

## ENABLING AGRICULTURE: THE EVOLUTION AND PROMISE OF AGRICULTURAL KNOWLEDGE FRAMEWORKS

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### **Abstract**

*This paper reviews the evolution of different agricultural knowledge frameworks and assesses their different approaches to enabling agricultural development. We identify the strengths and weaknesses in early and current frameworks and discuss present trends in thinking about how best to promote innovation and rural development. The paper's practical purpose is to contribute to strengthening the foundation that donors and governments use for their planning and investments in developing effective knowledge systems to support rural development. The paper traces how four major international knowledge frameworks for enabling agriculture have evolved over time. Starting from investment in public institutes, inefficiencies and lack of sustainability led to pluralistic approaches to promote private sector participation in technology sub-systems. This latter trend continued with more comprehensive investments in knowledge and information systems responsive to client demands and is now moving toward an approach based on comprehensive (technical, managerial, and institutional) innovation systems. In reviewing the value and limitations of each of the four frameworks, we stress the importance of undertaking situational assessment of individual countries before investing in the reform and development of agricultural knowledge systems. Thus, we add our voice to those who argue that development is country-specific and path-dependent.*

### **Introduction**

Agricultural development depends on constantly improving existing practices and on the development and adoption of innovations. Promoting agricultural development in developing countries by investing in research and extension is a well-established approach. Indeed the international community has spent considerable resources in this field during the last decades, as is reflected by the World Bank, which from 1980 to 2001 invested over three billion US dollars in agricultural extension and two billion US dollars in agricultural research and 0.394 billion in agricultural education (World Bank 2004).

There are at least 100,000 agricultural scientists have been employed in public research institutions in the developing world (Pardey & Beintema 2001), at least 800,000 extension agents (Anderson & Feder 2002:2), and about 1600 agricultural universities in developing countries (World Bank 1999).

A recent review of 289 studies of economic returns to agricultural research and extension found an average rate of return of 80 percent for both extension and research investments (Evenson 1997 and Alston *et al.* 2000). In spite of such impressive rates of return, evaluations have often criticized extension programs for low efficiency and lack of equity in service provision (Evenson 1987) and research institutions for inefficiency, irrelevance and lack of sustainability (Beye 2002). In view of the large investments made in agricultural research and extension but only minimally in agricultural education, as indicated above, the performance of these systems and the frameworks used to evaluate and develop these systems is critical if agriculture is to meet the challenges of the 1<sup>st</sup> century.

### **Purpose**

The paper reviews the concept of frameworks and then examines in sequence four major frameworks utilized by international organizations: (1) the National Agricultural Research Institutes approach (NARI), (2) the National Agricultural Research Systems approach (NARS, which covers all three knowledge systems – the National Agricultural Research System, the National Agricultural Extension System, and the National Agricultural Education and Training System), (3) the Agricultural Knowledge and Information System for Rural Development approach (AKIS/RD, which seeks to link the three knowledge systems more closely), and (4) the Agricultural Innovation System approach (AIS).

The need to invest in agriculture to achieve food security and promote agriculture as an engine of pro-poor growth in low-income countries is high on the agenda of international development agencies and developing countries. It is against this background that the present paper re-examines the frameworks that propose to enable agricultural development.

### **Evolution of the Frameworks**

#### *The Framework Concept*

Frameworks are conceptual models that structure reality. A framework identifies the elements that are considered relevant and specifies their relative importance and relations. As such, a framework represents the mental model of how reality is perceived.

Frameworks tend to evolve as conceptualizations, such as the NARI and the NARS systems, and then become subject to academic research. They may also evolve in the academic writings of a particular discipline, such as the National System of Innovations (NSI) industrial framework, and then find their way into different communities of practice, in this case: agriculture. Frameworks are also embedded in wider paradigms, as agricultural knowledge frameworks are embedded in the modernization paradigm that stresses the primacy of modern science, and the post-modern paradigm that acknowledges pluralistic sources of knowledge.

Frameworks are used by development agencies to guide interventions and investment. Therefore, the adoption of a framework by development agencies also has a political dimension. During the last 50 years, a variety of frameworks have appeared, characterized by different acronyms. We discuss four of them in this paper. These four gained importance on an international level because they were used by the major international organizations promoting agricultural

research and development, most notably by the World Bank, the FAO, and the International Food Policy Research Institute (IFPRI).

## **THE FRAMEWORKS**

### **The National Research Institutes Framework**

#### *Overview*

Starting in the 1950s and 1960s world population increases and fears of famine provided an impetus for major investments in agricultural technology to increase food production. Initial investments focused on building public sector research departments/institutes (NARIs) and extension services. Many agricultural universities were established or strengthened during this period. It was thought that the durable solution for improving agricultural performance lay largely in the transformation of agricultural research through effective National Agricultural Research Institutes capable of creating productivity enhancing technologies.

Then as now, economic research provided theoretical justification for public sector involvement in research and extension, pointing to its public goods character and the problem of market failure in this field, as well as to the reasonable and often high rates of return associated with these institutions (Evenson 1987, 1997; Byerlee & Traxler 1995).

Most investments in agricultural research and development guided by the early NARI framework went into “bricks and mortar” facilities and into building human and institutional capacity in the public sector to drive innovation in agriculture. Due to the early successes of this institutional approach, development of the NARI institutional structure became the dominant framework for decades and continues even today.

#### **Achievements**

Even though the achievements of the Green Revolution continue to be debated, the fact remains that where successful, it contributed considerably to improving food security and to promoting agriculture as an engine of economic development (Borlaug & Dowsell 2001; Evenson & Gollin 2003; IFPRI 2005). The experience with this framework showed that public investment in agricultural research and extension can be very effective, especially in the food staples sector, which is less attractive to the private sector than export-oriented crops. This experience also energized further investments by donors in public agricultural research and extension systems.

In deriving lessons from the early framework, it needs to be acknowledged that some nations proved more prepared than others to promote agricultural sector innovation through public sector agencies, especially those that started with greater physical, infrastructural, financial and skilled human resource endowments. Even early findings gave proof that there is no blue-print solution, that approaches need to be country specific -- that systems and solutions effective in one place may not be successful or even possible in another.

#### **Limitations**

The approach focusing on the NARI institutes was firmly grounded in the modernization paradigm, which emphasizes the supremacy of modern science and technology. A major limitation of this approach can be seen in its “top-down” nature. International and national research institutes were considered to be the centers of developing new technologies, and extension was seen as a “pipeline” for one-way channeling of information to the farmers, who were considered as the “end of pipe recipients” of new technologies. The notion of the farmers as

“backwards” and in need of instruction and education prevailed, at least until Theodore Schultz (1964) recognized farmers in developing countries as “poor but efficient” and marked a change in thinking on the perception of farmers.

The goals of the NARI institutes were focused on production increase only, environmental objectives and equity considerations were not yet prominent on the policy agenda. Consequently agricultural research, extension and education did not pay attention to these issues, which resulted in some of the problems associated with the Green Revolution and its lack of concern about environmental sustainability and equity. In Africa the NARIs eventually fell into various sorts of crisis: funding, lack of incentives to perform, crisis in priorities -- ambitiously developing new technologies instead of just screening and adapting technologies developed elsewhere to local conditions and in overly centralized procedures (SPAAR 1999).

### **The National Systems Framework: NARS, NAES and NAETS**

#### *Overview*

Beginning in the 1980s, the approach to promoting agricultural technology generation and dissemination was broadened. The NARS framework was instituted, comprised of many and diverse components including National Agricultural Research Institutes (NARIs), universities (private and public), and those elements of the private commercial sector, farmers organizations and NGOs involved in research and extension, started to gain acceptance.

During the 1980s, the World Bank, the Consultative Group for International Agricultural Research (CGIAR), the Food and Agriculture Organization (FAO), and other international agencies began to shift their agricultural development emphasis toward system approaches that involved a wider range of institutions in technology programs. Private sector firms, NGOs, farmer organizations, and universities were recognized as legitimate partners and participants in a National Agricultural Research Systems (NARS) that included National Agricultural Extension Systems (NAES) and National Agricultural Education and Training Systems (NAETS).

#### **Achievements**

Large investments have been made in the NARS and NAES (see Figure 1) and to a lesser extent in the NAETS. NARS and NAES made use of capabilities established under earlier investment in the national institutes, employing under-utilized laboratories and other facilities and under-employed scientists and technicians with support from the private sector and users.

Reforms that resulted in the involvement of other, usually private, institutions in technology programs brought several benefits. First, the inclusiveness of NARS enlisted more scientists and technicians from universities, NGOs, private firms, and other institutions more directly and legitimately in promoting innovation and technical change. This brought in additional funds, though usually less than expected. Improved linkages between researchers, extension personnel, and educators in different institutions helped to reduce duplication of efforts and encouraged sharing of experience and best practice. The real or presumed competition between institutions for funding, recognition, and client impact – while sometimes a negative factor – probably has served to improve program performance (FAO 1997).

#### **Limitations**

A funding crisis and the reduction of public expenditure that occurred in the 1980s affected almost all the specialized institutions dedicated to agricultural research and extension,

including national institutes and universities. Structural reforms, global market development, and the deregulation of national economies, combined with urban growth, have created new technological demands related to improving quality and competitiveness. Research in developing countries has generally been unresponsive to the changing patterns of demand for AET (agricultural education and training), as well as for new and applicable technologies. Declining donor funding in the early part of this 21<sup>st</sup> century and the conservatism of many NARI and NAET institutions contributed to limiting the development of pluralistic NARS systems.

### **The Agricultural Knowledge and Information System (AKIS) and the AKIS/RD Framework**

#### *Overview*

The recognition of the three national knowledge systems gave rise to a new nomenclature, the Agricultural Knowledge and Information System (AKIS), which developed in the 1980s and gained wide acceptance among development agencies in the 1990s. AKIS put forward a more integrated concept – stressing the important connection among the three knowledge systems, viewing them as part of an agricultural knowledge system “triangle”. This framework also extended beyond public sector institutions to include the existing stock of agricultural knowledge and all those involved in generating and disseminating knowledge.

The AKIS concept emerged as a guiding framework for conceptualizing agricultural knowledge systems. In contrast to the efforts to build separate National Systems (NARS/NAES/NAETS), the AKIS concept was intended to promote linkages among and between knowledge institutions and with existing and potential end-users of agricultural knowledge. The AKIS concept was a logical extension of the NARS/NAES/NAETS sub-systems.

In the late 1990s, the AKIS framework was revisited as an essential contribution not just for agricultural development, but also more broadly to rural development (RD), and began to be referred to as AKIS/RD. In 2000, the FAO and the World Bank jointly published a seminal document: *AKIS/RD: Strategic vision and guiding principles*, and the concept of AKIS/RD began to be widely accepted. An effective AKIS was seen as responding “to the technological, knowledge and information needs of rural people, to help them reach informed decisions on the better management of their farms, households and communities (FAO/World Bank, 2000)”

#### *Origins*

The AKIS framework had been conceived as early as the end of the 1970s by extension specialists who highlighted the inappropriateness of perceived “one-way” knowledge flow from the research center to the farmers (Nagel 1979). Bunting (1986:46) and Röling (1987:13) further advanced this concept in the mid-1980s, which aimed to make the disparate functions of research, extension and utilization work more synergistically.

Even in the early 1970s it was suggested that the agricultural knowledge systems coordinate knowledge from all the various agricultural development institutions. Although focused at that time toward the public sector, the concept of *Agricultural Development Knowledge Systems* (Axinn & Thorat 1972) envisioned knowledge flowing not only *from* research, education and extension (and *through* extension) but also from sources regarding supply and credit institutions as well as markets (see also Rivera & Schram 1987; Rivera & Gustafson 1991). Axinn and Thorat (1972) stressed linkages and the flow of information to farmers throughout the agricultural development process, not just within the “triangle” of agricultural research, extension and education. As Janssen noted

(1994), the impact of agricultural research policy can be evaluated “only in relation to other policies.”

### *Elements and Principles of the Framework*

Coordination among the agricultural knowledge systems of research, extension and agriculture has long been a concern and goal of development agencies. Viewed as “the agricultural knowledge triangle” some authors recommend that agricultural research, extension, and education receive complementary investments (Eicher 2001). Eicher argues that these three pillars should be planned and sequenced as a system rather than as separate entities, and should be responsive to global change and the demands and needs of clientele.

The “triangle” concept represents a change in perceptions about the role and relative importance of the different institutions. Earlier frameworks considered agricultural research as the locus where new technologies were developed, and extension was the “pipeline” for transferring the new technologies, with the farmer as the recipient at the end of the pipeline. In the triangle approach, the farmers are placed in the center, and agricultural research, extension and education appear as equal partners in the mental model underlying this approach.

Institutional pluralism and stakeholder participation are important factors in rural transformation and in facilitating conditions for effective research and extension, as well as for empowering people for their own development (Binswanger 2004). The key element of this model lies in the central role of the producer and producer organizations, in voicing demands for research, extension, and education to drive innovation. To enable these conditions, political and macroeconomic climates are needed to encourage the formation of local groups, such as administrative and fiscal decentralization of government agencies, and procedures to allow rural people a voice in the processes of planning and other relevant management decisions (Farrington 1999). “Participation”, “demand-driven”, and “market orientation” are elements emphasized by this approach.

In the late 1990s, another dimension was added in promoting the shift from an AKIS to an AKIS/RD framework. The FAO and the World Bank re-envisioned AKIS as “an integrated approach to agricultural education, research, and extension with a view to responding to the technological, knowledge and information needs of rural people, to help them reach informed decisions on the better management of their farms, households and communities” (FAO/World Bank 2000). AKIS was seen as an aspect of rural, not just agricultural, development and this expanded concept was adopted, outlining a strategic vision and guiding principles for designing AKIS/RD systems. The thrust of the vision is to reduce poverty by promoting gains in agricultural productivity, and ensuring food security and environmental sustainability in developing countries.

Following the publication of *AKIS/RD: Strategic vision and guiding principles* (FAO/World Bank 2000), the FAO convened AKIS/RD workshops in 10 different countries (from 2000-2003), and as follow-up in 2004 commissioned a comparative study of ten country case studies on AKIS/RD (Rivera & Qamar 2005). The Organization of Economic Cooperation and Development (OECD) undertook a comparable effort, supporting linkages among agricultural knowledge systems. In 2000, OECD organized a major conference to discuss their agricultural knowledge systems (AKS). Representatives from agricultural research, education and extension institutions – together with government officials with authority to formulate AKS policy – stressed the opportunities for AKS to address the wider societal issues associated with

agriculture (OECD 2001). In this scenario the planning and sequencing of AKS as a single system is seen as ever more imperative.

### **Achievements**

In addition to its accelerated promotion of linkages between the different systems that support knowledge flows, a major achievement of the AKIS framework is its appreciation of the farmer and other stakeholders as central actors in the development and diffusion of innovations, rather than as “end of pipe” recipients.

Extension is afforded a significant and quite broad purpose in AKIS and AKIS/RD, one that goes beyond dissemination of agricultural information and technology to include education. Extension is viewed as a non-formal education system paralleling the formal education system, as well as providing technology and information to farmers and farm families. Innovation results from research only if there are channels to the potential clients of the research work. In his paper on the “re-discovery” of extension as a “key player,” Nagel (2005) points out that the central question is not which reforms are better than others but rather which reforms help to achieve which societal objectives. If poverty reduction is the goal, then governments should play a strong role in strategy and policy formulation (Farrington, Christoplos & Kidd 2002).

Ultimately, the adoption of AKIS/RD as a nationwide concept and general practice depends on government interest and determination to foster agricultural knowledge and information for the contribution it can make to the national economy and more particularly to growth and equity in the rural sector. Several governments are moving in this direction, as noted in the FAO’s comparative study of ten country case studies on AKIS/RD (Rivera & Qamar).

### **Limitations**

Since the 1960s, there are more stakeholders in the agricultural development field, most prominently the private sector, and not least the private-sector farmers whose interests more than ever demand attention. As a result, there is a need to involve these various stakeholders in knowledge exchange, and to facilitate the development of innovations, both technical and managerial. AKIS/RD, however, does not specifically provide this kind of “mapping tool” organized around problems and commodities, but rather puts the onus on the developing countries to determine what agro-ecological zones, commodities, and social innovations to pursue. . The framework does not specifically seek to promote the resolution of problems and advance the production of selected commodities. The framework concentrates on organizations, their functions, and their strategic alignment while under-emphasizing the importance of particular, for instance high-value, commodities or sub-sector problems.

## **The Agricultural Innovation Systems (AIS) Framework**

### *Overview*

The Agricultural Innovation System (AIS) framework was developed in the 1990s, based on the National Innovation System (NIS) industrial approach, which emerged in evolutionary economics and gained wide acceptance in science policy in industrialized countries at that time (see Balzat and Hanusch, 2004, on sector aspects of NIS). By the early 2000s, the Agricultural Innovation Systems (AIS) framework started to gain increasing attention in the international development community. While stressing the need for linkages, AIS moves “innovation” to the center of attention and stresses a wide range of stakeholders and pluralistic networking among agriculturally relevant institutions.

### *Origins of the Framework*

The AIS literature has so far mostly used the innovation systems concept to emphasize the need to acknowledge linkages between different types of actors to explain particular innovation processes (Hall *et al.*, 2001; Hall *et al.*, 2003; Ekboir & Parellada 2002; Hall *et al.* 2004). More recently AIS has been used might best be that of a “mapping tool” to determine where innovations might best be developed (Pehu 2005; USAID 2005).

Articles published on AIS also reveal that this framework did not evolve as a further development of the AKIS framework, but rather as a parallel development which did not build upon the insights of the AKIS literature and the practical experience in applying this framework. One reason for this parallel rather than consecutive development may be due the fact that, considering the background of the leading authors, AKIS/RD evolved from the extension perspective, while AIS was developed from a research perspective.

### *Definition of Innovation*

Although not all of the studies promoting the innovation systems frameworks define the concept of innovation (see, e.g., Hall *et al.*, 2001; Hall *et al.*, 2003, Hall, Yoganand, *et al.* 2004;), they generally imply a rather wide definition of innovation, such as the OECD definition quoted by Ekboir and Parellada (2002: 138), *viz.*: “Innovation is defined as anything new introduced into an economic or social process.” Basically, an innovation is “the ability to use knowledge creatively in response to market opportunities and other social needs.” It does not matter whether this is new to producers, competitors or the economy.

What renders AIS distinct from previous systems is its emphasis on innovations related to value added commodities, integrated supply chains and market chains. Supply chain development strategies are common, especially as applied to high value products and export markets. These strategies look at the whole range of functions within a commodity sub-sector from input supply to production to marketing and processing. This serves as a basis for identifying key constraints and opportunities to increase productivity and profitability.

“The growing economic importance of knowledge has forced many analysts to revisit the concepts underpinning our understanding of the ways it is produced and used” (Hall 2002). The AIS framework seeks to foster the integration of research and education systems, as well as develop public-private partnerships, develop and strengthen farmer organizations, establish technology transfer units, build decentralized regional innovation centers, and implement new governance models for research and extension.

### **Limitations**

The newly conceived AIS framework being promoted by ISNAR (2005) and the World Bank (2005) is intended to provide the main framework for policy and institutional research, embracing as it does the institutional pluralism prominently espoused and promoted in the current international literature and to revive the notion and importance of “innovation” as a change catalyst for development. While innovation has always been the keystone purpose of agricultural research, extension and higher education, the AIS concept proposes to advance various types of innovation – technical, attitudinal, managerial, organizational – and involve all relevant institutional, organizational and individual actors in the agricultural domain – public, private, and third sector. It is an important conceptual innovation in and of itself.

The lack of a tested approach to investing in a comprehensive AIS and the uncertainty of implementing system-wide inclusiveness restrict the current value of the AIS which Hall (2004) suggests may eventually not only “diagnose or evaluate existing arrangements and circumstances [but] even identify intervention points.” The innovation systems concept – that Hall *et al.* (2000), Nelson (1993), and Lundvall (1992) describe – will need to be transformed from an analytical concept into a workable operational concept, from analysis and evaluation into implemented mechanisms to strengthen agricultural innovation. AIS institutional mechanisms can then contribute to fostering the integration of research and education systems, developing public-private partnerships, developing and strengthening of farmer organizations, establishing technology transfer units, building decentralized regional innovation centers, or implementing new governance models for research and extension.

#### *Achievements*

While the AIS approach does not yet guide or promote analytic thinking distinct from what is already known from other frameworks, it does point up the over-whelming complexity of a multi-functional, institutionally pluralistic system of agricultural development in an increasingly globalized world. It will be interesting to track how the AIS as a framework for planning investments, confronts the all-embracing nature of the concept.

#### **Educational Implications and Application**

The four frameworks examined underscore the fact that effective knowledge systems for enabling agricultural development generally require (1) a core capacity in public sector technology institutions that (2) promote pluralistic (sector-wide) research systems and pluralistic (i.e., sector-wide) extension and information services that are (3) strategically aligned in knowledge and information systems for *that increase coordination* and respond to client demands (4) to advance innovation fostered by a facilitating policy and institutional environment.

We conclude that capacity strengthening, system coordination, and the promotion of interconnectedness between public and commercial institutions to promote innovations are the fundamental elements of a comprehensive knowledge system, essential though not sufficient, for the advancement of agricultural development.

In the final analysis, any investment program to advance a pluralistic national agricultural knowledge system must ascertain that there is the *political will* to promote agriculture in general and agricultural knowledge systems more specifically; an *institutional environment* that is conducive to the flow of knowledge, to collaboration, experimentation and implementation of innovations; a *well articulated demand for new knowledge and technology*; and the *effective supply of new knowledge and technology*, from the public research system as well as from other sources, including indigenous knowledge, private sector research and transfers from abroad (Alex 2004).

This review of the evolution and promise of previous and present agricultural knowledge systems and frameworks is intended to be a step toward helping to clarify the most important elements associated with frameworks for guiding agricultural knowledge systems and enabling agricultural development.

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