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Building an Agricultural Research for Development System in Africa

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Abstract

This paper discusses how impact-oriented agricultural research for development systems in Africa can be better organized and managed. Specifically, the paper puts forth the argument that achieving the development targets set by African leaders and the international community, for example, through the Millennium Development Goals, will be extremely difficult without a satisfactory re-orientation of the organization and management of African research for development systems. Such a re-orientation involves carefully linking the agricultural research agenda with national development priorities; improving coordination, interaction, interlinkages, partnerships, and networks among system agents—that is, agricultural research institutes, extension systems, higher education institutions, farmer organizations, civil society, and the private sector—and finding innovative financing and resourcing mechanisms to support the numerous components of the system.

Keywords: Agricultural research for development, Organization and management of agricultural research, Africa

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1. Introduction: Agriculture and Economic Development in Africa

Agriculture remains the backbone of many African economies. It accounts for 57 percent of total employment, 17 percent of gross domestic product (GDP) and 11 percent of export earnings in Africa (FAO 2005). But agricultural productivity on the continent continues to raise serious concerns. At present, many countries barely achieve 1 percent annual growth in agricultural output. A recent study by the InterAcademy Council (IAC 2004) observes that the impact of investments in agricultural research has been relatively weaker in Africa than elsewhere, a finding supported by the United Nations Economic Commission for Africa (UNECA 2005, 9):

> *Many African indigenous food crops and animals on which 80 percent of the African population depends, have reaped few benefits from modern R&D on their breeding improvements, agronomy, processing and commercialization.*

The consequences of this have been catastrophic. A continent primarily inhabited by farmers has been unable to feed its people. Over 28 percent of the population (or 200 million people) are classified as chronically hungry (FAO 2005), and 4 in 10 Africans live on less than one U.S. dollar per day (UNECA 2005). Sub-Saharan Africa is the only region in the world where per capita food grain output has declined over the past four decades, requiring it to depend on imports for 25 percent of its food grain requirements (Hazell et al. 2003; UNECA 2005). African agriculture is undercapitalized, uncompetitive, and underperforming; it is characterized by relatively low yields, overdependence on primary exports, and high price volatility (Hazell et al. 2003; FAO 2005). The region's competitiveness in its traditional areas of comparative advantage is increasingly being eroded by technological innovations in the rest of the world and by increased globalization, which is squeezing both its internal and external markets (UNECA 2005). Africa's share of global export trade fell from 5.9 percent in 1980 to under 2 percent at the end of the 1990s, while its share of global value-added in

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manufacturing declined by half, from 0.6 in 1970 to 0.3 percent in the 1990s (UNECA 2005, 5).

To address this situation and reduce poverty and food insecurity, African leaders have set a target of increasing agricultural output by 6 percent per year over the next 20 years. The New Partnership for Africa's Development (NEPAD) estimates that achieving just half this target—that is, 3 percent annual agricultural growth—will require, among other factors: (a) accelerated adoption of the most-promising available technologies so as to support immediate improvement of African production by linking research and extension systems to producers more efficiently; (b) technology delivery systems that quickly bring innovations to farmers and agribusinesses; (c) enhanced capability on the part of agricultural research systems to effectively and efficiently generate and adapt to African indigenous knowledge systems and new knowledge and modern technologies, such as biotechnology, which is necessary for increasing output and productivity while conserving the environment; and (d) mechanisms that reduce the costs and risks of adopting new technologies (FAO 2002).

This paper presents the argument that it will be extremely difficult to achieve the targets set by African leaders, such as via NEPAD, or those of the international community, for example, through the Millennium Development Goals, without

1. carefully linking the research agenda with national development priorities;

2. increasing coordination, interaction, interlinkages, partnerships, and networks among the various agents associated with African research for development systems; and

3. securing innovative financing and resourcing mechanisms.

More impact-oriented and integrated agricultural research for development (AR4D) systems will help to catalyze agents of agricultural innovation in Africa and support them

in attaining the necessary development targets. This paper examines how this re-orientation of the system can be achieved.

2. Problems with Scope, Scale, and Resources in the "Old" Paradigms of Agricultural Research in Africa

The original structural features of African national agricultural research systems NARS (including agenda-setting mechanisms) were established by colonial governments.[1] Consequently, they tended to be narrowly focused, often concentrating on the production of export crops for use as "raw materials" European industries (Lynam and Elliot 2004). With independence, these systems were adjusted to include the integration of African smallholders into commercial agriculture and to address the needs of subsistence farmers. This dual focus remained the defining characteristic of African NARS until structural adjustment programs, beginning in the 1980s, attempted to introduce change (Lynam and Elliott 2004; Mbabu et al. 2004). As a result, Africa's agricultural R&D system remained fragmented. Universities and faculties of agriculture developed independently of the research system so that research was limited to station trial and organized along disciplinary lines, and little effort was made to link university research with agricultural research institutes, national extension services, the private sector, and users—especially farmers and consumers (Chema, Gilbert, and Roseboom 2003; Lynam and Elliott 2004). Even within Ministries of Agriculture, which were the primary focus for agricultural research, different divisions tended to develop their own capacities and compete with other departments rather than following a demand-driven agenda and letting that agenda drive expansion (Lynam and Elliot 2004). For these reasons, the resulting national agricultural research systems did not promote demand-driven, impact-oriented innovation.

[1] The characteristics of African NARS largely grew out of the mandates, visions, and agendas of national statutes and development plans on which they were based. Thus, many of the agendas were crop-specific, and many were rigid, reflecting state-led approaches to development in many African countries prior to the structural adjustment programs of the early 1980s onwards.

These conditions are exemplified by the situation in Kenya, which has the third-largest NARS in Sub-Saharan Africa, after Nigeria and South Africa (Lynam and Elliott 2004). Until the early 1980s, Kenya's agricultural sector was celebrated as one of the most successful in the region (Bates 1989; Lofchie 1989). Early postcolonial successes in agriculture are often traced to the Swynnerton Plan of 1954 (Bates 1989; Ochieng 2005). Named after its lead author (Roger Swynnerton, the Assistant Director of Agriculture at the time) the plan laid the foundation for the national agricultural innovation system in postcolonial Kenya.[2] It set in place institutional, organizational, technological, and policy innovations that have since dominated postcolonial Kenyan agriculture, including private rights to land, contract farming, public–private partnerships, and politico-economic organizations and management of agriculture.

Ochieng (2005) has argued that, while these innovations were successful in integrating smallholders into commercial agriculture as primary commodity producers, such innovations were not geared toward agricultural value-added or value innovation. To illustrate, despite Kenya's being the third-largest NARS in Sub-Saharan Africa, its agricultural value-added is no better than many African countries with relatively smaller systems (World Bank 2002). It is not that the Swynnerton Plan failed to create a successful agricultural innovation system—the plan succeeded in achieving exactly the kind of system intended (Thurston 1987)—but rather the postcolonial Kenyan state lacked the strategic foresight to build on the innovative successes of the plan to achieve a

[2] The Swynnerton Plan was a response to the Mau Mau war of independence. It had twin political and economic objectives: to ensure political stability in the colony by creating a class of yeomen African farmers, whose prosperity would not only lead to allegiance and support for the status quo, but also quell potentially rebellious or radical landless Africans who would be employed as wage laborers. The plan went beyond simple legalization of African production of high-value cash crops to seek two fundamental objectives. The first was the promotion of African commodity production through the provision of administrative and technological services, such as agricultural research programs, marketing boards, and crop authorities to facilitate the uptake of new crops and credit schemes for which private land would serve as collateral, enabling cash-strapped farmers to enter the production of high-value export crops. The second was the establishment of private land-ownership rights, which were viewed as a means of internalizing the benefits of innovative activities and providing economic incentives for agricultural productivity increases, solving what was regarded as chronic and costly litigation arising from the customary land tenure system. In effect, the plan sought to establish both market and state support for the commercialization of African agriculture (Ochieng 2005).

shift from integrating smallholders into commercial agriculture as producers of primary commodities to a much more integrated, value-added agro-industrial orientation (that is, the system lacked a value chain or "farm to fork" approach, at least until the early 21st century. In the absence of this strategic foresight, the technological, institutional, organizational, and policy innovations of the agricultural innovation system created by the Swynnerton Plan became a constraint, limiting further development of Kenyan agriculture beyond its narrow specialization in traditional commodity production.

Many African NARSs grew out of strategies similar to the Swynnerton Plan, with the result that they have faced similar limitations to those of Kenya. Agricultural innovation is a complex process, the outcomes of which are typically uncertain. Success requires the management and reduction of technological, commercial, organizational, and social uncertainties—that is, approaches must be demonstrably feasible. Teece (1986) has argued that even if a new product or process is technologically viable, there is no guarantee that the innovator will appropriate the benefits of the innovation. The development and exploitation of technology should thus be congruent with the overall strategy and capabilities of the firm (Martin and Hall 2005), and it must recognize and accommodate potentially detrimental side effects for secondary stakeholders and society as a whole (Popper 1959).

Organizing and managing systems of innovation is a crucial part of the process. Technological innovation has the potential to generate novel (often difficult-to-imitate) organizational competencies that can lead to a competitive advantage (Penrose 1959; Martin and Hall 2005) or disrupt competency along the value chain (Tushman and Anderson 1986; Christensen 1997). The challenge facing African NARSs is how to organize and manage systems to promote impact-oriented innovation in an increasingly competitive world. This calls for an organizational "value logic"—that is, a business model or the methodology for creating value within an organization (Accenture 2005), which African agriculture severely lacks.

As discussed above, the structure of African agricultural R&D systems is generally antithetical to the encouragement of client responsiveness and organizational collaboration and partnerships; it therefore lacks impact orientation. For the most part, these systems have operated with little, if any, systemic linkages, either within or among institutions (Chema, Gilbert, and Roseboom 2003; Lynam and Elliott. 2004). The IAC report (2004) noted that the Ministry of Agriculture was primarily responsible for agricultural research in 44 of 54 African countries, while the Ministry of Science was the responsible agency in the remaining 10 countries. Within these ministries, several separate departments were responsible for individual components of the national agricultural research system, making coordination difficult. Overall, government research agencies (mainly national agricultural research institutes or NARIs) represented 81 percent of the total research capacity of African NARS; universities were responsible for 18 percent, and the private and the nonprofit sectors together accounted for 1 percent (IAC 2004).

Typically, linkages between agencies are either weak or nonexistent, although research has shown that the returns to investment in agricultural research, extension, or higher education in a specific core agricultural subsector would be higher if investments were coordinated and sequenced (IAC 2004). The IAC report argues that this requires an organizational structure that facilitates linkages and interactions among complementary institutions, as well as a reward structure that encourages managers, scientists, and academics to communicate and cooperate. Increasingly, donors are pushing for such systemic interactions and linkages, for example, through competitive grant systems that prioritize collaboration across organizations (Chema, Gilbert, and Roseboom 2003). Thus, much is currently made of public–private research partnerships, regional (commodity) research networks, and research–farmer–extension linkages. IAC (2004) has argued that the weak or nonexistent linkages within the African NARSs represent a failure to exploit possible synergies, despite the acknowledged human, physical, and financial constraints facing these systems.

This paper is an attempt to frame an appropriate organizational structure and value logic for African NARSs. Drawing significantly from business literature, it presents a number of suggested mechanisms, highlighting current system gaps and opportunities for synchronization from the perspective of scope, scale, and resourcing.

Most African NARSs are still in the phase described by Rothwell (1994) as the first generation of innovation: the push for technology. This was the foundation of the industrial revolution; innovation came with new, technologically advanced products and means of production, which were pushed into the market (Terziovskim, Samson, and Glassop 2001). This approach to innovation is largely supply driven. In African agricultural R&D systems, it has seen scientists developing plant varieties and production techniques that are then disseminated to farmers as end users. Increasingly, donors have been prompting these systems to move into the second generation of innovation: the need or demand pull (Chema, Gilbert, and Roseboom 2003). The focus at this stage is consumer or market determined needs. Thus, nearly every African NARI now has a market-orientation approach, which typically manifests itself in the creation of socioeconomics and postharvest departments.

While African NARSs have been grappling with mastering this second generation of innovation, much of the world has already moved through the third, fourth, and fifth generations (see Rothwell 1994). The third generation of innovation combines the first and second generations in a push–pull relationship (Terziovski, Samson, and Glassop 2001, 2):

> *The market might need new ideas, but production technology refined them. Alternatively, R&D developed new ideas that marketing refined with market feedback. R&D and marketing were linked*.

In turn, the fourth generation integrates marketing, R&D activity, suppliers, and leading customers whilst the fifth generation involves broader systems integration and networking models, including strategic partnerships with suppliers and customers, and

collaborative marketing and research arrangements (Terziovski, Samson, and Glassop 2001).

This is where the concept of "the logic of organizational value" in organizing and managing an integrated African agricultural R&D system comes in. There is no compelling reason why Africa should spend time cycling through each successive generation of innovation. In order to arrest the loss of its competitive advantage in traditional markets and create new market space for both traditional and new products—as exemplified by new product development in cassava and sweet potato, among other crops—Africa must actually leapfrog to the fifth generation of innovation. The AR4D framework proposed in this paper could help move African agricultural R&D systems through the third, fourth, and fifth generations of innovation (not necessarily sequentially) by helping agents within agricultural innovation systems (AIS), to reformulate their scope, scale, and resourcing, thereby restructuring their organization and management to maximize desired impact, both individually and collectively.

3. Why Africa Needs an Agricultural Research for Development System

Recent studies show that many publicly funded agricultural organizations in Africa—such as agricultural research organizations, universities, extension services, and farmer organizations—are facing a crisis of confidence among key stakeholders arising out of the failure to deliver the desired development impact (Ashby et al. 2000; Biggs and Smith 1998; Chema, Gilbert, and Roseboom 2003; Hall and Nahdy 1999; Paterson, Adam, and Mullin 2003). This failure is attributable to the supply-driven agenda of NARSs (lack of responsiveness to clients and inadequate participation by end-users and other stakeholders); obstructive intra- and interorganizational boundaries (inadequate linkages, partnerships, and coordination within and between organizations); lack of inter- or multidisciplinarity; weak monitoring, evaluation, and performance cultures (including lack of institutionalized organizational learning); and precarious resource conditions stemming from overdependence on donor and state funding and lack of innovative

mechanisms to finance physical, human, and capital resources. These factors have resulted in organizational inefficiencies and management problems, decreased investor confidence, low staff morale and motivation, high staff turnover, and brain drain (leading to human capacity problems). The ultimate result is limited research, service, and outreach outputs and, unsurprisingly, limited development impact (IAC 2004).

The justification for the emerging AR4D system as a subsystem of the broader agricultural innovation system essentially derives from the need to bring together diverse agents with a variety of competences and resources to work synergistically toward the common goal of increasing sustainable agricultural productivity as a means of improving the livelihoods of the poor in Africa (NEPAD 2002; FARA 2006). The resulting struggle to achieve impact in the lives of poor people in developing countries has significantly widened and deepened the scope for AR4D. Thus, the scope now commonly incorporates multiple dimensions: different types of research (basic, strategic, applied, and adaptive), sectors (commodity, factor, and ecoregional), sub sectors along the value chain (agricultural production, postharvest, agroprocessing, packaging, marketing, and market access), policies, and institutions. Further, the notion of AR4D tends to evoke not only the generation of scientific information, but also the incorporation of indigenous knowledge and the use of both types of knowledge among diverse—and especially disadvantaged—societal groups.

This increased scope inevitably calls for involvement of diverse agents (public, private, and nongovernmental) in the agricultural and natural resource management sectors. These agents include research organizations, extension systems, producer organizations, and colleges of agriculture. While the need to involve these diverse agents is compelling, organization and management systems need to be in place to facilitate the development of a responsive and coherent agenda and a rational division of labor that allows both collaboration and competition as needed. In the absence of such organization and management, the generation of systemic synergies will remain an untapped opportunity. Equally lacking are mechanisms for sustainable financing of broad-based

AR4D. Given that the many organizations within the AR4D system already thrive under independent governance systems, organization and management systems, and even independent financing mechanisms, the process of deconstructing these to accommodate new arrangements will need to be organically grafted at different levels of operation (that is, the system, organization, program, project, and activity levels). Thus, while the process could borrow best practices from elsewhere or even from within respective organizations, the process will need to be based on solid "learning by doing," preferably through action research to ensure systematic learning.

The Agricultural Research for Development System Framework

In most cases, the AR4D system is conceived as a subsystem of a larger agricultural innovation system (FARA 2004; Sumberg 2005; FARA 2006). To understand the AR4D system, it is therefore important to understand the broader system within which it is nested. Definitions for the innovation system vary considerably across studies. Some, like Metcalfe (1995), define the system narrowly and regard it as a specific sector of the economy (for example, universities and R&D organizations) supported by specific institutions (for example, patent rights). Others view it more broadly as a specific aspect of the economic process located in almost every part of the economy (Lundvall 1992). Lundvall (1992) emphasizes that the everyday learning experiences and activities of engineers, sales representatives, and other employees, as well as of consumers, make important contributions to innovation, and that such innovations are not only limited to the sphere of technology but include institutional, organizational, and managerial innovations. Key characteristics most commonly associated with the innovation systems approach include:

1. breaking away from the traditional linear and supply-driven thinking of "research → technology transfer → application," instead emphasizing interdependence and nonlinearity in innovation processes and demand as a determinant of innovation, which is strongly influenced by evolutionary thinking;

2. emphasizing that innovation processes and systems are context specific and strongly influenced by each country's past economic and sociopolitical experiences, and, consequently, that multiple innovation systems exist with varying strengths and weaknesses in any given context;

3. emphasizing the role of institutions, both in terms of patterns behavior like norms, rules, and laws (the rules of the game) and the agents involved (individuals, groups, and organizations); and

4. emphasizing the patterns and intensity of interactions among different agents within the innovation system.

In applying the innovation system concept to the agricultural sector, a more complete picture of agricultural innovation processes can be captured compared with the more restrictive system concepts existing within NARS or, for example, within agricultural knowledge systems (AKIS). Knowledge and information may spill into the agricultural innovation system from domains other than NARSs and, perhaps even more crucially, knowledge and information may emerge from outside the realm of formal research because of on- and off-farm learning—that is, learning through doing, using, and interacting. In particular, institutional, organizational, and managerial types of innovation more often have their origins in on-site learning processes rather than off-site formal research.

The AR4D concept—which the International Centre for Development Oriented Research in Agriculture (ICRA) now calls action research development (ARD)—is based on the realization that "research designed and implemented by teams drawn from different disciplines, institutions and stakeholder groups is better able to solve complex problems and meet multiple objectives . . . and is more likely to come up with the full range of technological, policy and institutional options needed if a broader set of users is to support and benefit from change." (ICRA undated a).This study agrees with ICRA in the view that ARD is characterized by the following:

1. action research;
2. participatory processes that facilitate collective action at multiple levels (that is, at community, organizational, policy, institutional, and agro-industrial levels);
3. participation of stakeholders in identifying needs, strategies, and solutions to problems and in collective innovation systems involving joint learning and the generation of knowledge and research outputs with the aim of realizing impact and evaluating outcomes based on a range of criteria (such as effects on the magnitude, stability, and sustainability of natural, physical, human, social, and financial resources);
4. systemic approaches integrating disciplinary and stakeholder perspectives and analysis and action at different levels (such as the farm, community, enterprise, district, and national levels);
5. teamwork and partnerships as mechanisms for solving complex problems by addressing issues that cut across sectors on the basis that issues and solutions are interrelated—some lying outside the traditional field of agricultural research and some not initially clear and perceived differently by different stakeholders;
6. contributions to broader development goals as opposed to mere increases in productivity; and
7. recognition that technological innovation, by itself, is insufficient, and that research must lead to social, economic, and political reform if it is to bring lasting benefits (this involves the identification of development strategies that integrate technological, institutional and policy options).

AR4D draws from, is influenced by, and seeks to improve upon past approaches to agricultural research, most notably including farming systems research, farmer participatory research, rapid appraisal of agricultural knowledge systems, the sustainable livelihoods approach, integrated natural research management, integrated agricultural

research for development (IAR4D), and the territorial approach to rural agro-enterprise development (see ICRA undated b). However, while appreciating the need for the potentially viable AR4D system, the system is still in its infancy, which affirms the need for careful study and nurturance.

Key Agents in Agricultural Research for Development Systems

In most AR4D systems, there are at least four key categories of agents, the first three of which are presumably committed to serving the needs of the fourth: public or private agricultural research organizations, agricultural extension and advisory services, colleges of agriculture, and agricultural producers and their organizations. In most cases, however, these service providers tend to be inward-looking, engaging in only modest interactions. Consequently, the virtual system tends to generate more conflict than collaboration, thereby losing opportunities for synergies or constructive competition. Each of the key agents is organized at different levels of aggregation, whether local, national, regional, and global.

Agricultural Producers

Within AR4D systems, agricultural producers are presumed to be the key drivers of the entire system. These include both small- and large-scale farmers, traders, transporters, processors, retailers, and consumers. This broader framework is a departure from the traditional view that perceives agricultural producers as farmers who receive production technology from formal agricultural research and extension systems. Within an AR4D system, agricultural producers are encouraged to take center stage, even in formal research and extension systems. However, depending on the specific politico-economic circumstances, the intensity of their participation can vary greatly, from consultation to full responsibility, including financing—as in the case of some commodity boards for commercial export crops (Reardon et al. 2003). The challenge is to mobilize, facilitate, and balance participation among these different stakeholders. Agricultural producers as stakeholders in AR4D systems perform three key roles: (a) as an information interface

between formal agricultural innovation agencies and agricultural producers; (b) as a constituency for formal agricultural innovation agencies, ensuring accountability; and (c) as participants in agricultural innovation by assuming responsibility for the financing and implementation of innovation activities (Bebbington, Merrill-Sands, and Farrington 1994).

However, producer organizations differ widely in their objectives, legal standing, membership, size, and spatial coverage. Whether and to what extent they are involved in formal system activities as stakeholder organizations depends on local and historical circumstances. Open participation processes usually favor the better organized and more powerful groups in society, often excluding women—the majority producers in most smallholder agriculture. This can lead to distortions in technology preferences that favor the rich rather than the poor (de Janvry, Sadoulet, and Fafchamps 1989). Participation can be costly, particularly for the poorest strata of the population, while the expected benefits are insecure (Anandajayasekeram 2005a, b). Thus, there is an urgent need to strengthen and empower stakeholder groups so that they can participate in system processes more effectively and efficiently. In this regard, the challenge remains to develop approaches and mechanisms to mobilize and organize these diverse agents to bring them to the forefront of agricultural innovation processes in developing countries.

Agricultural Research Organizations

Agricultural research organizations in most developing countries evolved from a tradition heavily focused on the biophysical sciences, trying to explain biophysical constraints to agricultural production. The typical model of the research system generated technological options for varying agroecological conditions on the understanding that public extension systems would pick up the interventions, then package and deliver them to needy farmers. However, as scientific research continued generating technological options that were not readily adopted by the poor, pressure begun to build for change. Recent reforms in agricultural research around the world have been strongly influenced by concepts closely associated with the new public management school. According to Kettle (2000)

the new public management school aims to foster a more performance-oriented culture within a less-centralized public sector.

One of the key characteristics of new public management thinking is strict separation of the roles of the government as policymaker, financier, and implementer. The advantages of this separation include reduced conflict of interest in governmental decisionmaking and the expansion of service options. For example, by granting intellectual property rights or providing subsidies, governments can provide incentives for private-sector investment in agricultural research. Similarly, publicly funded agricultural research activities can be outsourced to semipublic or private agencies. These are fundamental changes that can have a profound impact on the structure and operation of the AR4D system and their constituent organizations (Chema, Gilbert, and Roseboom 2003; Roseboom 2004b).

Accountability in government bureaucracies has traditionally focused on the use of inputs rather than what they actually produce or achieve. Under the new reforms, outputs, outcomes, and impact become the primary focus of processes and accountability measures. In agricultural research organizations, this has resulted in greater demand for documenting the ex ante and ex post impact of agricultural research. Research funding agencies, for example, increasingly require that research proposals include a logical framework detailing project impact, and this has also become a prerequisite for research funding (Chema, Gilbert, and Roseboom 2003).

Another emerging feature in the reform process is the concept of pluralistic agricultural research systems (World Bank 2004a, b). While individual organizations continue to play an important role in agricultural research, appreciation for the contributions made by alternative public- and private-sector suppliers is growing. In many countries, the research capacity of alternative suppliers, such as universities, non-governmental organizations (NGOs), and private companies, is growing faster than that of traditional public organizations.

Regional and international research alliances are also being promoted within a broader global context. Although international collaboration in agricultural research has a long tradition, there is renewed interest in strengthening and exploiting the benefits of supra-national collaboration—for example, a system of regional and global agricultural research forums has been created in recent years (Mrema et al. 2004; Sumberg 2005).

Enhanced stakeholder involvement is another feature of the reform agenda in agricultural research systems. However, most stakeholder participation takes the form of voluntary consultation. This can be quite effective, but there are no guarantees that stakeholders will actively participate or that researchers will follow stakeholder suggestions. Control over the research budget gives stakeholders more power. The World Bank and other donors strongly favor this approach (World Bank 2004a); however, because the financial resources are not their own, stakeholders may not be fully interested in how such resources are allocated. Stakeholder financing could possibly solve this problem, but it only works for research components for which beneficiaries can easily be identified, enabling the collection of appropriate voluntary contributions or levies. This type of participation, therefore, commonly involves commercial export commodities, such as coffee and cotton (Chema, Gilbert, and Roseboom 2003), and many developing countries have experience in collecting taxes or voluntary contributions to finance research on commercial export crops (Byerlee and Echeverría 2002).

As discussed, attempts are now being made to expand private participation, but this will require fundamental changes in the organization and management of many AR4D systems.

In many ways, the introduction of competitive grant systems marks a significant change in the organization and management of agricultural research (Byerlee and Echeverría 2002; Gill and Carney 1999; Reifschneider, Byerlee, and Basilio de Souza 2002). Such schemes have been more common in university-based academic and basic research, but the application of such instruments in more downstream adaptive research is relatively new. Potential advantages include closer alignment of research activities with

research priorities, and facilitation of cross-institutional or cross-national collaboration in agricultural research. However, a major shortfall is in balancing short-term project-based grants with longer term thematic or programmatic thrusts.

Agricultural Extension and Advisory Services

In most countries, agricultural extension service evolved in relation to agricultural research systems. The underlying assumption was that research systems would develop agricultural technologies, and extension systems would disseminate them to farmers. In most developing countries, agricultural extension was, and in some cases still is, organized as a single, centralized, solely public agency. However, since cases of limited impact—especially among majority (thought marginalized) farming communities—have come to the fore in public discourse, the extension system has suffered much criticism (Haug 1999; Rivera 2001; and Rivera, Qamar, and Crowder 2001). Key among the concerns are farmers being viewed as passive beneficiaries rather than clients, stakeholders, and active participants; weak research–extension linkages; high incidences of corruption; and inappropriately trained and poorly paid staff. Consequently, different countries have been adopting alternative extension models. In Latin America, many countries dismantled their national agricultural extension services entirely (Bedergué 2002). In Africa, a pluralistic model is currently being tried out involving client orientation and participation; decentralization of service delivery; outsourcing of service delivery; and co-financing by direct beneficiaries (Alex, Zijp, and Byerlee 2002; Anderson and Feder 2003; NAADS 2004). As in the case of agricultural research, these reforms are consistent with new public management school concepts.

By adopting a stronger client orientation, advisory services are now expected to provide tailor-made solutions to innovators in their specific circumstances. Moreover, such advice should not only cover the technical aspects of agricultural production, but also the economic, financial, and institutional dimensions. In Chile, for example, for each farmer entering the advisory services trajectory, an individual business plan is designed, setting out mechanisms for transforming the farm into an economically viable enterprise.

The underlying assumption is that farmers will receive intensive support in the transition period (four to five years), after which they are expected to rely on more generic or private information sources (Bebbington and Sotomayor 1998; Bedergué and Marchant 2002). In other countries, extension/advisory services remain more generic but rely heavily on farmer participation in the identification and prioritization of needs through local consultation. Even in such consultations, however, emphasis has shifted toward market opportunities and how they can be exploited and developed (Roseboom et al. 2004).

Interest has increased both for demand-driven technological innovations and client and stakeholder involvement in the governance of the new services. Such participation can range from regular consultations to full control over the organization and management of the extension/advisory units (for example, by a majority vote on the local boards). Uganda's National Agricultural Advisory Services (NAADS) foresees the establishment of farmer forums that will play an active role in determining and contracting services. Such forums have already been established at regional and district levels, but plans are also underway for a National Farmers' Forum, to be elected by the district forums and assume the responsibilities of the NAADS Board (NAADS 2004).

As implementation of extension services becomes decentralized, financing has remained at the national level. This is partly because few regional or local governments in developing countries are able to raise their own taxes.[3] Governments have also devolved responsibility for extension services to the private sector altogether, but this has only worked in the few well-organized commercial commodities. The establishment of the NAADS in Uganda is a good example of delegating responsibility in four different but complementary ways: (a) formulating the demand for agricultural services at the regional level, involving farmer groups; (b) managing resources through regional chiefs who report to district coordinators, who in turn report to the NAADS Secretariat; (c)

[3] An exception is Brazil, where the federal government shifted full responsibility for agricultural extension—including financing—to state governments in the early 1990s. The present federal government, however, plans to reverse this decision.

requiring farmer groups to contribute to the cost of services delivered, initially modestly but eventually to a share of at least 50 percent; and (d) outsourcing service delivery to private or semi-private local and regional providers (NAADS 2005).

Institutions of Higher Learning

The primary function of institutions of higher learning in AR4D systems is to train the next generation of agricultural specialists, including researchers and extensionists. In addition, most institutions of higher learning are expected to conduct research in support of their teaching portfolio. In some colleges of agriculture, lecturers are also expected to conduct outreach–extension activities. However, the contribution of universities to agricultural knowledge creation and diffusion in many developing countries has been limited for several reasons: teaching, which absorbs most if not all the available human resource capacity; the lack of adequate facilities and funding for agricultural research and extension activities; the lack of critical mass due to the relatively low numbers of qualified faculty staff; inadequate links to users and potential clients; and inadequate linkages with other agricultural research and extension providers, causing overlap and duplication instead of complementary roles (FAO 1996; Beintema, Pardey, and Roseboom (1998); Idachaba (2003); Michelsen et al. 2003; Eicher 2004; Oniang'o and Eicher (2004). Despite having better trained staff, lecturers in colleges of agriculture in Sub-Saharan Africa spend only a modest proportion of their time on agricultural research (10–30 percent). However, institutions of higher learning are increasingly developing strategies for their research and outreach activities, including specialized research and outreach offices, despite the fact that in many instances these activities are covered largely through external means (Roseboom et al. 2004).

Training agricultural specialists. Since the type of knowledge and skills required of agricultural graduates changes over time, institutions of higher learning need to review and update their curricula regularly. This entails the difficult task of forecasting future needs in the labor market and adjusting training accordingly. Idachaba (2003) argues that agricultural universities in Africa are responsible for producing graduates with market-

oriented skills, leadership qualities, and communications skills. Other desirable characteristics are ethics, entrepreneurship, managerial skills, and teamwork. In addition, students should be socially and environmentally informed. In the context of agricultural innovation processes, students should be trained as problem-solving generalists in agriculture (Eicher 2004). The idea of life-long learning (Idachaba 2003; Eicher 2004) is increasingly gaining support from both employers and employees. Other frequent concerns regarding the training of agricultural specialists are the share of female students in agricultural sciences, the low status of agricultural sciences among the potential student population, and the low interest of students in sciences in general.

Agricultural research and extension agencies typically represent an important employer in this market. Nevertheless, it is not uncommon to encounter major imbalances in the market. In eastern and southern Africa, for example, many public agricultural research and extension agencies have difficulty contracting and retaining socioeconomists (Obwona and Norman 2001). This has triggered initiatives by donors and others to lobby for and support expanded training capacity in this area (Roseboom, Elliott, and Minde 2005). An underlying problem is poorly functioning labor markets for agricultural specialists, reinforced by outdated central approaches to human resource planning.

Generation and diffusion of knowledge. When it comes to implementing agricultural research and extension activities, institutions of higher education are confronted with the same kinds of challenges as agricultural research and extension agencies. This includes adapting to new goals and a new technology development model. Like research institutes, institutions of higher learning also struggle with issues of stakeholder participation and decentralization. There are some opportunities to fill niches in hitherto neglected regions and issues. State-level agricultural universities in India and Nigeria, for example, contribute to the spatial spread of agricultural research capacity. With the increasing complexity of the agricultural research agenda, opportunities exist for universities to innovate through multidisciplinary initiatives involving nontraditional

partnerships. In the field of biotechnology and nanotechnology, for example, biological sciences have increasing need for input from the physical sciences, engineering, law, sociology, economics, philosophy and ethics, and nutrition and health.

In addition to reaching out to farmers directly through research and extension, agricultural institutions of higher learning are increasingly connecting with agricultural input and processing industries and agricultural service providers. By clustering around an education agency in so-called agro-business parks, the exchange of knowledge and information between university scientists and private companies can be enhanced. Such agro-business parks often have resources ("incubators") to facilitate commercial spin-offs from university research (Roseboom, Elliott, and Minde 2005).

One of the more difficult system-related questions confronting policymakers is determining the optimal number of higher education agencies needed, along with their size, location, and specializations. While in most small countries one faculty of agriculture or agricultural university is usually sufficient, in most medium- to large-sized countries room exists for several. There is also an important trade-off between the geographical spread of capacity and critical mass. In some countries, expansion of higher education has led to a large number of small and poorly financed institutions, with little or no impact (Eicher 2004). This is a problem that cannot be solved by these institutions individually but requires intervention at the system level.

Many developing-country universities have seen their student populations expand at much faster rates than their funding (Beintema, Pardey, and Roseboom 1998), forcing them to resort to other funding sources—student fees, income generating activities, and donor contributions—or accept deterioration in the quality of their services. Many have also lost their better trained staff because they are unable to compete with salaries in other sectors or abroad (Obwona and Norman 2001).

4. Organizing Scope for the Agricultural Research for Development System

The concept of the AR4D system is currently evolving in response to the growing interest in linking agricultural research more directly with development objectives. The link between research and development objectives essentially involves transforming development objectives into system objectives, system objectives into organizational strategic objectives, and strategic objectives into program and project priorities (Figure 1). In most countries, development objectives will be articulated in medium-term development strategies, for example in the currently popular in poverty reduction strategy papers (PRSPs). However, at this level of specification, development objectives tend to be generic, covering multisectoral interests such as economic growth and poverty eradication. Thus, the respective sectors need to modify these general objectives to fit their more specific strategic objectives, niches, and expected contributions to system objectives. Ministries of agriculture, for example, could commit to increased agricultural production and enhanced natural resource management.

Within such a context, AR4D systems would need to focus on their unique contribution. For example, they could commit to ensuring increased agricultural productivity and enhanced environmental services. Within such a context, the respective AR4D agents would then need to identify their respective niches by defining their own strategic objectives depending on their core competencies and interests. For example, an advanced research institute may commit to addressing the implications of climate change to agricultural production; a NARI might commit to enhance the livelihoods of the poor

through enhanced agricultural productivity and natural resource management; a commodity program within a NARI might focus on developing varieties of high-value crops that meet market demand; an extension system might commit to introducing high-value commodities in smallholder production systems; an NGO might focus on organizing smallholder farmers of high-value commodities to meet market demands on quality and timeliness of delivery; a community-based organization (CBO) might focus on organizing community members to gain access to farm inputs and markets for high-value products; a private-sector agent might commit to focusing on postharvest processing, packaging, and marketing of high-value commodities, and so on. While such complementary roles can be potentially envisaged among diverse agents within a given AR4D system, successfully achieving such complementarity would require systemic leadership, coordination, and incentives that are not readily available in many developing countries.

With clear strategic objectives, respective actors in the AR4D system are well positioned to address other dimensions of scope in the AR4D agenda: types of research—basic, strategic, adaptive, and uptake pathways; areas of focus—production, postharvest, processing, marketing, policies, and institutions; and methodological approaches—commodity focus, farming systems, agroecosystems, development domains, and value chains (Lynam and Elliott 2004). Thus, while conceptualizing the research for development agenda, it is necessary to make informed choices not only within but also among these three dimensions. Thus, AR4D confronts a complex reality that requires sophisticated processes to interpret and develop as a coherent and responsive research agenda. This begs the question of how to proceed, systematically, to disentangle the respective dimensions and organize scope for a system whose key agents are relatively autonomous and have varying interests.

In thinking about organizing scope within AR4D framework—especially in agricultural research systems that may be strongly rooted in scientific perspectives focusing on the generation of scientific findings—fundamental shifts in thinking and

expectations are needed. We hypothesize that the extent to which a system makes coherent and consistent choices within and among different dimensions of scope depends on the extent to which the system consciously develops and implements a particular world view of development or impact. For example, a system pursuing research findings would have a different character from one pursuing technology development and diffusion (Table 1).

Table 1. Diverse strategic objectives and the corresponding institutional arrangements

Strategic objectives	Areas of focus	Institutional arrangements
1. Scientific excellence	Scientific specialization (for example, reproductive physiology; plant pathology; production econ)	Disciplinary approaches
2. Relevance to target groups	Supply of products and services (for example, draught resistant varieties or agronomic practices)	Multidisciplinary approaches possible within same organization
3. Productivity gains	Utilization of products and services (for example, recommended varieties and related agronomic practices, such as fertilizer use and spacing)	Multidisciplinary and multi-institutional partnerships (for example, among research, extension, farmer organizations—that is, AKIS)
4. Productivity gains with environmental integrity	Sustainability of production systems (for example, balance between yield gains, soil fertility management, water efficiency)	Partnerships between commodity and factor specialists, and among producer organizations within catchments areas—that is, INRM)
5. Income generation (poverty eradication)	Livelihood strategies (for example, increased profitability; improved nutrition, increased assets)	Partnership between commodity and factor specialists, policy and institutional specialists, and producer organizations (along value chain) and market agents—that is, AIS)

Historically, many NARSs have lacked an institutionalized paradigm—beyond their legislated mandates and national development plans—to guide their decisionmaking, especially their agenda setting. Thus, many have typically based their agenda on state priorities. While this is important, it is inadequate, especially in relatively less democratic systems where state policymaking processes are not sufficiently consultative or participatory. However, increasing economic liberalization and political

democratization are leading to much more demand-led agenda setting in some NARSs across Africa. For instance, the Ugandan NARS now sets its agenda in line with[4]

1. the NARS Act,
2. National Agricultural Research Policy (NARP),
3. stakeholder articulated (and implied) demand (through stakeholder conferences and consultations, representations, and key aspects of NARSs),
4. domestic and international market trends and consumer preferences,
5. national socioeconomic concerns, and
6. informed opinion of the scientific community (through scientific conferences), and Internal and external reviews (Baguma 2006).

This represents movement toward a more demand-driven and client-responsive research agenda that conceivably makes it easier for different agents within the Ugandan AIS to work together (see Section 5, below). It also makes it easier for individual organizations to rationalize their own work. Hitherto, NARIs promised things (derived from broader national goals) that programs and projects fail to or cannot deliver because of lack of proper synchronization between agenda and organizational capabilities, among other reasons. This discrepancy in part explains criticism that agricultural research systems in Africa have not delivered the desired impact. This underscores the need to involve policymakers, potential clients, institutional leaders, program and project leaders, and potential partners in the formulation of the overall vision, strategy, programs, and projects in AR4D systems. This approach requires careful study and innovative institutional processes that take into account the strategic objective that unifies a particular system and the interests of the respective actors that may need to contribute to the mission of the overall system. This calls for re-thinking the way we conceive and conduct planning processes at different levels of operation in the AR4D systems. Importantly, planning, monitoring, and evaluation processes need to be seen as sequentially related at each level of operation. Further, the expected outcomes and impact

[4] Similar approaches are also employed by the Kenya Agricultural Research Institute (KARI), although the other key components of the Kenyan NARS (universities, extension services, farmer organizations) are yet to adopt this method (see Murithi and Wabule 2006).

at higher levels of operation need to inform the objectives of the vertically linked operational levels (Mbabu et al. 2004).

Strategic Planning

Strategic planning should lay the basis for choosing and developing an institutional culture for the AR4D system. The process should seek to develop or articulate competing institutional cultures based on competing values. Thus, the process should strive to engage potential clients and stakeholders in reflective processes to identify and develop consensus on fundamental values that feed into assumptions on institutional content and form. In this regard, methodologies need to be developed to determine fundamental values, key indicators of success at the system level (identifying the system based on expected outcomes), knowledge and skill gaps, operating principles for achieving the identified indicators of success, institutionalization strategies, and the documentation of system results and lessons learned. Strategic planning processes should be reflective rather than mechanical; they should also link system-level concerns (such as policy and legislation) with programmatic issues. The challenge for the AR4D system is to synchronize systemic objectives with those of member organizations. In many countries, respective research organizations carry out their strategic planning processes, but few do this in relation to the broader AR4D system that integrates the objectives of the key actors—research, extension, universities, and producer organizations. Similar strategic planning processes are also carried in subregional, regional, and even global forums where the respective NARIs are members. Thought therefore needs to be given in the definition of AR4D system to ensure value-adding roles in the respective organizational layers.

Program Development

A fundamental challenge in program development is ensuring that short-term research objectives connect, logically, with medium- and long-term institutional goals. The transformation of outputs into useful products and services requires a series of inter-

related interventions that can be bundled meaningfully as coherent projects. However, those products and services also need to be consumed by the relevant economic agents to achieve grassroots impact. Further, even when pilot cases establish that particular products and services have the necessary impact, success still hinges on translating the lessons into the broader context (up-scaling), which requires not only technical interventions, but also policy and institutional innovations and complex coordination in both the short-term and the long-term. Thus, a key challenge remains in developing necessary methodologies to incorporate core institutional values into program objectives, focus program objectives on client needs and expected institutional outcomes, design operational methods that best suit the delivery of the expected outcomes, determine knowledge and skill gaps for program development, develop partnerships and associated mechanisms and incentives to match expected outcomes, and develop an institutionalization strategy for effective program management. Specific to an AR4D system, it will be particularly challenging to conceive systemic programs alongside those that respond to the narrower objectives of specific member organizations. This challenge is already surfacing in the context of regional and subregional competitive grant systems that invite broad-based collaboration and or competition among member countries and their respective organizations. Thus, member organizations respond to these research calls, while running their own independent programs. The ensuing confusion calls for careful consideration in the way systemic programs are developed so as to ensure value-adding to the individual members' initiatives.

Priority Setting

As observed above, the scope of AR4D systems has expanded in recent years. Agricultural research, for example, now addresses key staples, livestock, fisheries, natural resources, climate change, genetic resources, and health and nutrition along commodity and factor value chains, and research has broadened to include production, postharvest, marketing, policy, and institutions. Agricultural research is also expected to link basic and strategic research, strategic and adaptive research, and adaptive research

outcomes and uptake pathways. Compounding this challenge, it is no longer acceptable to simply publish results. Scientific findings need to have grassroots impact. Ironically, this expansion has been accompanied by declining resources, putting systems under significant pressure to do more with less. Hence, priority setting is crucial. The pressing challenge is to develop approaches and methods that align priority-setting processes with systemic vision and strategy; achieve consensus with clients, stakeholders, and potential partners; and result in acceptable resource allocation guidelines. Such a methodology would need to address the issues of how to determine the ultimate beneficiaries and their priority needs, how to transform identified needs into research-based interventions, how to determine competing themes that reflect science-based options to resolve development objectives (potential projects), how to determine the relative weights and scores for competing options, how to determine knowledge and skills gaps for priority setting, how to link priority-setting results with resource-allocation processes, and how to develop an institutionalization strategy for priority setting.

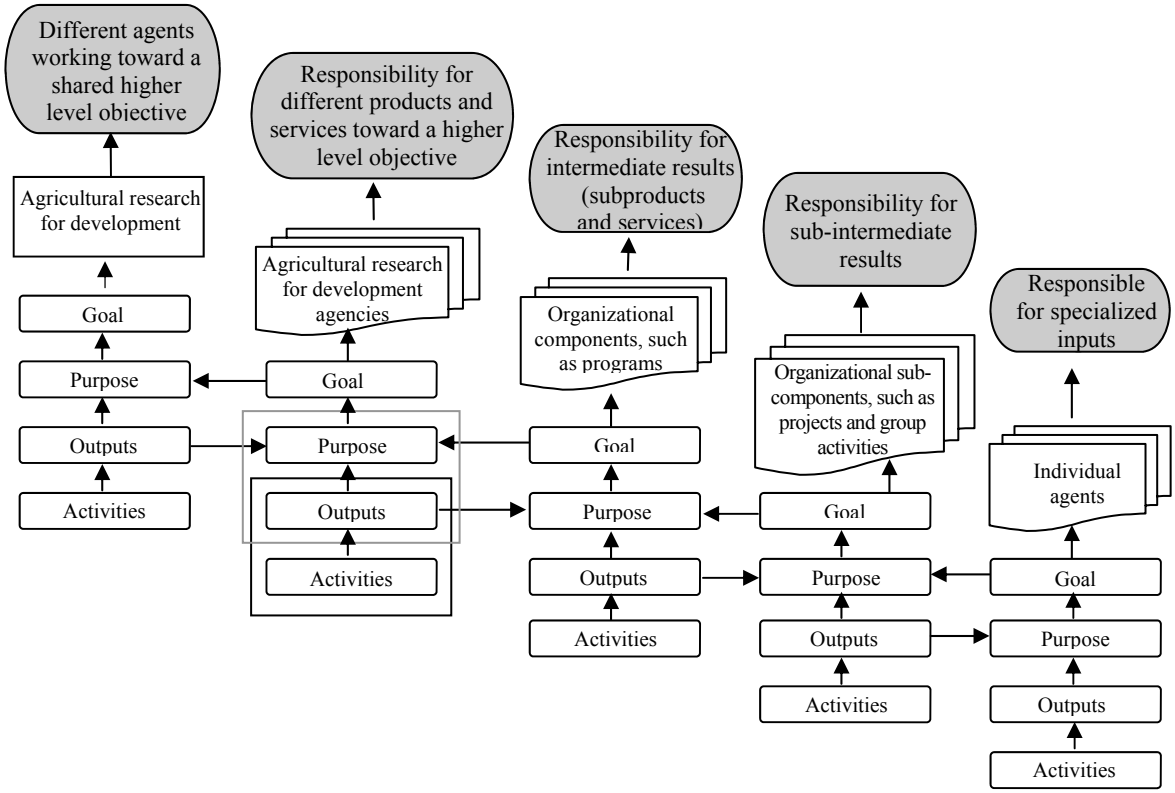
Project Development and Implementation

Delivering system objectives requires synergy among projects over a given time period and sequential project logic over time. In this way, projects gain and add value to current and long-term shared objectives. Interesting ideas can be systematically transformed into products and services, products and services can be popularized among potential users, and widespread use can eventually be achieved, creating ultimate impact. However, challenges remain in identifying or developing approaches and methods to transform potential opportunities into themes that address development objectives; determine short-, medium-, and long-term objectives; specify indicators of success for the respective sets of objectives; specify means of verification and underlying assumptions for success; determine required knowledge, skills, and resources to deliver expected results and outcomes; and develop suitable partnerships, mechanisms, and incentives for delivery of expected results and outcomes.

Monitoring and Evaluation Framework

More often than not, monitoring and evaluation (M&E) systems are conceived and implemented within the context of a project management cycle. This is not surprising, given that funding is often provided through project-specific frameworks. However, the mismatch between short-term projects and long-term development objectives has made it increasingly necessary to re-design M&E systems to generate concurrent and sequential synergies among projects. One method of achieving this is illustrated by cascading logic, whereby system components are aggregated sequentially, to form a pyramid-shaped network (Figure 1). Within this framework, the challenge remains to identify or develop suitable methodological approaches to transform long-term system objectives into shorter term program, project, and activity objectives; specify indicators of success for the respective operating levels; specify means of verifying underlying assumptions for success; determine the required knowledge, skills, and resources to conduct effective systemwide M&E, including impact assessment; and develop implementation and institutionalization strategies for a comprehensive M&E system.

Figure 1. Vertical and horizontal linkages among agents of the AR4D system



Source: Adapted from Mbabu and Mugah (1998).

5. Organizing Scale for the Agricultural Research for Development System

The AR4D system principally consists of four main categories of agents: producer organizations, research systems, extension systems, and colleges of agriculture. Within the respective categories are constituent sub categories comprising public and private entities, NGOs, and community-based organizations (CBOs). In most of African countries, all the four categories of agents have evolved independently of each other. This not withstanding, agricultural research and extension systems have had closer interactions in many countries. This is partly because both systems are governed through the same parent government ministries (agriculture and related sectors). However, even when they share the same ministry, both research and extension systems have tended to be organized under separate directorates. In most African countries, all the four categories of agents are dominated by the public sector. However, following budgetary constraints in public organizations, NGOs and, to a lesser extent, CBOs have slowly gained ground in the system. The private sector is also making a mark but to a far lesser extent. The greatest challenge is in bringing these different agents together in some form of coherent collective action.

Many NARSs have been less innovative or adventurous in this regard, preferring to stick with mechanisms that have demonstrated little impact; these include memoranda of understanding, memoranda of agreement, letters of agreement, material transfer agreements, and contract and collaborative research. These mechanisms are useful in *bilateral* arrangements, typically involving less intensive sharing of organizational, management, and research activities and materials among partners. Where more intensive collaboration, partnership, and organization and management are required, more innovative and incentive-based mechanisms are also needed. Case studies from the business literature suggest that these include, but are not limited to, virtual teams, projects, programs, corporations, and integration, as well as horizontal and vertical integration (Box 1). Another common problem with scale is the optimal degree of centralization and decentralization—currently a topical issue in agricultural research

systems. We suggest that this should be informed by the goal or purpose of the organization.

Box 1. Virtual Integration, Entities, and Activities

Virtual Integration

Virtual integration attempts to link components of integrated system to operate as a single entity using information systems and avoids investing in large numbers of people and facilities. It seeks to link the core competencies of individual organizations through cost- and risk-sharing agreements so that these organizations can act as a larger, single entity (Zimba 1998).

Virtual Corporations or Organizations

A virtual organization or company is a transitory network of nonexclusive portfolio individuals, coupled by advanced communications technologies (Barnatt 1996). The members are geographically separate, while appearing to others as a unified (single) organization. In virtual organization, the work needed to meet a given goal is divided among various entities based on the perceived competencies of the agents involved.

Virtual Team, Project, or Program

Virtual teams (also known as geographically dispersed teams) are a group of individuals who work across time, space, and organizational boundaries with links strengthened by webs of communications technology. They have complementary skills, are committed to a common purpose, have interdependent performance goals, and share an approach to work for which they hold themselves mutually accountable. A virtual project is a collaborative effort toward a specific goal or accomplishment based on collective, yet remote, performance (Krill and Juell 1997). Cantu (1997) claims that teams can become virtual when any one of the following three components are present:

1. Team members are from different geographic locations.
2. Team members are from different organizations or parts of the organization.
3. While team members work different time periods, they still work together as a team.

For example, Reuters normally relies on a team of people who are actually employed by other organizations but are brought together on specific projects.

Systemic Level

Cascading logic illustrates an ideal type, suggesting that despite system diversities, it is still possible to negotiate a virtual system held together by shared objectives. This,

however, assumes the existence of a governing body that provides a sense of common vision and shared purpose, sets and enforces the "rules of the game," and provides incentives to which potential agents can respond. Needless to say, in most African countries where the AR4D system is being introduced, such broad-based bodies do not exist, but mechanisms to bring public research organizations to collective action do exist. A good example is vertically linked national, subregional, regional, and global agricultural research forums (Mrema et al. 2004; Sumberg 2005). Nevertheless, even these do not have binding authority over their members. Furthermore, they tend to be dominated by the NARIs, which are an important but only one among many other agents in the AR4D system (Mukiibi and Youdeowel 2005). A few countries are working toward establishing an all-inclusive legal mechanism to provide oversight and necessary funding mechanisms in support of AR4D initiatives. Uganda is a good example of this (Baguma 2006). While such a body may play a significant role in attracting diverse agents toward a shared vision and strategy, it remains to be seen how they will reorient themselves to participate at the system level, while at the same time running their relatively independent programs. The principle of "subsidiarity" has often been evoked to distinguish the appropriate divisions of labor in system and subsystem operations, but the challenge of defining the value-adding role of such associations remains unresolved.

Organizational Level

Most of the agents in the AR4D system are relatively independent organizations. Some of the public agricultural research institutes still operate as directorates within ministries of agriculture or science and technology, while others operate as parastatals that are publicly funded but enjoy relative autonomy (Mukiibi and Youdeowel 2005). Public universities, the other key agents, usually operate independently under an act of Parliament but report to the Ministry of Education and or of Science and Technology. NGOs and the CBOs are registered under relevant government bodies and serve under independent management systems. The private sector, of course, operates under boards of trustees representing shareholders. The point being made here is that the respective agents are more likely than

not to have interests that go well beyond those that can be addressed by the AR4D platform. The fact that they have independent governance mechanisms also suggests that the apex body cannot force them into any obligations. Thus, participation can only be voluntary to the extent that their specific interests are met. Further, considering that the implementation process of system-induced initiatives can only be implemented within the jurisdiction of the respective agents, it is absolutely necessary that systemic and organizational authorities agree on basic operational principles, management systems, and accountability processes for their joint ventures. To the extent that several agents could be engaged in collaborative activities, similar understanding would need to be reached among all. Needless to say, this calls for unprecedented institutional, organizational, and management innovations.

Program Level

Programs are organizational instruments to focus on specialized thematic areas that require long-term attention. The substantive areas of focus vary with the strategic objective of a particular organization. For example, a university organized by disciplines will tend to articulate programs in disciplinary terms, such as reproductive physiology, animal husbandry, plant pathology, production economics, development sociology, and so on. A national agricultural research institute organized by commodities and factors may articulate programs by clusters: cereals, horticulture, soil, and water. A competitive grants system focusing on improved livelihoods may articulate programs based on objectives such as increased incomes among smallholder producers, enhanced nutrition among the marginalized poor, and enhanced soil fertility in mixed crop systems. Within AR4D systems, which need to link research and development objectives, programmatic arrangements would be highly beneficial to maintain coherence among shorter term projects over time, to address long-term development objectives, and to ensure synergy among related projects at a given point in time. Nevertheless, in a virtual system such as AR4D, the challenge remains to determine where to house the coordination mechanism

for a cross-cutting program, and what authority to bestow on the coordinator across the diverse organizations that may have independent lines of authority.

Project Level

Several factors explain the prevailing popularity of the project management mode in agricultural research initiatives. These include: donor preference for short-term funding, the appropriateness of delivering focused research products and services within a specified timeframe and specific resource units, and the ability to bring multidisciplinary and even multi-institutional competences to address a common purpose. In the context of the AR4D system where longer term development objectives define the scope and scale of projects, it is important that project leadership remains in close liaison with the relevant program leaders. However, given that project leaders may be separately located from the program leader, appropriate lines of authority and accountability need to be determined within the host organization and the systemic program leadership. This is particularly important given that the same researchers working on a system-induced project may also be working on projects sponsored by the parent organization.

6. Generating System Resources

In looking at resources—usually human, physical, and financial—justification for continued support is often overlooked. It has become increasingly clear in agricultural research systems that key investors understandably want to see real impact on people's lives. But, as previously stated, this is not something that can be achieved by individual researchers or institutions. Thus, as organizations strive to diversify their resource base and maximize efficiencies, only cumulative, coordinated investment efforts will produce satisfactory results. Consequently, opportunities for improving resource sustainability in the AR4D system must go beyond the traditional parameters to include innovative structures and management systems that facilitate resource pooling. In most countries, agricultural research is funded through individual organizations; however, considering

the need to involve diverse agents in collaborative activities, alternative funding mechanisms are currently being introduced. In this regard, the challenge remains to identify mechanisms that will foster collective sourcing, pooling, and use of resources in pursuit of shared goals, given disparate capacity among system institutions and agents.

For a long time, many African NARSs have relied on government and donor funding, which worked relatively well in the era of supply-driven agendas. However, changes in the role of the state and national priority setting and the perceived failure of many public service providers have resulted in reduced state financing and increasing emphasis on efficiency, sustainability, and cost effectiveness (Lynam and Elliot 2004). Many NARS are increasingly looking to diversify their funding sources. In countries such as Kenya and Uganda (Baguma 2006; Murithi and Wabule 2006), this has taken the form of block grants ("core" funding from the government), matching grants, loans, self-generated revenues (raised from product levies and services rendered), and competitive grant systems. But the need for innovative sources of funding—for example, co-financing or cost-sharing arrangements, contract research, outsourcing, public–private partnerships and privatization—persists (Heemskerk and Wennink 2005).

Public policy and development experts attribute disappointing development outcomes to inadequate citizen involvement in the design and implementation of policies and projects or lack of participation (Holland and Blackburn 1998; Poteete 1999; Cernea 1985; Chambers 1985; and Brautigam 2004). They argue that the presence or absence of participatory policymaking accounts for some of the variation in the success of policy implementation. Participatory policymaking can be defined as a process by which the full development of a policy in any field is examined using a high degree of creative participation by the agents and stakeholders concerned, who act as the main source of proposals, values, and guidance (Poteete 1999).

Participatory budgeting is an innovative policymaking process in which a wide range of stakeholders (the general public, poor and vulnerable groups, including farmers, women, organized civil society, the private sector, parliaments, and donors) have the

opportunity to debate, analyze, and allocate resources, prioritize broad social and economic policies, and monitor public spending and investments (Wambler 2000; World Bank 2001a, b). According to the World Bank (2001a, b), participatory budgeting can occur in three different stages of public expenditure management. In budget formulation and analysis, citizens participate in allocating budgets according to priorities identified in participatory poverty diagnostics, formulate alternative budgets or assess proposed allocations in relation to government policy commitments and stated objectives, while in expenditure monitoring and tracking, they track public spending in relation to the allocations made in the budget. In monitoring public service delivery, citizens monitor the quality of goods and services provided by the government in relation to expenditures made for these goods and services.

Participatory budgeting challenges social and political exclusion as traditionally excluded groups (such as farmers) are given the opportunity to make policy decisions. It is designed *inter alia* to incorporate citizens into the policymaking process, distribute public resources more equitably (enhance social justice), and spur administrative reforms (Wambler 2000). Schneider and Goldfrank (2002) suggest that, most notably, participatory budgeting articulates the political agenda of excluded groups, who seek to promote a popular vision of democracy and development. It expands their alliances and legitimizes their vision as they contend with opposing class coalitions that advance either narrow versions of development (for example, neoliberal approaches) or democracy.

Participatory budgeting could be a great instrument in AR4D systems in Africa because the budget "provides an opportunity to channel benefits to political allies while shifting costs to political opponents, which makes the introduction of the [participatory budgeting] a unique opportunity to influence partisan competition," (Schneider and Goldfrank 2002, 13). The introduction of participatory budgeting in African AR4D systems would include farmers and other excluded groups in confronting, negotiating, and ultimately overcoming opposition from interest groups that have traditionally captured a disproportionate share of the benefits from conventional budgeting

approaches. For instance, despite the importance of agriculture to African economies, IAC (2004) found that agricultural research does not rank high in a majority of African PRSPs—the superficial version of participatory economic policymaking in Africa, pushed through by the World Bank and International Monetary Fund (World Bank and IMF 2002; Brautigam 2004). More importantly, although African leaders have committed to increasing agricultural expenditure to 10 percent of their annual budgets by 2007 through the Comprehensive Africa Agriculture Development Programme (CAADP), so far few countries have met this target; participatory budgeting would be a helpful instrument for lobbying, tracking, and monitoring this objective.

From their study of participatory budgeting in Porto Allegre, Brazil, and elsewhere, Schneider and Goldfrank (2002); Brautigam (2004); and IADB (2004) conclude that participatory budgeting promotes redistributive development, participatory democracy, and the formulation of and investment in pro-poor policies by expanding the political power of lower socioeconomic groups and advancing the interests of the poor and a vision of popular democracy in which citizens participate directly in decisionmaking. The World Bank agrees: "Experiences with participatory budgeting have shown positive links between participation, sound macroeconomic policies and more effective government" (2001, 1). This is certainly the case in Mauritius where Brautigam (2004, 10–11) attributes the impressive agricultural transformation over the past two decades, in part, to the introduction of participatory budgeting in 1982, by then Finance Minister, Paul Berenger.

Closely related to participatory policymaking is participatory institutional development (PID). A PID approach to rural development and poverty alleviation outlines (participatory) methodologies and mechanisms for improving given institutional arrangements, including laws (governing production and trade of commodities such as food safety regulations and regional and international trade rules), property rights regimes (including intellectual property rights), collective action, and social capital, which according to Baas (1997) reconcile and optimize individual and societal rationality.

Institutions and organizations can either be opportunities for, or obstacles to, productive and equitable development (Baas 1997). They can facilitate opportunities by promoting collective action, reducing coordination and transaction costs, and enabling individuals to transcend the limitations or transaction costs of acting in isolation. But they can also become obstacles by perpetuating (through path dependency or other means) the preferences of powerful interest groups in society.

Like participatory policymaking, PID raises the need for better organization of smallholder farmers. Baas (1997) identifies social capital as a special aspect of PID that can be used to do this. He suggests that PID is made up of four interrelated elements: it is a development process whose motivating force is built on solidarity through mutual social support and economic collaboration, empowerment through processes of collective bargaining and the construction of group identities, participatory decisionmaking, and networking—this includes collaborative action among groups, horizontal (local) networking, and (at higher levels) vertical networking. PID aims to strengthen the social capital of the poor through group formation at local levels and through horizontal organizational and institutional linkages (group networking and inter-group associations), as well as vertical organizational and institutional linkages for poverty alleviation (networks, partnerships, and alliances between grassroots organizations, civil society organizations, and key decisionmakers in government and the private sector). As Baas (1997, 2) puts it, "Participatory institutional development strengthens localized social capital accumulation by mobilizing self help capacities, progressive skills development and local resource mobilization (savings, indigenous knowledge) in order to improve ultimately the group member's human, natural and economic resource base and their political power." PID reduces costs at both ends—that is, the service delivery costs of governments, the private sector, and NGOs and the access costs of the poor in obtaining these services. Given the resource constraints facing African AR4D systems, this is particularly relevant.

In recent years, several Latin American countries (and South Africa) have begun to invest significantly more in science, technology, and innovation in order to strengthen their economies and become more globally competitive. This has opened up new competitive funding sources for agricultural research that are not agriculture-specific (Roseboom et al. 2004). In many ways, the introduction of competitive grant systems marks a significant change in the organization and management of agricultural research (Gill and Carney 1999; Byerlee and Echeverría 2002; Reifschneider, Byerlee, and Basilio de Souza 2002). Such schemes have been more common in university-based academic and basic research, but the application of such instruments in economically oriented research is revolutionary. The trend is strongly promoted by donors like the World Bank, the United States Agency for International Development (USAID), and the U.K. Department for International Development (DFID). Potential advantages include the following:

1. closer alignment of research activities with research priorities, with calls for proposals often formulated on the basis of consultations with stakeholders;
2. stronger project-based cultures within agricultural research organizations, and improvements in the development of research proposals;
3. enhanced objectivity and transparency in the selection of agricultural research projects (given that proposals are usually reviewed by at least two external reviewers, approved and selected projects are publicly listed, and many funds have project databases that can be consulted on line);
4. close monitoring and evaluation of project implementation (a longstanding weak spot) enhanced by the external financing agency's stronger position in requiring adherence to monitoring and evaluation (M&E) tasks;
5. facilitation of cross-institutional or cross-national collaboration in agricultural research;
6. insight into the number of reviewer approved (that is, "good") research projects that go unfunded; and

7. mobilization of under-utilized capacity.

Potential disadvantages of competitive research funding include the following:

1. Separate allocation of operating resources and human and capital resources requires major coordination to avoid wastage, which is particularly the case when multiple competitive research funding schemes operate simultaneously.
2. Since it can be very difficult to organize impartial reviews of research project proposals, especially in small science communities, mobilizing foreign reviewers may be a solution, though it could be quite costly.
3. Competitive schemes usually fund projects of two to four years duration; hence, they are not necessarily the best instruments for long-term agricultural research activities such as plant breeding and strategic research.
4. Competitive funding schemes can be inflexible due to strict adherence to selection transparency and procedures; simple mistakes in budgets or incomplete documentation, for example, can cause proposals to be rejected.
5. Funding uncertainty is common because of competition for resources, short time horizons, and lack of continuity due to dependence on donor support.
6. Government agencies often find it difficult to administer a research grant within existing bureaucratic procedures.
7. Transaction costs are comparatively high because the available funding under competitive schemes is generally small.

This discussion shows that, although widely employed in many African NARSs, competitive grant systems are not the only innovative method for funding an AR4D system. Much room for innovation exists, provided organizations are willing to fundamentally change how they organize, manage, and provide resources for their research activities. Importantly, organizations must also learn to account not only for expended resources, but also for outputs, outcomes, and impact.

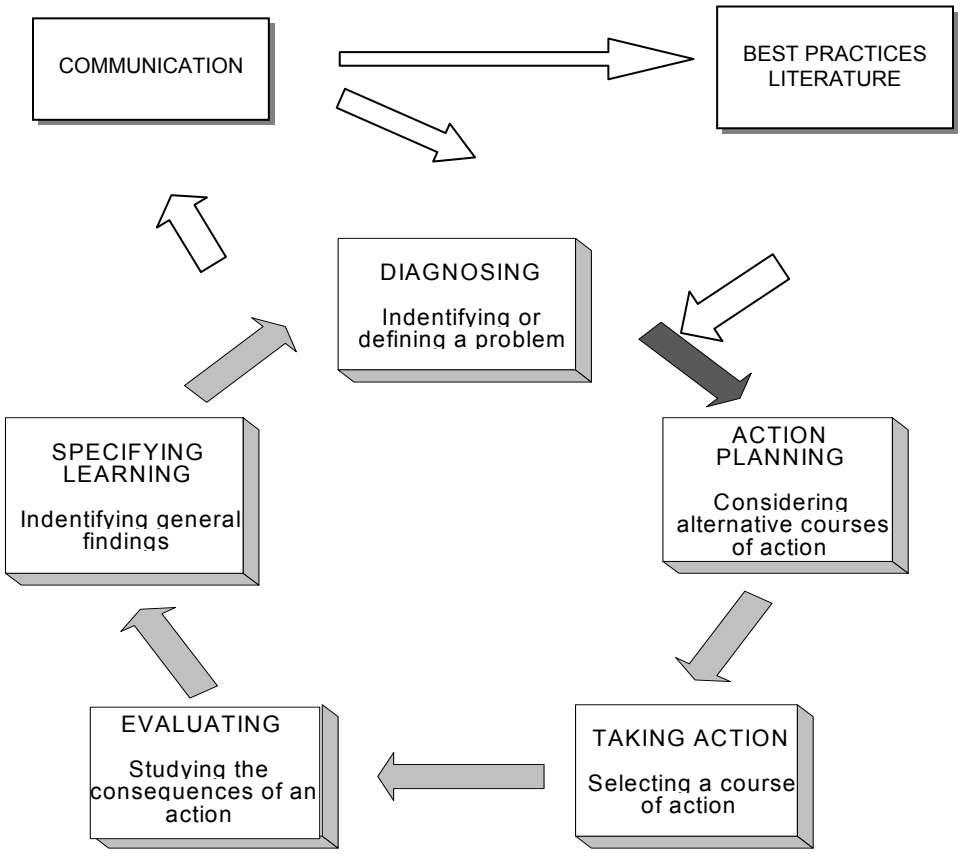
7. Consolidating an Agricultural Research for Development System

The proposed AR4D system places great emphasis on organizational learning, which will require a fundamental restructuring of existing AR4D agents. To effect such organizational transformation, it will be necessary to catalyze an organic process that would best be steered through action research. Action research is chosen when circumstances require flexibility, the involvement of people, or quick or holistic change. It is often applied by practitioners who want to gain understanding of their practice; social change activists trying to mount an action campaign; or academics who have been invited into an organization (or other domain) by decisionmakers, aware of a problem requiring attention, but lacking the methodological knowledge to deal with it.

Action research, which is inherently participatory, is an approach that focuses on learning by doing. Reform practitioners use this approach to systematically study complex problems in order to guide, correct, and evaluate their decisions and actions (Lewin 1958; Huizer 1979, 1983; Fernandez and Tandon 1981; Carr and Kemmis 1986; Sohng 1995). Thus, project participants effectively become researchers on the assumption that people learn best and are more willing to apply what they have learned when they actively participate. Such research is always associated with social action, attempting to understand and improve the way things are in relation to how they could be.

Action research is typically cyclic; Carr and Kemmis (1986) conceive of each action research cycle as comprising planning, action, observation, and reflection. Susman (1983) distinguishes five phases of action research (Figure 2). First, a problem is identified and data collected for detailed diagnosis. This is followed by a collective postulation of several possible solutions from which a single plan of action emerges and is implemented. Next, best practice literature provides a useful input into the cycle by providing promising, alternative courses of action. Data on the results of the intervention are collected and analyzed, then the findings are interpreted in light of the action's level of success. Finally the problem is re-assessed, another cycle begins, and the process continues until the problem is solved.

Figure 2. The action research cycle



Source: Adapted from Susman (1983).

8. Discussion

Cascading logic illustrates that, despite system diversities, it is possible to negotiate a virtual system held together by shared objectives. The system determines intended outcomes and invites diverse agents to develop a coherent division of labor, demonstrating how the various competences can contribute. To manage innovation processes effectively to achieve grassroots impact, it is important to consolidate activities through a logical hierarchy of objectives—with associated responsibilities and accountability—whereby the goal of each activity is linked to the overall purpose of the host project. Similarly, project goals should feed into program goals, program goals into

institutional goals, and institutional goals into system goals. Thus, cascading logic provides a simplified representation of a highly complex network, forming a pyramid with the individual agents at the base and the AR4D system at the apex.

Linkages among key agents in the AR4D system are an important area of focus because no agent can complete an innovation process successfully on its own (Kaimowitz 1990). Extension agencies, for example, may be dependent on research organizations for the development of new technologies, while both research and extension agencies may be dependent on institutions of higher learning to train qualified staff. Similarly, both research and extension agencies may need inputs from producers in order to develop and diffuse new technologies that are relevant. The lack of an obvious hierarchical structure means that linkages cannot be imposed from above. If collaboration is to occur, it is usually through voluntary participation. But the existence of such arrangements does not guarantee effective interaction. A classic example is the widespread failure of research–extension linkage committees in developing countries. A related issue pertains to the transaction costs of diverse interactions and collaboration. Moreover, AR4D systems are not static; hence, linkages that worked perfectly at one time may become obstacles at another. In that sense, the system is integral to its economic or cultural context (Hall et al. 2002).

Another important dimension in sustaining the AR4D system is considering motives and mechanisms for interaction. It is often argued, for example, that public–private partnerships should be avoided because interests are diametrically opposed. Increasingly, however, there is realization that such a rigid division is counterproductive and that most innovation processes have both public and private dimensions. So what is important in such public–private partnerships is recognition that the participating partners' apparent different objectives may also partially overlap. In identifying this common ground, such partnerships can be successful.

Competition versus collaboration is another interesting dimension in AR4D systems. Greater competition, such as through competitive funding schemes, is

increasingly being promoted among service providers to increase system efficiency and effectiveness and to curb monopolistic behavior. This might, however, have a negative effect on collaboration across institutions and between individual agents within institutions. In universities, for example, evidence is emerging that competitive funding schemes may be promoting an individualistic culture (Roseboom et al. 2004). To some extent this may be the result of financing small projects. Increasingly, competitive science and technology funds are addressing this issue by developing funding instruments that favor research clusters and networks, thereby enabling competitive funding schemes to facilitate the desired forms of collaboration.

It is clear from these insights that the AR4D system is crystallizing as its component parts restructure to meet compelling demands. In search of impact, each of the component parts is slowly recognizing that no agent can complete an innovation process successfully on its own. Under the circumstances, agents are sharpening their internal processes to increase their respective efficiencies and effectiveness, while simultaneously building bridges to more effectively interact with the related agents for even greater outcomes and impact. Given the long, independent evolution of the respective agents the restructuring process is necessarily challenging and painful, but arising from this is the question of the extent to which the respective agents and associated system leaders realize the complexity of the process they are steering and the need to systematically learn as the process continues. Platforms and mechanisms to stimulate the development of a systemwide vision among the respective agents would be extremely beneficial by providing a focal point for internal processes of change. Such platforms could also provide the opportunity for mutual learning and support.

9. Conclusion

While the need to involve the diverse agents in the AR4D system is compelling, questions still remain regarding how to achieve the necessary organization and management systems to facilitate the development of

1. a responsive and coherent agenda,
2. a rational division of labor that generates systemic synergies and enables both collaboration and competition as the need arises, and
3. appropriate mechanisms for sustainably financing a broad-based AR4D system.

Given that many AR4D system organizations already thrive under independent governance systems, O&M systems, and even independent financing mechanisms, the process of deconstructing these to accommodate new arrangements will need to be organically grafted at different levels of operation (that is, at the system, organization, program, project, and activity levels). Thus, while the process could borrow best practices from elsewhere or even from within the respective organizations, it will need to be solidly based on "learning by doing," preferably through action research to ensure systematic learning.

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