ASTI
Agricultural Science & Technology Indicators
FACILITATED BY IFPRI

FARA

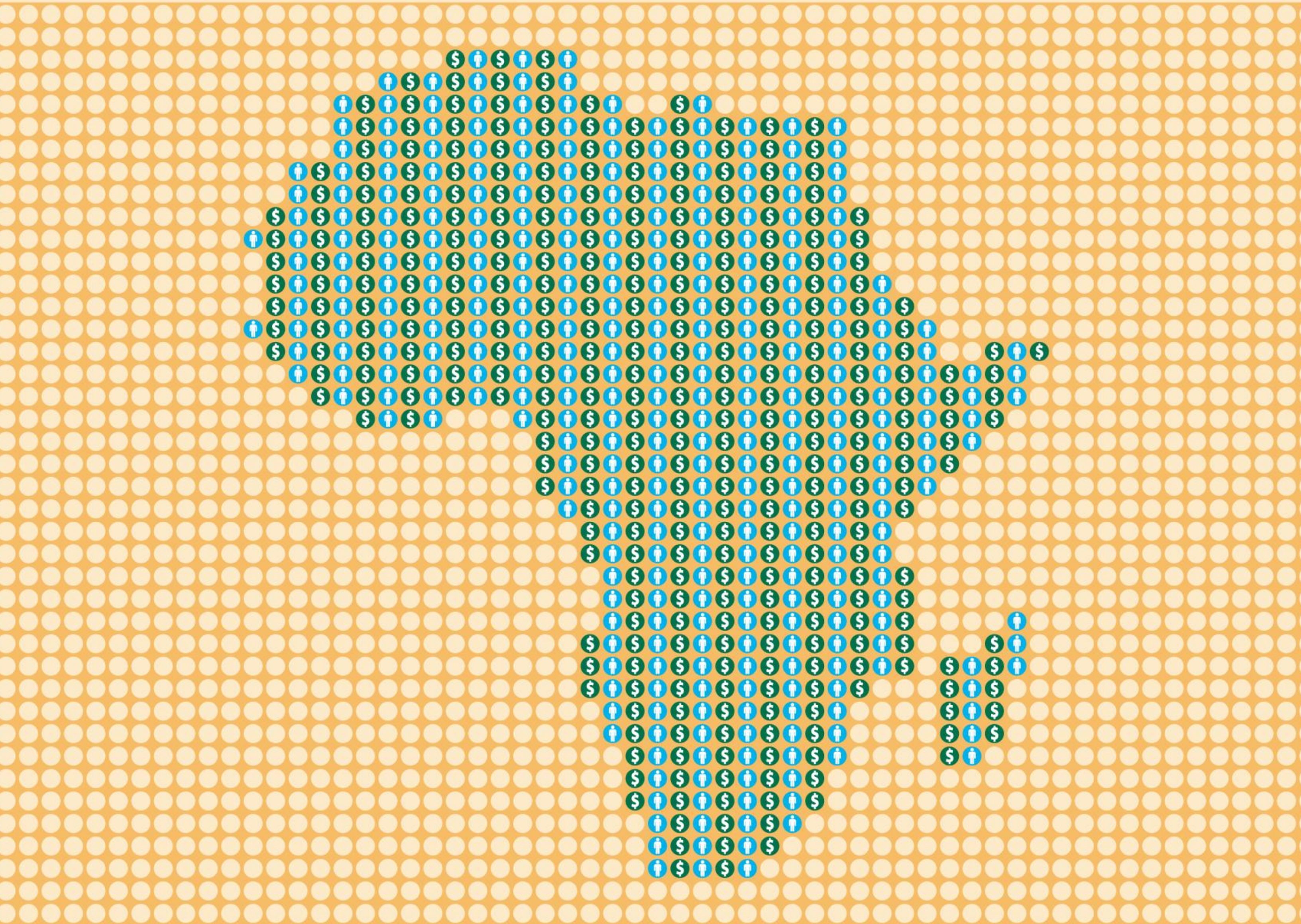
# THE ROLE OF AGRICULTURAL R&D WITHIN THE AGRICULTURAL INNOVATION SYSTEMS FRAMEWORK

Ponniah Anandajayasekeram

Conference Working Paper 6

Prepared for the ASTI/IFPRI–FARA Conference | Accra, Ghana | December 5–7, 2011

AGRICULTURAL R&D: INVESTING IN AFRICA'S FUTURE
Analyzing Trends, Challenges, and Opportunities



## Table of Contents

## List of Tables



## List of Figures



## List of Boxes

## About the Author

**Ponniah Anandajayasekeram** (anandaponniah@gmail.com) is an independent consultant. He is also a professor extraordinary at the University of Pretoria and a senior research fellow at the University of Free State, South Africa.

## Acknowledgments

The author appreciates the valuable comments from John Lynam and an anonymous reviewer.

## Acronyms and Abbreviations

| | |
|---|---|
| AIS(s) | agricultural innovation system(s) |
| AKIS(s) | agricultural knowledge and information system(s) |
| AR4D | agricultural research for development |
| CORAF/WECARD | West and Central African Council for Agricultural Research and Development |
| CBO(s) | community-based organization(s) |
| FARA | Forum for Agricultural Research in Africa |
| IAR4D | integrated agricultural research for development |
| ISP | innovations systems perspective |
| NAES(s) | national agricultural extension system(s) |
| NAETS(s) | national agricultural education and training system(s) |
| NARS(s) | national agricultural research system(s) |
| NEPAD | New Partnership for Africa's Development |
| NGO(s) | nongovernmental organization(s) |
| R&D | research and development |
| S&T | science and technology |
| SADC | Southern Africa Development Community |
| SSA | Sub-Saharan Africa |
| TDT | technology development and transfer (systems) |
| VCA | value chain analysis |

## Abstract

This paper traces the evolution of the innovation systems framework within the agricultural sector in Sub-Saharan Africa, and presents a conceptual framework for agricultural innovation systems. The difference between innovation ecology/ecosystems and intervention-based innovations systems is highlighted, given that these two concepts are used at different levels in promoting and sustaining agricultural innovations. The role of open innovation, innovation platforms, and innovation intermediaries in catalyzing, enhancing, and facilitating the innovation process are discussed, as is the role of R&D in the innovation process. The paper goes on to consider the interconnectedness of the innovation systems perspective and value-chain analysis in agricultural R&D processes, before summarizing the current status of agricultural R&D in Sub-Saharan Africa, lessons from past experience, and implications and key challenges confronting development practitioners in institutionalizing the agricultural innovation systems concept within the agricultural R&D in the region. Finally, some key conclusions and areas for investment are presented.

## 1. INTRODUCTION

Agricultural research and development (R&D) has undergone a number of paradigm shifts in Sub-Saharan Africa (SSA) over time, which have had serious implications for the way agricultural research is conceived, designed, implemented, and evaluated, as well as how the results are disseminated and utilized to generate innovations. Over the past four decades, international consensus on the importance of agriculture in economic development has varied from very high (until 1980s), to very low (until 1990s), to what could currently be described as a rediscovery. Growing consensus suggests that, in the 21st century, agriculture remains fundamental for poverty reduction, economic growth, and environmental sustainability in agriculture-based countries (World Bank 2008). Increasingly, developing countries are viewing science and technology (S&T) as the drivers of economic growth, and agricultural R&D is expected to play a significant role in the process.

The scientific methods of experimentation and discovery have not changed since their exposition in the 19th century. What changes constantly is the environment within which discovery and innovation occurs. This influences the organization and, in turn, the social process of discovery and innovation. Rapid changes are taking place in the structure and authority of governments, the global economy, the structure of the farming sector, and the global and local food industries and retail businesses. The institutional landscape is also changing dramatically. Cross-sectoral linkages between agriculture and other sectors are becoming more important. The agricultural sector is expected to play a significant role in alleviating poverty and ensuring food and nutrition security, while protecting the environment. With reduced funding, agricultural R&D systems are now forced to raise questions about their continuing relevance, approaches, accountability, and impact. Funding for research and support services can no longer be separated from broader developmental questions.

Managing this dynamic and complex environment requires a range of skills and tactical planning and shifts in paradigms. In responding to these changes, the central source model of innovation of the 1970s and 1980s has gradually evolved to the current agricultural innovation systems (AIS) approach. This evolution occurred as a result of identified weaknesses in the predominant paradigm of the time, and the emerging challenges and needs of society. Currently, the R&D processes within the agricultural sector in SSA are influenced by four concepts and principles: (1) the innovation systems perspective; (2) value chain and value-chain analysis (VCA); (3) impact orientation; and (4) integrated research for development (IR4D). Much has been written on these topics as though they are mutually exclusive. A closer examination of these concepts demonstrates that they are complementary and mutually reinforcing, and could be effectively integrated into existing farmer participatory agricultural R&D processes.

## 2. THE EVOLUTION OF THE APPLICATION OF THE INNOVATION SYSTEMS FRAMEWORK IN AGRICULTURE

Systems thinking is not new to agriculture.[1] The earliest work in systems has its roots in 20th century biology, and its systematic application in the agricultural sector began in the mid-20th century. The application of the "systems" concept in agricultural R&D started with farming systems research to address farm-level productivity constraints in the 1970s. Now the use has expanded to apply in

[1] A system is a collection of related elements that must function in concert to achieve a desired result (Bean and Radford 2002). It consists of interlinked subsystems, of which it is more than the sum; the central feature is its integrity and synergy. A system contains one or more feedback loops that are central to the system's behavior and permit the system to function in a self-managed, self-sustained way. Two key conclusions emerge from systems thinking: (1) the interrelated parts drive the system, and (2) the feedback loops are circular rather than linear.

organizational and institutional analysis, resulting in the AIS concept. The following sections of this paper trace this evolution and its applications for managing agricultural R&D in SSA.

A review of the literature clearly demonstrates that a number of sources have contributed to the adoption of the innovation systems concept in agriculture in SSA. These sources include the successful application of the national innovation systems perspective in the industrial sector; the inadequacy of the linear model to explain the innovation process; the inadequacy of existing frameworks for organizational analysis to be all inclusive; and the increased demand for developmental impacts. Each of these factors is further explored below.

The **first** factor is the successful application of the innovation systems perspective in the industrial sector of many developed countries. The concept was first mentioned in industrial innovation literature in the late-1980s. Freeman (1987) defined national innovation systems as the network of institutes in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse technologies. Lundvall (1992) highlighted that learning and the role of institutions are critical components of national innovation systems, emphasizing the notion of diffusion of economically useful knowledge. Edquist (1997) emphasized the importance of organizational and institutional change in addition to the more popular technological innovation.

The study of national innovations systems started with relatively simple descriptive analysis that tried to explain the difference in innovative activity and performance among countries. More recently, however, the theoretical underpinning of the approach has been substantially improved by the addition of insights from various streams of thought, including evolutionary economics, theories of learning, institutional thesis, and systems theory (Roseboom 2004). The national innovation systems perspective is not a blue print for organizing innovation but simply an analytical tool for use in planning and policymaking to enhance innovation. Because of its early success in the industrial sector, the concept is being applied in other sectors of the economy, including agriculture.

The **second** factor is the inadequacy of the linear model to explain the actual process of innovation in the real world. The linear model of technical change is now widely regarded as dysfunctional. A sequential conception is inadequate because the task domains of basic and applied research (S&T, research, and extension) are seen as requiring multiple inputs and generating multiple outputs. This realization led to the multiple source of innovation model for agricultural research and technology promotion first proposed by Biggs (1989). In the multiple-source model, all technology generation and promotional activities take place in a historically defined political, economic, agro-climatic, and institutional context. In this model, major emphasis is given to the idea that innovations come from multiple sources. Not only do innovations come from those who have been designated the role of "researchers," but also come from "practitioners" in numerous settings throughout research, extension, and production systems. This may include research-minded farmers, innovative research practitioners, research-minded administrative practitioners, innovations from nongovernmental organizations (NGOs), innovations from private corporations, and so on. Another key feature of this model is the recognition that agricultural research and technology dissemination systems contain a multitude of actors and organizations with highly diverse objectives. In addition, the model focuses attention on the continuous state of disequilibrium in which agricultural research and production activities take place. Biggs argues that the multiple-source model better fits the practice of agricultural R&D.

As a result, a systemic model has gained substantial favor for purposes of design, administration, and analysis of innovation capabilities. Beyond empirical demonstrations on nonlinearity in innovation, an interactive model is considered to be attractive because of the interdependence and potential complementarities that arise in an environment in which diverse actors invest in knowledge production at comparable levels. In other words, coordination and competition are dynamics of consequence when no single actor dominates, so an interactive model of technical change becomes necessary.

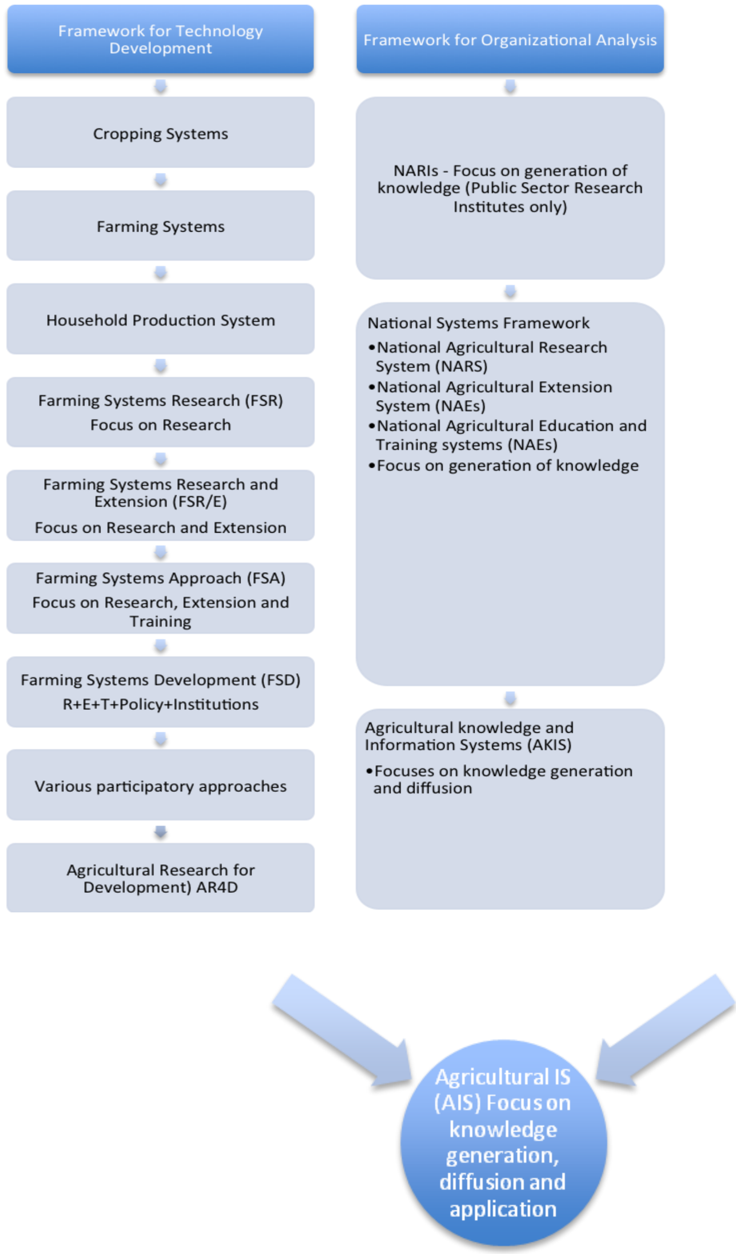
The **third** factor is the inability of the existing organizational framework to be all inclusive. Here the systems concept is used in the organizational analysis. The framework for national agricultural research institutes (NARIs) was the first to emerge after World War II that facilitates major investments in agricultural technology to increase food production. NARIs offered an organizational structure for agricultural research by the colonial powers to serve their interests in promoting export crop production. Due to its early success, this institutional framework dominated for decades; however, the inadequacy of NARI concept to address agricultural R&D problems forced practitioners to look for an alternate framework to accommodate all public institutes involved in agricultural research, extension, and education. The national systems framework resulted from a need to look at the various organizations undertaking agricultural research as a system, including national agricultural research systems (NARS), National Agricultural Extension Systems (NAES), and National Agricultural Education and Training System (NAETS). This trend of thinking continued to include the other institutes involved in agricultural R&D and resulted in a number of other concepts, such as agricultural knowledge and information systems (AKIS), the Technology Development and Transfer system (TDT) and AISs (Elliot 2008).

The **fourth** factor that contributed to the adoption of innovation systems in the agricultural sector is the contribution expected from the R&D community to overall economic growth and development. The concept of research for development emphasizes this expectation. When formal research was first introduced in early 1990s, the focus was near term technologies and enhanced productivity. However, unsustainable cultural practices, expansion of agricultural activities to marginal and hazard-prone agroecological zones, and concerns that agricultural practices do not adequately address the environmental externalities accompanying technological changes led to the incorporation of environmental and ecological considerations. Currently, research is expected to contribute to broader developmental goals, such as poverty alleviation, food and nutritional security, environmental sustainability, and other Millennium Development Goals. This links research directly to development and cannot be achieved by developing technologies or knowledge alone. Innovation is crucial to the realization of development impacts.

Thus, within the agricultural sector the application of the concept evolved in two different directions: (1) as a framework for organizational analysis, and (2) as a framework for technology development and dissemination, both leading to the innovations systems concept (Figure 1). On the organizational side, it began with NARIs and led to AISs, including all organizations focusing on knowledge generation, dissemination, and application. On the knowledge side, it moved from near term technology and productivity gains to broader development goals of poverty alleviation, food and nutrition security, and environmental sustainability. Both developments eventually led to the concept of innovation—a process that not only involves research, but also involves a wide range of activities, actors, and relationships associated with the creation and transmission of knowledge and its productive use.

In the context of SSA, this evolutionary R&D process is additive. It is not a totally new concept but rather a framework built on existing approaches and borrowing lessons from other sectors. A pragmatic approach for integrating this framework into the existing agricultural R&D systems in SSA is to identify the new elements from the innovations systems framework and incorporate them into the existing system.

**Figure 1. The evolution of systems thinking and its application in agriculture**




Source: Anandajayasekeram et al. (2005).

It is worth noting that in the shift from NARIs to AISs, the goal of the system is broadened (from research and technology to agricultural innovation), and the number of organizations/actors[2] considered

---

[2] The potential (generic) partners in an AIS are commodity, factor, and thematic research institutes; a national coordinating body or mechanism; universities and faculties of agriculture; international agricultural research centers; other international research organizations; advanced research institutes; universities in advanced countries; (national and international) private-sector research organizations; farmer and commodity organizations; national extension or parastatal development organizations; agricultural input and output marketing organizations; cooperatives and farmer-based intermediaries; (agricultural-based as well as community-based) nongovernmental organizations; subregional, regional, and global coordinating bodies; national policymaking mechanisms; and external S&T context (Elliot 2004).

as key players also becomes larger and all inclusive. The issue of linkages, partnerships, and interactions become more central to organizational performance. These developments also demonstrate that there is no uniquely "best system" (Table 1).

**Table 1. Defining features of national agricultural research systems and agricultural knowledge and information systems in relation to agricultural innovation systems**

| Defining feature | National agricultural research systems (NARSs) | Agricultural knowledge and information systems (AKISs) | Agricultural innovation systems (AISs) |
|---|---|---|---|
| Purpose | Planning capacity for agricultural research, technology development, and technology transfer | Strengthening communication and knowledge delivery services to people in the rural sector | Strengthening the capacity to innovate throughout the agricultural production and marketing system |
| Actors | National agricultural research organizations, agricultural universities or faculties of agriculture, extension services, and farmers | National agricultural research organizations, agricultural universities or faculties of agriculture, extension services, farmers, nongovernmental organizations, and entrepreneurs in rural areas | Potentially all actors in the public and private sectors involved in the creation, diffusion, adaptation, and use of all types of knowledge relevant to agricultural production and marketing |
| Outcome | Technology invention and technology transfer | Technology adoption and innovation in agricultural production | Combinations of technical and institutional innovations throughout the production, marketing, policy research, and enterprise domains |
| Organizing principle | Use of science to create inventions | Accessing agricultural knowledge | New uses of knowledge for social and economic change |
| Mechanism for innovation | Transfer of technology | Interactive learning | Interactive learning |
| Degree of market integration | Nil | Low | High |
| Role of policy | Resource allocation, priority setting | Enabling framework | Integrated component and enabling framework |
| Nature of capacity strengthening | Infrastructure and human resource development | Strengthening communication between actors in rural areas | Strengthening interactions between actors; institutional development and change to support interaction, learning, and innovation; creating an enabling environment |

Source: World Bank (2006).
Note: Knowledge and information systems are defined per the Food and Agriculture Organization of the United Nations and the World Bank.

While each of these concepts has its own strengths and weaknesses, they can be seen as interlinked and cumulative. NARSs focus on the generation of knowledge, AKISs on the generation and diffusion of knowledge, and AISs on the generation, diffusion, and application of knowledge (Roseboom 2004). Conceptually, NARSs, AKISs, and AISs are soft systems. A soft system is a social construct that does not physically exist but is nevertheless more relevant when studying social phenomena, such as research, knowledge, or innovation. Such concepts are used analytically to describe a loose conglomerate of different agencies and actors that perform similar tasks, or work toward a common goal. Although not real entities, such systems are referred to as though they really exist—for example, the education system, the legal system, the financial system, and so on.

## 3. THE AGRICULTURAL INNOVATION SYSTEMS PERSPECTIVE

### What is Innovation?

There are as many definitions of innovation as there are supposed innovation experts around the world. In the literature, authors have defined the term innovation differently (Freeman 1982; Lundvall 1992; Rothwell 1992; Metcalfe 1995; Edquist 1997; Drukker 1998; OECD 1997; and EC 1995). The simplest definition is anything new introduced into an economic or social process (OECD 1997). The most useful definition of innovation in the R&D context is given by Bean and Radford (2002), who define innovation as the economically successful use of invention; here invention is defined as a solution to a problem. The term invention refers to new concepts/products/processes derived from individuals or from scientific or other forms of research or a novel combination of existing knowledge. Innovation, on the other hand, is the commercialization and actual use of the intervention itself. Such innovations are not limited to technological (both product and process) innovations but also include institutional, organizational, managerial, and service delivery innovations. Innovations are new creations of economic significance. In the context of agricultural research, innovation in its broadest sense covers the activities and processes associated with production, distribution, adaptation, and use of new technical, institutional, organizational, and managerial knowledge and service delivery (Hall, Mytelka, and Oyeyinka 2005).

According to Bennett (2008) research converts money into knowledge, and innovation converts knowledge into money. The transformation of knowledge into products and processes does not follow a linear path, but rather is characterized by complicated feedback mechanisms and interactive relations involving science, technology, learning, production, policy, and demand. Taking a brilliant idea on an often painful journey, to become something that is widely used involves more steps and use of resources and problem solving along the way. This also emphasizes the notion that the responsibility of agricultural research organizations does not end with the production of new technology or knowledge only. Success can only be claimed when inventions are being disseminated, adopted, and used (Chema, Gilbert, and Roseboom 2001).

Innovations are divided into two broad categories: evolutionary innovations and revolutionary innovations. Evolutionary innovations are brought about by numerous incremental advances in technology or processes. Revolutionary innovations (also called discontinuous innovations) require a good deal of user learning and often disrupt the users' routines and may even require a new behavior pattern. The four basic requirements for innovation are that it (1) is something new to the user, (2) is better than what currently exists, (3) is economically viable (and socially desirable), and (4) has a widespread appeal. Conventionally it has been assumed that the more radical and revolutionary innovations tend to emerge from formal R&D, and the more evolutionary innovations may emerge from practice, but there are many exceptions to each of these trends. According to Arnold and Bell (2001), the dominant activity in innovation is working with and reworking the existing stock of knowledge in a novel way.

The main attraction of innovation systems framework stems from the fact that (1) it recognizes innovation as a process of generating, accessing, and putting knowledge into use; (2) it explicitly recognizes the interactions and knowledge flows among different actors in the process; and (3) it emphasizes that institutions are vital in shaping the nature of these innovations and learning as a means of evolving new arrangements specific to local contexts (Sulaiman 2008).

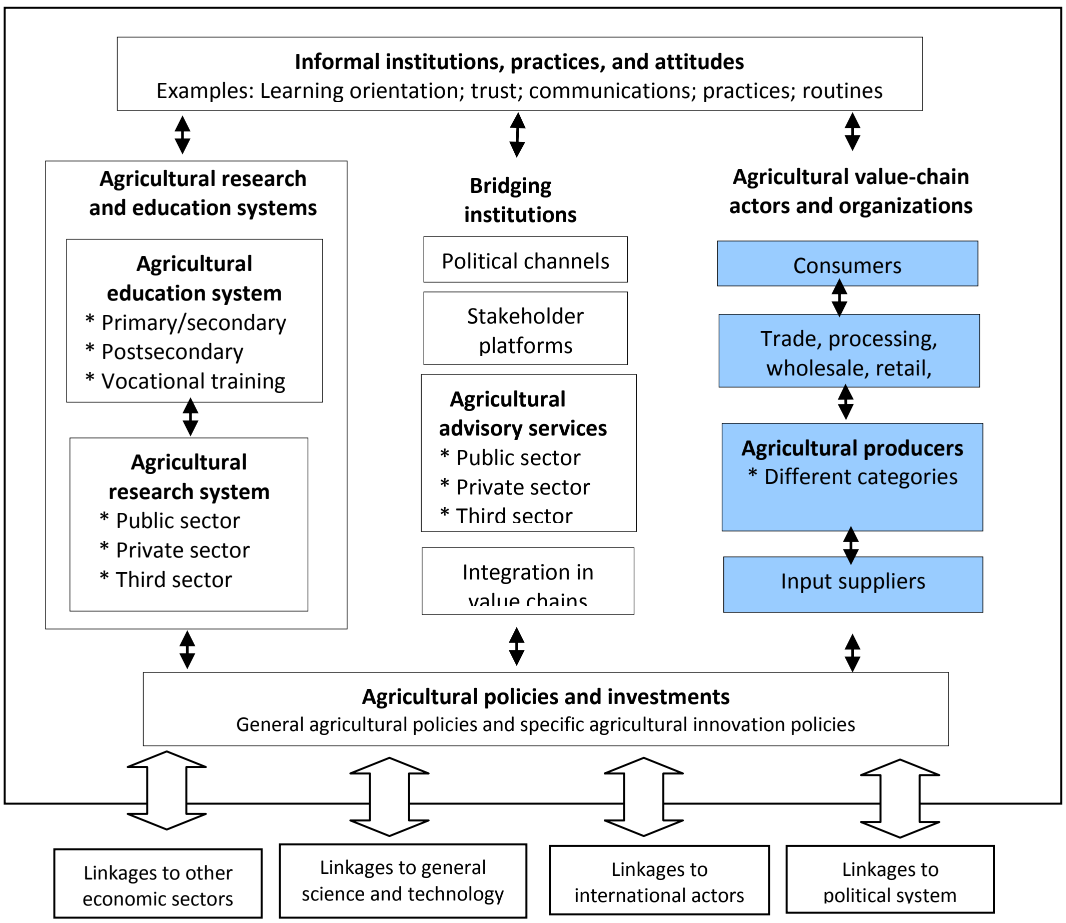
### What Is an Innovation System?

In its simplest form, an innovation system has three elements: (1) the organization and individuals involved in generating, diffusing, adapting, and using new knowledge; (2) the interactive learning that occurs when organizations engage in these processes and the way this leads to new products and processes (innovation); and (3) the institutions—rules, norms, and conventions, both formal and informal—that govern how these interactions and processes take place (Horton 1990; North 1995). Innovations systems as a concept is the study of how societies generate, exchange, and use knowledge (Spielman 2006). An innovation system can be defined at the national[3] or sectoral level, or from the perspective of a commodity or intervention. The latter three are relevant to this paper and are covered below.

### *Agricultural Innovation Systems (AISs)*

An AIS is a collaborative arrangement bringing together several organizations working toward technological, managerial, organizational, and institutional change in agriculture. Such a system may include the traditional sources of innovations (indigenous technical knowledge); the modern actors (NARIs, international agricultural research institutes, and advanced research institutes); private sectors, including (local, national, and multinationals) agro-industrial firms and entrepreneurs; civil society organizations (NGOs, farmers and consumer organizations, and pressure groups); and those institutions (laws, regulations, beliefs, customs, and norms) that affect the process by which innovations are developed and delivered (Figure 2).

**Figure 2. A typical national agricultural innovation system framework**




Source: World Bank (2007).

[3] For a detailed discussion of national innovation systems, see Metcalfe (1995); Paterson, Adam, and Mullin (2003); Roseboom (2004); Hall, Mytelka, and Oyeyinka (2005); Arnold and Bell (2001); and Clark (2002).

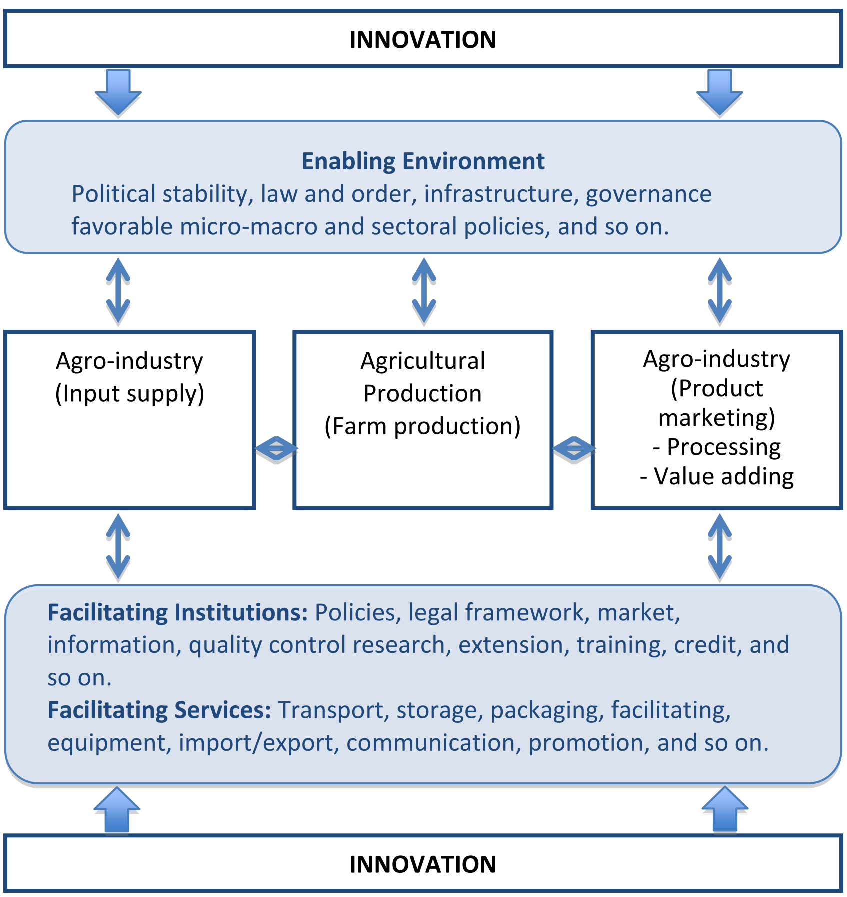
As shown in Figure 2, a generic AIS incorporates a complete system of diverse agents whose interactions are conditioned by formal and informal socioeconomic institutions. The AIS concept focuses on the totality of actors needed to stimulate innovation and growth, and emphasizes the outcomes of knowledge generation and adoption. The framework captures not only the influence of market forces, but also the impacts of organizational learning and behavioral change, nonmarket institutions, and public policy processes (World Bank 2006). It highlights the importance of framework conditions and linkages to other sectors, and the broader S&T community both within and outside the country. This framework also implicitly integrates the value-chain concept.

The AIS perspective provides a means of analyzing how knowledge is exchanged and how institutional and technological change occurs in a given society by examining the roles and interactions of diverse agents involved in the research, development, and delivery of innovations that are directly or indirectly relevant to agricultural production and consumption. The AIS concept has a broader perspective than does the NARS concept, as shown in Table 1. A number of transforming agricultural R&D systems in many countries have already incorporated some elements of the evolving AIS.

### *Commodity-Based Innovation Systems*

A commodity-based innovation system incorporates the various actors, their actions and interactions, as well as the enabling environment, facilitating institutions, and services that condition the various forms of innovation along the value chain of that commodity (Figure 3). This emphasizes the notion that innovation can occur anywhere along the value chain, not necessarily at the farm level, thus broadening the research agenda to incorporate both biophysical and socioeconomic research within the research for development portfolio.

**Figure 3. A typical commodity-based innovation system**




Source: World Bank (2007).

### *Intervention-Based Innovation Systems*

An intervention-based innovation system can be constructed based on the nature of the problem and the context in which the innovation is applied. It is important to distinguish between intervention-based innovation systems and innovation ecology. According to Metcalfe and Ramlogan (2008) the term innovation ecologies refers to a set of individuals usually working within organizations who are the repositories and generators of existing and new knowledge. Included in this ecology are those organizations that store and retrieve information, as well as those that manage the general flow of information. The principal actors are usually profit-seeking firms (in the value chain), universities and other public and private specialist research organizations, and knowledge-based consultancies. They collectively exhibit a division of labor that is characteristic of the production of knowledge. These ecologies are typically national in scope, with a subnational degree of variation (often generic in nature), necessarily reflecting rules of law, business practice, and the social and political regulation of business of the economies in which they are located. The concepts of national innovation systems, AIS, and commodity-based innovations systems are all generic and fall under the category of innovation ecology.

Problem-focused innovation systems, on the other hand, are constructed to address specific problems. These systems are highly specific, deal with the connection between relevant components of the ecology, and ensure that the flow of information is directed to a specific purpose. Depending upon the problem at hand there can be multiple intervention-based innovation systems supported by the same innovation ecology. Moreover, since the solution of one problem typically leads to different and new problems, it is also expected that as the problem evolves the actors in the system, as well as their interconnectedness, will also vary. Thus, while the ecologies are more permanent, problem-focused innovation systems are transient or temporary. Once a particular problem sequence is solved, the associated system can be dissolved. The dynamism of an economy/value chain depends on the adaptability with which innovation systems are created, grow, stabilize, and change as problem sequence evolves (Metcalfe and Ramlogan 2008). A problem-focused innovation system can be transboundary or cut across national boundaries, and may be spatially unconstrained. This problem- focused, transboundary, dynamic nature of the innovation system is the most relevant one for the agricultural R&D community.

## What Is an Innovation Systems Perspective?

An innovation systems perspective (ISP) implies the use of an innovation lens in the design, implementation, and evaluation of the activities of the various actors involved in the innovation process. Within an ISP, the innovative performance of an economy depends not only on how individual institutes (firms, research institutes, universities, and so on) perform in isolation, but also on how they interact with each other as elements of a collective system, and how they interact with *social* institutions, such as values, norms, and legal frameworks. ISP suggests the analysis of three elements: (1) the components of the system, principally its actors; (2) the relationships and interactions between these components; and (3) the competencies, functions, process, and results that such components generate. Therefore the analytical implications of and ISP are the need to consider a range of activities and organizations related to R&D and how these might function collectively, and the need to locate R&D planning and implementation in the context of the norms and cultural and political economy in which it takes place—that is, the wider institutional context. Here the ultimate goal of the actors is innovation.

## 4. THE CONCEPTS OF OPEN INNOVATION, INNOVATION INTERMEDIARIES, AND INNOVATION PLATFORMS

In the implementation process, practitioners use various mechanisms to acquire and share knowledge and to facilitate innovation processes. This section discusses three key concepts that are widely in use: open innovation, innovation intermediaries, and innovation platforms.

An ISP emphasizes the need for all stakeholders to work together toward innovation for development. It reinforces the fact that the effective use of new technologies to become innovations is often defined by conditions other than simple access to knowledge and information; it often requires appropriate institutional and organizational settings. ISP, therefore, considers links between actors, interactive learning processes, and the policy and institutional contexts that govern the system in order to gain an understanding of the generation, dissemination, and application of knowledge, information, and technologies (Wennink and Heemskerk 2006).

### Open Innovation

Open Innovation is a paradigm that assumes that firms/organizations/groups can and should use external as well as internal ideas as they look to advance their technology (Chesbrough 2003) in creating innovation. The central idea behind open innovation is that, in a world of widely distributed knowledge, organizations cannot rely entirely on their own research, but should instead buy or license processes and inventions from other institutes. A systematic open innovation protocol includes the following steps: (1) formulating the right problem; (2) calling for an open innovation solution; (3) ranking the selection; (4) identifying and resolving the "yes, buts"; and (5) transferring tacit knowledge.

Open innovation is a "necessary" part of the innovation equation; however, it is not "sufficient" in its own right. Open innovation is founded on the idea that someone somewhere has already solved the problem currently being faced. Common problems encountered in implementing the open innovation initiatives are as follows:

1. The initial problem posed is the "wrong problem"
2. Lack of objective means to determine whether the new solution is better than the existing solution (mainly due to lack of outside contextual knowledge); the solution may be theoretically/ technically possible, but may not be practical given the circumstances
3. Failure to adequately solve the inevitable "yes, but" problems as an external solution is imported into the specific context of the organization posting the challenge; they want something but something else stops them from achieving it
4. Failure to adequately transfer the surrounding tacit knowledge from domain to domain; tacit knowledge is knowledge that domain experts are unable to formally communicate to third parties

Tacit knowledge transfer is the most difficult of the four problems; however, this problem tends to appear after the other three have been successfully overcome. There are a few established formal ways and means of eliciting tacit knowledge. Nearly all open innovation projects seek to resolve tacit knowledge problems by introducing a development or validation phase into the contractual relationship they form with a solution provider. The validation phase is designed to deliver the knowledge from technology owner to problem owner, providing an opportunity to work together until the problem owner is able to grasp the idea and acquire the necessary skills (for example, a retainer-based consultancy).

Open innovation as a concept makes considerable sense, but it is still relatively new and may require adaptation to local conditions. The open innovation concept has great potential for accelerating the creation of novel solutions (through intelligent borrowing of technologies). However, by itself it is fundamentally insufficient to drive continuous innovation.

**Innovation Intermediaries**

Deploying research for innovation and development requires a capacity development approach, which involves improving the links among a variety of producers and users of information, as well as new ways of working to help make those links work. Often, the missing link in the process is brokering alliances around different topics. Brokering involves finding ways to remove bottlenecks and negotiating working relationships (Hall 2010).

"Innovation intermediaries" is a concept in innovation studies that assists with our understanding of the role of firms, agencies, and individuals that facilitate innovation by providing the bridging, brokering, knowledge transfer necessary to bring together the range of different organizations, and knowledge needed to create successful innovation (Klerkx and Leeuwis 2009). With the recent passion for open innovation involving complex networks of entities end users, organizations and individuals such as consultants, conference organizers, trade organizations, government innovation agencies, targeted service organizations, and so on, are now recognized as playing a central role in facilitating and coordinating innovation. Innovation intermediaries are important because the developers of a new invention or technique are seldom connected to their potential users or the firms and organizations that have complementary expertise, knowledge, and resources. The same applies to potential users of innovations, so that intermediaries are needed to bring organizations/users and knowledge together to kick start the innovation process. In some cases "innovation champions" (individuals and institutes) are used as intermediaries to promote and add value to existing innovation activities (RIU 2007). These intermediaries or innovation brokers perform a range of management tasks related to innovation, including articulating demand for research; assisting in providing access to technical expertise, markets, and credits; facilitating in forming and strengthening networks; and training and providing advocacy for policy and regulatory change (Hall 2010; Ugbe 2010).

"Intermediate organizations" often prove to be crucial to successful innovation, particularly when their task is to find out what producers (and their end users) want, and to search for options within the stock of existing and new knowledge to find what best meets the needs. Sometimes donor agencies and development partners play this critical role.

**Innovation Platforms**

An innovation platform is a physical or virtual forum that creates an environment within which to share and discuss ideas, listen and learn, think and talk, and collaborate with a view to innovate. Innovation platforms have been widely used in other sectors of the economy for a considerable period of time.[4] In the recent past, the innovation platform concept has been used in the agricultural sector in SSA (Box 1), first, to facilitate interactions and learning among stakeholders selected from a commodity chain leading to participatory diagnosis of problems; and second, joint exploration of opportunities and investigation of solutions leading to the promotion of agricultural innovation along the value chain of the targeted

[4]Examples of innovation platforms include the UK Engineering and Physical Sciences Research Council Platform for building low carbon cars; the European-Eco Innovation Platform to accelerate the uptake of eco-innovative solutions in Europe; the International Health Innovation Platform to accelerate the development of global health technologies in a multidisciplinary research environment, addressing the needs of patients and physicians in resource-poor settings; NANO Futures, a European multisectoral platform with the objective of connecting and establishing cooperation and representation of all technology platforms that require nano technologies in their industrial sectors and products; Netherlands Innovation Platform established to strengthen the Netherlands' capacity for innovation; and the Dutch Fisheries Innovation Platform, which was established to encourage innovation toward sustainable and profitable development of the North Sea fisheries sector and related supply chain).

commodity/enterprise (Adekunle, Fatunbi, and Jones 2010; Manuel undated; van Rooyen and Homann 2008; Ugbe 2010 and Griffith 2009).

As articulated by Adekunle, Fatunbi, and Jones (2010), to be effective, innovation platforms are required at different levels of management and governance related to agricultural development. At the strategic level, innovation platforms are established at the higher level of governance and management hierarchies, normally at national or subregional levels. Strategic innovation platforms target the chief executives/senior managers of stakeholder organizations to discuss and facilitate strategies to promote innovation along the targeted commodity or system. They also facilitate the functioning of innovation platforms at lower levels.

Innovation platforms established at the grassroots level have a different focus. They target frontline staff in organizations that facilitate operations and who participate in the activities of the platform because of their current role or skills. Grassroots innovation platforms are also sometimes referred to as innovation clusters (Adekunle, Fatunbi, and Jones 2010). The composition of the cluster depends on the nature of the activities and can change over time. In many instances work done by innovation clusters is closely aligned with the market chain and the priority problem being investigated. Cluster members do hands-on work in diagnosing, exploring, and investigating solutions, and in facilitating adoptions. They normally operate at the level of intervention-based innovation systems. Strategic innovation platforms and innovation clusters are complementary and reinforce each other in promoting innovation.

**Box 1. Some examples of projects with innovation platforms being used in Sub-Saharan Africa**

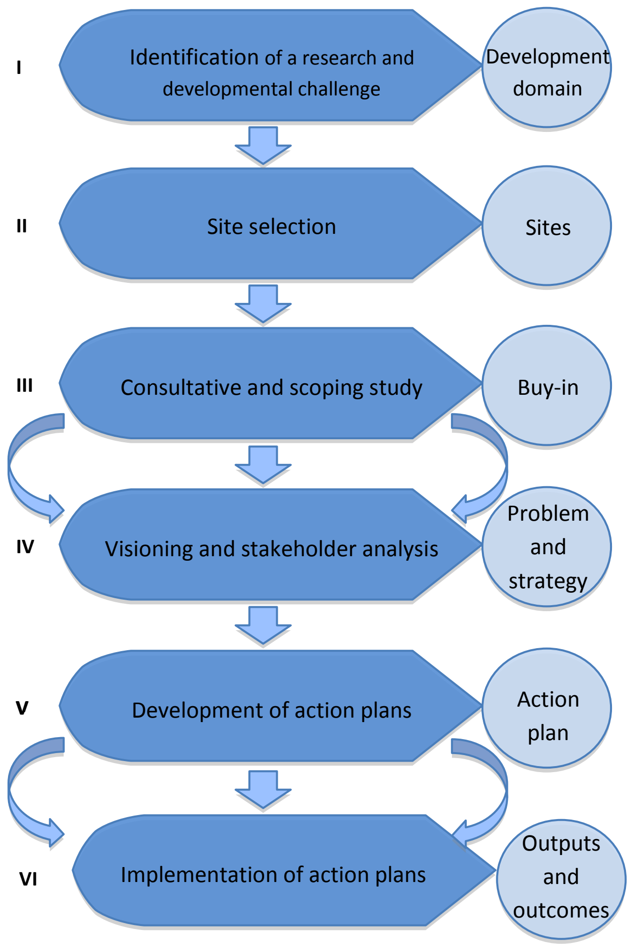
- The CIAT–led project Enabling Rural Innovation to improve the livelihoods of households through the creation of rural enterprises implemented in Malawi, Uganda, Zimbabwe, Mozambique, Rwanda, Burundi, DR Congo
- The DFID–funded RIU Project on Partnership for Agricultural Development (PIAD) or the National Innovation Coalition that works to influence policymakers in Sierra Leone, Malawi, Rwanda, Zambia, Nigeria, Tanzania
- The FARA-led Sub-Saharan Africa Challenge Program (SSA-CP) implemented in Zimbabwe, Malawi, Mozambique, Rwanda, Burundi, Uganda, the Sahel, Sudan and Northern Guinea
- The ILRI–led Fodder Innovation Project in Nigeria
- The NGO-led project Promoting Local Innovation (PROLINNOVA), implemented in Burkina Faso, Ethiopia, Ghana, Kenya, Mali, Mozambique, Niger, Nigeria, Senegal, South Africa, Sudan, Tanzania and Uganda
- The CIMMYT–led project Sustainable Intensification of Maize-Legume Cropping Systems for food security in Eastern and Southern Africa (SIMLESA), implemented in Malawi, Zimbabwe, Mozambique, Ethiopia, Kenya, Tanzania, Uganda, South Africa
- The ILRI–Led Livelihood and Market Project (LILI Markets), implemented in Mozambique, Namibia, and Zimbabwe
- The AURDC–lead project, “vegetable Breeding and Seed Systems For poverty Reduction in SSA, implemented in Tanzania, Madagascar, Mali, and Cameroon.
- The World Bank–financed agricultural productivity program in eastern Africa (Uganda, Tanzania, Ethiopia and Kenya) and western Africa (Ghana, Mali, Senegal, Burkina Faso, Niger and seven other countries)

Source: Compiled by author.
Note: This list is not exhaustive.

Innovation clusters are fluid entities with evolving memberships that draw in relevant expertise depending on the problem being addressed. The central partners, often comprising those with the most at stake, such as producers, buyers, and R&D agencies, provide insights on technology and information, and articulate market requirements. By bringing together the various stakeholders and providing them with a stage to voice their needs/requirements, the innovation cluster generates site-specific solutions to align production with market requirements, which in turn will ensure better prices for smallholder producers (van Rooyen and Homann 2008, no date). The iterative nature of the innovation cluster provides an ideal opportunity for monitoring and evaluating impacts, and sharing successes and lessons learned.

The key steps and processes involved in the establishment and management of innovation clusters are well documented (Adekunle, Fatunbi, and Jones 2010; van Rooyen and Homann 2008; Tenywa et al. 2011; Agyemang 2007; and Mapila, Kirsten, and Meyer 2011) and summarized in Figure 4. The formation and management of innovation clusters is a dynamic, highly context specific process. Strong leadership, strategic partnerships, information flows, interactions, and dealing with recurrent challenges in the formation and management of innovation cluster are critical factors in fostering innovations.

**Figure 4. Steps in the formation of agricultural innovation platforms**




Source: Tenywa et al. 2011.

There is also evidence on the ground that some of these commodity-based innovation platforms are now being used by government agencies to implement their programs. For example, in Mozambique the innovation platform at Changara is now used by local government officials as one of the major entry points for government-led interventions in the livestock community. The platform members were the first groups to receive the new animal registration card issued by the government (Filipe 2010). The Cassava and Aquaculture Innovation Platforms in Nigeria, established in 2009 and recently renamed the Agricultural Innovation Platform, has embarked on a diverse range of programs, including agricultural mechanization (tractor-hiring services), the propagation of cocoa/yams and yam seeds, fertilizer distribution, and other self-help initiatives in line with the current national agricultural priorities.

The key challenges in the implementation of innovation platforms are the low capacity of partner organizations (especially the skills required by the farmers to understand and articulate key issues), dealing with persistent "handout-syndrome," building new relationships between the private and public sectors and farmers for mutual and sustainable benefits, and ensuring inclusiveness and eliminating marginalization within the platforms. The success of commodity-based innovation platforms requires farmers to be able to negotiate as equal partners with others. At present in many instances farmers are unable to express their concerns or demands as an organized voice. It is also worth noting that many of the innovation platforms are currently driven by projects or "external" agents, and therefore sustainability beyond the life of these projects is a key issue of concern.

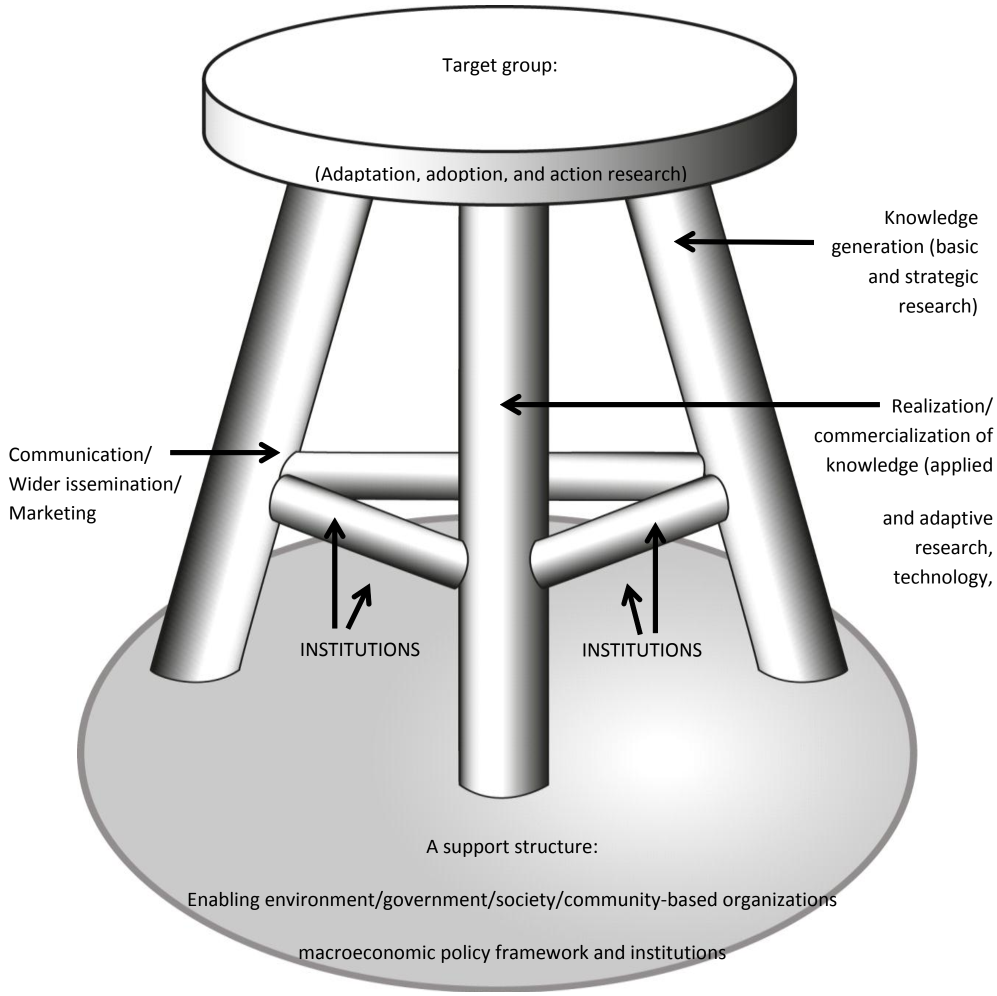
Empirical work clearly demonstrates that innovation does not just happen within the supply side (based on new technological possibilities) or as a result of the articulation of user demand (based on social needs and market requirements); it occurs through a complex set of processes that link many different actors—not only the developers and users, but also a wide variety of intermediary organizations, platforms, and individuals.

## 5. THE ROLE OF R&D IN INNOVATION

A three-legged stool is a useful illustration of the innovation process and role of research (Blackswan 2010). Three legs are the minimum required to achieve a stable structure, and to be effective, all three legs need to be of the same length (Figure 5). The three critical elements in the innovation process are

1. education or knowledge generated through basic and strategic research;
2. an ability to translate the knowledge into real products and services through strategic, applied, and adaptive research; and
3. the ability to communicate/market the ideas to the world through commercialization, communication, and service delivery.

**Figure 5. Components of the innovation process**




Source: Adapted from Blackswan (2010).

Next, a platform is needed to hold the legs, that is, the customers (end users) and to support the stool (the government, society, institutes, and institutions). If any of these five elements change, then the overall system may become unstable

The four sets of activities involved in the stages of the innovation process are (1) invention (creation of knowledge and development of appropriate solutions to the priority problems); (2) translation/realization (transforming knowledge into technologies, products, and processes); (3) commercialization (dissemination and provision of support services); and (4) adoption and use in meaningful ways to create socioeconomic benefits. To be called an innovation, an idea must be replicable at an economic cost and must satisfy a specific need. Innovation cannot occur in silos. Very often there are "domain experts" in the research system rather than "innovators." For innovations to occur research/knowledge is fundamental, and "support structures" are needed specifically to get all three key actors—researchers, realizers, and markets—talking to each another and interacting in a meaningful way. This support structure creates a new kind of expertise, one that transcends the silos.

In discussing innovations, much attention is given in the literature to formal R&D; it is worth noting, however, that innovations may be developed by less formal modifications of practice on-the-job, through the exchange and combination of professional experience, among many other routes. Most organizational, managerial, institutional, and service delivery innovations emanate from these informal processes. At the heart of innovation is the process of creating, sharing, and putting knowledge into productive use, which recognizes research as an important part of a wider network of knowledge and processes, and an essential ingredient in innovation.

The three-legged stool analogy has a number of implications:

- All functions (research, commercialization, marketing, and so on) need to be performed, but who performs them and how is not predetermined. The actual conditions of each case need to be assessed, together with who among the actors from the innovation ecology may assume responsibility for one or more functions.
- If innovations are to be effective, adequate investments should be made to support all actors and activities.
- Innovation takes place through the combination of different types of information, not exclusively through research; it is usually driven by market, policy, or practical opportunities and conditions (Hall 2009).
- To contribute to development, research should not operate in isolation, but should be embedded in the entrepreneurial, political, and policy processes it targets (that is, it has to be embedded in the development context to generate continuous innovation).
- "Knowledge frontier" research remains important and includes global technological fixes; some issues need to be understood globally.
- All types of research (basic, strategic, applied, adaptive, action-oriented, and so on) are still relevant, but development-oriented research is well placed to contribute to innovation and socioeconomic impact

The single most-important enabling factor for innovation is an understanding of the users' needs and the translation that knowledge into action across all functional areas.

## 6. VALUE-CHAIN ANALYSIS AND INNOVATION

As indicated earlier, the three key paradigms, integrated agricultural research for development (IAR4D), ISP, and VCA, are impact-oriented and complementary. IAR4D stresses that research is a means to an end, and the end goal is development. VCA on the other hand broadens the scope of research beyond the farm level, indicating that innovation can occur anywhere along the value chain, making the entire process much more effective and competitive. An ISP stresses that, unless knowledge and information are transformed into products and processes and used in socially and economically meaningful ways, it will not become innovation.

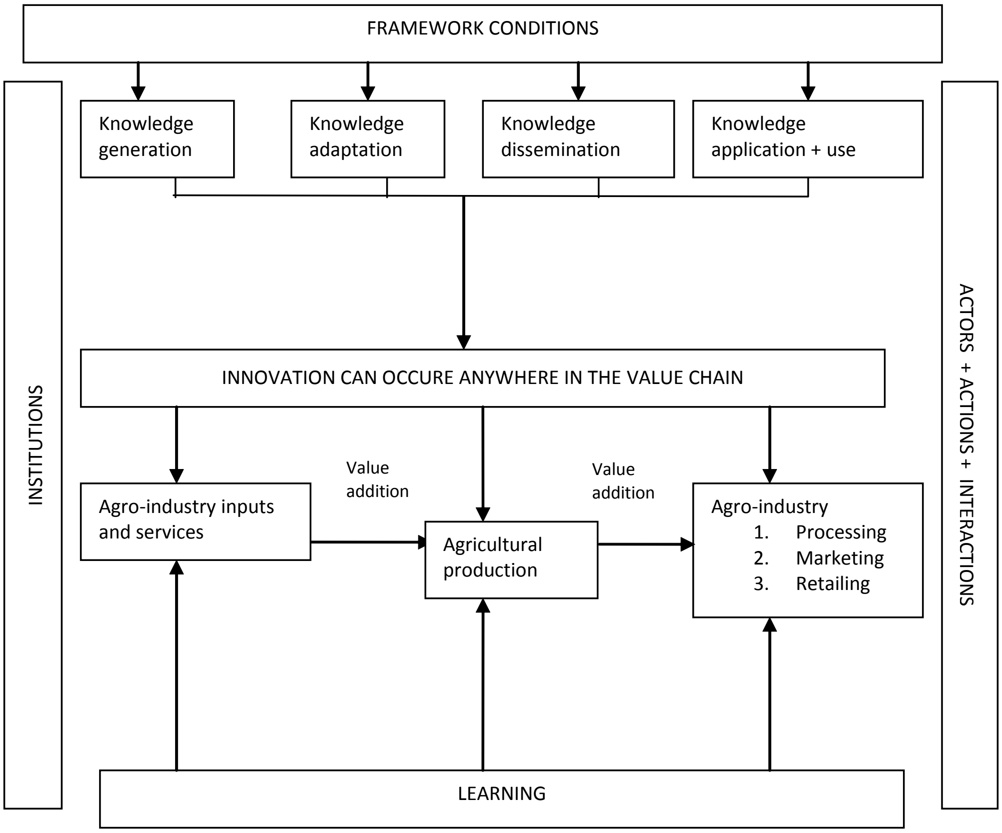
An agricultural value chain is usually defined by a particular finished product or closely related products, and includes all firms and their activities engaged in input supply, production, transport, processing, and marketing (or distribution) of the product or products. The approaches and practices that encompass the full range of activities and services of market actors required to bring a product or service from its conception to its end use and beyond is termed a value chain (Kaplinsky and Morris 2001; Markelova et al. 2009; Reardon et al. 2009). An agricultural value chain can, therefore, be considered an economic unit of analysis of a particular commodity (for example, milk) or a group of commodities (for example, dairy) that encompasses a meaningful cluster of economic activities linked by market relationships. The emphasis is on the relationships between networks of input suppliers, producers, traders, processors, and distributors (UNCTAD 2000).

The value chain concept entails the addition of value as the product progresses from input suppliers, to producers, to consumers. At each stage in the value chain, the product changes hands through chain actors, transaction costs are incurred, and generally some form of value is added. Value addition results from diverse activities, including bulking, cleaning, grading, packaging, transporting, storing, and processing. Moreover, the development and operation of enabling and supportive business development services (for example, market information, transport, and credit) play a critical role in how well the value chain responds to consumer demands. The constellation of value chain actors and the business development services supporting it constitute the innovation system of a particular value chain (Anandajayasekeram and Gebremedhin 2009; Rich, Negassa, and Ross 2008).

Value chains and an AIS can operate at multiple levels and can pursue various objectives. AISs can operate at the individual, farm, community, regional, national, or international levels (Rajalahti, Janssen, and Pehu 2008). VCA could also identify leverage interventions at similar levels. Information flows up and down the chain can trigger innovation in a particular stage of the chain, or in the way chain stages are organized and coordinated. In other words, innovations in a value chain can focus at a particular stage of the chain, or span several or all of its stages in terms of how activities are coordinated. The concept of following a product from its inception to the end use and beyond, and engaging all actors along each step, offers opportunities to select research from several options, with stakeholders input and implementation, and the generation of products and services with immediate value.

Enterprises and value chains are implicitly embedded in an innovation system (as presented in Figure 2). Market processes and innovation systems are mutually embedded, and it is not possible to have one without the other. Innovation systems are not an alternative to the market process. Markets are part of the necessary, adaptive link between innovation and development, but they are not sufficient of themselves; other instituted activities, such as education, research, and service delivery, all matter. The value chain concept enables the incorporation of backward and forward linkages, and the realization of the entire contribution of a particular sector or commodity to the overall economy. It also allows issues beyond the farm boundaries to be addressed. Innovation is perceived as a continuous learning process in which individuals/groups/organizations/ firms master and implement the design, production, and marketing of goods and services that are new to them, although not necessarily new to their colleagues or competitors, whether domestic or foreign (Metcalfe and Ramlogan 2008). Innovation can occur anywhere along the value chain and can be of different types (Figure 6). A procedure to integrate VCA and ISP into the participatory IAR4D processes is presented in Appendix A. In practice innovation systems are constructed to solve “local” real world problems using a value chain approach. The diagnostic process allows priority problems to be addressed anywhere along the value chain, and an innovation system can be constructed around these problems.

**Figure 6. Integration of innovation into value chains**




Source: Adapted from Anandajayasekeram and Gebremedhin 2009.

To facilitate the effective integration of VCA and ISP in participatory IAR4D processes, the capacity of all stakeholders along the value chain needs to be enhanced, and the necessary policy and institutional environments need to be created. The innovation capacity of the value chain, the ability of chain actors to innovate as a group and respond to changing consumer demands is, therefore, a sum total of the individual innovation capacity of the actors in the different stages of the value chain. Successful dynamic improvement in value chain performance critically depends on the ability of the chain actors to acquire, absorb, disseminate, and apply new technological, organizational, and institutional inventions continuously. This is a challenge facing R&D practitioners and policymakers.

## 7. THE AGRICULTURAL INNOVATION SYSTEM FRAMEWORK AND AGRICULTURAL R&D IN SSA

### The Organizational Landscape

The countries in SSA have a complex array of institutes responsible for planning, funding, and implementing agricultural R&D activities. These institutes include the NARIs, universities; international agricultural research centers, and extension services, which historically have been publicly funded. In addition there are farmer organizations, NGOs, and community-based organizations (CBOs) that are predominantly funded through private sources. Government research agencies represent 81 percent of total research capacity of African national agricultural research systems; universities contribute 18 percent; and the private and nonprofit sectors contribute the remaining 1 percent (IAC 2004).

In 44 countries, the Ministry of Agriculture is primarily responsible for agricultural research. The Ministry of Science is the responsible agency for only 10 of the countries, and all but two of these are in Francophone Africa. Within these ministries there can be several separate departments responsible for individual components of the NARS, making coordination a critical factor to enhance effective operation. Crop and livestock research is under one Ministry in 28 of the 31 SSA countries for which ASTI data is available (the exceptions being Burkina Faso, Tanzania, and Zambia). In the majority of SSA countries in Africa, NARIs account for over 60 percent of the national agricultural research investment and human resource capacity, and research activities are commodity oriented.

The research capacity at the universities in most countries is small and fragmented, but has tended to grow slightly faster than research capacity at nonacademic agencies. Based on a comparative study (Michelsen and Hartwich 2004), university scientists—particularly those at universities offering PhD and MSc degree programs also benefit from the availability of students—spent about 30 percent of their time on research, on average. Many universities (for example, in Ghana, Nigeria, Tanzania, and Uganda) play an increasingly important role in public agricultural R&D. Some universities have an explicit mandate for development-oriented research. Michelsen and Hartwich (2004) also noted that the higher education system in Francophone countries focuses less on R&D and more on teaching and thesis supervision, and the Anglophone university scientists have closer links with NARIs and technology users than do Francophone university scientists. The universities throughout SSA are facing severe financial problems, coupled with a decline in the quality of the educational experience. The IAASTD report (2008b) for SSA concluded that the current education, training and extension structures are incompatible with the innovative approaches to Agricultural Knowledge Science and Technology (AKST) for development: an area worthy of further analysis.

A number of subregional and continental organizations are contributing to agricultural R&D in many ways, including the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the West and Central African Council for Agricultural Research and Development (CORAF/WECARD), the Southern Africa Development Community (SADC), the Forum for Agricultural Research in Africa (FARA), and the New Partnership for Africa's development (NEPAD). These organizations have improved the coordination of agricultural research among NARIs by sharing information, mobilizing resources, building capacity, and using scarce research resources efficiently. They also assist in establishing regional priorities and influencing national policy processes within their respective regions.

Nonprofit agricultural research primarily focuses on important export crops where commodity fees and levies and used to fund the research, and producers are increasingly involved in setting the research agenda. Although private investment is on the increase, this involvement is still very limited. In many countries, the necessary policy environment to facilitate private involvement is extremely weak or nonexistent (Alston, Pardey, and Piggott 2006).

Public-sector extension services in SSA are undergoing serious transformation and restructuring. Over the years the countries of SSA have tested a number of extension models: the public extension model, commodity extension model, NGO model, private-sector model, the training and visit approach, farmer field school model, and finally the pluralistic extension system where extension services are provided by the public sector, the private nonprofit sector, and the private-for-profit sector. In the process, the role of extension services is being redefined from that of messengers to knowledge brokers, resource connectors, and facilitators.

The average research intensity (that is, agricultural R&D spending as a share of agricultural output) for SSA was 0.61 in 2008. Only 8 of the 31 countries for which data were available met NEPAD's 1 percent R&D investment target. Overall investment levels in most SSA countries are still below the levels required to sustain agricultural R&D needs. Countries that have increased their expenditures, have directed most of the funds toward salary increases and the rehabilitation of infrastructure and equipment. Beintema and Stads (2011) noted that in order to reap the benefits of these important investments, additional resources are required to increase the number, variety, and intensity of actual research activities.

### Research Approach, Processes, and Linkages

In terms of the approach to research, SSA countries have made significant progress in moving away from the "prescriptive" tradition toward participatory and action-oriented research. As noted, R&D activities in the region are heavily influenced by the VCA, IAR4D, and ISP frameworks. A number of key elements of system-oriented participatory approaches—such as the farming systems perspective; household systems as units of analysis; using diagnostic information in research planning and priority setting; and involving beneficiaries in the design, implementation, and evaluation of research—are already embedded in the R&D systems in many countries (Anandajayasekeram and Stilwell 1998; Collinson 2000).

In terms of research output, this re-orientation has contributed to the development of appropriate and site-specific recommendations but not innovations. That means the job is incomplete in terms of innovation. Linkages have been and still are a major issue. The NARS concept has brought NARIs and universities closer together, and participatory approach and methods have led to increased grassroots collaborations and interactions between researchers, extension staff, farmers, NGOs, and CBOs. The most recent work on value chains and market orientation has contributed to the involvement of market agents and input suppliers in the R&D processes in pilot sites. Increasingly, farmers' organizations now voice the needs of their members in various forums on policymaking and orienting service provision.

Nevertheless, the current status of linkages and collaboration among the various stakeholders is far from ideal. To a large extent, these organizations still act independently of each other with minimum coordination, which undermines the feedback loop necessary for developing responsive research agendas and compromises access to knowledge. Learning to think and operate collaboratively is both a major pathway and a major challenge to organic growth.

### The Current Status of Activities Related to Agricultural Innovation Systems in the Region

A number of major studies, such as World Bank (2008), IAASTD (2008a, 2008b), and IAC (2004), concluded that technology development in SSA needs to be embedded within a broader development and innovation systems concept. The three subregional organizations (ASARECA, CORAF/WECARD, and SADC) have embraced ISP and integrated it into R&D projects under their umbrella. IARCs and some development agencies (the World Bank, UK Department for International Development, European Union, and Australian Centre for International Agricultural Research) are supporting regional projects explicitly integrating ISP into R&D activities (see Box 1). In many countries, innovation and ISP are identified as organizing principles in the various strategy documents, but not much has been done to effectively integrate them into the R&D process. A recent study conducted in Malawi (Mapila, Kirsten, and Meyer 2011) concluded that agricultural research interventions that are driven by AIS concepts have the potential to positively impact the livelihood outcomes of rural smallholder farmers in Africa. One recommendation of this study is that AIS concepts should be mainstreamed in all public agricultural research and extension programs to ensure sustained rural innovations and robust livelihood outcomes.

### Lessons from Past Experience

Considerable experience in the region exists with regard to the institutionalization of farming systems and participatory research methods. The farming systems approach to agricultural R&D was introduced in Africa in the mid-1970s. It took almost 25 years to integrate these concepts, procedures, and practices into the R&D system. The following key conclusions and lessons are helpful in guiding the internalization of ISP into R&D processes.

1. Institutionalization is an evolutionary process, and to a large extent the initial approach taken by individual countries is determined by the existing organizational structure and modalities of operation. Although a good number of countries in SSA emphasize the systems approach and participatory processes, they employ different models for institutionalization (Anandajayasekeram and Stilwell 1998; Collinson 2000). There are four types of models used in the region: centralized with separate farming systems research departments; decentralized with separate farming systems research departments; systemwide and centralized; and systemwide and decentralized
2. Several conditions must be satisfied, or should be in place, to ensure a successful institutionalization process (Box 2).
3. The process of institutionalization or integration should be undertaken in two phases: a preparatory phase and an institutionalization phase.

**Box 2. Preconditions for successful institutionalization**

1. A clear demonstration of utility of the process
2. Policy and leadership commitment, including the necessary resources, to integrate the concept and processes within the organization
3. Broader participation and effective linkages among the various stakeholders
4. Experienced, trained, motivated, and committed staff
5. A clear (internally driven) organizational strategy for institutionalization
6. The national capacity to offer continuous training on the concept, principles, and procedures (that is, integration into the learning curricula)

Key activities of the preparatory phase include

- initial exposure of the concepts and preliminary training (for both practitioners and trainers) to develop the nucleus of professionals;
- initiation of pilot studies to demonstrate results and value addition;
- sensitization workshops for senior and middle-level managers and policymakers;
- sharing experiences of the pilot countries; and
- developing a national strategy, an all inclusive participatory process, with input from multiple sources.

Key activities of the institutionalization phase include

- mass training of the different key stakeholders,
- preparing the academic institutes and internalizing training (including training of trainers and curriculum development),
- creating in service and on-the-job training capacity,
- mobilizing resources and allocating adequate human and financial resources,
- establishing mechanisms for interorganizational and interdisciplinary collaboration and linkages,
- clarifying roles and responsibilities of various partners/stakeholders,
- establishing career prospects (including performance assessment and a reward system), and

- establishing coordinating mechanisms and avenues for sharing lessons and experiences.

In essence, the application of an AIS framework in SSA is in the pre-institutionalization stage. There is a need to demonstrate its utility and policy relevance, and the case still needs to be made that AIS has potential as an approach in the context of SSA in order to move the agenda forward.

1. Activities related to farming systems research have been weak in providing policy feedback from the field level to decisionmakers. The apparent lack of policy linkages led to lack of real commitment by policymakers, and a consequent lack of resource allocation.
2. Resource imbalance between research and extension significantly affected effectiveness and linkages, including collaboration in field-level activities. Shared goals, perceived interdependency, mutual respect, integrated planning, division of labor, joint allocation of resources, and establishment of a reward system that recognizes the contributions of each partner are all effective means of strengthening linkages. Project approval and funding mechanisms can ensure effective collaboration among relevant stakeholders.
3. It is possible to effectively integrate the concepts and procedures into the education and training system. This is closely linked to the integration process within the research and extension system. A strong need exists to make efforts to prepare the learning institutes. There should be a comprehensive capacity strengthening strategy to build the skills of key stakeholders. Mechanisms should be put in place to train existing staff, as well as the next generation of staff.
4. The single most important factor that contributed to successful institutionalization is collaboration and long-term commitment by the NARIs, IARCs, and donors to support these activities.
5. One of the biggest obstacles to institutionalizing farming systems research and other participatory, client-driven research and extension in the public sector is that most agricultural R&D systems are neither penalized for producing technologies that farmers cannot use, nor rewarded for successful client-oriented research with higher adoption rates. Research and extension services could be made more client-oriented and accountable by linking reward and incentive systems to user evaluation, and devising mechanisms that enable users to draw on public resources for services of their choice. For this to occur, the users should be empowered to effectively articulate their demand.
6. Commodity-oriented programs are much more conducive to integrating the system concepts and multidisciplinary research processes than are disciplinary-oriented programs.

**Lessons from the Nonagricultural Sector**

Although the concept of innovation is relatively new to agriculture, the innovation system framework has long been used in the industrial sector. In a landmark study in the United Kingdom, Rothwell (1992) identified a number of factors as characteristics of successful innovation, including emphasizing satisfying user needs, establishing good internal and external communication, treating innovation as a corporate task, committing resources early, screening new projects openly, appraising projects regularly, and ensuring high-quality management. Wycoff (2004) also identified the top 10 killers of innovation (Box 3). These lessons can offer some useful guidance when introducing an AIS framework in the agricultural sector.

**Box 3. The top 10 killers of innovation**

- Not creating a culture that supports innovation
- Not getting buy-in and ownership from business unit managers
- Not having widely understood, system-wide process
- Not allocating resources to the process
- Not tying projects to company strategy
- Not spending enough time and energy on the fuzzy front-end
- Not building sufficient diversity into the process
- Not developing criteria and metrics in advance
- Not training and coaching innovation teams
- Not having an idea management system

Source: Wycoff (2004).

## 8. IMPLICATIONS AND CHALLENGES

The next two subsections deal with the broader implications and challenges that need to be addressed by the R&D community in adopting and institutionalizing the integration of ISP and VCA in AR4D in SSA.

### Implications for Agricultural Research for Development

An agricultural ISP recognizes the importance of technological, organizational, and institutional management and service delivery inventions, but focuses on the application of inventions to achieve economic, social, and environmental gains. Agricultural research and technology development are only part of the innovation system. The shift from viewing research as the central actor to being only one important component of the innovation system carries profound implications for the organization, management, and operation of the research system and how researchers operate (Rajalahti, Janssen, and Pehu 2008). Research systems and researchers are, therefore, required to encompass a range of new activities and processes that have previously fallen outside their mandate.

The ISP gives explicit attention to development outcomes and as such focuses on factors that facilitate or hinder sector development beyond strengthening research capacities. This includes the methods of interaction used in conducting research to produce goods and services. In particular, interactions within the agricultural R&D system are needed to establish and foster partnerships, as is learning through networking with other actors who innovate dynamically to adapt to changing environments. Hence, the development of research capacity should encompass nurturing interactions with other actors in the innovation ecology.

Skills in negotiation, facilitation, and conflict management will be critical for researchers. Funding and incentives to institutionalize and foster partnership and partner interactions will be needed more than ever. Hence, the ISP requires improved research system governance that fosters partnerships. Research management should be organized in such a way as to allow relevant actors to participate in strategy development, priority setting and funding, evaluation and co-learning.

Fostering innovations in agricultural R&D requires a multidisciplinary and multi-organizational approach to R&D. The structural organization of research institutes should reflect the multidisciplinary nature of the research.

### Implications for Investments

Developing economies should be innovating economies. Creating new comparative advantages requires continuous innovation. Continuous investment in innovation capacity is, therefore, required to achieve sustained economic growth. Innovation investments can be categorized into two broad areas: innovation capacity and enabling environments. Innovation capacity relates to the skills and capacity needed for AIS, that is, partnerships and collaboration, becoming a learning organization, enabling collective action, behavioral and organizational change, and building innovation networks and linkages. The enabling environment relates to S&T policy, fiscal policy, commercial and trade policy, education policy, property rights policy, and so on. There is no single innovation policy, but a set of complementary policies is required to facilitate and guide innovations. For example, policies that are intended to create a conducive environment to foster innovation can remain ineffective unless accompanied by interventions to change the prevailing attitudes and practices of the change agents and modify the reward systems.

Investment in the enabling environment involves (1) promoting stakeholder engagement and collaboration through foresight activities, innovation platforms, adequate incentives for actors, and the development of rules for interaction (related to intellectual property rights, research funding, agent roles, and so on); (2) strengthening knowledge management capacities and collaborative arrangements that will lead to better use of available information, knowledge, and technology at national, regional, and global levels, both in the public and private sectors; and (3) institutionalizing the ISP approach.

One important area of innovation investment is investment in AR4D. However, investment priorities to foster innovation are different from the traditional investment areas. Investment in R&D to foster innovation emphasizes patterns of interaction between research performers and other actors, and the alignment of policies and procedures of research organizations to the requirements of partnership and collaboration. A direct link between research and users is vital.

### Leadership and Building a Culture of Innovation

Innovation is fostered through a culture that aims to meet the needs of all stakeholders, including end users, teams, employees, policymakers, development practitioners, and so on. Leadership shapes the organizational culture and climate.[5] Therefore cultural change for promoting innovation starts at the top, with leaders who provide strong direction for innovation and establish an organizational culture and climate that is conducive to innovation-related activities. Those who are perceived to succeed at innovation combine leadership and culture with robust processes and structures that support innovation. African R&D organizations need a mix of people who show leadership ability as collaborators, who demonstrate a results-focus, and who can build an organization and mentor and develop others. High-level management will need to create a shared vision, where innovation has purpose and is valued, and a culture that fosters and rewards a user focus, collaboration, innovation, and high standards of performance within the organization.

[5] Organizational culture represents the norms, standards, and values that broadly define "how things are done" in an organization. While often taken for granted by employees, organizational culture and values drive employee behavior in important ways. The organizational culture should promote individual initiatives, high levels of teamwork, partnerships, and collaborative ventures, and strive to innovate. While culture is a macro-level organizational phenomenon, climate is much more micro in terms of the immediate work environment, which is created by middle managers and their teams. Effective leaders and managers should create a climate (of standards, responsibilities, facilities, clarity, flexibility, and so on) where people's productivity is maximized. An effective climate supports individual performance.

**Challenges**

Embracing the emerging paradigms in AR4D processes offers a number of opportunities, as well as challenges. Key challenges need to be collectively addressed while pursuing activities that generate socially beneficial innovations.

- The **first** key challenge is to change the organizational culture to incorporate innovation as a core value and to institutionalize the emerging paradigms (especially AIS and VAC and the multidisciplinary nature of research) into research for development processes. There are several related key challenges, such as how to facilitate the creation of learning institutes and how to develop improved research governance that fosters innovation.
- The **second** key challenge is creating the necessary capacity for innovation. Currently, there is limited awareness of the concept, its application, and implications for the AR4D community. Capacity is needed to apply the concept, as well as to sustainably build further capacity. The notion of capacity building in a system sense entails building the collective capacity of networks or systems of actors interactively linked with a view to innovate. Stimulating changes in the behavior of the system and the institutions that govern the system must become the primary objective of capacity strengthening for innovation (Oyelaran-Oyeyinka 2005). There is a need for a comprehensive strategy for capacity strengthening. The national agricultural higher learning institutes and subregional organizations should play a significant role in the planning and implementation of this strategy. A number of educational institutes in the region have already incorporated the farming systems concepts and procedures in their curricula (Anandajayasekeram 2000). As such, the additional materials could be incorporated without much difficulty. However the issues of training trainers, developing location-specific training materials, and coordinating and financing training at national and regional levels, as well as aspects of on the job training, coaching, and mentoring, require further attention.
- The **third** key challenge is how to scale up innovations and the capacity to innovate. Both aspects are equally important and deserve attention. Included in this challenge is how to develop productive and sustainable mechanisms and arrangements for AIS along the value chain. Criteria for sustainable innovation systems are growing inter-relationships between participants in the innovation system, an intensive communication among all stakeholders, and a political and economic context favoring the agricultural innovation process. The term "institutional arrangement" in this context describes the mechanisms by which the various actors cooperate to promote technical and economic progress in agriculture. The emerging strategic innovation platforms and innovation clusters can be effectively used for this purpose.
- The **fourth** key challenge is creating the necessary environment and incentive system, and the investments needed to foster partnership and the reduce transaction costs of partnership and collaboration. What preconditions are needed to achieve this? How should successful partnerships, networks, and innovations be assessed? How can rewards and incentives be provided for the various partners in an innovation system? How should the mindset of actors be changed? In short, how can the wide set of attitudes and practices needed to foster the culture of innovation be developed. In particular, positive attitudes toward partnership, interaction, networking, and learning need to be nurtured, not only in the AR4D system, but also across a wide array of actors in the sector.
- The **fifth** key challenge is the limited empirical evidence of the application of AIS, its utility, and value addition. This challenge entails conducting credible empirical analysis, and documenting and communicating results and experiences. How do we demonstrate the

utility and added value of this approach? How can we improve our understanding of the factors that contribute to successful and sustainable innovations? What are the central concepts, methodologies, and principles that contribute to the institutional and organizational transformation needed to promote successful innovations? How are the increased transaction costs inherent in ISP justified and financed? In order to address this challenge every attempt should be made to demonstrate value addition and document and share the lessons and experiences of the various ongoing projects based on the AIS framework in the region.

- The **sixth key** challenge, concurrent with promoting innovation and supporting institutional arrangements, is how to ensure that due attention is given to factors such as socioeconomic equity and environmental sustainability, while also generating new wealth and opportunities. What types of innovations will address poverty? How the development of pro-poor innovation be facilitated? The concept of recommendation domain/target group used in the participatory research methods can be used to address the issue of socioeconomic equity. In identifying intervention options environmental sustainability and equity can be explicitly considered as criteria for selection.
- The **final** key challenge is how to develop a coherent set of policies that foster innovation.

There is no blueprint or recipe to address these challenges. This is a long-term process requiring action on a number of fronts. This type of a system pre-supposes a demand–supply relationship between users of services and service providers, a switch from a hierarchical model to a more market-based mode of cooperation, re-directing the incentives for AR4D services. Here the centralized AR4D bureaucracies are to be replaced by self-responsive and responsible systems. This change is gradual, thus calling for a long-term commitment by policymakers, donors, and development partners.

## 9. CONCLUSION

Innovation is an essential ingredient to future success in AR4D. The key challenge for AR4D managers is to learn how to identify and generate commercially relevant innovation along the value chain, and to do this consistently. With greater emphasis on the broader developmental goal, research for development strategies have shifted over the past decades. Currently most research for development activities are influenced by four key concepts: ISP, value chain orientation, research for development, and impact orientation. This change in thinking is based on a recognition that innovation takes place throughout the whole economy, and not all innovations have their origin in a formal R&D system, nor are all exclusively technical. Innovation can occur anywhere along the value chain. The new perspective places more emphasis on the role of farmers, input suppliers, transporters, processors, market actors, and intermediaries in the innovation process. These developments clearly demonstrate that there is no uniquely best system to analyze all situations. The goal is to find the most appropriate system for the situation (Elliot 2004; van der Heijden 1966). It is also possible to integrate the emerging paradigms in a meaningful way in empirical studies. Leadership is critical in this integration process. Research protocols should be modified to accommodate this reorientation.

An ISP does not undermine the value of research, good communication, or effective extension services. These are necessary preconditions. The ISP and value chain orientation underscore the need to invest not only in the research that generates this knowledge, but also in high-quality and effective delivery channels, process mechanisms, and organizations/stakeholders that will use the knowledge once it emerges along the value chain. The role of institutions in this process is emphasized. Innovation intermediaries, innovation platforms and open innovation processes are critical to accelerate as well as mainstream the ISP within the agricultural R&D systems.

The innovation system concept does not provide a generic model for innovation; hence, instead of postulating defined roles for different actors, it becomes necessary to assess the actual conditions of each case and identify who among several partners may take over one or more of these functions. From this perspective, the different functions from funding, to research to technology dissemination, and technology adoption are still critical functions, but who performs them and how is not pre-determined. Therefore, the concept of innovation is an empirical construct. One has to observe who is interested in a particular innovation, who participates in developing it, and which rules and regulatory mechanisms are operating. As we progress from knowledge and technology generation to innovation, the roles and responsibilities of individual actors change. This needs to be recognized and acknowledged by all R&D practitioners. Institutionalizing such a perspective in the AR4D system offers both opportunities and challenges. Building the necessary capacity and developing, nurturing, and managing a productive and sustainable institutional mechanism and modality of operation is an evolutionary process. It takes time. Long-term commitment by all key actors involved is a must.

## REFERENCES

Adekunle, A. A., A. O Fatunbi, and M.P. Jones. 2010. How to set up Innovation Platforms. A Concept Guide for the Sub-Saharan African Challenge Program (SSACP). Forum for Agricultural Research in Africa, Accra, Ghana.

Agyemang, K. 2007. Innovation Systems Concepts and Principles and their Application to Integrated Agricultural Research for Development (IAR4D): Personal Views and Perspectives, May.

Alston, J. M., P. G. Pardey, and R. R. Piggott. 2006. Synthesis of Themes and Policy Issues. In *Agricultural R&D in the Developing World: Too little, too late?* J. M. Alston, P. G. Pardey, and R. R. Piggott, eds. Washington, DC: International Food Policy Research Institute.

Anandajayasekeram, P. 2000. The History of FSR Training in East, Central and Southern Africa. In *A History of Farming Systems Research*, M. Collinson, ed. Wallingford, UK: CABI.

Anandajayasekeram, P., and B. Gebremedhin. 2009. *Integrating ISP and VC Analysis in Agricultural Research for Development: Implications and Challenges.* Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project. Working Paper 16. Nairobi: International Livestock Research Institute.

Anandajayasekeram, P., and T. Stilwell. 1998. *Institionalization of Farming Systems Approach in Eastern and Southern Africa*. Harare, Zimbabwe: FARMESA.

Anandajayasekeram, P., J. Dijkman, S. Workneh. 2005. ISs Approach and its Implication to Agricultural R&D. Presentation at the *Southern and Eastern African Association for Farming Systems Research-Extension (SEAAFSRE),* Lilongwe, Malawi, September19–21.

Anandajayasekeram, P., R. Puskur, and E. Zerfu. 2009. *Applying Innovation System Concepts in Agricultural Research for Development: A Learning Module.* Nairobi: International Livestock Research Institute.

Arnold, E., and M. Bell. 2001. Some New Ideas about Research for Development. In *Partnership at the Leading Edge: A Danish Vision for Knowledge, R&D*. Danish Ministry of Foreign Affairs.

Bean, R., and R. W. Radford. 2002. *The Business of Innovation: Managing the Corporate Imagination for Maximum Results*. New York: AMACOM.

Beintema, N., and G. J. Stads. 2011. African Agricultural R&D in the New Millennium: Progress for Some, Challenges for Many. IFPRI Food Policy Report. Washington, DC: International Food Policy Research Institute.

Bennett, A., 2008. Up-scaling Knowledge and Innovation for Development. Paper presented at the International Food Policy Research Institute conference, “Advancing Agriculture in Developing Countries through Knowledge and Innovation,” Addis Ababa, Ethiopia, April 7, 2008.

Biggs, S. 1989. *Resource-Poor Farmer Participation in Research: A Synthesis of Experiences from Nine National Agricultural Research Systems.* OFCOR Comparative Study Paper. The Hague: International Service for National Agricultural Research.

Blackswan. 2010. *The 3-Legged Stool of Innovation: Driving Innovation Success.* Blackswan Whitepaper Series.

Chema, S., E. Gilbert, and J. Roseboom. 2001. *A Review of Key Issues and Recent Experiences in Reforming Agricultural Research.* ISNAR Research Report 24. The Hague: International Service for National Agricultural Research.

Chesborough, H. W. 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.

Clark, N. G. 2002. ISs, Technology Assessment and the New Knowledge Market: Implication for the Third World Development. *Journal of the Economics of Innovation and New technology* 11 (4/5): 353–368.

Collinson, M., ed. 2000. A History of Farming System Research. Wallingford, UK, and Rome: CABI Publishing and Food and Agricultural Organization of the United Nations.

Drucker, P. F. 1998. The Discipline of Innovation. *Harvard Business Review*.

EC (European Commission). 1995. Green paper on Innovation. <http://europa.eu.int/en/record/green/gp002en.doc>.

Edquist, C., ed. 1997. *Systems of Innovation, Technologies, Institutions and Organizations.* London: Printer Publishers.

Elliot, H. 2004. *Systems Thinking, Commodity Chains and Agricultural Innovation Strategy*. Entebbe: Association for Strengthening Agricultural Research in East and Central Africa.

Elliott, E. 2008. Evolution of Systems Thinking: Towards Agricultural ISs. Paper presented at the International Food Policy Research Institute conference "Advancing Agriculture in Developing Countries through Knowledge and Innovation," Addis Ababa, Ethiopia, April 7, 2008.

Filipe, M. 2010. The Innovation Platform in Mozambique: Evidence from Chicualacuala and Changara. Project Report. Nairobi: International Livestock Research Institute.

Freeman, C. 1982. *The Economics of Industrial Innovation*. London: Frances Printer.

________. 1987. *Technology Policy and Economic Performance: Lessons from Japan*. London: Pinter Publishers.

Griffith, G. 2009. What Really Drives Profit? *Beef Bulletin* (Spring). Armidale, NSW, Australia: University of New England.

Hall, A. 2009. Better Research Communication: Will It Enhance Innovation and Impact? LINK News Bulletin (February–March). Maastricht, The Netherlands: United Nations University, MERIT.

________. 2010. Research Into Use: An Experiment in Innovation, LINK Look Editorial (March). Hyderabad, India: LINK.

Hall, A., L. Mytelka, and B. Oyeyinka. 2005. *ISs: Implications for Agricultural Policy and Practice.* ILCA Brief 2. Addis Ababa: International Livestock Centre for Africa.

Horton, D. E. 1990. Assessing the Impact of International Research: Concepts and Challenges. In *Methods for Diagnosing Research System Constraints and Assessing the Impact of Agricultural Research*. Vol. II, R.G. Echeverría, ed. The Hague: International Service for National Agricultural Research.

IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for Development) 2008a. *Synthesis Report.* Washington, DC: Island Press.

________. 2008b. Agriculture at a Crossroads: Summary for Decision Makers Sub-Saharan Africa. Washington, DC: Island Press.

IAC (Inter Academy Council). 2004. Realizing the Promise and Potential of African Agriculture. In *Science and Technology Strategies for Improving Agricultural Productivity and Food Security in Africa*. Amsterdam.

Kaplinsky, R., and M. Morris. 2001. *A Handbook of VC Analysis.* IDRC Working Paper. Brighton, UK: Institute for Development Studies.

Klerkx, L., and C. Leeuwis. 2009. Establishing and Embedding Innovation Brokers at Different Innovation System Levels: Insights from the Dutch Agricultural Sector. *Technological Forecasting and Social Change* 76: 849–860.

Lundvall, B. A., ed. 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.

Manuel, F. (no date). The Innovation Platform in Mozambique: Evidence from Chicualacuala and Changara, International Livestock Research Institute, Maputo, Mozambique.

Mapila, M., J. F. Kirsten, and F. H. Meyer. 2011. The Impact of Agricultural Innovation Systems Interventions on Rural Livelihood Outcomes. *Development Southern Africa* (March–June).

Markelova, H., R. Meinzen-Dick, J. Hellin, and S. Dohrn. 2009. Collective Action for Smallholder Market Access. *Food Policy* 34: 1–7.

Metcalfe, S. 1995. The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives. In *Handbook of the Economics of Innovation and Technological Change*, P. Stoneman, ed. Oxford: Blackwell.

Metcalfe, S., and R. Ramlogan. 2008. ISs and the Competitive Process in Developing Economies. Q*uarterly Review of Economics and finance* 48: 433–446.

Michelsen, H., and F. Hartwich. 2004. *University-Based Agricultural Research: A Comparative Study in Sub-Saharan Africa.* ISNAR Research Report 26. The Hague: International Service for National Agricultural Research.

North, D. 1995. The New Institutional Economics and Third World Development. In *The New Institutional Economics and Third World Development*, J. Harris, J. Hunter, and C. Lewis, eds. New York: Routledge.

OECD (Organisation for Economic Co-operation and Development). 1997. *National Innovation Systems*. Paris.

Oyelaran-Oyeyinka, B. 2005. Partnerships for Building Science and Technology Capacity in Africa. United Nations University, Institute for New Technologies (UNU-INTECH), Maastricht, The Netherlands.

Paterson, A., R. Adam, and J. Mullin. 2003. The Relevance of the National System of Innovation Approach to Mainstreaming Science and Technology for Development in NEPAD and the AU. Pretoria: New Partnership for Africa's Development.

Rajalahti, R., W. Janssen and E. Pehu. 2008. Agricultural ISs: From Diagnostic Toward Operational Practices. Agricultural and Rural Development Discussion Paper 38. Washington, DC: World Bank.

Reardon, T., C. B. Barrett, J. A. Berdegué, J. Swinnen. 2009. Agrifood Industry Transformation and Farmers in Developing Countries *World Development* 37 (11/ November).

Rich, K., A. Negassa, and B. Ross. 2008. Concepts, Applications and Extensions of VC Analysis to Livestock Products in Developing Countries: A Review and Research Agenda. International Livestock Research Institute, Nairobi, Kenya.

RIU (Research Into Use Programme: Supporting Innovation–Changing Lives, Malawi Strategy and Programme Design Team). 2007. Malawi strategy. Lilongwe.

Roseboom, H. 2004. *Adopting an Agricultural ISP: Implications for ASARECA's strategy.* Entebbe: ASARECA.

Rothwell, R. 1992. Successful Industrial Innovation: Critical Success Factors for the 1990's. *R&D Management* 22/3: 221–239.

Spielman, D. J.  2006. A critique on innovation systems perspective on agricultural research in developing countries. *Innovation Strategy Today* 2 (1): 41–54.

Sulaiman, V. R. 2008. Extension from an ISP. Paper presented at the IFPRI conference "Advancing Agriculture in Developing Countries through Knowledge and Innovation," Addis Ababa, Ethiopia, April 7, 2008.

Tenywa, M. M., K.P.C., J. B. Tukahirwa, R. Bruchara, A. A. Adekunle, J. Mugabe, C. Wanjiku, S. Mutabazi, B. Fungo, N. I. M. Kashja, P, Pali, S. Mapatano, C. Ngaboyisonga, A. Farrow, J. Njuki, and A. Abenakyo. 2011. Agricultural Innovation Platform as a Tool for Development Oriented Research: Lessons and Challenges in the Formation and Operationalization. *Learning Publics Journal of Agriculture and Environmental Studies* 2 (1): 117–146.

Ugbe, U. P. 2010. *What Does Innovation Smell like? A Concptual Framework for Analysing and Evaluating DFID-RIU Experiments in Brokering Agricultural Innovation and Development*. Research Into Use Discussion Paper 10. London: Department for International Development.

UNCTAD (United Nations Conference on Trade and Development). 2000. Strategies for Diversification and Adding Value to Food Exports: A VC Perspective. Geneva: UNCTAD/DITC/COM/TM/1.14.

van der Heijden, K. 1966. Scenarios: The Art of Strategic Conservation. New York: Wiley.

van Rooyen, A., and S. Homann, (no date). *Innovation Platforms: A New Approach for Market Development and Technology Uptake in Southern Africa.* Bulawayo, Zimbabwe: International Crop Research Institute for Semi-Arid Tropics.

________. 2008. Livestock Innovation Platforms for Market Development and Market-Led Technology Adoption. LILI Communication Output. Bulawayo, Zimbabwe: International Crop Research Institute for Semi Arid Tropics.

Wennin, K. B., and W. Heemskerk, eds. 2006. *Farmers' Organizations and Agricultural Innovations: Case Studies from Benin, Rwanda and Tanzania.* Bulletin 374. Amsterdam: Koninklijk Instituut voor de Tropen (KIT) Development Policy and Practice.

World Bank. 2006. *Enhancing Agricultural Innovations: How to Go Beyond Strengthening Research Systems.* Washington, DC.

________ 2007a. *First Phase of a Support Programme to the West Africa Agricultural Productivity Programme (WRAPP)*, Project Information Document, Report 43482. Washington, DC.

________ 2007b. *Cultivating Knowledge and Skills to Grow African Agriculture*. Washington, DC.

________. 2008. *World Development Report 2008: Agriculture for Development*. Washington, DC.

Wycoff. J. 2004. The Big Ten Innovation Killers and How to Keep Your IS Alive and Well. <http://www.thinksmart.com>.

## APPENDIX A. INTEGRATION OF ISP AND VCA WITHIN IAR4D PROCESSES

Although the innovation system can be defined and constructed at different levels, the most relevant innovation system is problem/intervention-based.[6] In practice innovation systems are constructed to solve "local" real world problems using a value chain approach in a diagnostic process that allows us to identify the priority problems needing to be addressed anywhere along the value chain. An innovation system can be constructed around these problems.

One of the key questions often asked by the researchers and research managers is how an ISP and VCA can be effectively integrated and applied in participatory AR4D processes. The key step involved in this integrated participatory research process, is outlined in Figure 7. One could have many intervention-based innovation systems within a single value chain. Problem/intervention-focused innovation systems are transient. Once the particular problem sequence is solved, the associated system can be dissolved. Depending on the nature of the problem, the relevant innovation system may be spatially unconstrained, cutting across national boundaries.

In terms of integrating innovation system and value chain analysis in the AR4D, the following points need to be kept in mind:

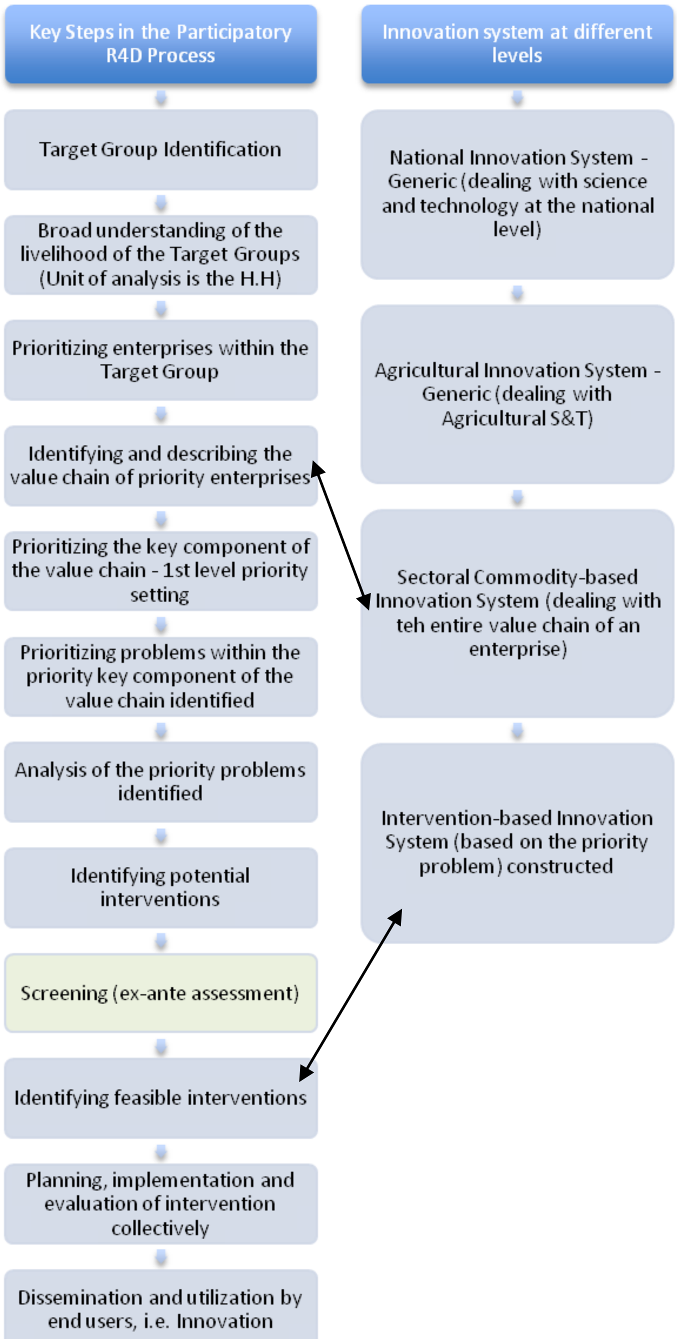
- Use the value chain of an enterprise as the unit of analysis and focus on innovation of the entire VCAs (as shown in Figure 5). The entry point for diagnostic purposes is still the household livelihood system of the target group.
- Identify the most binding constraint in the value chain that is inhibiting the exploitation of the its full potential. Rank the key components of the VC in terms of where the greater efficiency and impact could be achieved.
- Within the high-priority component (which offers the greatest opportunity) identify the various problems (options) and rank them. Note the two-stage ranking process.
- For the priority problem identified, brainstorm the potential options. Screen and identify feasible interventions. Depending on the availability of technologies and the level of confidence of replicability, the intervention may involve technology/knowledge generation, technology/knowledge adaptation, and/or scaling up and out.
- Construct an "innovation system" that is relevant to the priority intervention(s) identified. Use the innovation lens to identify the various stakeholders who need to participate to enable this intervention to become an innovation.
- Involve all the relevant key stakeholders in the planning process. Clearly identify the roles, responsibilities, resource commitment, reward sharing, rules of engagement, and so on.
- Implement the intervention collectively. Note that the roles of the individual stakeholder may change as the implementation proceeds. Make sure that the various stakeholders participate in the monitoring and ongoing evaluation process.
- Evaluate the performance and impact collectively.
- Document and disseminate results and plan for scaling up and scaling out.

To facilitate the effective integration, the capacity of all stakeholders along the value chain needs to be enhanced, and the necessary policy and institutional environments need to be created. This is a challenge focusing **on** the R&D practitioners and policymakers.

---

[6] For a more detailed discussion please see Anandajayasekeram, Puskur, and Zerfu 2009.

**Figure A1. Integration of R&D, value chains, and an innovation system perspective**




Source: Anandajaysekeram, Puskur, and Zerfu 2009.
Note: This is not a linear process; it is often characterized by constant iterative interactions and feedback loops, based on the "action–reflection–action" principle.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
sustainable solutions for ending hunger and poverty
Supported by the CGIAR

2033 K Street, NW | Washington, DC 20006-1002 USA
Tel: +1.202.862.5600 | Skype: ifprihomeoffice
Fax: +1.202.467.4439 | Email: ifpri@cgiar.org
**www.ifpri.org**

FORUM FOR AGRICULTURAL RESEARCH IN AFRICA

PMB CT 173 | Accra, Ghana
Tel: +233.302.772823
Fax: +233.302.773676 | Email: info@fara-africa.org
**www.fara-africa.org**

The Agricultural Science and Technology Indicators (ASTI) initiative compiles, analyzes, and publishes data on levels and trends in agricultural R&D investments, capacities, and institutional arrangements in developing countries. ASTI is managed by the International Food Policy Research Institute (IFPRI) and involves collaborative alliances with many national and regional R&D agencies.

Jointly convened by ASTI/IFPRI and the Forum for Agricultural Research in Africa (FARA), the conference, "Agricultural R&D—Investing in Africa's Future: Analyzing Trends, Challenges, and Opportunities," brought together experts and stakeholders from the region to contribute their expertise for the purpose of distilling new insights and creating synergies to expand the current knowledge base. The themes under focus were (1) why African governments under invest in agricultural R&D; (2) how human resource capacity in agricultural R&D can be developed and sustained; (3) how institutional structures can be aligned and rationalized to support agricultural R&D; and (4) how the effectiveness of agricultural R&D systems can be measured and improved.

The conference was funded by the Bill and Melinda Gates Foundation and FARA.