifying production. They may be more inclined to become partners in innovation systems focusing on high-value, low-volume products, especially if sufficient scale is achieved by forming producer groups. Public-private partnerships can be instrumental in engaging these farmers in profitable enterprises.
- In this setting, pro-poor innovation may be maximized by improving opportunities for wage labor, providing technical and financial services to small enterprises hiring rural people, monitoring environmental and health effects of economic activities, and promoting market development.

Small-scale farmers with limited assets

In some areas, most of the population consists of small-scale farmers and small rural entrepreneurs who are interested in market-driven activities but cannot participate. They either lack the capacity and/or assets to respond, or the transaction costs of participating are too high. Several interventions can help to include smallholders in innovation processes in such areas.

- Support social and human capacity-building as well as economic activities. The public sector has a central role to play here.
- Through facilitators and expert groups who possess deep knowledge of the farming communities, provide skills and other resources to bring farmers within the realm of the innovation system. Adapt institutional arrangements to ensure that farmers are represented fairly.
- Enhance smallholders' asset position and productivity by promoting effective organizations for collective action.
- Confront the institutional and market failures that reduce productivity and innovation potential through land and financial markets and overall modernization of traditional product markets.
- Improve the provision of public goods—among which infrastructure (such as roads or information and communications technology) should have a very high priority—to reduce transaction costs.
- Other examples of pro-poor economic activities include: making small-scale farming more profitable via cooperative value-adding and marketing; lobbying to ensure recognition of certain livelihoods in national policies; linking smallholders with the business sector for better marketing; and building partners' capacity in marketing and forming market linkages.

The most disadvantaged farmers and rural people

Farmers and other rural people located in environments that are very unfavorable to agriculture often lack most assets. These groups require a slightly different approach to benefit from innovation processes. Some sectors rely heavily on

Box 11 (Continued)

small-scale farmers as the production base for an industry (cassava processing is an example from the case studies), whereas other sectors (such as medicinal plants in India) rely heavily on the natural resource base. Creating a sustainable sector requires attention to the “triple bottom line”: interventions and policy support must be pro-poor, pro-environment, and pro-business.

- Processes must be broad-based, help manage risk, reduce vulnerability, and also provide safety nets.
- Interventions should look into opportunities in environmental services and specialty markets based on identity-based goods and services. Dealing with social and environmental issues may require new types of expertise and insights into the social structure, asset base, and functions of farming communities, which can guide interventions to bring these communities into innovation systems as partners.

Source: Authors; Berdegue 2005; World Bank 2006a.

Build capacity of the weakest

As emphasized previously, aside from building assets and identifying proper livelihood opportunities, often it may be necessary to build the capacities of the weakest partners if the poor are to benefit from an innovation process. Specific measures must be in place to ensure inclusion, identify demand carefully by wealth group, design research that meets the specific needs of the poor, and particularly to use capacity-building, empowerment, and associated tools that support the inclusion of poor people and also have a positive impact on outcomes for them (Authors). The benefits must not be captured by any particular group.

Examine institutional issues

Institutions determine the extent to which the poor will be able to participate in the process of innovation and to share in its potential benefits. The distributional effects of innovation processes are mediated by institutions such as those related to social class, gender, age, ethnicity, or political power. The great importance of institutions presents a challenge to rural development agencies, as the institutional framework often needs substantial changes for certain pro-poor innovations to take off. Laws and regulations regarding intellectual property may be biased against the poor; secure access to assets such as land or credit may be difficult or impossible for the poor; social norms may prevent poor women from taking on certain roles required for innovation; social stratification may block the formation of social networks needed for innovation; manipulation of product markets may destroy the economic incentive to innovate; and bribery and political repression may increase the risks and costs of innovation to such a degree as to make it unfeasible (Berdegue 2005).

Consider the gender dimension

The gender dimension of the institutions that regulate innovation processes is very important. Unless gender is addressed explicitly, most innovation processes will not be gender neutral and often will limit opportunities for

women to participate and benefit (Crowden 2003). The opportunities to participate in interagent communication, which lies at the heart of innovation and innovation networks, are also gendered, as they entail perceptions of social risk in male-dominated environments (Berdegúe 2005).

Identify which actors will support smallholder involvement

The organization of rural stakeholders is a common element of value chain approaches and community-driven development. Given that investments in organization are fundamental to most development efforts in agriculture (the corollary in irrigation, for example, is the water user association), they offer important possibilities for synergy with agricultural innovation efforts. Organization can foster two capacities that rural stakeholders tend to lack: the ability to articulate and gain a hearing for their demands, and the ability to negotiate. In other words, investing in rural organizations tends to make AIS more effective. Agricultural organization does not substitute for technology, but it does improve the ability to articulate and communicate needs for particular kinds of technology, and it increases the likelihood that technology is used (World Bank 2006b).

Because the public sector often will be called upon to facilitate and coordinate partnerships or create opportunities for other impartial organizations to facilitate these interactions, it has a significant responsibility to ensure that poor people's interests are taken into account (Authors). The transaction costs to the private sector must also be low enough to serve as an incentive to partner with the poor and smallholders. The public sector can also help to make sure that partnerships and potential contractual arrangements are equitable for those with limited negotiating power. Capacity building and support in dealing with contractual issues are important in this respect.

Civil society also has a role to play in pro-poor innovation. Typically civil society organizations (CSOs) are formed to advance common interests and facilitate collective action. They help citizens participate in local development and service delivery initiatives and work on advocacy and structural change. Pro-poor CSOs share a service-oriented and rights-driven political agenda, yet civil society is increasingly active in enhancing citizen and CSO participation in economic life. This work focuses on market engagement by poor, vulnerable people on their terms and for their economic needs, and it aims to make pro-poor economic growth a reality. In Bangladesh, civil society has played a fundamental role in facilitating and strengthening small-scale food processing among the poor.²⁰ In many contexts, there is a need to overcome the considerable suspicion that exists between the business sector and CSOs and to ensure that relationships are forged in ways that do not detract from the interests of the poor and vulnerable. CSOs are also important in cultivating the values of trust, dignity, culture, and identity that create the bedrock for mutually respectful social relationships. They can help to build trust based on positive experiences, which is essential for joint action in other domains. CSO activities in these areas include informal support groups for indigenous peoples, minorities, cultural expressions, and vibrant community centers (Berdegúe 2005).

How Can the Private Sector Become Engaged?

The importance of agroindustries, postharvest technologies, and the development of small- and medium-sized rural enterprises for innovation is apparent. Agroindustries of different types are becoming an important component of socioeconomic development in rural areas. They are playing a critical role in meeting food security objectives and eradicating poverty by generating employment and income in the rural sector. The challenge is *how* to orient the private sector toward effective rural development, which implies promoting an agroindustrial development pattern that also benefits smallholders in rural areas (Authors).

To engage the private sector in overall rural development, it is essential to attract the private sector to participate in innovation networks and innovation clusters, rather than focus on innovative farmers working on their own (Authors). Innovation in most of the case studies was either driven by the private sector or included the private sector in some other manner, but it is not completely clear how to engage private actors and the poor in a mutually meaningful way. Aside from a good investment climate, including communications, credit, supportive central government policy, and a regulatory framework conducive to private sector engagement, a number of other issues are important for partnering (Authors; Hartwich, Gonzalez, and Vieira 2005; World Bank 2005):

- **Clear fast-track benefits.** The private sector engages in collaboration if there is a profit to be made and will partner with public organizations in which they have confidence. Private sector research capacity can be harnessed by building the credibility of national institutions to conduct cutting-edge, relevant, and timely research. Partnership must be based on genuine demand and clear expectations. Short- and long-term benefits and results should be balanced. As private sector involvement becomes more important in driving innovation and short-term benefits are sought, the role of pilot projects (and funding for them) becomes more important. Such pilots help to demonstrate benefits, build confidence, and reduce tensions between partners.
- **Lower transaction costs.** Reduce the transaction costs of working with many small farmers by promoting effective smallholder organizations for collective action. Strengthen smallholders as contributors—address asymmetry and enhance their asset position and productivity. It is also worthwhile to explore the private sector's interest and commitment to working with smallholders by addressing the social and environmental responsibility agenda.
- **Building trust and establishing ground rules for collaboration.** Most public-private partnerships (PPPs) succeed when strong leadership in partnership is in place. It is also important to develop cooperation and dispute settlement mechanisms that are workable for both public and private parties. Commercial private companies' distrust of the public sector and reluctance to work with smallholders (because of the risk entailed) may be overcome if partnership is relevant for their business, if

they can access new productive areas or fulfill a social responsibility, and if partnership rules and benefit sharing are clear from the first. Box 12 summarizes key findings and lessons from a PPP study in Latin America.

- **Flexible funding.** Funding mechanisms, such as competitive and matching grants and joint funding schemes, must have flexibility. Matching grants, which combine the managerial, infrastructure, and mobility inputs of the private sector, the land and labor of farmers, and the monetary contribution of the loan, are particularly suitable for developing local innovation systems.

Box 12. Lessons from Public-Private Partnerships in Agrichains in Latin America

Partnerships are crucial for developing innovations. From their analysis of more than 100 public-private partnerships (PPPs) in Latin America, Hartwich, Gonzalez, and Vieira (2005) draw a number of useful lessons.

Rationale and impact of PPPs

There were two types of private partners: (1) firms and (2) associations of farmers, processors, or exporters that had different objectives and thus strove for different benefits. Firms were profit-oriented, whereas associations represented broader sectoral interests. Most companies conducted some sort of profitability studies to support their decision to enter partnerships, although these studies were rarely of a formal quantitative character. Firms also tended to provide more funding when products could be protected by intellectual property rights. Associations, in contrast, were anxious to solve the pressing problems of their members and entire production chains. They tended to focus on adaptive rather than applied research.

Most partners were satisfied with the partnership's objectives and achievements. A high percentage of partners perceived a positive impact on competitiveness, suggesting that there is congruence between the initial objectives and the results obtained. Yet despite broad support from governments, as well as from funding and development agencies, PPPs have not led to a systematic improvement of development-oriented agricultural research in Latin America. The private perspective continues to dominate, and the public sector often does not push partnerships to generate social benefits.

The main challenges for PPPs

The main challenge for the PPPs studied concerned the motives for initiating the partnership. Neither public nor private partners engaged in sufficient strategic planning or priority setting to determine where research and development were most urgently needed and where the greatest positive impact could be made. Instead, partnerships were created mainly because: (1) a public sector researcher realized that partnering with the private sector would provide access to either public grants or private funds; (2) individual firms sought collaboration when they were unable to generate innovations on their own; and (3) local small-scale farmers and processors tried to obtain public support to increase the value-added of their agricultural production and raise the quality of their products to access local and international markets.

Conditions for successful PPPs

- *The common interest-space condition:* Viable partnerships develop only in the space where the interests of the public and private sector overlap, as determined by technological, market, and public demands in the agricultural value chain.

Box 12 (Continued)

- *The cost-benefit condition:* Partners enter partnerships when the expected benefits outweigh expected costs.
- *The synergy-through-collaboration condition:* Partners enter partnerships when the expected benefits are higher than those from equivalent investments in other arrangements.
- *The no-conflict condition:* Partners enter partnerships when the partnership does not substantially conflict with other interests of the parties, or where the partnership does not generate substantially negative externalities for society.
- *The proportional-benefits condition:* Partners enter partnerships when their own contributions and expected benefits are not disproportionately lower than those expected for the other partners.

Source: Adapted from Hartwich, Gonzalez, and Vieira 2005.

Evidence from the Case Studies

Several case studies examine ways of making innovations pro-poor and/or integrating and empowering smallholders more effectively. Recommended strategies include linking market agents with actors in different networks and various means of empowering farmers to participate in an AIS.

Linking market and other networks

An innovation system framework and social network analysis tool²¹ were used to assess ways of leveraging change to benefit smallholders in the Ethiopian coffee sector.²² In this case, networks formed around dense concentrations of public sector service providers, Sometimes NGOs complemented the public sector by increasing the size of the network and connecting smallholders (directly or indirectly) with other innovation actors. The market agents remained peripheral, however. An innovation system relying on interaction between farmers, the public sector, and NGOs cannot respond well to market signals if market actors are not present or remain peripheral. In particular, smallholders' ability to innovate in response to changes in the market—to change on-farm practices and strategies—is potentially constrained. This case illustrates the power of networks that are closely linked to smallholders' innovation processes. Such networks affect: (1) the roles and responsibilities of diverse actors; (2) their relationships and interactions; (3) policy and market environments that influence innovation; (4) the complex dynamics of innovation; and (5) potential areas for strategic policy interventions. Box 13 summarizes lessons from the case study.

Building farmer capacity for a functional AIS

In Benin,²³ the Songhai Training and Learning Program transformed farmers into more effective nodes within the AIS and demonstrated that “innovators are not born, they are made.” A key finding from this experience is that capacity-building and development among farmers are essential to achieving results in an innovation system. No other investment will replace that investment in human capital, which should focus on (1) building technical and

Box 13. Expanding Market Links and Empowering Farmers: Lessons from Ethiopia

A case study of small-scale coffee producers in Ethiopia presents lessons for expanding market links, empowering farmers, and initiating a longer-term process of innovation.

- *Open space for market agents to foster innovation by:* encouraging larger network size, multiple ties, and balanced density and by building stronger links between market and nonmarket actors.
- *Diversify options for input distribution by:* subcontracting, privatization, or other options and by expanding opportunities for smallholders.
- *Refocus extension policies and programs to:* provide incentives for new actors to participate; strengthen the capabilities of public sector actors to interact effectively with others; shift the role of extension away from input distribution and credit recovery toward providing production/marketing linkages and information; provide capacity strengthening and retraining in farmer training centers and technical and vocational training centers.
- *Strengthen linkages through policy and organizational changes by:* strengthening public sector linkages and the public sector's coordination role and by strengthening public-private-civil society linkages. Policy and organizational changes are more challenging to achieve when more complex changes are needed and when the linkage problems are more deeply rooted. Some changes do not lend themselves easily to simple investment and intervention, especially problems that are rooted in public linkages of leadership, personalities, and structures.

Source: Adapted from Spielman et al. 2007.

entrepreneurial skills (technical know-how) and (2) supporting farmers with the know-how on with whom, where and when to cooperate. There is also a need to build and sustain appropriate credit systems to finance innovations in agriculture. In this effort, building farmers' capacity is again a factor, because the skills of borrowers are an important element of risk analysis and credit allocation by financial institutions.

Empowering farmers through communication-oriented partnerships

Uganda's NAADS program²⁴ aims at improving agricultural services to help raise farm productivity and incomes among poor farmers. The program promotes market-oriented farming by increasing the availability of appropriate technologies, technical advice, and information to farmers. Market-oriented services are provided by contracted service providers based at the sub-county level and controlled by farmers. Aside from illustrating a number of innovations in implementation,²⁵ NAADS enables farmers to organize and create institutions through which they can act collectively and get their voices heard in (and control) decision-making processes; builds farmers' capacity to demand research and productivity-enhancing agricultural advisory services and technologies; enables farmers to access information and resources to influence policies that affect them and thus control the provision of agricultural services; builds farmers' capacity to monitor and evaluate the program in general and service provision in particular; and facilitates linkages to profitable markets.

Bringing smallholders into an AIS by building skills

The case study on cut flowers in Kenya²⁶ reveals several capacity-building needs among smallholders. Two key weaknesses face the floriculture innovation system: (1) weak interactions between national R&D and growers and (2) inadequate overall attention to smallholders. The following interventions may help address these weaknesses: training smallholder growers in essential production and postharvest techniques; facilitating farmers' access to research information; organizing knowledge exchange workshops between farmers and researchers; recognizing and harnessing farmer innovations (for example in biological control); and facilitating market access (by addressing stringent phytosanitary requirements, freight costs, and lack of market information).

Similarly, the pineapple industry in Ghana²⁷ seems likely to face challenges unless it addresses the asymmetry in smallholders' negotiating and other skills. Continued smallholder involvement in the industry requires the development of equitable compensation and contractual arrangements (for example, by standardizing collaboration agreements and contracts). The challenge of ensuring quality assurance in the pineapple industry highlights the need for stronger linkages among the critical actors. Exporters need to establish and maintain strong relationships with scientists and agricultural extension officers, who also must develop strong relationships with farmers to ensure that they adhere to the basic agronomic steps on the farm.

Finding a Way Forward

Although an innovation system ideally involves partners with disparate resources and capabilities that in totality contribute to its common goal, engaging smallholders and private sector actors is challenging because of asymmetries in capacity, power, and resources. A primary consideration is to provide funding to meet the transaction costs involved in forming and maintaining partnerships; a second is to improve skills in facilitation and coordination; and a third is to foster flexibility—for example, in activities, budgets, partners, and timetables. A working group on pro-poor innovation systems discussed how to include poor people in innovation processes and ensure that they benefit. Findings and recommendations are summarized in box 14.

Box 14. How Can Innovation Systems Include and Benefit the Poor?

The rural poor who live on less than US\$ 1 per day work land that is not economically viable, have limited access to diverse resources, and thus have little resilience in crises precipitated by illness, drought, or some other factor. When planning innovation system interventions, a number of issues and actions are important to maximize the inclusion of the poor and the benefits they receive.

Understand and be aware of the local context, history, culture, traditions, and livelihoods.

- Start by clarifying *who* can benefit from the process. It should not be only a few farmers.
- Facilitate the assessment of options and opportunities.

Box 14 (Continued)

- An understanding of local knowledge can expand the windows of opportunity for innovation. It can also make it easier to recognize local capabilities and build on them.

Ensure that the poor are recognized by other stakeholders. Include the poor in networks.

Ensure that they are seen and heard.

- Engage the poor in the process. Facilitate networking, interest them in participating, and do not let other participants isolate them. The process should truly be inclusive.
- Provide capacity-building so the poor can acquire the skills that will help them to become attractive and reliable partners for the private sector.

Empower the poor to innovate through access to information, knowledge, and other resources and capabilities.

- Support organization around clear common interests and objectives, but move beyond immediate goals to medium-term aspirations and goals.
- Improve or facilitate access to resources (human, social, financial/economic, physical) to improve the capabilities of the poor to negotiate.
- Facilitate the recombination of multiple sources of knowledge and promote participation and synergies.
- Build capacity in local institutions so that they may independently identify their priorities and organize and conduct the activities that address those priorities.

Build resilience and catalyze innovation processes.

- Build the capacity for decision making and innovation so that the poor can respond to continuous changes in their environment and in market demand (new niches, high-value markets, and also mainstream market trends).
- Encourage a combination of technological and process innovations (organizational, institutional, financial) and at the same time address problems of risk and uncertainty (economic and ecological).
- Develop appropriate financial schemes to promote innovation processes that can deal with risk.
- Take into account differential access to markets, technology, economic/financial resources, and human resources.
- Scaling up may require a focus on the process (methods, tools, and so forth).

Source: Workshop working group on pro-poor innovation systems.

6 How to Nurture Innovation Capacity

Two important findings concern ways of nurturing innovation capacity. First, actors must be able to learn and innovate in the changing environment, which means that they require the capacity to adapt to continuously changing circumstances. Second, this dynamic adaptive capacity is often associated with local institutions possessing sufficient organizational and technical capacity.

What Is Innovation Capacity?

As summarized in box 2 (chapter 2), innovation is neither science nor technology but the application of knowledge of all types to achieve desired social and economic outcomes. Innovation typically combines technical, institutional, organizational, and other sorts of change. Its broad features include a combination of: (1) scientific, entrepreneurial, managerial, and other skills and knowledge; (2) partnerships, alliances, and networks linking different sources of knowledge and different areas of social and economic activity; (3) routines, organizational culture, and traditional practices that pattern the propensity to innovate; (4) an ability for continuously learning how to use knowledge more effectively; and (5) clusters of supportive policies and other incentives, governance structures, and the nature of the policy process²⁸ (Hall and Dijkman 2005). The differences between research capacity, technological capacity, and innovation capacity are summarized in table 4.

An effective innovation system requires a cadre of professionals with a special skill mix; technical expertise needs to be complemented with functional expertise, for example in markets, agribusiness, intellectual property law, rural institutions, and rural finance. New ways of working require attention to a range of skills: scientific, technical, managerial, and entrepreneurial skills and skills and routines related to partnering, negotiating, building consensus, and learning. Unfortunately, investments in tertiary agricultural education have generally been limited over the past few decades (World Bank, forthcoming), and the experience with agricultural education and training (AET) geared toward AIS is very limited. A much greater understanding is needed of AET's role in promoting innovation, development, and growth in agriculture. More specifically, a better understanding is urgently needed of how to shift AET organizations into closer, more productive relationships with other actors in the agricultural sector and the wider economy. Despite the lack of experience with AET specifically designed to support AIS, some key principles are identified and summarized in box 15 (see also Davis et al.,²⁹ Rivera,³⁰ working group on AET; and World Bank, forthcoming). The rest of this chapter examines the prospects for nurturing innovation capacity by examining how attitudes and practices embedded in organizational culture can influence the ability to learn continuously.

	Research capacity	Technological capacity	Innovation capacity
Nature of capacity	Resources needed to conduct scientific research	Resources needed to manage technical change	Resources needed to continuously innovate in dynamic environments
Main actors	Research scientists and managers	Potentially all scientific, entrepreneurial, policy, and training actors related to technical change	Potentially all scientific, entrepreneurial, policy, and training actors related to innovation
Defining processes	Knowledge creation	Knowledge search and acquisition	Knowledge use
Key variables	Number of scientists, research infrastructure, and research expenditure	Scientific, managerial, and scientific skills and experience; patterns of linkage between actors	Diversity of sources of knowledge and their interactions
Nature of structures	Static	Static	Dynamic
Modes of capacity strengthening	Training, research, and infrastructure investments	Training, research, and infrastructure investments; networking and cluster development	Training, research, and infrastructure investments; networking and institutional change

Source: Adapted from Hall and Dijkman 2005.

Box 15. Selected Strategies and Approaches for Strengthening Human Capital to Meet the Changing Needs of Agriculture

Rapid change in agriculture, especially in developing countries, is making it even more urgent for educational institutions to instill the skills that can support more effective agricultural innovation. Although the role of agricultural education and training (AET) in promoting innovation and development is not yet well understood, a number of strategies and approaches may offer a way forward.

Realign AET with national development goals

The visions and mandates of AET organizations can be aligned with national development aspirations through new educational programs that are more strategically attuned to the different needs of social and productive actors. The Workforce Education System (WES) perspective, which aims to develop a competent agricultural workforce, could advance education and training toward agricultural innovation system development (Rivera 2006). The WES would

Box 15 (Continued)

entail considerable consultation and strategic planning among multiple stakeholders and ministries. It would also involve new designs aimed at connecting formal, postsecondary agricultural education institutions, in-service training programs, and informal training and development programs (for example, field training offered by extension services, NGOs, and others) and linking them to support an agricultural innovation systems approach. On-the-job programs, distance education, and other modalities specifically adapted to the needs of diverse actors could also be strengthened. AET organizations can also explore new ways of leveraging expertise and resources from international research organizations and foreign universities, and they can work to meet the needs of private industry. Private sources of AET can complement the formal, public AET system and be catalyzed, for example, by government incentives to promote greater innovation in agriculture (AET working group; Davis et al. 2007).

Develop new curricula

Educational organizations must develop new curricula that foster the capacity to deal with complexity, change, and multiactor processes in rural innovation and also permit greater specialization in skills and subject matter. This kind of curriculum development will require a change in the institutional culture of many AET organizations. They must attain a better balance between transferring knowledge in classrooms and learning how to learn in real-world situations, and between promoting individualism and competition on the one hand and teamwork and collaboration on the other. If AET organizations are to become better aligned with national development strategies, in many cases they will need to give greater emphasis to skills and methods that support pro-poor agricultural innovation and development.

Strengthen innovation capacity within AET organizations

The capacity for innovation within AET organizations and professionals can be strengthened by improving incentives to forge stronger linkages between the AET and diverse user communities, knowledge sources, and private industry (Davis et al. 2007). Instilling this capacity to innovate is particularly important to the long-term sustainability of an agricultural innovation systems approach.

Foster changes in professional culture

Changing any professional culture can be a challenge. The emphasis should be on improving incentives for human capital development and intensifying linkage-building efforts. Important means of supporting these goals include organizational reform, client service charters, staff motivation packages, and strong links between incentives and staff performance. An important entry point in staff education and organizational change is to identify and train champions and leaders (from different organizations/units) who influence and promote change management and coordination.

Source: Adapted from workshop working group on AET; World Bank (forthcoming); "Strengthening Agricultural Education and Training in Sub-Saharan Africa from an Innovation Systems Perspective: Case Studies of Ethiopia and Mozambique," an unpublished draft report for the International Food Policy Research Institute (IFPRI) by K. Davis, J. Ekboir, W. Mekasha, C.M.O. Ochieng, D. Spielman, and E. Zerfu; and "Transforming Post-secondary Agricultural Education and Training by Design: Solutions for Sub-Saharan Africa," an unpublished document by W.M. Rivera, Washington, DC, World Bank, 2006.

Attitudes, Practices, and Organizational Culture

“Organizations” are bodies such as enterprises, research institutes, farmer associations, government, and NGOs, whereas “institutions” are sets of common habits, routines, practices, rules, or laws that regulate the relationships and interactions between individuals and groups (Edquist 1997). These sets of habits, rules, and so on largely determine the propensity of actors and organizations to innovate. An “organizational culture” can be defined as a set of basic assumptions that are invented, discovered, or developed by a group in the process of learning how to deal with external adaptation and internal integration (Schein 1984). Institutions, in turn, greatly influence organizations and their culture.

A clear understanding of the nature and dynamics of organizational culture is essential when seeking to promote innovation and innovative behavior, such as collaboration and networking, sharing knowledge and information, taking account of other stakeholders’ interests, taking risks, or responding to innovation triggers. Although habits and practices are learned behaviors that may change gradually or suddenly, efforts to induce organizational change are typically gradual and longer term (Authors). Sudden shocks to a system or sector may unleash relatively rapid change in practices, as seen in the case studies from Colombia and Bangladesh. The classic response of more successful innovation systems, when faced with external shocks, is to reconfigure linkages or networks of partners (Mytelka and Farinelli 2003). As it is impossible to be prescriptive about the types of networks, linkages, and partnerships that organizations will need in the future, one way of dealing with this uncertainty is to develop attitudes that encourage dynamic and rapid responses to changing circumstances—by building self-confidence and trust, fostering preparedness for change, and stimulating creativity (World Bank 2006b). To enhance the capacity for innovation, it is essential to invest in learning and capacity-building, provide incentives that allow actors to put these skills into use, and nurture the new attitudes and practices.

Becoming a Learning Organization

To foster innovation capacity, programs should be considered that encourage greater openness in organizations to collaborating with diverse formal and informal actors, introduce organizational and managerial innovations within organizations, or strengthen individual and organizational incentives to develop innovation capacity (Hall and Dijkman 2005; World Bank 2006b).

Building innovation capacity necessitates investing in learning and becoming a learning organization. The new ways of working that result from learning enhance the ability of organizations and sectors to access and use knowledge more effectively and therefore to innovate (World Bank 2006b). However, the collective innovative capabilities of an organization reside in individuals (including leaders, managers, and employees); in the information and technology used by the organization; and in the organization’s structure, routines, and coordination methods (Argote and Darr 2000; Ekboir et al. 2007). Organizations can learn only through the

individual learning of their members or by incorporating new members with new knowledge (in Ekboir et al. 2007). Organizations that purposely try to sustain their innovative capabilities often do so by investing in learning and by hiring new employees with specific knowledge (Christensen and Raynor 2003). An alternative to reforming entire organizations is therefore to invest in those individuals with demonstrated potential to learn, change, and effect change. This is still a challenging task, because innovative capabilities such as learning ability, task commitment, and creativity are highly unevenly distributed among individuals (Renzulli 2003). Building these capabilities is often difficult because they cannot easily be bought, and, even when they are, it is often a complex process to integrate them into existing structures.

Nevertheless, these individuals need to be identified and nurtured to develop a critical mass that can then initiate a larger process of change from within. One way to do this is to introduce more flexible employment conditions, thereby allowing organizations to select those individuals with greater promise and potential, and allowing professionals to select organizations that allow them to realize their own potential, inducing greater mobility between and among organizations.³¹ Organizational reform, client service charters, and staff motivation packages are of primary importance for changing mindsets. Changes in staff attitude and behavior are most likely to occur when incentives are explicitly linked to staff performance (KIT 2004).

The case studies highlight several steps toward becoming a learning organization, including fostering the power of collective action within and among organizations; promoting flexibility (which allows self-organization); building self-confidence and trust; fostering preparedness for change; and stimulating creativity. All of these steps require an enabling environment in which policies and funds provide incentives to adopt the desired behavior (see the evidence from the case studies below). Thus the efficient development of new capabilities requires a vision of the changes to be introduced, a large number of trials to reduce uncertainty, effective feedback loops to evaluate the trials, and debate within the organization to develop a consensus about what is desirable and what is acceptable (Dosi, Nelson, and Winter 2000). This effort may involve new initiatives (such as technology forecasting or scenario planning) or organizational processes (such as communities of practice to capture tacit knowledge in organizational learning) that can promote knowledge management, knowledge sharing, and learning to respond to change effectively (World Bank 2006b). Table 5 lists a number of interventions to strengthen social capital in AIS.

The Role of Policy

Policies can shape innovation and innovation capacity by affecting both the production of knowledge (for example, through S&T policy) as well as the productive use of that knowledge (for example, through market and trade policy, investment incentives, regulatory regimes, and intellectual property rights) (Hall and Dijkman 2006). In addition to providing the right incentives,

Table 5 Possible Interventions to Strengthen Social Capital in Agricultural Innovation Systems in Diverse Domains

Domain	Intervention options
Within agricultural research organizations	Team building across disciplines; developing reflection and learning skills; institutional learning and change programs
Within local private companies	Training in problem solving, quality management, information management, and double-loop learning skills (learning to learn)
Among farmers	Farmer field schools; farmer to farmer visits; creation of farmer associations
Within civil society organizations	Strengthen research skills
Between agricultural research organizations	Stipulation of competitive grant schemes; membership of governing boards
Between local companies	Industry associations; stipulation of competitive grant schemes
Between research organizations and farmers	Training in participatory methods; development of partnering, reflection, and learning skills; professional incentives that relate to developmental objectives as well as scientific ones; institutional learning and change programs
Between research organization and local private companies	Stipulation of competitive grant schemes; joint supervision of students; sandwich degree courses; industrial placement for research personnel
Between agricultural research organization, local companies, and international life science companies	The use of third-party agencies; membership of governing board; change programs; stipulations of competitive grant schemes
Within government	Cross-ministerial consultations
Between government, private companies, research, and civil society organizations	Foresight exercises (consultative priority visioning exercises using panels of stakeholders); policy working groups; taskforces
<i>Source: Hall 2005.</i>	

resources, and support structures, policies also must be relevant to the local context and the attitudes and practices of the actors whose behavior they are designed to influence (World Bank 2006b). The capacity to understand, analyze, and influence the policy-making process is scarce among researchers, and policy makers themselves may have limited understanding of the innovation process. Thus if innovation capacity is to become stronger, policy capacity also needs to become stronger. Box 16 lists important issues to consider when developing innovation policies.

Box 16. Innovation Policy Development

The following points are important in assessing and developing policies supporting innovation systems:

1. Policies may have multiple and/or unexpected effects, so it is necessary to examine:
 - How policies that directly affect the agricultural sector (for example, agricultural research and extension arrangements) may affect farmers and others actors.
 - How policies may affect inputs to the sector (for example, industrial and education policies) and the incentives to producers and to companies (for example, tax, land-use, transport, and tariff policies).
 - How policies may affect opportunities for learning and competition in the domestic market (for example, intellectual property rights regimes or foreign investment policies).
2. It is crucial to recognize that policy changes in the global environment will affect local innovation systems and thus shape the parameters within which choices about learning, linkage, and investment will be made.
3. In addition, it is vital to explore the nature of the policy process, linkages between actors in the different policy domains that are relevant to innovation, linkages between policy and practice, and the existence of (and constraints to) policy learning.

Source: World Bank 2006b.

Evidence from the Case Studies

A learning organization: Nurturing individuals and encouraging collective action

There is increasing evidence that successful networks of interaction and learning are often self-organizing. Mexico's Produce Foundations (Fundaciones Produce)³² were created to manage competitive funds for agricultural research and extension. The funds were intended to allow farmers to influence the allocation of research funds, provide additional funding for the national agricultural research organization, and improve the flexibility of research funding. The main assumption was that leading farmers with superior technical skills—invited to serve on the research board—knew how to “guide” research and extension. This assumption was somewhat flawed, but a few farmers started to exchange information on operational procedures.

Most of the foundations' impacts on the research and innovation system resulted from their *actions* rather than from the *funds* they managed. The actions, which were introduced as the foundations learned, included: (1) opening new opportunities for researchers and policy makers to interact with other actors in the innovation system; (2) weakening the hierarchies in the research institutions; (3) participating in the governing boards of several federal and state research institutions; (4) supporting transformation of the national agricultural research organization; (5) introducing new approaches

for the design of sectoral and science and innovation policies; and (6) influencing the allocation of funds for research and extension.

The key success factors were the presence of innovative farmers on the board, the farmers' experience in farmer organizations, the capabilities of the managers, and the political climate in the state in which each foundation functioned. Other factors that contributed to the foundations' success as influential learning organizations include: an effective process of self-organization; variation in organizations (there are 32 foundations instead of one centralized organization); nurturing individuals with creativity and innovative capacity (acting as change agents); an enabling environment; an emphasis on learning and collective action by individuals and eventually organizations (resulting in the creation of a common culture, collective learning routines, and governance structures); and the importance of looking for unexpected impacts. Box 17 lists the main issues related to the success of the Produce Foundation approach and provides suggestions on how to implement the approach in another context/country.

Box 17. Promoting Learning Organizations: Lessons from Mexico's Produce Foundations

Mexico created Produce Foundations (Fundaciones Produce) in each state to manage competitive funds for agricultural research and extension. Experience with the foundations offers insights into how learning organizations evolve and influence innovation. Many of the foundations' impacts on the research and innovation system were unexpected. They were caused by actions that were not envisaged in the foundations' original design but that emerged as the foundations learned.

- Most countries create just one or very few institutions to foster innovation, effectively hindering evolution. The large number of interacting Produce Foundations created variation, which enabled agents of innovation to emerge. It is possible to create similar diversity by encouraging similar institutions from different countries to exchange experiences.
- The crucial importance of innovative individuals is usually overlooked in the creation of new organizations. Policy makers and multilateral organizations typically pay attention to formal operational rules. A few individuals in the Produce Foundations (less than 12, from a total of about 130) played crucial roles in creating an innovative environment and inducing other farmers and managers to change. Organizations cannot simply depend on the emergence of gifted innovators, however. In creating new organizations to foster innovation, it is still important to establish appropriate incentives and promote best practices in organizational management.
- Given the complexities of innovation processes, it is important to include strong capacity-building programs in innovation-fostering organizations. The innovative individuals in the Produce Foundations did not have a clear idea of what innovation was and the best ways to foster agricultural innovation. This experience is common in most organizations that fund research and extension.
- An enabling political environment is fundamental to success. The Produce Foundations were able to change because they gained independence from the

Box 17 (Continued)

state governments and were managed by innovative farmers. In turn, the federal government supported the evolution of the foundations. In other countries, governments are reluctant to give up control and force institutions to adhere to the original design and objectives.

- Programs to foster innovation should include in their design a strong monitoring system that treats each subproject as an experiment that can yield useful lessons. A few individual Produce Foundations explored new methods to foster innovation. The potential to learn from these experiences was hampered, however, by the lack of an effective centralized monitoring system. Such a system could have helped to evaluate the individual experiments and diffused the lessons learned.
- The foundations' most important impacts were caused by actions that were not included in the original design. The actions originally envisaged had minimum impact. This fact is extremely important for impact assessment and project evaluation. In complex systems, actions usually have unintended results, which can be more important than those originally sought. If the impact assessment looks only at what was originally planned, it may miss the most important impacts.

Source: Adapted from "What Is a Learning Organization? The Mexican Produce Foundations," an unpublished workshop paper by Javier Ekboir.

Knowledge management and the importance of tacit and codified knowledge sources

Many organizations dealing with rapid change must improve their capacity for continuous learning and innovation. Knowledge, both codified and tacit,³³ plays an important role in this learning and interaction. Collective learning by organizations is a combination of elements, some explicit and articulated and others tacit and subconscious. Thus two important elements of collective learning are (1) the ability to share the knowledge among different areas of the social structure and with new team members and (2) the ability to make tacit knowledge explicit, so that the organization can digest it and transfer it across time (Ekboir et al. 2007). In sectors experiencing rapid change, the role of tacit knowledge in determining innovation capacity can be particularly important, as acknowledged in recent research on livestock in India (CRISP 2007).

The importance of integrating codified and tacit knowledge networks is illustrated by the case study of stakeholders both within and outside the supply chain for high-value mango exports in India.³⁴ The codified knowledge networks of the formal mango producers and exporters have customarily focused more on raising productivity than on issues of increasing importance in export markets for high-value food, such as food safety and quality (for example, shelf life, the legislative requirements of importing countries, and product appeal for customers). Nor are the tacit knowledge networks of the informal sector, which are a common feature of subsistence agriculture, likely to be sufficient for addressing many of the quality and other aspects of high-value agriculture. The mango study shows how weak or missing linkages, particularly between formal service providers and market actors, not only severely curtailed producers' and market actors' capacity to access services

from the public sector but also diminished the effectiveness of knowledge networks. The study addresses the relevance of technological as well as nontechnological innovations as part of innovation performance. Three key lessons include: (1) a prerequisite for promoting more effective knowledge networks is to integrate tacit and codified knowledge systems; (2) it is essential to improve functional linkages between actors, particularly between formal R&D systems and market actors (for example, through a coordinating body and long-term collaborative interventions); and (3) it is important to invest in processing/marketing infrastructure as well as interactive learning.

In conclusion

Innovation capacity is sustainable only when a very wide array of attitudes and practices come together to create a *culture of innovation*, including a wide appreciation of the importance of S&T in competitiveness; business models that embrace social and environmental sustainability; attitudes that embrace a diversity of cultures and knowledge systems and pursue inclusive problem solving and coordination capacity; institutional learning as a common routine; and a forward-looking rather than a reactive perspective (World Bank 2006b). Box 18 summarizes general suggestions on how to invest in innovation capacity.

Box 18. Suggestions for Investing in Innovation Capacity

An agenda for strengthening innovation capacity should focus on building networks of interaction and learning that will enable new and existing knowledge to be used. Building these networks will require either coordination or the provision of strong incentives and help for self-organization. Institutional and policy change are typically at the heart of innovation capacity development, particularly in the long term. As the context changes and the actors and needs evolve, it is important to build adaptive capacity and retain flexibility.

While it is impossible to be definitive about what a context-specific and adaptive capacity for agricultural innovation might entail, some broad elements can be described:

- *A national culture that appreciates the value of scientific knowledge* in enterprise and development. It is important to advocate for such a culture and enhance it.
- *A critical mass of scientists*, trained in frontier areas of science, who are supported by sufficient *infrastructure* and *funding* to be employed productively in research and development in the public and private sectors.
- *Appropriate training organizations*, including universities, which are engaged and strengthened to create this human capital.
- *Appreciation and engagement of a range of actors* with different types of agricultural knowledge, codified and tacit, in the public, private, and non-governmental sectors.
- *Linkages* between key sources of knowledge and the social capital that permits new linkages to be brought into play when needed. It is crucial to initiate and sustain relationships and institutions (including habits and practices) that support dialogue, knowledge access, sharing, and learning between different sources of knowledge, between different interest groups, and between policy actors, practitioners, and researchers.

Box 18 (Continued)

- *Coordination and facilitation mechanisms* that foster linkages and meaningful engagement of actors. These mechanisms include sector associations and development authorities or boards as well as incentive and support structures (such as subsidies or credit) to strengthen the system's coherence in the absence of market signals.
- *New ways of working*. Working in an innovation system requires attention to a range of skills. These include scientific, technical, managerial, and entrepreneurial skills, as well as the skills and routines related to partnering, negotiating, building consensus, and learning. For change management and coordination to succeed, it is important to identify and train champions and leaders from different organizations and units.
- *Foresight skills and activities*. Learning necessitates change management competencies and mechanisms to help predict and cope with evolving innovation environments (one example is technology foresight). These competencies include the ability to link scientific knowledge to policy, problem solving, and long-term planning.
- *Clusters of supportive policies*. Such policies will foster the production of knowledge (for example, science and technology policy) as well as productive use of that knowledge (for example, through market and trade policy, investment incentives, regulatory regimes, and intellectual property rights).
- *Policy capacity*, attained, for example, by training policy makers, researchers, and others. This skill is vital to: (1) create the conditions to make productive use of knowledge rather than focusing on the creation of knowledge; (2) recognize the multiple innovation systems operating in the agricultural sector; and (3) promote innovation as a systemic phenomenon.

Source: Authors; Hall and Dijkman 2005; Hartwich, Gonzalez, and Vieira et al. 2005.

7 The Enabling Environment for Innovation

A country's economic or social performance depends on a set of *enabling conditions*—such as market infrastructure, appropriate property rights, and effective governance in input and output markets—that help the agents of innovation to emerge (Powell and Grodal 2005; Nelson and Rosenberg 1993; OECD 1999; Rycroft and Kash 1999). The workshop findings reinforce this perspective by emphasizing that (1) the features of an AIS—the actors, attitudes, practices, and patterns of interaction—are shaped by the institutional, policy, and historical context and (2) the enabling environment, encompassing (for example) a supportive policy and fiscal framework for S&T as well as for legal, advisory, and trade issues, particularly affects interaction between the various actors in the AIS. These enabling conditions are essential at the international, national, and local levels for effective innovation processes. Most developing countries lack an optimum enabling environment and must determine how to foster one. This chapter discusses several options for improving enabling environments.

Infrastructure plays an important role in the enabling environment for innovation. In this era of globalization and knowledge-based economies, the quality and functionality of ICT and logistical infrastructure are essential for academic and research institutions to continue to develop (Ridley, Yee-Cheong, and Juma 2006). Weaknesses in infrastructure—ranging from limited supplies of electricity and inadequate telephone systems to weak banking systems, underfunded universities, and sparse expertise—often form the biggest constraint to the effective application of much research in developing countries. In many countries, poor infrastructure makes it unlikely that research alone will result in innovation that reduces poverty (Barnett 2005).

Infrastructure is also a key component of the investment climate, reducing the costs of agribusiness and enabling people to access markets (Holloway et al. 2000). Other pertinent issues for enterprise development and innovation are intellectual property rights, access to finance, and rules governing trade (these issues are not discussed here; see the case studies).

Policies play an important role in forming an enabling environment. There is no such thing as a single “innovation policy” but rather a set of policies that work together to shape innovation. Demand for certain sorts of innovation can be stimulated by policy—for example, by incentives to adopt a certain technology or management practice. Policies may also stimulate innovation by providing the right resources (including new knowledge from research), and support structures (such as an educational or financial system or labor

policies). Important questions to address in policy interventions include (Hall and Dijkman 2006; World Bank 2006b):

- Are there S&T policies to promote collaboration (such as competitive grant funds for partnerships), scale up innovations (such as incubators or venture capital), or encourage private research investments (such as matching grants or clarity on intellectual property rights)?
- Do fiscal policies promote R&D?
- Are farmer and other organizations involved in defining research and innovation challenges?
- Do legal frameworks exist to facilitate the application of new knowledge from within or outside the country?

Suggestions arising from the workshop working group on S&T policy are summarized in box 19.

Box 19. Suggestions for Science and Technology Policy

“Science and technology policy” can be described as the collective principles, declarations, guidelines, decisions, instruments, and mechanisms intended to foster scientific and technological development in the short term, medium term, and long term. Within an agricultural innovation system, science and technology policy might have the following general aims:

- Promote efficient knowledge management processes capable of delivering knowledge and technologies to all actors in the production process, to reduce failures that arise because of poor links between actors in the innovation system.
- Contribute to poverty reduction.
- Recognize that innovation in agriculture may come from institutions that do not view themselves as part of the agricultural sector, such as information and communications technology, biotechnology, and systems modeling organizations.
- *An especially important aim of science and technology policy is to establish an enabling environment for innovation, perhaps by:*
 - Establishing an institutional body to support innovation in science and technology and mechanisms to implement and enforce it. This body could also coordinate with other sectors (such as trade, environment, health, and education) to encourage working in an integrated fashion within the agricultural innovation system. Investment in policy capacity will be essential.
 - Redefining and strengthening government’s role in innovation so that government becomes more of a facilitator or a promoter.
 - Promoting new mechanisms for flexible joint funding.
 - Promoting stakeholder engagement. For example, collaboration and system linkages could be fostered through foresight activities and innovation platforms (using adequate incentives). Defining adequate incentives for actors (based on their needs and capabilities) could broaden engagement; an additional option may be to define rules for interaction among actors in the innovation process (for example, with respect to intellectual property rights, research funding, and agents’ roles). Decentralization may also play a role in expanding participation. It is important to enhance localized and varied service demand, negotiation, and collaboration, as well as to promote the

Box 19 (Continued)

involvement of the local private sector in research and development for agriculture and the rural sector.

- Creating and strengthening knowledge management capacities and collaborative arrangements to promote better use of available information, knowledge, and technologies at the national, regional, and global level, in the public and private sector.
- Developing and appropriately funding an effective infrastructure to facilitate agricultural research and innovation.

Source: Adapted from the workshop working group on science and technology policy.

The enabling environment is considered an important promoter of *innovation capacity*; as such it often influences how the actors in a sector can put their knowledge to use. Yet evidence suggests that even when an enabling environment exists, the range of actors and the *attitudes and practices* in a sector may constrain the development of sustainable innovation capacity in a more fundamental manner. This finding suggests that policy interventions aimed at creating an enabling environment for innovation may often be ineffective if they are not accompanied by efforts to change prevailing attitudes and practices (World Bank 2006b). In other words, it is essential to address innovation-related issues *in an integrated way*.

Another important finding is that the ability to agree on the innovation challenges facing a sector is much greater when *effective value chain coordination* is in place. Value chain coordination makes it more feasible to link policy support and innovation efforts and to focus on those enabling activities that actually support innovation (World Bank 2006b). Thus, improvements in the enabling environment will be more effective if they are combined with activities to strengthen other aspects of innovation capacity (particularly patterns of interaction among the main actors) and if efforts to strengthen the enabling environment focus on identified innovation needs, addressing the need for sector coordination.

Evidence from the Case Studies

Although most case studies discuss the enabling environment to some extent, the importance of an enabling environment for innovation may not have come across very clearly. This area requires further analysis and strengthening in the development of AIS.

Incentives for market-led development of innovations

The success of Kenya's cut flower industry³⁵ is attributed to a number of factors, including a favorable policy environment, government incentives, climatic factors, and international trade agreements (easy access into the European market under the Lome IV Convention was especially instrumental to the industry's growth). Early on, the government recognized the importance of horticulture and created the Horticultural Crops Development Authority in 1966. The government enacted several laws and policies to support horticultural crops and provided investors with incentives, such as

allowances on capital investments and export promotion schemes. Small-scale investors in the major potential growing areas were provided with additional incentives, such as cold storage facilities, collection centers, precooling facilities, and refrigerated trucks. The economic liberalization policies and the structural adjustment programs of the 1980s favored limited government involvement and a hands-off approach that created room for very robust participation by the private sector in the cut flower industry. Kenyan law protects intellectual property. Aspects of innovation systems have been introduced into policies that explicitly encourage industries to develop mutually beneficial contractual links with research institutes to generate technology and foster stronger links between farming communities and agroindustries. Despite this favorable enabling environment, the availability of R&D, and a positive industry response, further attention must be given to needs and innovations among farmers.

A case study from Ghana³⁶ describes how pineapple exports developed in response to improved market opportunities. Policies that favored market liberalization and improved the availability of finance enabled entrepreneurs to invest in pineapple exports. A number of actors were involved: large-scale exporters, smallholders and outgrowers, the scientific community (research institutes and public universities), government agencies, development partners, and consumers in international markets. A number of innovations were required, including innovations in organizational issues (for example, a company was established to work with farmer-based cooperatives; farmers own shares in the company). R&D organizations were involved in a number of technical innovations, partly as a response to consumer demand for certain color and taste traits. However, as pointed out earlier, an enabling environment alone may not be sufficient when the sector is not adequately coordinated and when attitudes and practices among actors work against it. The sector has many challenges related to partnership arrangements. For example, members operate with extreme independence, there is a lack of cooperation, and smallholders have only limited participation.

Appropriate links with markets and sources of advice and information strengthen the effectiveness of the innovation system

The Bangladesh case study³⁷ illustrates well how focusing on technical expertise and knowledge among one set of actors at the expense of other enabling factors, actors, and coordination will ultimately hamper a sector's development. In this case, CSOs had identified small-scale food processing as an important livelihood option for poor people. Their intervention, led by an international NGO working on appropriate technologies, was based primarily on the assumption that the poor have limited know-how with respect to food preparation. Thus training in food processing became a mainstream development intervention. During the early phase, fragmentation among stakeholders prevented the sector from realizing its potential. For example, the fact that the success of an enterprise depends on a range of other factors, like financial assistance, entrepreneurial skills, and market linkages, was addressed only cursorily. One of the major recommendations is to invest in

further coordination by the public sector and also to invest in R&D, technology generation, and the establishment of an enabling environment.

Importance of creating framework conditions for value chains

The case studies of cassava and cut flowers in Colombia³⁸ describe industries where innovation systems function relatively well. In two decades, cassava in Colombia has evolved from a traditional subsistence crop into an important agroindustrial crop because of its wide range of uses. The industry's success is primarily the result of policy and institutional factors that created a dense network between the main actors. Examples include an apex association that links cooperatives in processing and marketing innovations and a research-focused network comprising a regional consortium, the industry (with its small-scale farmer base), national and international research organizations, the government, and financial organizations. The Colombian government went to considerable effort to organize agricultural value chains and foster interaction and coordination between value chain agents. In 2004 the government included cassava in its competitive call for R&D projects. All of this support for funding and value chains created a favorable enabling environment.

The government involved itself very little in Colombia's flower industry, with two obvious exceptions: the development of phytosanitary regulations and support for coordinating the flower value chain. Local adjustment strategies in the 1990s focused on alternative production and marketing mechanisms to strengthen the value chain. A move to collective production and marketing, along with a search for diversified distribution channels, was pursued by newly created, vertically integrated firms and newly formed groups. However, public research had been negligible for a long time, and continuous underinvestment in local research and technology for the flower sector fostered dependence on foreign technology and expertise and stifled the local capacity to innovate. The attitudes and practices of the main flower export association have hampered its ability to bring research expertise to bear on problems in the industry.

Conclusions

The success of innovation relies to an enormous extent on the framework conditions and basic infrastructure available to an AIS (Barnett 2005). A supportive policy and fiscal framework for science, technology, legal, advisory, and trade issues will affect interaction among the actors in an AIS. The evidence from the case studies indicates that timely access to appropriate inputs (including finance), markets, advice, and information are crucial constituents of an enabling environment. Issues related to intellectual property rights may also need to be addressed. The challenge for the public sector is to support the development of AIS in an enabling way—for example, by providing the framework and incentives for joint action—without intervening in an unsustainable manner (Authors).

8 Summary and Main Recommendations

The summary discussion and recommendations presented in this chapter are derived from the workshop case studies and findings, working group recommendations, and other contextual material. The reader should keep in mind that the case studies were rather limited in scope, in that they focused primarily on commodities. More research on AIS in general is warranted, as well as research focusing particularly on how to apply an AIS approach to staple crops and natural resource management.

This chapter begins with some reflections by the authors on general issues that require attention in attempting the AIS approach (Authors). This section is followed by recommendations with respect to investments, especially investment in the skills and capacity needed to develop AIS (education, research system, and advisory services), in partnerships and collaboration, and in becoming a learning organization. The discussion on the enabling environment focuses on policy issues related to S&T.

Investing in Innovation: General Issues

No “blueprint approach” to AIS exists. AIS is an evolving framework, and its application requires flexibility and learning. Investing in an innovation system is a long-term process. The specific objective of the AIS, its desired scale, and particularly the context in which it will operate will all greatly influence the planning, implementation, and outcomes of investing in the AIS.

Linking to national strategies

Investment in an AIS should be viewed as part of a government’s national S&T policy and strategy. The overall national aspirations and agenda for agricultural and rural development should also guide AIS activities, particularly the long-term prioritization of needs and investments in innovation capacity. Strategic planning and prioritization of AIS needs and investments may also benefit from the use of scenario planning and development.³⁹

Communicating AIS benefits and challenges

The AIS community needs to identify how to communicate the potential benefits and challenges of AIS effectively to stakeholders, including decision makers and investors. Well-chosen, practical pilot projects and other experiments are usually powerful ways to convey this message. An important aspect of communication is to stimulate political will and provide the relevant economic arguments to ministries and the private sector. Similarly, the implementation of an AIS approach requires a strong emphasis

throughout the process on communication, sensitization, and awareness-building about AIS and the benefits and challenges. Typically, communication and consultation occur in parallel with an assessment of the existing AIS system.

Consulting with stakeholders

During the early stages, a consultation and discussion phase that engages multiple stakeholders is imperative and may be achieved through multistakeholder platforms (see chapter 4). Such platforms can help identify and plan activities related to implementing an AIS approach, including an assessment and analysis of the current approach to agricultural innovation, the identification of needs to be addressed through an AIS, and especially the prioritization of AIS framework needs. The consultation phase enables all stakeholders to develop a better understanding of the overall AIS approach and the particular needs to be met. It also enables productive partnerships to be formed (chapter 4). As an AIS approach emphasizes relationships, interactions, and transparency, these features need to be built into the design phase of projects.

Assessing the system

It is important to understand the critical factors, actors, and conditions for innovation in a given context—often by mapping and analyzing the status of the innovation system. Useful tools for this task include stakeholder mapping/analysis (World Bank 2006b), functional analysis (Bergek et al. 2005), an actor matrix (World Bank 2006b), and social network analysis (Schiffer, forthcoming) (see also chapters 2 and 5).

Assessing innovation capacity and developing a capacity-building plan

At the outset, it is useful for projects to systematically explore innovation capacity and institutional issues. Such an investigation will help highlight patterns of interaction and institutional factors that a project may need to deal with directly. It may also identify policy and institutional issues that must be addressed for a project to achieve its immediate objectives as well as its wider objective of promoting innovation capacity through institutional and policy change at the sectoral and national levels (Hall 2007). Depending on the context, the findings of the AIS capacity assessment, and potential prioritization of key investment areas, an innovation capacity strengthening plan, including identification of organizations capable of training and promoting innovation capacity, may be developed.

Investing in Innovation Capacity

The innovation systems approach calls for integrated programs that address scientific, entrepreneurial, and other skills; private sector investment; the financial system; the policy and regulatory environment; and stakeholder participation. These investments may be divided roughly into two categories: investments related to innovation capacity and those related to the enabling environment. The recommendations in this chapter relate primarily to innovation capacity (see also chapters 4 to 6).

Scientific, entrepreneurial, managerial, and other skills and knowledge

An effective innovation system requires a cadre of professionals with a specific mix of skills. These skills, which will enable them to pursue the new ways of working that evolve in an AIS, include scientific, technical, managerial, and entrepreneurial skills as well as skills and routines related to partnering, negotiating, building consensus, and learning.

Innovation requires *a critical mass of scientists*, trained in frontier areas of science, as well as the *scientific infrastructure and funds* to employ them productively in public and private R&D. Capacity building, aside from developing the skills of scientists, should also target the *other actors in an AIS*, such as mediators, farmers, private organizations, advisory services, universities, and research organizations, with the goals of initiating behavioral and organizational change, building learning organizations, enabling collective action, providing the coordination for building innovation networks and linkages, and building the social skills of mediators, extension agents, and other actors.

To create this human capital, it will be essential to engage and strengthen appropriate training organizations, including universities. Although a greater understanding of AET's role in promoting innovation and development is needed, some key principles have been identified:

- It is important to align the visions and mandates of AET organizations with national development aspirations by promoting new educational programs that are more strategically attuned to the different needs of social and productive actors. A workforce education system (WES) perspective, which aims to meet the need for a competent agricultural workforce, could be valuable in advancing education and training toward the development of an AIS. For educational organizations, this shift implies developing new curricula that build the capacity to deal with complexity, change, and multiactor processes in rural innovation, with attention to hands-on training and collaborative skills in addition to enhanced specialization.
- Strengthening the innovative capabilities of AET organizations and professionals is an important entry point, particularly for guaranteeing the long-term sustainability of an AIS approach. Emphasis should be placed on improving incentives for human capital development; intensifying linkage-building efforts, organizational reform, client service charters, and staff motivation packages; and strongly linking incentives and staff performance.

The dual challenge facing public research institutions is to remain relevant to demand-driven priorities at the regional, national, or local level and at the same time provide global public goods that anticipate future needs (box 4). *Support to research systems must focus more on developing their interface with the rest of the sector they serve and also with society.* Increasingly, public research organizations are viewed as essential for coordination and facilitation, standard setting, and regulation of competition, aside from their important role in conducting research of a public good nature. Along with engaging farmers and civil society in public research efforts, there is a need to reengage the often

underfunded *university research systems* and to involve the *private sector* to ensure that research remains relevant to stakeholders. Entry points include: private sector participation in research linked to long-term business development; consumer concerns over fair trade principles; partnerships to enhance private sector interest in research outside of areas where complete market capture is possible; and some international companies' interest to fund development activity in the interests of smallholders and public relations.

Moving toward an AIS approach requires attention to improving research system governance and strengthening the ability to form partnerships. The innovation systems approach requires systems thinking all the way from production to consumption, so that all the technology, input, finance, information, market, legal, and regulatory considerations are thought through from the start, and the necessary skills, processes, and linkages are put into place to make the whole system work. (The challenges and recommendations related to partnerships are discussed in the next section.)

The engagement of diverse partners, particularly smallholders and the private sector, places more emphasis on the need to *balance short- and long-term research results*. As private sector involvement becomes more important, the role of pilot projects and funding for them becomes more important.

Funding mechanisms must be flexible. Evidence points to the usefulness of trust funds and partners for startup research and for using grants as a key incentive to foster a variety of outcomes at a wide variety of scales, from local to regional and international. Competitive grants remain the best means of funding research under loan projects when given according to strict criteria and monitored using appropriate indicators. The matching grant approach, in which the managerial, infrastructure, and mobility inputs of the private sector, the land and labor of farmers, and the monetary contribution of the loan are combined, is particularly suitable for local innovation systems development. Microfinance is another option that allows beneficiaries to adopt innovations, particularly in remote areas where the banking sector is absent or operates on highly restrictive terms.

Advisory services should have a revised mandate. The emphasis of extension should shift away from primarily emphasizing technology transfer to creating connections to outlets, institutions, and people. Extension needs to *provide a wider range of services and support* to the diverse clientele that improves their capacity to access, adapt, and use knowledge, inputs, and services.

Extension agents should see their main roles as *intermediaries* and *knowledge brokers*. They are ideally placed to serve as intermediaries and lead the innovation agenda, particularly in local settings. Performing this role requires scouting for needs and opportunities among smallholders and other actors. Extension also has a role in linking farmers with other farmers, research, agribusiness, exporters, training, investors, financial services, and so forth. In this way, extension can build coalitions of stakeholders, in essence acting as a bridging among all of the actors and facilitating partnerships. Critical activities and mechanisms for performing this role include attention to: (1) organizing forums and supporting the establishment of producer

organizations and (2) promoting information flows and experimentation with new approaches to facilitate access to knowledge, skills, and services from a wide range of organizations. Specific attention must be paid to: empowering, building capacity, and teaching—particularly among smallholders; organizing producers and the rural poor; and identifying, articulating, and building demand through financing and capacity building (Sulaiman V, Hall, and Raina 2006; working group on advisory services). *Partnering with other actors* with these skills and expertise is the only way forward. Despite serious attempts at strengthening links between extension and research, these links remain weak and continue to be a matter of great concern.

Technical innovation is not necessarily the starting point for extension. *Institutional innovations are of great importance.* Examples include new ways of organizing production, input management, marketing, or sharing common resources; the development of a new producer company; or the development of a new way to provide extension support. Flexible funding and governance arrangements are needed, given that centralized funding, implementation, monitoring, and evaluation have been found to stifle the generation of locally relevant institutional innovations.

Partnerships, alliances, and networks

As an AIS approach is intrinsically multisectoral, it is essential to promote cooperation among different ministries, departments, and units (an example would be a coordinating body for the medicinal plant industry in India) and obviously among all of the various stakeholders. There has to be a system to facilitate collaboration and synergies among the different agencies, ministries, and stakeholders. Relationships and institutions, including habits and practices, that support dialogue, access to knowledge, knowledge sharing, and learning between different sources of knowledge, between different interest groups, and between policy actors, practitioners, and researchers, are crucial. The lessons on partnerships are directly applicable to any one organization and thematic area.

Special considerations apply in partnering with the poor. Although lessons on partnerships and networks are directly applicable to working with the poor, a few special considerations may have to be addressed. The partners involved may not be equal in some respects, heightening the potential for asymmetry (in power, voice, resources, benefits, and other traits), both real and perceived. Often it is necessary to build capacity among the weakest partners to reduce asymmetries and explore the common ground for partnering. Besides capacity building, other actions include jointly exploring needs and opportunities, facilitating access to assets and other resources, and especially engaging other stakeholders. Boxes 11 and 14 offer suggestions on pro-poor innovation.

PPPs for innovation development may be particularly useful in agrichains characterized by outdated knowledge and technology and limited research capacity and funding. Although such partnerships can offer a number of advantages, they tend to be complex to design, implement, and manage. They should be weighed against alternatives such as contracting and outsourcing,

the hiring of researchers, and the acquisition of R&D departments of entire companies.

A number of lessons related to partnerships, networks, and PPPs are worth recapitulating:

- Most successful instances of multipartner partnerships and collective action require active *coordination* and *facilitation* to initiate and maintain. Typically an *impartial intermediary organization, the public sector, and/or a coordination body*, such as a commodity board, a steering committee, sector association, development authority, or some other type of platform, is needed. *Useful interaction tools* include networking tools, learning platforms, coordination bodies, foresight activities, innovation policy and agency, demand identification tools, conflict resolution tools/skills, and the development of science parks.
- *A shared vision, shared values, and realistic objectives* are typically crucial to successful partnerships. Often there may be initial resistance to forming partnerships because of distrust, limited awareness of goals and benefits, or simply because of the difficulties inherent in collaborating. It is important to develop a communication strategy and associated resources, a budget for joint activities, and a managerial structure to enable the work to be done.
- *Visionary and strong leadership at the political and organizational level* is important. Experience highlights *the importance of individuals* as opposed to organizations and the value of diverse opinions. A good practice is to set up outreach units and champions in diverse organizations to help apply planning and evaluation procedures and to support public agents in negotiating partnership arrangements, setting them up, and ensuring that they function.
- *Partnerships must be based on genuine demand, clear expectations, and real benefits*. People and organizations collaborate if there are benefits and/or profits to be gained and partners in which they have confidence. The role of adequately funded pilot projects is important, because they can demonstrate benefits, build confidence, and reduce tensions between partners.
- *Reduce the transaction costs of partnering*. The transaction costs may be reduced by *promoting collective action* (such as organizing, building capacity, and building assets among small-scale farmers, although these activities themselves involve initial transaction costs) and by developing *ground rules on collaboration*. Introduce a businesslike approach, workable for all partners, into cooperation and settlement mechanisms. A *memorandum of understanding* delineating the roles and responsibilities, funding shares, and reporting and accountability requirements of all parties may be a useful tool. Such documents need to be clearly set out but are common parts of grant or other funding agreements. Aside from their other advantages, *flexible funding arrangements* are essential for reducing the transaction costs of partnerships and thus encouraging them to form, grow, and be maintained.

- *Partnering requires skills that many organizations lack.* Special assistance for capacity building—not only in the public but also in the private sector—includes the development of skills that are especially related to partnering (for example, among those who can provide leadership for partnership development), contractual issues, fund management, and exploring new opportunities. In research particularly, attention and capacity building on managing the intellectual property rights of multiple partners is important.
- *It is important to develop an evaluation framework to assess the social, environmental, and economic benefits and lessons from partnerships and innovation.* Such an evaluation framework should be practical and allow for rapid appraisals under conditions of limited data availability.

Enhancing the propensity to innovate among individuals and organizations

Common habits, routines, practices, rules, or laws largely determine the propensity of actors and organizations to learn and innovate. Understanding organizational culture is therefore essential when aspiring to promote innovation and innovative behavior. Efforts to induce organizational change are typically a gradual process that builds self-confidence and trust, fosters preparedness for change, and stimulates creativity by promoting attitudes that encourage dynamic and rapid responses to changing circumstances. The following steps are recommended for building learning organizations.

- *Invest in learning and becoming a learning organization.* Learning makes it necessary to develop change management competencies and mechanisms to help predict and cope with evolving innovation environments. Investments should focus on an organization's innovative capabilities (which reside in innovative individuals), the information and technology it uses, and its structure, routines, and coordination methods.
- *Invest in individuals as an alternative to reforming entire organizations.* These individuals might include leaders, managers, and employees with demonstrated potential to learn, change, and effect change. Examples include: introducing more flexible employment conditions that allow the selection of individuals with greater promise and potential; promoting organizational reform, client service charters, and staff motivation packages that can change established mindsets; and inducing changes in staff attitude and behavior through incentives explicitly linked to staff performance.
- *Develop a critical mass for collective action.* Innovative individuals—either current or prospective members of the organization—need to be identified and nurtured to eventually develop a critical mass that can then force a larger process of change from within the organization. It is important to include strong capacity-building programs that emphasize learning, collective action (by individuals and eventually organizations) that creates a common culture, collective learning routines, and governance structures. Consider policies and programs that encourage greater openness in organizations to collaborating with diverse formal and informal actors, introduce organizational and managerial innovations

within organizations, or strengthen individual and organizational incentives to develop innovative capacity.

- *It is important to strengthen organizational processes that can promote knowledge management, sharing, and learning to respond to change effectively.* An important part of this process is a strong monitoring system that has effective feedback loops to allow evaluation of the “trials,” capture useful lessons, and detect unintended effects.

The roles of policies and other incentives, governance, and the policy process

A functioning innovation system requires policies that support the production of knowledge (that is, S&T policy) as well as the productive use of that knowledge (that is, market and trade policy, investment incentives, regulatory regimes, and intellectual property rights, among others). “Science and technology policy” consists of a set of principles, declarations, guidelines, decisions, instruments, and mechanisms oriented towards scientific and technological development in the short, medium, and long term. For an AIS, the objectives of S&T policy are to (1) promote efficient knowledge management processes capable of delivering knowledge and technologies to all those involved in the production process to reduce systemic failures (arising from a lack of articulation in the system) and (2) help to reduce poverty while recognizing that innovation in agriculture may come from institutions that do not consider themselves part of the agricultural sector, such as those related to ICT, biotechnology, and systems modeling.

A key function of S&T policy is to help establish the enabling environment for innovation. Aside from funding an effective agricultural research infrastructure, policy can address this need in other ways:

- An institutional body and mechanisms can be established to better facilitate coordination with other sectors (such as trade, environment, health, and education). The government can play a stronger role by becoming more of a facilitator or promoter of innovation.
- New financing mechanisms can be promoted to allow flexible joint funding.
- Stakeholder engagement, collaboration, and system linkages can be promoted through foresight activities and innovation platforms that make use of incentives, interaction rules (for intellectual property rights, research funding, and agent roles, for example), and (potentially) decentralization.
- Policy can help to create and strengthen knowledge management capacities and collaboration arrangements that lead to a better use of available information, knowledge, and technologies at the national, regional, and global level, both in the public and private sector.

9 Next Steps

To address the challenges identified in the workshop, participants agreed that the innovation systems community must pursue further steps and initiatives, which are listed briefly here.

1. Improve the Understanding of the AIS Concept

The AIS approach is gradually moving toward an operational framework with certain characteristics, success factors, operational implications, and analytical/operational tools. Even so, it is an evolving concept and must be better understood.

2. Communicate the Potential of the AIS Approach

The AIS community must communicate more effectively about the AIS approach and its benefits and challenges to stakeholders such as decision makers and investors. Well-chosen, practical pilot projects and other experiments are usually powerful ways to convey this message. Two important aspects of communication about the AIS approach are to stimulate political will and to provide relevant economic arguments to ministries and the private sector.

3. Develop Tools for Studying and Evaluating Impact

Most partnerships analyzed in the case studies have not paid sufficient attention to monitoring and evaluation. Monitoring and evaluation requires the development of suitable, partnership-specific indicators or innovation. Indicators may be used for various purposes: as a learning tool (for example, to monitor progress toward goals); for external accountability; and as a research tool (for example, to better understand the nature of innovation processes, identify the forces that drive innovation, and compare innovation systems in different situations).

Without indicators of impact, it is difficult to demonstrate that one approach to innovation management has more impact than another, and the evidence for policy change is weakened. The development and communication of agricultural innovation indicators can be a powerful tool to facilitate policy dialogue and guide agricultural innovation policy. An important next step is to undertake a study that develops a benchmarking tool for AIS at the national level. Such a tool would make it possible to compare the strengths and weaknesses of AIS across countries and could be valuable for guiding investments in sustainable AIS.

4. Establish a Community of Practice

The above-mentioned challenges may be better addressed through the AIS community. It is proposed that a global community of practice in agricultural innovation be established to enable the widest possible sharing of experiences and further operationalization of the AIS approach.

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Annex 1 The Developmental Phases in the Orchestrated and Market-Driven Trajectories

The Pre-Planned Phase

In the pre-planned phase, new opportunities have not yet been identified. Local expertise is available, but producers and entrepreneurs are not sufficiently linked to jointly evaluate market trends and identify emerging opportunities.

- *Actors and roles.* Public research and training organizations and private sector actors are present, but they focus on the traditional priorities of the agricultural sector. Intermediary organizations that could link actors, broker partnerships, or provide access to new sources of knowledge and information are absent.
- *Attitudes and practices.* Research organizations have an ivory tower tradition. The public and the private sectors work independently of each other, and trust between the two is limited.
- *Patterns of interaction.* Interaction among actors is structured around traditional sectors. Research links to farmers through agricultural extension arrangements; there is little or no interaction between research and the private sector; and the private sector interacts with government mainly through political lobbying. The public and private sectors have poor access to information about emerging markets and other opportunities, which restricts them from sharing knowledge about new opportunities.
- *Enabling environment.* Generic research and training provisions might be in place, but measures in support of a specific sector are not, because the opportunities have not been identified. Financing mechanisms for innovation are usually absent.

The Foundation Phase

In the foundation phase, government has identified new opportunities and set sector priorities. The main tools for stimulating innovation have been investments in research and training, but the sector has not taken off (for example, demand for livestock products may be growing rapidly, but livestock research has not had a strong impact on the sector). The private sector has started to engage in these areas of new opportunity.

- *Actors and roles.* Government and R&D organizations have chosen priority themes or established specific programs. Although new technologies may have been developed, they have not been adopted by farmers or entrepreneurs. Entrepreneurial activity is already greater than in the pre-planned phase. Companies are exploring new opportunities identified by the public sector. Intermediary organizations that could link the actors are either absent or weak. Financial organizations do not play an effective role.

- *Attitudes and practices.* Research systems are compartmentalized, hierarchical, and not conducive for interdisciplinary collaboration. The public and private sectors have little trust in one another or practice in working together.
- *Patterns of interaction.* Interaction remains within each sector and does not cross the public/private sector divide (for example, research agencies collaborate with extension agencies but not with input suppliers). This is likely to be the main constraint to innovation in this phase.
- *Enabling environment.* Primarily supply-driven public research and training arrangements are in place. Incentives for entrepreneurial activity may also be in place, but the financing of innovation may still be a bottleneck.

The Nascent Phase

In the nascent phase of the opportunity-driven trajectory, entrepreneurs and sometimes NGOs may have started to recognize opportunities for innovation, such as new high-value commodities, organic foods, biofuels, or opportunities for transforming traditional sectors. Because local expertise and actors are present, some initiatives result in new markets. However, the government is unaware of these promising opportunities.

- *Actors.* The main actors consist of a small number of producers, entrepreneurs, or NGOs that have recognized new opportunities. Traditional public research organizations may be in place.
- *Attitudes and practices.* The entrepreneurs involved display strong risk-taking and opportunity-searching behavior.
- *Patterns of interaction.* Entrepreneurs have sufficient local links to gain information about emerging markets and other new opportunities but have not developed any networks within the sector.
- *Enabling environment.* Public research and training programs may be in place but are not focused on the new opportunities.

The Emergence Phase

Following the lead of one pioneering company or individual, other companies or individuals have gotten involved in the same sector, imitating or perhaps improving on the achievements of the pioneer. At this stage, the sector often relies on low prices as the source of competitiveness. The emergence phase may be short-lived in dynamic market conditions. Although this phase may be brief, interventions may still be important. Often the networks that could respond to the new conditions through innovation are missing, and the sector may become stagnant.

- *Actors and roles.* The innovation system is dominated by entrepreneurs who rely on their own knowledge and who gain access to new technology and information through their informal networks. Technical expertise such as cold chain facilities might be purchased from private providers. Public research plays a traditional, limited role. Farmer and industry associations may have been established.
- *Attitudes and practices.* The business community has no tradition of paying attention to social and environmental considerations, nor has it much trust

in or experience in partnerships with the public sector. Quality and environmental standards may exist but are usually unenforceable.

- *Patterns of interaction.* Despite good informal local networks, entrepreneurs hardly interact with the research and policy-making communities. Poor links between industry and research organizations create a vicious circle of weak demand for research and subsequent irrelevant results. As low prices are the main source of sector competitiveness, sector upgrading or creation of a national brand image receive little attention. Where industry associations exist, they focus on lobbying for policy change.
- *Enabling environment.* The enabling environment is usually quite weak. Research, training, and financing organizations do not focus on the needs of the sector. Policy makers are only just starting to recognize the sector's importance.

The Expansion Phase

By the time this phase is underway, government has identified a few promising opportunities for meeting such national goals as growth in exports or a reduction in rural poverty. Typical of this phase is a range of time-bound projects and programs, not all of which succeed. This pilot phase is important, because it provides an opportunity to find out what sort of arrangements are likely to lead to the emergence of a dynamic system of innovation in different settings (specific sectors and countries).

- *Actors and roles.* Public, private, and civil society actors, each with different roles, have formed clusters, which are typically centered on research or enterprise development. Sector-coordinating organizations, usually established with government support, may be in place. Financial organizations are often not yet included in the innovation system. It is increasingly clear that the main actors have varying capacity to function effectively in their roles.
- *Attitudes and practices.* Pilot interventions have enhanced the willingness to collaborate across the public and private sectors, but the practice of collaboration is still fragile and vulnerable to misunderstandings.
- *Patterns of interaction.* The main actors within the clusters interact, but their interaction still depends on public sector incentives and support. Inclusiveness is still rather weak; for example, NGOs often cannot guarantee the participation of the poor, or an NGO-led cluster network usually does not link with the corporate sector.
- *Enabling environment.* Funding for research and training is in place. The availability of venture capital and tax incentives for innovation investments may be constrained. The lack of a clear intellectual property rights regime may hinder collaboration and innovation.

The Stagnation Phase

Many traditional sectors find themselves stuck at this phase, whereas many other sectors that have emerged more recently often quickly enter this phase. Typically the actors cannot innovate around emerging constraints, or they fail

to take advantage of new opportunities. A further complication is that there is limited capacity to deal with social and environmental concerns as an integrated part of sector development. Government and donors actively try to support the sector, with varying degrees of success; they usually address problems piecemeal and fail to build sustainable capacity for innovation.

- *Actors and roles.* Multiple actors have become well established but often entrenched. Entrepreneurs and traditional farmers play a large role. The public sector has recognized the sector and provides support. CSOs may have become active, but they often get mired in a technology transfer role. Coordinating bodies, often established by the public sector, are often ineffective. Industry associations (established, for example, to deal with marketing and political lobbying for policy change) may be unable to expand their scope and begin promoting innovation.
- *Attitudes and practices.* Most actors have become effective in their initial roles but face difficulties in transforming their practices to respond to new situations. The focus of industry associations on marketing or lobbying for policy support restricts their ability to engage in technological upgrading. The regulatory focus of public coordinating bodies restricts their ability to act as troubleshooters. Public research programs are in place but poorly articulated with the farm and business community. As a result, research is often considered irrelevant. Interventions focus more on technical assistance and problem solving and less on creating capacity to anticipate and deal with new problems.
- *Interaction.* Collaboration among the multiple actors is weak. Private sector linkages with the research and training community are still poor; CSOs often act independently of other actors. Even where competitive pressures provide strong incentives for partnership, collaboration does not develop.
- *Enabling environment.* Research and training support and financing mechanisms are in place but poorly attuned to the emerging needs of the sector. Intellectual property protection may have become important to allow providers of new technologies to grow, but a property rights regime is not in place or cannot be enforced.

Dynamic System of Innovation Phase

In this phase, an agile sector responds quickly to emerging challenges and opportunities and delivers socially inclusive and environmentally sustainable economic growth. The sector is not led by public or private actors alone but is characterized by a high degree of interaction among them, including collaboration in planning and implementation.

- *Actors and roles.* Government, private, and civil society organizations all play an active role in the sector. Roles are determined by the nature of the sector and the challenges it faces, and they have evolved over time. Research plays a prominent role, either through strong private sector demand for public research or through privately funded and/or operated research. Sector-coordinating bodies help identify and address technical and organizational issues, including research priorities, quality standards, sector brand image,

and trade and policy negotiations. Financial organizations have developed financial products for the sector's specific needs.

- *Attitudes and practices.* There is openness to partnering, a tradition of collaboration, trust between major groups of actors, inclusiveness of poor actors, a strong culture of research within enterprises, and a willingness to take risks. Social and environmental concerns are part of the business culture.
- *Patterns of interaction.* A dense network of interactions links the key actors. These links may be contract based, project based, governance based, or informal. The network renews and adapts itself in response to new opportunities and challenges.
- *The enabling environment.* Sufficient resources are available for research and training, which are organized in ways that encourage interaction between organizations. Incentives exist for risk taking, and venture capital is available to promote innovation.

Annex 2 Development and Management of Specific Multisectoral Innovation Networks: Lessons Learned

Networks are generally considered a kind of organizational framework that allows for the interaction of a variety of institutional actors, such as firms, universities, and government bodies, in the pursuit of common goals. *Innovation-oriented networks* infuse the organizational structures of network participants with the flexibility and adaptability they need to cope with the complexity of technological progress.

Several factors affect an organization's motivation to cooperate with others and help to promote and sustain cooperative attitudes within multisectoral networks. These are summarized below.

Actors Involved

- Success requires network members to share a common vision and clear goals for cooperation.
- Needs evolve. Work programs should be flexible and actors should be involved as early as possible.
- Success requires capable network brokers who continuously promote and evaluate relationships and processes within the network and strong leadership.
- The long-term motivation of network members is *not* strongly dependent on external financial support. Successful cooperation depends upon the careful selection of the right partners.
- Organizations participating in the network should exhibit similarities in size, resources, and economic and innovative performance.
- The absence of direct competitors facilitates frank and honest cooperation between members. It also builds trust and open communication.
- Network participants should exhibit complementary idiosyncratic abilities.
- The network should start with a small, cohesive, and enthusiastic number of organizations and grow gradually, ensuring that the interests of all members are conveniently catered for.
- The involvement of organizations' top executives improves the conditions for cooperation.
- Credibility, institutional visibility, and the reputation of the other partners is an important determining factor for partners.

Network Structure

- The opportunity and frequency of informal gatherings is an important success factor. Such gatherings create and reinforce trust-based relationships between partners.
- When networks develop formal structures, they may become absorbed in organizational and administrative issues at the expense of conducting the strategic business for which they were conceived. It is essential to neutralize this tendency by actively promoting personal relationships both at operational and strategic levels among member organizations.
- Where asymmetrical relationships may exist, informal subgroups may be formed that reflect affinities in interests and competencies.
- The intensity and density of relationships highly influence the success of network activities over time. A successful network requires a critical mass in the quality and quantity of its relationships.
- Creating effective synergies for joint product development is important. They can drive innovation, develop knowledge, and provide skills, which are all critical factors for developing a multisectoral network.
- The ability to adapt to change is decisive for the success of multisectoral networks. Adaptation requires network members to possess the routines and competencies for identifying and developing new connections and the capacity to involve external actors to cope with change.
- A network's openness to new partnerships has proved to be important to success over time.
- It is essential to pay attention to how power is distributed within a network. A governing body is needed to take day-to-day decisions, and a general council is needed to deal with strategic issues. No particular network member should have the dominant influence in decision making.
- Network members' commitment is materially expressed by the payment of an annual fee that is used to cover the costs of organizing and managing the network's activities.

Network Coordination and Management

- The management function of multisectoral networks benefits from the existence of two complementary teams. One is mainly operational and is in charge of network logistics and organization. It should be an efficient, small structure, composed of a coordinator and administrative and secretarial employees. The other team plays a more strategic and decision-making role. It consists of three or five network members, elected by their peers, who meet fortnightly. The coordinator of this team plays a key role in the network's success.
- A balance should be achieved between breakthrough innovative projects based on high levels of creativity and more goal-oriented projects with shorter deadlines that satisfy partners' present needs.

- Effective management of communication (both formal and informal) and recognition of the critical role played by individuals are essential ingredients for success.
- The availability of financial resources to organize and manage the network is crucial to its sustainability. Self-funding is a sign of commitment and a reason for involvement.
- External funds are sometimes required, especially when the subject of interest rests on the development of breakthrough innovations and shows evidence of important economic externalities.

Annex 3 Overviews, Case Studies, Authors, and Presenters

Positioning Knowledge Systems for Enhancing Agricultural Innovation Systems

Enhancing Agricultural Innovation Systems: Key Findings

Connie Bernard (World Bank)

Innovation Systems Framework and Principles

Andy Hall (UNU/INTECH)

Development Phases and Intervention Options

Willem Janssen (World Bank)

Challenges, Opportunities, and Lessons Learned in Enhancing Agricultural Innovation Systems – Experience and Evidence from the Field

Experiences with Public Sector Promoted Innovation Systems among Smallholders

Christian Hoste (CIRAD)

Promotion of Small-scale Food Processing in Bangladesh

Muhammed Taher (Technology Policy and Development Consultant)

Learning to Innovate: The Case of Songhai Farmers in Benin

Daniel Nougbeignon Dalohoun (UNU-INRA)

The Potential of Cassava Processing in Ghana

George Essegbey (Science Technology Policy Research Institute)

A New Pathway of Agricultural Science: Case Studies from Benin and Ghana

Arnold van Huis, Dominique Hounkonnou, and Niels Röling (Wageningen University)

From the Bottom-up: Building Meaningful Partnerships between Research and Other Stakeholders

Bernard Triomphe (CIRAD)

Innovation System Responses to Market Opportunities

Smallholder Innovation in Ethiopia: Concepts, Tools, and Empirical Findings

David J. Spielman, Kristin E. Davis, Martha Negash, and Gezahegn Ayele (IFPRI)

A Partnership for Learning How to Foster Innovation

Javier Ekboir (IFPRI), Cesar Ocaña, and Raúl Romo (COFUPRO)

The Participatory Market Chain Actor Approach

André Devaux, Claudio Velasco, Gastón López, Augusto Guidi, Thomas Bernet, Miguel Ordinola, and Graham Thiele (CIP)

Innovation Partnerships for Effective Adaptive Research and Technology Uptake

Barry Pound, Kasindei Massawe, and Fazluddin Fazl (NRI)

NAADS Project: A Case Study from Uganda

Silim Nahdy (NAADS)

Medicinal Plants in India: Challenges and Opportunities to Develop Innovation Capacity

Rasheed Sulaiman V (CRISP)

The Growing Pineapple Exports from Ghana

George Essegbey (Science Technology Policy Research Institute)

Learning Alliances: Building Multistakeholder Innovation Systems in Agro-Enterprise Development

Mark Lundy (CIAT) and Veronica Gottret (CATIE)

Challenges in Maintaining Innovation Momentum

Impacts of Weak Stakeholder Linkages on Innovation in High-value Agriculture: Mango in Andhra Pradesh, India

Laxmi Prasad Pant, Helen Hambly Odame (University of Guelph), Andy Hall (UNU), Rasheed Sulaiman V (CRISP)

Applying Innovation Systems to Agricultural Science, Technology, and Innovation (ASTI): The Case of Kenya's Floriculture Industry

Maurice Bolo (ATPS)

A Thriving Shrimp Sector in Bangladesh

Zahir Ahmed (Jahagirnagar University)

Challenges of the Indian Vanilla Market

Rasheed Sulaiman V (CRISP)

Toward Functioning Innovation Systems

The Public Sector Coordinated Cassava Processing in Colombia

Isabel Bortagaray (Georgia Institute of Technology)

Increasing Cut Flower Exports from Colombia

Isabel Bortagaray (Georgia Institute of Technology)

The Regional Plan for Collective Action in Agricultural Research in Eastern and Southern Africa: An Institutional Innovation in Progress

Howard Elliott and Ravi Prabhu (ASARECA)

Strategies to Operationalize Innovation Systems Concepts: Guidelines and Division into Eight Working Groups

Community of Practice

Helen Hambly Odame (University of Guelph)

Science and Technology Policy

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Investments in R&D

Richard Chisholm (World Bank)

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Pro-poor Innovation

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Organizational and Management Culture

Enrique Alarcon (IICA)

Innovation System Indicators

Regina Birner (IFPRI)

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Critical Issues and New Directions Identified in Enhancing Agricultural Innovation Systems

Panelists: *Mark Cackler (World Bank), Dylan Winder (DFID), Judith Francis (CTA), Howard Elliott, Santiago Perry (PBA Corporation), and Pedro Arreas (EMBRAPA)*

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Endnotes

¹ Case studies, authors, and presenters are listed in Annex 3.

² This chapter draws from World Bank (2006b) and unpublished workshop presentations by Andy Hall (“Enhancing Agricultural Innovation: Framework and Principles”) and Willem Janssen (“Towards an Intervention Framework for Strengthening Agricultural Innovation Capacity”).

³ From this point onward, “case studies” refer to the ones presented in the workshop (see Annex 3 for lists of case studies, countries, authors, and presenters).

⁴ The citation “Authors” is used throughout this paper to distinguish perspectives provided by the proceedings authors from other sources and workshop conclusions.

⁵ Maintenance research is done to protect research gains that have already been made but that could be lost again if farmers’ circumstances change. For example, a popular crop variety can lose its resistance to a particular disease. If plant breeders monitor the disease-causing pathogens as they evolve and adjust their breeding strategies accordingly, they can provide farmers with varieties that resist the newly evolved pathogens before they can do much damage. Maintenance research therefore enables farmers to maintain yields despite the emergence of new threats.

⁶ In innovation systems literature, “foresight” is often used to describe the process of assessing future needs and opportunities for an economy of a country or region, with a view to formulating appropriate R&D, investment, and trade strategies. See, for example, www.nordicinnovation.net/_img/foresight_in_nordic_innovation_systems.pdf.

⁷ “A New Pathway of Agricultural Science: Case Studies from Benin and Ghana,” unpublished workshop paper by Arnold van Huis, Dominique Hounkonnou, and Niels Röling.

⁸ Technography and diagnostic studies were used in these case studies to describe the domain in which technological interventions take place. Technography was used to map the actors, processes, and client groups to permit the analyst to see beyond the problems that technological applications are supposed to solve and understand which parties and interests are mobilized in arriving at solutions. Technography not only pays attention to machinery and techniques but also to institutional values, task-group organization, and culture. The diagnostic studies were used to explore technological histories, markets, institutions, framework conditions, stakeholders, and contextual factors at a macro level.

⁹ “Innovation Partnerships for Effective Adaptive Research and Technology Uptake,” an unpublished workshop paper by Barry Pound, Kasindei Massawe, and Fazluddin Fazl.

¹⁰ “The National Agricultural Advisory Services,” an unpublished workshop paper by Silim Nahdy.

¹¹ “Learning Alliances: Building Multi-Stakeholder Innovation Systems in Agro-Enterprise Development,” an unpublished workshop paper by Mark Lundy and Maria Verónica Gottret.

¹² For more information on the process, see www.cgiar-ilac.org/downloads/Briefs/Brief8Proof2.pdf.

¹³ “Nurturing Innovation Processes by Building Multiple Stakeholder Partnerships: Opportunities and Challenges for Research,” an unpublished workshop paper by Bernard Triomphe, Henri Hocdé, and Guy Faure.

¹⁴ “Stimulating Pro-Poor Innovation within the Market Chain of Native Potatoes: The Case of Peru,” an unpublished workshop paper by André Devaux, Miguel Ordinola, Kurt Manrique, Gaston Lopez, and Graham Thiele.

¹⁵ “Cassava Innovation in Ghana and the Case of Linkages,” an unpublished workshop paper by George Essegbey

¹⁶ “Innovation Challenges in the Medicinal Plants Sector in India,” an unpublished workshop paper by Rasheed Sulaiman V.

¹⁷ “A Thriving Shrimp Sector in Bangladesh,” an unpublished workshop paper by Zahir Ahmed.

¹⁸ “Vanilla in India: Boom and Bust,” an unpublished workshop paper by Rasheed Sulaiman V.

¹⁹ “The Regional Plan for Collective Action in Agricultural Research in Eastern and Southern Africa: An Institutional Innovation in Progress,” an unpublished workshop paper by Howard Elliott and Ravi Prabhu.

²⁰ “Small-scale Food Processing in Bangladesh: A Diagnostic Innovation System Study,” an unpublished workshop paper by Muhammad Taher.

²¹ Social network analysis, which maps relationships between individuals in social networks, “views social relationships in terms of *nodes* and *ties*. Nodes are the individual actors within the networks, and ties are the relationships between the actors” (http://en.wikipedia.org/wiki/Social_network, accessed November 15, 2007).

²² “Enabling Smallholder Innovation: Findings from Ethiopia,” an unpublished workshop paper by David J. Spielman, Kristin E. Davis, Martha Negash, and Gezahegn Ayele.

²³ “Learning to Innovate: The Case of Songhaï Farmers in Benin,” an unpublished workshop paper by Daniel Nougbeignon Dalohoun.

²⁴ “The National Agricultural Advisory Services,” an unpublished workshop paper by Silim Nahdy.

²⁵ Examples include: a zonal production strategy; a PPP strategy; integrated support to farmer groups; enterprise mix strategy; value chain development strategy; regional development plans; participatory monitoring and evaluation; and a Sub-Saharan Africa network on agricultural advisory services.

²⁶ "Applying Innovation Systems to Agricultural Science, Technology, and Innovation (ASTI): The Case of Kenya's Floriculture Industry," an unpublished workshop paper by Maurice Bolo.

²⁷ "The Growing Pineapple Exports from Ghana," an unpublished workshop paper by George Essegbey.

²⁸ The Maastricht Economic and Social Research and Training Centre on Innovation and Technology (MERIT), which operates under the aegis of the United Nations University and Maastricht University, is a valuable source of information on the sources of innovation capacity (including the roles of governance and policy in supporting innovation) (see www.merit.unu.edu).

²⁹ "Strengthening Agricultural Education and Training in Sub-Saharan Africa from an Innovation Systems Perspective: Case Studies of Ethiopia and Mozambique," an unpublished draft report for the International Food Policy Research Institute (IFPRI) by K. Davis, J. Ekboir, W. Mekasha, C.M.O. Ochieng, D. Spielman, and E. Zerfu.

³⁰ "Transforming Post-Secondary Agricultural Education and Training by Design: Solutions for Sub-Saharan Africa," an unpublished document by W.M. Rivera, Washington, DC, World Bank, 2006.

³¹ "Strengthening Agricultural Education and Training in Sub-Saharan Africa from an Innovation Systems Perspective: Case Studies of Ethiopia and Mozambique," an unpublished draft report for the International Food Policy Research Institute (IFPRI) by K. Davis, J. Ekboir, W. Mekasha, C.M.O. Ochieng, D. Spielman, and E. Zerfu.

³² "What Is a Learning Organization? The Mexican Produce Foundations," an unpublished workshop paper by Javier Ekboir.

³³ "Codified" or "explicit" knowledge "has been or can be articulated, codified, and stored in certain media. It can be readily transmitted to others. The most common forms of explicit knowledge are manuals, documents, and procedures" (Wikipedia, http://en.wikipedia.org/wiki/Explicit_knowledge, accessed November 2007). "Tacit" knowledge "by definition . . . is knowledge that people carry in their minds and is, therefore, difficult to access. Often, people are not aware of the knowledge they possess or how it can be valuable to others. Tacit knowledge . . . provides context for people, places, ideas, and experiences. . . . Tacit knowledge is not easily shared" (http://en.wikipedia.org/wiki/Tacit_knowledge, accessed 26 November 2007). Tacit knowledge often consists of habits and culture that we do not recognize in ourselves, and effective transfer of tacit knowledge generally requires extensive personal contact and trust.

³⁴ “Stakeholder Linkages for Innovations in High Value Agriculture: Mango in Andhra Pradesh, India,” an unpublished workshop paper by Laxmi Prasad Pant, Helen Hambly Odame, Andy Hall, and Rasheed Sulaiman V.

³⁵ “Applying Innovation Systems to Agricultural Science, Technology, and Innovation (ASTI): The Case of Kenya’s Floriculture Industry,” an unpublished workshop paper by Maurice Bolo.

³⁶ “The National Innovation System and the Pineapple Export Industry in Ghana,” an unpublished workshop paper by George Essegbey.

³⁷ “Small-scale Food Processing in Bangladesh: A Diagnostic Innovation System Study,” an unpublished workshop paper by Muhammad Taher. This study presents an actor linkage matrix that is an effective analytical tool for systematically investigating the extent of links between the various actors. The matrix is often considered more useful than diagrams. The matrix enables one to learn about the nature of relationships between different actors quite quickly, because all actors in the sector are woven together through the first row and the first column to describe the linkage status.

³⁸ “Cassava and Cut Flower Sectors in Colombia,” an unpublished workshop paper by Isabel Bortagaray.

³⁹ “Scenario planning” is a structured process of thinking about and anticipating the future. It entails developing a set of narrative scenarios, each describing an alternative environment that shows how different interpretations of the forces driving the future can lead to different plausible outcomes and affect (for example) individuals, organizations, or societies (Rajalahti et al. 2006).

