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Developing Research Systems to Support the Changing Agricultural Sector

ARD AGRICULTURE AND RURAL DEVELOPMENT

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Acronyms

AKIS	Agricultural Knowledge and Information Systems
CAS	Country Assistance Strategy
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	French Agricultural Research Centre for International Development
COFUPRO	Coordinator of Produce Foundations, Mexico
CONACYT	National Council of Science and Technology, Mexico
CRSP	Collaborative Research Support Programs
CRADA	Cooperative Research and Development Agreements
DFID	Department for International Development, UK
EARO	East African Research Organization
ECA	Europe and Central Asia
EMBRAPA	Brazilian Agricultural Research Corporation
EU	European Union
GFAR	Global Forum on Agricultural Research
ICT	Information and Communication Technology
IFAP	International Federation of Agricultural Producers
IPR	Intellectual Property Rights
ISNAR	International Service for National Agricultural Research
NARO	National Agriculture Research Organization
NARS	National Agriculture Research Systems
NGO	Non-Governmental Organization
M&E	Monitoring and Evaluation
PPP	Public-Private Partnerships
PROMSA	Modernization Program for Agricultural Services
R&D	Research and Development
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food Products, Mexico
S&T	Science and Technology
USAID	United States Aid for International Development
USDA	United States Department of Agriculture
WTO	World Trade Organization

Preface

This paper is a product of a workshop on "Development of Research Systems to Support the Changing Agricultural Sector" organized by the Agriculture and Rural Development Department of the World Bank, June 8-9, 2004, Washington, D.C. The paper incorporates views and content from the Overview and Case Study presentations on key reform elements and problems of relevance and sustainability of research systems. It also presents the converging views of the Workshop participants and the emerging agenda for Agricultural Research.

The authors would like to thank all the presenters and participants for their time and contributions during the Research Workshop. The World Bank's SASKI (Sustainable Agriculture Systems Knowledge and Institutions) Thematic Group is acknowledged for its contribution to the development of the thematic issues included in the Workshop, as well as for its financial support. Particular thanks are extended to Rockefeller Foundation and USAID for their financial contributions. Special thanks are due to Derek Byerlee and Matthew McMahon for their substantial contributions for the Workshop content development. Gary Alex, Willem Janssen, and Jock Anderson are acknowledged for their helpful commentary on this manuscript.

Executive Summary

Given the pace of globalization of agriculture, rapid changes in the science supporting the agricultural sector, and the diverse regional features of agricultural research systems, there is a need to take stock of recent experience and re-think strategies for the future development of national agricultural research and innovation systems. The World Bank, with support from Rockefeller Foundation and United States Agency for International Development (USAID), organized a workshop with about 70 experts representing donors, practitioners, and World Bank staff to evaluate experience of key reform elements and problems of relevance and sustainability of research approaches currently being promoted in different regions and to identify promising directions for future investments. The workshop began with an introductory session on "Positioning knowledge systems for changing agriculture and changing science." A summary of the content of the subsequent sessions, including the major points the participants agreed on, is presented below:

Positioning knowledge systems for changing agriculture and changing science. Due to rapid global changes in the economic, political, sociological, technological and natural environments, the knowledge system of tomorrow will have multiple sources, partners, and users. The major goals of agricultural research are: (i) to produce new agricultural technologies to contribute to rapid economic growth; (ii) to facilitate adjustment to a rapidly changing international economy and changing policies; (iii) to address emerging environmental concerns; and (iv) to contribute to the reduction of poverty by increasing the supply of staple products and by increasing the international competitiveness of national economies. It was felt strongly by participants that, in order to respond to the changing requirements, agricultural research systems must reform, and integrate better into the broader science and technology (S&T) environment and global knowledge economy.

*Responsiveness of agricultural research systems to changing needs of the agricultural sector***.** Decentralization and diversification of demand and supply for research and development (R&D) were identified to be key ingredients in a successful transition to become more efficient and responsive to the increasing local and international demands. The potential transition towards a more diversified innovation system, however, is case specific and depends on the local context, target group(s) and objective(s), the stage of diversification in a given country and the ability to manage this change process. Competitive grants can be used as a tool to guide the reform processes but must be accompanied by a long-term strategy for research areas and priorities, a well articulated balance between strategic and applied research, and adequacy of both the core and operational funding.

*Public-private partnerships for market-driven development***.** Several of the reported cases pointed out that public-private partnerships (PPPs) provide many opportunities in agricultural R&D and S&T in general and have been most successful when developed as a long-term partnership between trusted partners in building capacity and developing marketable technologies. The agricultural value chain has usually proven to be a good starting point. PPPs can, however, have

high transaction costs: they are management intensive and often operate in complex international and national legal environments. There is a clear need for development of clear policies and contractual arrangements on intellectual property rights. PPPs should also allow representative participation by farmer groups and relevant civil society organizations to balance corporate influence and power over priority setting.

Sustainable development of core public R&D capacity. Sustainable core support to research systems is needed for underpinning long-term strategy formulation as well as management of operations. Four factors critical to successful development of core public research capacity are: (i) political support; (ii) accountability mechanisms; (iii) complementarities; and (iv) system responsiveness. To receive adequate political support it is helpful to develop a common vision for agricultural research and enhance linkages between research and policy. Competitive and other special funds can be an effective means to increase the plurality of research service providers and to enhance the quality of research. An idea discussed in the meeting was that of a competitive fund for supporting provision of research infrastructure and equipment in addition to operational funds. The right balance between core and competitive funding naturally also depends on other factors such as need to maintain institutional stability, the type of research, and the size of the economy and resources available within it.

Promotion of regional and international research alliances and technology spill-ins from a country-perspective. The changing agenda for agriculture, reorganization of agricultural research systems in many countries and contemporary advances in S&T are among the factors responsible for the upsurge of various types of international research alliances. Some of the lessons learnt from successful alliances and networks include need for: (i) long-term commitment of the potential partners; (ii) transparency and balance in alliances; (iii) flexible structure of collaborative models; and (iv) capacity-building in management and negotiating skills. While international networks and alliances are expected to increase further in number and complexity, and although there is an increasing body of recommendations on how to make such networks work, the understanding of how to successfully manage such complex arrangements still needs to be strengthened.

Decentralization of national agricultural research systems and promotion of participatory approaches. Decentralization of research systems and participatory approaches can serve to provide administrative flexibility and to make agricultural research more client-oriented and impact driven by bringing researchers closer to the end-users. The effectiveness of decentralization approaches depends mainly on the selection of an appropriate strategy and the type of research (strategic vs. applied research). Incentive structures and management mechanisms must be designed and implemented in a specific context tailored to each country and the type of research. Changes should be introduced in an evolutionary way. Major challenges for the introduction of decentralized systems and participatory approaches include: (i) maximizing economic efficiency; (ii) balancing demand-driven and supply-driven approaches; (iii) building capacity at various levels of research implementation; and (iv) changing the mentality among scientists, research managers, extension workers, and farmers.

CONVERGING VIEWS, EMERGING AGENDA, AND NEXT STEPS

Converging views. Participants were optimistic about the potential of agricultural research to support increased competitiveness and to contribute to poverty reduction. This view is also based

on the revitalized awareness of donors and borrowers of the important role of agriculture and rural development in reaching the Millennium Development Goals. However, participants generally agreed on the necessity of agricultural research systems to reform in order to play the anticipated role. In particular, there is a perceived need for better integration of agricultural research into the broader S&T system and global knowledge economy. This was seen as necessary to improve the ability of the agricultural sector to satisfy the changing demands placed on it. It would also guide investments towards building an agricultural innovation system that recognizes the innovative capacity of stakeholders, from producers to the marketplace. Monitoring and Evaluation (M&E) was generally seen as an important tool for project and program management, to track progress, and to make corrections as needed.

Emerging agenda. While there was clear consensus on the future directions necessary for agricultural research to be able to respond to changing demand, there was less agreement and experience on how to address the challenges of promoting reforms that can be sufficiently adapted to local socioeconomic, institutional, and political circumstances. Moreover, there is a need to refine and/or develop tools, including new models for PPPs and tools for M&E, which support the implementation of the recommendations. In more detail, the following are the main emerging issues:

- Understanding of the changes in the economic, political, sociological, technological, and natural environments and their impacts on the demand of the agricultural sector needs to be improved in regional and country-specific contexts.
- A new concept on Agricultural Innovation Systems is emerging. These link multiple sources of innovation and uptake pathways, along the continuum from basic research to technology adoption. There is a need to analyze the challenges and opportunities in promoting such a concept.
- M&E tools need to be developed that increasingly focus on outcomes and impacts and are able to capture the recent changes in Agricultural Research or Innovation Systems.
- Decentralization of agricultural research systems can be helpful in increasing efficiency and boosting the positive impact of agricultural science and technology. However, decentralization has to be analyzed case by case in terms of the appropriate 'dose': implementation strategies have to be identified based on country-specific circumstances.
- Competitive grants must be accompanied by a long-term strategy for research capacity development, and a carefully thought out balance between strategic and applied research, and between core and operational funding. Appropriate institutional mechanisms have to be identified to facilitate this process.

Next steps. The participants agreed that further steps and initiatives are needed to address the challenges identified during the workshop. Relevant activities and studies planned in this context are:

- The International Assessment of Agricultural Science and Technology for Development,[1] which will assess the economic, environmental, health, and social implications of current and potential future technologies. It will also assess the effectiveness of institutional arrangements on which technology generation and transfer are based.
- Further studies are planned by the World Bank and its partners to develop an analytical framework for Agricultural Innovation Systems, and to consider the pros and cons relative to the more traditional conceptual structures of Agricultural Knowledge and Information Systems (AKIS) and national agricultural research systems (NARS). Application of a scenario planning approach, to inform investments in Indian agricultural science and technology in the light of the challenges and uncertainties that surround them, is also under way.
- Revitalized awareness of the importance of M&E for project management, better use of scarce financial resources, increased focus of donors and borrowers on outcomes and impact, and recent changes in the agricultural innovation systems, are currently leading to a high demand for expertise in M&E, including impact analysis.

[1] The International Assessment of Agricultural Science and Technology for Development aims to bring an objective view of the long-term challenges facing world agriculture and consider how these might be addressed by the development and appropriate use of agricultural knowledge and technologies, learning from both past experiences and our present knowledge. The Assessment process has been catalyzed by the World Bank, in open partnership with a multi-stakeholder group of organizations, including FAO, the Global Environment Facility, UNDP, UNEP, WHO, and UNESCO and representatives of governments, civil society, private sector and scientific institutions from around the world. It uses a strongly consultative 'bottom-up' process that recognizes the different needs of different regions and communities. http://www.agassessment.org/

1. Workshop Context and Objectives

Population growth, improved incomes, and shifting dietary patterns continue to increase and diversify the demand for food and other agricultural products. At the same time, the natural resource base underpinning agricultural production is under threat. Revolutionary advances in biological and information sciences offer great potential to address these new demands and resource constraints. However, making research benefits available to small-scale farmers is a challenge. International trade is increasing rapidly, bringing with it new challenges for farmers to remain competitive and for governments to ensure the safety of agricultural value chains. How to adapt agricultural research systems to best meet the new demands of the changing environments and how to improve their responsiveness to the changing needs of the agricultural sector? These are critical questions to be answered, if enhanced uptake and impact of the results of agricultural research systems are to be realized.

There is a wide consensus that effective agricultural research is essential to support competitiveness and sustainability of agricultural systems and to contribute to poverty reduction. Since 1980, the Bank and other donors have invested substantially in developing national agricultural research systems (NARSs). The evolution of this support can be roughly divided into three phases. The first generation (mid-1970s to mid-1980s) was characterized by building national agricultural research institutes and the second (1980s to 1990s) improving their performance. However, by the 1990s, it became clear that these institutes were not able to respond to rapid changes in their external environment. This led to a third stage from the mid-1990s, focusing on competitive mechanisms to broaden participation of research suppliers to include private sector, universities, and non-governmental organizations (NGOs), and working through rural producer organizations and other stakeholders to strengthen the demand side of research systems. At present there is a growing appreciation of the concept of broader innovation systems that link agricultural sector actors with multiple sources of innovation and uptake pathways, along the continuum from basic research to technology adoption.

While the above captures the general trends in Bank's investments in agricultural research, there are significant regional differences in the opportunities and challenges faced by the research systems. For example, facilitating public-private partnerships in technology generation and transfer is an opportunity in East Asia; modernizing the large agricultural research council-led research systems is a challenge in South Asia; building producer organizations' capacity to express demand for agricultural technologies is a critical question in Africa and supporting institutional reforms in the Europe and Central Asia (ECA) countries are examples of emerging issues of differing regional importance.

Given the pace of globalization of agriculture, rapid changes in science base, and the diverse regional features of the research systems, "business as usual" will not suffice. There is a need to take stock of recent experience and re-think strategies for the future development of national agricultural research and innovation systems. To this end, the World Bank organized a workshop including about 70 experts representing donors, practitioners, academia, and World Bank staff to

evaluate experience of key reform elements and problems of relevance and sustainability of research systems currently being promoted in different regions and to identify promising directions for future investments. The workshop began with an introductory session on "Positioning knowledge systems for changing agriculture and changing science." The subsequent presentations were organized around six themes, including overview presentations followed by sessions examining these issues:

1. Responsiveness of agricultural research systems to changing needs of the agricultural sector;
2. Public-private partnerships for market-driven development;
3. Sustainable development of core public R&D capacity (educational policies, personnel policies, and infrastructure);
4. Promotion of regional and international research alliances and technology spill-ins (with emphasis of the role of biotechnology, global science, and IPR);
5. Decentralization of national agricultural research systems and its economic, political and institutional dimensions;
6. Promotion of participatory approaches (including the utilization of indigenous knowledge and farmer-generated technologies).

This paper summarizes the main findings of the workshop, identifies areas of convergence, as well as the next steps.

2. Responding to Changes in Agriculture and Science

WHAT FACTORS DRIVE THE CHANGING KNOWLEDGE DEMANDS ON AGRICULTURAL RESEARCH?

Due to rapid global changes in the economic, political, sociological, technological, and natural environments, new demands for knowledge will come from multiple sources, partners, and users. In the global economy the following trends seem likely to continue: (i) rapid economic growth in many developing countries such as Brazil, China, and India ; (ii) global economic integration driven in part by technological flows from the more developed to developing countries; and (iii) liberalization of economic policies worldwide.

The importance of S&T for economic growth and development is widely accepted. Economic and social development is increasingly driven by the advancement and application of knowledge. Education in general – and tertiary education in S&T in particular – are fundamental to the construction of knowledge economies. However, S&T systems in developing and transition countries face persistent problems of finance, equity, quality and governance as well as links to tertiary education. The new challenges have amplified the chronic problems of linking agricultural research with other national S&T institutions and with education institutions and programs.

WHAT ARE CLIENTS DEMANDING AND HOW CAN RESEARCH SYSTEMS RESPOND?

The basic goals of agricultural research are to: (i) produce new agricultural technologies that contribute to rapid economic growth; (ii) facilitate adjustment to a rapidly changing international economy and to changing economic policies; (iii) address emerging environmental concerns; and (iv) contribute to the reduction of poverty by increasing the supply of staple products and by increasing competitiveness of national economies. These goals frame the changing demands for knowledge.

The following knowledge demands were identified during the workshop:

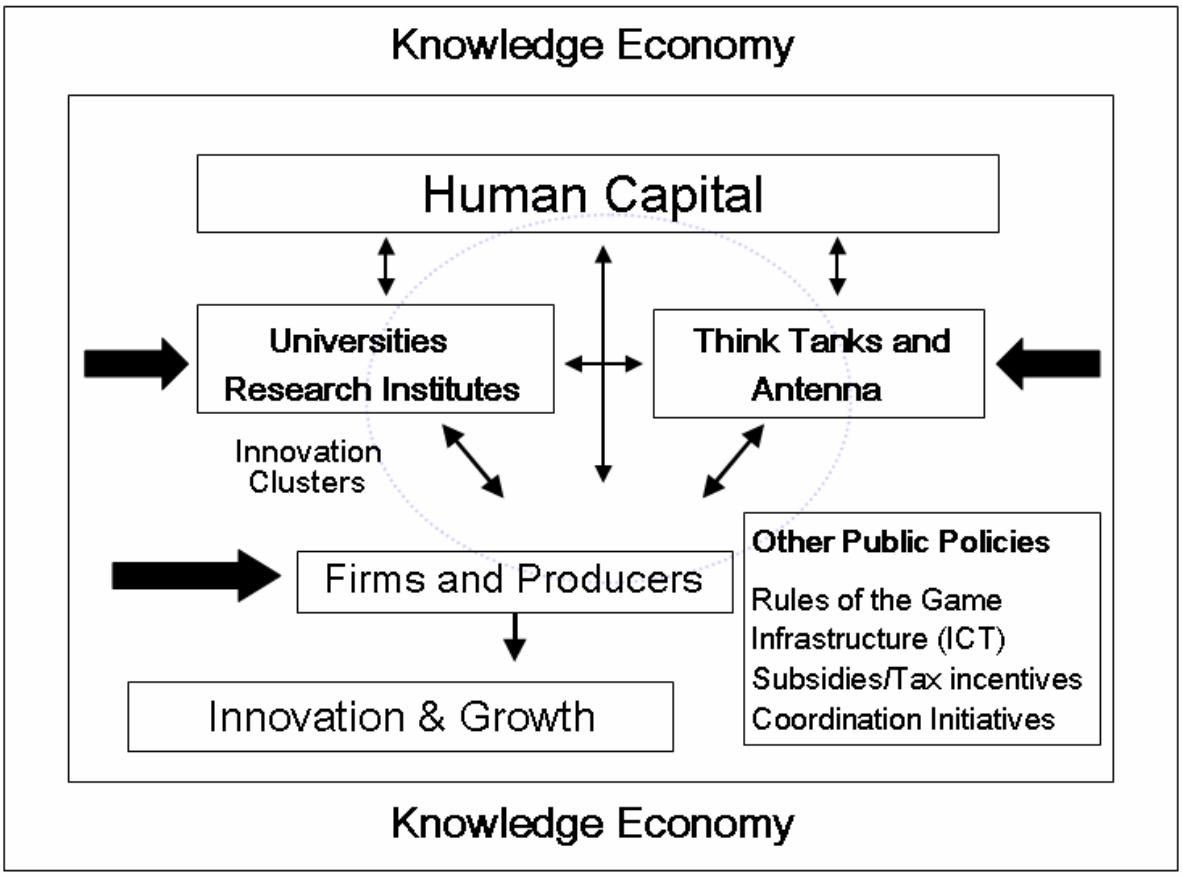
- *Trade and market liberalization*. The reduction in subsidies would reveal basic underlying comparative advantages that agricultural research could further enhance. Understanding these changes is also essential for the design of sound science and technology policies.
- *Recent technological advances*. The spread of new technologies in transportation and information and communication technologies (ICT) along with advances in biotechnology serve as catalysts for economic growth and poverty reduction and can generate new trade opportunities. Of particular importance in this context is how to close the knowledge gap between more developed and developing countries.
- *Health and nutrition.* New molecular biology has demonstrated the potential to create enriched foods. The demand for knowledge along these lines will grow as more is learned about the potential of such tools. Another issue is the lack of knowledge about the health of the rural population, and its impact on the productivity of labor. The spread of HIV/AIDS in the developing world has brought this issue to the forefront in the recent past.
- *Climate change and resource scarcity.* There is evidence that there will be significant changes in the geographical production patterns in response to climate change. Despite the uncertainty about whether global warming is driven by human activity, the potential consequences of global warming are too large and significant to be ignored. The growing scarcity of water and the deterioration of the natural resource base are especially important issues.

In order to respond to these challenges, agricultural research systems must reform and integrate into the broader S&T system. This requires investments in human capacity building—investments in higher education and R&D—and better understanding of linkages between the players in national innovation systems (universities, civil society, private sector, etc.).[2] The links between a National Innovation System and the Knowledge Economy are shown in Figure 1. The growing importance of the private sector in particular highlights the need to establish intellectual property right legislation. Research impact analysis and communication strategies are critical to

[2] Lauritz Holm-Nielsen addressed the link between the broader S&T environment and the global knowledge economy. There is a clear correlation between long-term economic growth and advanced human capital. Building the capacity to understand and use new technology will be important as indicated by the growth in Organization for Economic Cooperation and Development (OECD) countries that is increasingly knowledge-driven.

convince governments and donors of the importance of investing in S&T and to drive science-based policy formulation. For the World Bank, increase in the importance of S&T issues in Country Assistance Strategy (CAS) debates could serve as an entry point. Stable funding mechanisms for agricultural S&T and for higher education systems are fundamental to the construction of knowledge economies.

Figure 1. The national innovation system and its links to the overall knowledge economy



Source: Lauritz Holm-Nielsen, World Bank, modified from William F. Maloney in Ferranti, D., Perry, G., Gill, I., Guash, J., Sanchez-Paramo, C. and Schady, N. (2003) "Closing the Gap in Education and Technology", World Bank Latin American and Caribbean Studies, 2003. The World Bank, Washington D.C. .

EXPERIENCE FROM A CASE STUDY

A case study from Mexico[3] demonstrates how an agricultural research system has successfully responded to changing knowledge demands by implementing a new approach to assigning research funds. Traditionally, producers had little or no voice in setting priorities and did not participate in the implementation and evaluation of research projects. A new system gave

[3] The Case Study illustrates the major steps taken to make the research system more responsive to the local and global needs. It was presented by Jose Laborde, Mexico's Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food Products (SAGARPA), Mexico.

producers a definite role and an active part in approving research proposals. Research funds for agriculture come from matching funds of National Council of Science and Technology (CONACYT), Coordinator of Produce Foundations (COFUPRO), State Governments and Federal budgets, and are open to any Research Institution or University. Diagnosis of specific demands for research in the most important production systems was used to shift research capacity towards solving the problems as articulated by the producers. Projects, where different institutions work together, were encouraged. Key to success of the reform was the increased role not only of producers, but also of the other actors in the entire value chain, including industries, consumers, ministries, and universities.

3. Regional Experiences with Reform Processes

WHY ARE THE AGRICULTURAL RESEARCH SYSTEMS CHANGING?

As discussed in chapter 1, the external environment and needs of the agricultural sector have changed dramatically in the past decade, especially in developing countries. These changes are induced by: (i) lower prices for staple food crops; (ii) the drive toward competitiveness through cost reduction; (iii) diversification of agricultural production to higher value and value added products; (iv) higher and increasingly differentiated quality standards; (v) move to more complex and integrated value chains; (vi) the emerging issue of food safety; (vii) and increasing stress on environmental sustainability. Moreover, there is a generally acknowledged need to make R&D more responsive to client needs. Important factors contributing to improved responsiveness are the empowerment of clients, pluralism in delivery of agricultural services, and decentralization of services to enhance relevance to the clients. Thus, the existing R&D systems are confronting new priorities that have implications both for their structure and expected results.

WHAT MAJOR CHANGES HAVE TAKEN PLACE IN AGRICULTURAL RESEARCH SYSTEMS?

The changes in the context and environment of the agricultural sector have major implications for the type of technology and information required and the way R&D is organized and executed. In many Latin American countries, such as Colombia, Ecuador, Peru, Brazil, and Nicaragua,[4] the failure to meet demands of end users in association with institutional crises and macroeconomic changes led to major reform of agricultural research institutions. The institutional crisis was associated with public institutional monopolies, outdated strategies, loss of trained personnel, limited interaction with the scientific community, and lack of champions for change in the sector. Macroeconomic reforms were considered more important than sector reform and covered issues

[4] Case studies on Latin American countries described the driving forces and key principles for institutional reform of the R&E systems and the major impacts of and lessons learned from the process were presented by Matthew McMahon, World Bank.

such as fiscal restraint, trade liberalization, agriculture's role as a growth sector, and growing recognition of the crucial role of knowledge.

Since the research system reform was initiated, the emphasis has been on (i) more knowledge-based systems, (ii) funding by competitive allocation of funds and (iii) inclusion of new players, all contributing to increased diversification of supply of and demand for technology, and greater client-orientation and responsiveness. Besides diversification of research supply and demand, competitive funding fostered a new institutional culture encouraging increased inter-institutional interactions, improved project quality through better monitoring, a broadened research agenda along the value chain, international collaboration and spill-ins, as well as more effective research-education linkages. There has also been a slow transition towards integration of agricultural S&T with wider S&T, i.e., a move towards a more efficient national innovation system (Box 1 has a brief definition).

Box 1. National innovation system – a theoretical definition

A National Innovation System consists of all actors involved in the production, diffusion, adoption, and use of knowledge as well as the institutional and policy context that shape these processes.

The ultimate objective of a well functioning innovation system is to serve the needs of the economy by achieving better integration of the S&T infrastructure with production needs, by increasing private sector participation in technology development and by developing stronger linkages between industry, universities, and research institutions. Thus, knowledge is transformed into goods and services through a country's national innovation system.

Source: Goel V.K., E. Koryukin, M. Bhatia and P. Agarwal, 2004. Innovation Systems: World Bank Support of Science and Technology Development. World Bank Working Paper no 32.

A number of National Agricultural Research Systems (NARSs) in Africa, namely in Cote d'Ivoire, Ethiopia, Ghana, Kenya, Senegal, Tanzania, and Uganda, have initiated reforms that are in essence a move towards an innovation system in an effort to improve the effectiveness and relevance of NARSs.[5] A new paradigm of agricultural development is reflected in the reform themes: (i) redefinition of the role of government addressing stricter public good arguments, separation of funding, priority setting and implementation (coordination); (ii) deconcentration and decentralization (relevance and ownership); (iii) stakeholder participation through consultation, joint implementation, control of the budget and/or cofinancing; (iv) new funding instruments including competitive grants and both public and private contractual arrangements; and (v) improved system linkages between research agencies (national/regional/ international) and among research, extension, and farmers.

These reforms separate funding from execution of research, provide funding for contracted outputs rather than R&D inputs, and open the door to a wider range of service providers. As expected, the studies reveal that reforms are quite diverse, depending on the country context. They have the potential to improve the effectiveness and relevance of NARSs. However, the net effect depends on how well the reforms are implemented.

[5] Case studies on several NARSs in Africa (Cote d'Ivoire, Ethiopia, Ghana, Kenya, Senegal, Tanzania, and Uganda) presented by Han Roseboom and Sam Chema, Agricultural Research Foundation, Kenya.

SHARED FEATURES AMONG THE RECENT REFORMS OF AGRICULTURAL RESEARCH SYSTEMS

The case studies confirm that there is no "blueprint" for successful reform and transition. The process of moving towards a more responsive innovation system depends on: (i) the specific local context; (ii) target groups and (iii) objectives, such as, poverty alleviation versus market orientation; (iv) the initial stage of diversification in a given country, and more importantly, (v) the ability to manage this change process. Box 2 summarizes some key features of a responsive agricultural research system.

Box 2. The essential features of a responsive agricultural research system

The following key features in the transition to a diversified and responsive innovation system have been identified:

- Increased pluralism and decentralization of supply;
- Diversification of demand;
- A long-term strategy for research areas and priorities;
- A balance between strategic and applied research; and
- Adequate funding for core and operational research.

Successful tools:

- Competitive grants as a tool to guide the reform process; and
- Supply chain management system as a good starting point for transition.

Source: Authors.

The case studies from Africa indicated that a systems framework can be useful to understand the slow evolution of the systems, but can also guide in the design of appropriate interventions as countries typically start from different points and have different environments conditioned by history, conflicts, and economic structure. In addition, reforms must be internally owned; incentives, structures, and management mechanisms must be tailored to each country; and change must be evolutionary rather than revolutionary.

Despite the need for context specificity, diversification of demand and supply has proven to be the key element in the success of the reform process. Investments in smallholder organizations are essential to strengthen the demand. Similarly, decentralization can support the reform process. Diversification of demand and supply along with decentralization can also move institutions to become more responsive to international demands, such as WTO requirements, and can lead the transition to an agricultural or a national innovation system.

Competitive grants can be an effective tool to guide the reform process on both the supply and demand sides, but must be accompanied by a long-term strategy for prioritizing research topics, balance between strategic and applied research, and core and operational funding. Particularly in small countries, competitive grants and decentralization pose specific challenges: small countries must carefully allocate their limited resources between strategic and applied research. The low number of research providers can result in limited competition and poor research. While small countries would likely benefit from regional collaboration and spill-ins, drastic decentralization can result in fragmented systems with low absorptive capacity and limited ability to benefit from frontier research knowledge and skills. A value chain perspective is a good starting point as it has the potential to bring in a number of stakeholders, public and private, and lead to diversification of funding.

4. Public-private Partnerships for Market-driven Development

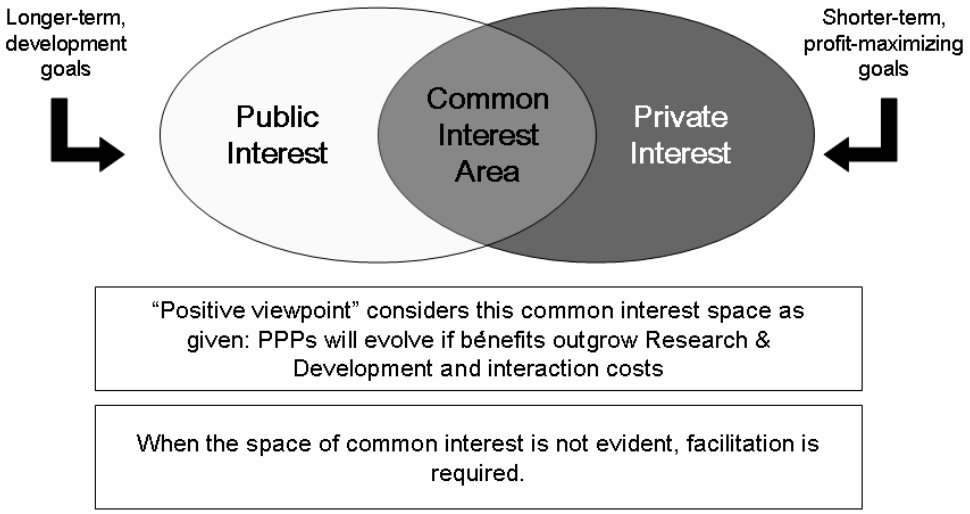
WHY ARE PUBLIC-PRIVATE PARTNERSHIPS BEING PURSUED?

Public agricultural research was the primary source of new technologies for agriculture during most of the 20th century. In recent decades, private enterprises have become important players in agricultural R&D and are active in fields formerly dominated by public research. In developed countries, the private sector is now the primary supplier of new agricultural technologies. However, this shift is not as widespread in the developing countries.

It is now recognized that there are many grey areas where R&D products are neither pure public nor private goods. Thus, some form of partnership that exploits complementary skills of both sectors is most appropriate. A large number of public-private partnerships for agricultural and agro-industrial research have emerged using resources and skill synergies from the two sectors. They are used to take advantage of new market opportunities, to purchase public/private research and advisory services, or to access public and/or private funding for research.

Interest among governments, development agencies, and the private sector in public-private partnerships (PPPs) is increasing, particularly as a mechanism for market-driven development. However, PPPs are still an underutilized tool in public policy in developing countries. Efforts to foster PPPs in agricultural research have had mixed results for varied reasons, such as clashes of working styles and complex IPR and contractual arrangements. They remain a long-term priority for science policy. Figure 2 shows the major assumptions implicit in use of PPPs.

Figure 2. The main assumptions in public-private partnerships



Source: modified from Veronica Gotrett's presentation.

WHAT ARE THE KEY ISSUES AND CHALLENGES IN DEVELOPING PUBLIC-PRIVATE PARTNERSHIPS?

There is a widespread recognition of the potential of PPPs in agricultural research as a means of developing the capacity of agricultural innovation systems. The starting point for many PPPs is usually in science and involves long-term collaboration and sharing of leadership and power. However, business interest has been the most important starting point for PPPs in some countries, such as the USA. Although science-based PPPs are important, in practice public-private innovations usually involve clusters or coalitions of organizations, including those from civil society, who together produce, adapt, and use the knowledge that drives innovation. These partnerships have usually emerged as a result of casual interaction between a private sector leader and a researcher, who know each other from the past giving them an initial level of trust that facilitates the start of a partnership.

Recently, many partnerships have been induced by competitive grant schemes that condition funding on the existence of linkages between researchers and private producers or industries. Besides technical innovations, the partners may look for other innovations: institutional, managerial and policy innovations, including aspects such as transfer of technologies, sharing of human resources and financing, appropriateness, and marketability of research results. When used appropriately, PPPs can also allow small countries to benefit from frontier research, knowledge and skills and can serve as an entry-point for the local NARS to understand and deal with the external global pressures.

These experiences produced a number of general points. Successful partnerships are always context-specific. There is a great diversity of arrangements dependent on the context in which partnerships arise and on the needs that trigger the partnerships. Recipes for PPP formation will probably be of limited use, but developing principles will be helpful.

PPPs have been most successful when developed as a long-term partnership between trusted partners, and when building capacity and developing marketable technologies. Case studies from the International Service for National Agricultural Research (ISNAR)[6] indicate that the most appropriate basis for building public-private partnerships is the value chain, where actors with common interests converge. However, a successful PPP may require pre-investment from publicly-funded or non-profit private research organizations in order to give the research organization recognition and credibility, particularly when public interests are to be negotiated with private ones on equal terms. Other key factors were: enhancement of social capacity, flexibility, leadership from a "promoter group" or a facilitator; clear identification of common objectives or the common interest space.

The study emphasized the importance of human resources and operational funds to facilitate partnerships, particularly when the actors are heterogeneous. Providing these has costs, but will probably yield more sustainable and effective public-private partnerships. Effective partnerships generally require: (i) a facilitating organization and a facilitator with a mandate and ability to promote PPPs; (ii) a visionary and innovative leader in the private sector with credibility and recognition within the sector; (iii) research organizations with goodwill and recognition that offer knowledge and technological options relevant and responsive to the demands of the value chain and (iv) researchers with a good knowledge of the value chain and available technological options, and with an aptitude to relate to the private sector.

Building partnerships has not been straightforward and often counter to deeply held professional norms. In many cases the main constraints are of an institutional nature and require institutional change, particularly in public research systems, so that a new tradition of working together can emerge. Other trade-offs inherent in public-private partnerships include management intensiveness of the partnerships and the complexity of the rapidly changing international and national laws that govern intellectual property rights, technology transfers and regulation of plant varieties. This was pointed out by the case study from Brazil.[7] Transaction costs are further increased with policies on competitive research grants that require capacity building beyond that provided by training on the identification of common interests, the negotiation of financial, governance and legal aspects, and the design of partnerships. Box 3 summarizes the key issues in forming and sustaining PPPs.

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6 The Case Study on Public-Private Partnerships Project for Agroindustrial Research, implemented by ISNAR, CIAT and national partners in Ecuador and the Dominican Republic, was presented by Veronica Gottret, CIAT. The Study analyzed the experiences of the action-research component of the project, which implemented its activities with a strong collaboration with national organizations in both countries.

7 The Case study on Brazilian Agricultural Research Corporation, EMBRAPA, illustrates Brazil's response to external and internal pressures to shift to more market-driven development and use of public-private partnerships between national public and private institutions (farmers, seed producers) and multinational companies. The study was presented by Maria Jose Sampaio, EMBRAPA.

Box 3. The key issues and challenges in promotion of Public-Private Partnerships (PPPs)

PPPs are often successful when:

- Developed as a long term flexible partnership between trusted partners;
- Used for capacity-building and development of marketable technologies;
- Common objectives and common interest space have been clearly identified;
- Readiness for institutional learning and change exists;
- Used for enhancement of social capacity; and
- Led by a facilitator.

The key challenges:

- High transaction costs - management intensiveness;
- Demand for human resources and operational funds;
- Resistance to institutional change;
- Complex operational setting, including disconnect between international and national laws; and
- Farmer and civil society involvement in technology development.

Source: Authors.

HOW CAN PUBLIC-PRIVATE PARTNERSHIPS BE FURTHER ENHANCED?

PPPs have much potential in agricultural R&D and in S&T in general, but have been slow to develop, primarily because of a lack of clarity among partners on the potential outcomes. In order to harness the advantages of PPPs, greater efforts are needed from both the public and private sectors to foster openness and clarity, minimize risk and uncertainty, and reduce the red tape associated with partnerships. Including a facilitator and/or facilitation organization in the process can reduce the transaction costs and bring clarity to the process. There is also a need for policy measures, such as intellectual property rights legislation, to shape the PPPs.

There should be a stronger emphasis on partnerships as a source of synergistic R&D rather than as a means of supplementing public sector funding. Partnerships are neither appropriate to every R&D situation nor a panacea to resource or capacity limitations in the public sector. Partnerships should not be considered for technical innovations only, but should encompass institutional, managerial and policy level collaboration. The United States Department of Agriculture (USDA) experience with Cooperative Research and Development Agreements (CRADAs)[8] suggests that CRADA priorities reflect a middle ground between public and private interests and that the public share of contributions is higher for areas where private incentives are low. While intellectual property concerns have been important, access to human capital has been the key benefit for private CRADA partners.

PPPs should also allow greater participation by farmer groups and other stakeholder groups (consumer organizations, environmental groups, etc.) to balance private sector influence and power over priority setting. In addition, increased capacity strengthening efforts are needed to

[8] The Case Study described the driving forces for establishing Public-Private Partnerships in USA as well as the benefits and challenges of using Cooperative Research and Development Agreements by USDA. The study was presented by Kelly Day-Rubenstein, USDA.

help innovation actors to accumulate social capital, develop cooperation skills, and build capacity to analyze needs of their particular value chains.

5. Sustainable Development of Core Public R&D Capacity

WHAT CHANGES HAVE TAKEN PLACE IN PUBLIC R&D INVESTMENTS?

Most public research organizations were created in the 1960 to 1980 as semi-autonomous public organizations split off from ministries of agriculture. They grew over time with strong donor support, and considerable capacity was also established in many universities. However, by the mid 1980s these public research organizations faced serious problems due to lack of effectiveness and efficiency, often claimed to result from the availability of long-term core funding that reduced the willingness to consider changes. On the other hand, in many occasions lack of sustainable core funding was claimed to result in low staff morale, reduced institutional capacity and unwillingness to reform. Core funding tends to be used for the long-term recurrent cost components, of which salaries is a key one, while the operational costs, that are shorter run in nature, remain a second priority.[9]

There is clearly a need to reform public research systems. However, the key question is how to reform and to what extent to reform. Key issues concerning public research include: (i) how should it be organized, governed, and coordinated; (ii) how to improve its accountability; (iii) how it should relate to private research; and (iv) what critical factors determine its success? To make research more demand-driven and pluralistic, development agencies are increasingly using instruments, such as competitive funding, as part of reform programs. Reforms associated with competitive funding resolve some of the problems. Since competitive funding typically only provides research operating costs, core public research capacity for long-term system sustainability continues to depreciate. Yet direct core funding to public research organizations to build capacity has often failed due to poor management and leadership.

Core research support for human research capacity and infrastructure is necessary to ensure sustainable research systems that promote high quality research, address long-term problems in key thematic areas, and undertake strategic research. A case study from Romania illustrated how core funding, along with accountability systems, is necessary for an efficient research organization. Inadequate means resulted in research staff allocating their time and resources in "extra-curricular" activities, such as selling of inputs and agricultural products, to supplement their salaries and maintain facilities. This came at the expense of initiating and conducting research. Sustainable core support to research systems is also needed for management of competitive and other special funds.

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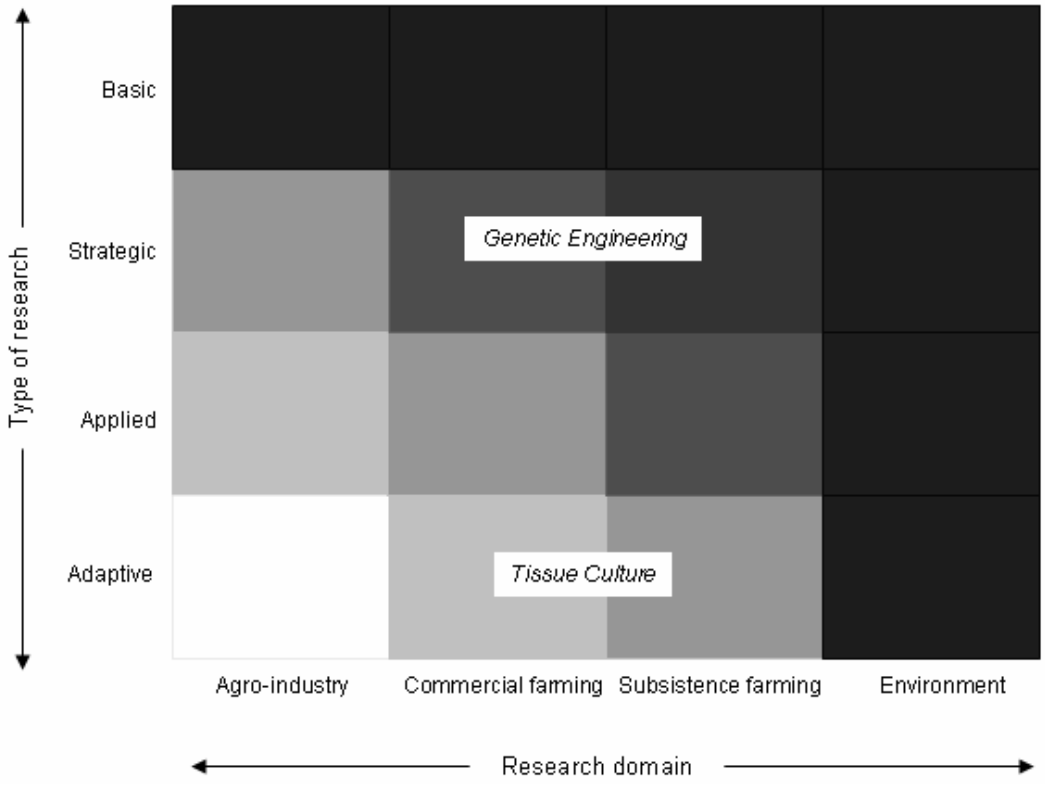
[9] Feast or famine funding plagued many research systems. While there were active donor projects, there were plenty of resources and little interest in reform. When projects ended, there was generally low morale, an emphasis on "getting the next project", and little attention to serious reform.

HOW CAN CORE R&D RESOURCES BE ALLOCATED AND USED EFFICIENTLY?

Sustainability demands that national governments provide adequate budgetary support to agricultural R&D, and "right-size" research organizations to the resources available, using funds saved for operating costs and for paying scientists competitive salaries. Four factors critical to successful development of core public research capacity are political support, accountability mechanisms, complementarities, and responsiveness of the system. The right balance between core and competitive funding also depends on the need to maintain institutional stability, the type of research, and the resources available in the country. A tool supporting decision-making for allocation of public funds for agricultural research is shown in Figure 3. In theory, the darker the color, the more public funding the research would warrant: (i) basic research would receive more public funding than adaptive research (type of research); (ii) research on environmental issues would be subject to more public funding than e.g. research on commodities; and (iii) infant industry might require more public funding at the beginning but over time, the funding would subside. How to convince governments to allocate resources to develop and maintain core research capacity development is a basic challenge in most countries. Better linkages between research and policy and politics are needed in order to build political support and provide science-based input for policy formulation. Advocacy and communication to bring agricultural S&T to Poverty Reduction Strategy Papers, Country Assistance Strategies, etc, are needed. It is also critical to have a common vision for agricultural research, i.e. one that has been formulated with inputs from all stakeholder groups from the bottom to the top (from local to national level).

Figure 3. A decision-making support tool for public funding for agricultural research



Source: Willem Janssen, World Bank.

Good governance of a public research system requires involvement of government, farmers, and private sector in the overall structure. Putting in place formal accountability systems, which include financial accountability, review of quality and relevance, and performance monitoring, is very important. Also, a certain level of complementarity is essential: an increase in public research spending seems to stimulate higher private sector investment in research in developed countries and in some developing countries. Thus, a strong public research system complements rather than substitutes for private research.

A balance between the ability to respond to new demands and to maintain institutional stability and security is essential. Different mechanisms that aim to increase demand responsiveness, such as competitive and matching grants, contract research, decentralization, or stakeholder-led governance, may lead to reduced institutional stability. However, models that improve the research system's responsiveness (e.g., by adopting competitive grant mechanisms) while maintaining public core capacity and hence institutional stability, could be introduced. The major issues to consider in building sustainable core support to research systems are summarized in Box 4. Public sector targeted competitive funding that includes some equipment costs and training can be used for developing new core capacity/stability. Other possibilities may include linkages between research organizations and national and/or foreign universities or developing long-term contracts. Sustainable core support to research systems is also needed to maintain the management of competitive and other special funds. Using a competitive fund for supplying long-term capacity-building among institutions is one option, but the sustainability of this mechanism must be discussed.

Box 4. The "how to" of maintaining sustainable core support to research systems

- Develop a common vision for agricultural research;
- Improve linkages between research and policy, and employ science for sound policy design to receive political support;
- Develop accountability systems;
- Improve responsiveness, e.g. by using competitive and other special funds to guide and generate better research outputs; and
- Use public research spending to complement and stimulate higher private sector investment in research.

Source: Authors.

In India,[10] institutionalized priority setting, allocation of funds to priority research areas, a competitive research funding mechanism, and a good blend of strategic, applied and adaptive research contributed to improved responsiveness of the R&D system. In Romania,[11] the prospects of joining the EU and having access to larger markets acted as the stimulus for the R&D system to become more effective and responsive.

[10] A Case Study on India's National Agricultural Research System, consisting of Indian Council of Agricultural Research Institutes and State Agricultural Universities, illustrated how the World Bank funded National Agricultural Technology Project guided the reform process towards more efficient and effective NARS. The study was presented by Paul Sidhu, World Bank.

[11] Driving factors and experiences from restructuring of Romanian agricultural research system were presented by Daniela Giurca, Institute of Agricultural Economics, Romania.

A case study from Spain[12] illustrated how major institutional changes in the S&T domain were addressed using strategic planning, geographical decentralization of research, competitive funding, research evaluation policy, and more flexible administrative procedures. The competitive grants proved an effective means to guide and generate higher quality research outputs, while maintaining core R&D capacity. The problem of low output in research was addressed by introducing new funding schemes in public sector institutions (i.e., increased project funding, funding of on-demand research, and sustained support to long-term research activities), and policies and programs that boosted interest and efforts of agricultural inputs and food sector firms in R&D (e.g., by providing subsidies to incorporate young technologists and to set up innovation departments in firms). However, the change from institutional to competitive funding produced co-ordination problems at the time of defining coherent research strategies.

The case study on Spain also illustrated how the size of the country and its resource base affect the level of core public R&D. A small country has to focus its resources more than a large country. It must concentrate on location-specific technologies and benefit from collaboration with partners having frontier research knowledge and skills in other essential research areas. Small countries may also allocate core research resources to universities that have a dual function to maintain education and core research. Another possibility is to establish regional collaboration where appropriate.

6. Promoting Research Alliances and Technology Spill-Ins

WHY ARE REGIONAL AND INTERNATIONAL ALLIANCES AND PARTNERSHIPS OF INCREASING IMPORTANCE?

Over the past several years, there has been a significant increase in regional and international research partnerships and alliances. Globalization of science and information provide enormous challenges and opportunities for developing countries. Research systems are increasingly required to have access to scientific knowledge in the global arena. Some of the factors responsible for this upsurge of international partnerships include: (i) a complex and changing agenda for agriculture and agricultural research, including increased focus on poverty reduction, human health, and food safety; (ii) a reorganization of the global agricultural research systems to include stakeholders, such as farmer organizations, NGOs, and private sector; (iii) an increasing demand from donors for regional alliances; (iv) the information communication technology revolution that has made the exchange of information across boundaries easier; and (v) the increasing prominence of biotechnologies that call for new competencies not always available in one institution.

[12] An overview of the recent history of science policy and agricultural research in Spain with particular emphasis on policies directed toward improving the technology development capacity of the agricultural research system was presented by Casimiro Herruzo, Technical University of Madrid, Spain.

Partnerships and alliances come in different forms and shapes and work in a variety of ways. They can be multi-institutional involving only research institutions or inclusive of other stakeholders in the form of multi-stakeholder partnerships. Partnerships exist between southern and northern groups and institutions or along the south-south axis. Box 5 lists a few critical drivers and success factors for the development of partnerships and alliances.

Box 5. Factors that influence the foundation and evolution of partnerships and alliances

Foundation factors:	***Evolution factors:***
1. Shared vision	1. Strategic relevance
2. Commitment	2. Solid management
3. Strong leadership	3. Effective communication
4. Financial resources	4. Shared decision making processes
5. Power equity	5. Trust and commitment
6. Complementarity	6. Credit and recognition

Source: Ola Smith, Global Forum on Agricultural Research.

7. What are the Features of International Alliances and Networks – Case Studies

Three case studies were presented during the workshop. The first case study on North-South Partnerships and Networks in Biotechnology Research[13] illustrated the results of an analysis of 18 different partnership projects in Kenya. The analysis showed that the partnership requires advanced management skills due to the large number of parties involved, communication with farmers and the local regulation and liability issues. The other two case studies, the Collaborative Research Support Programs (CRSP)[14] of the United States and the Modernization Program for Agricultural Services (PROMSA) in Ecuador[15] are described in Boxes 6 and 7.

[13] Joanna Chataway from the Open University, UK, presented a quick analysis of 18 different partnership projects in Kenya. Some examples of the biotechnology partnerships in the 1980s and 1990s included the Insect Resistant Maize for Africa in Kenya, Biotechnology to Benefit Small-scale Banana Producers in Kenya, Millet and Sorghum Improvement initiative in Mali, and Agricultural Genetic Engineering Research Institute in Egypt.

[14] Collaborative Research Partnerships for Technology Generation and Capacity Building presented by John Yohe, CRSP, University of Nebraska, USA.

[15] Experiences on regional and international alliances in Modernization Program for Agricultural Services, the World Bank (PROMSA) by Julio Chang, PROMSA, Ecuador.

The modus operandi of the latter two types of alliances differs significantly: one is managed by research institutes from an industrialized country, while the other has more local ownership. This does not necessarily translate to a supply-driven vs. demand-driven divide, as mechanisms for user participation in priority setting and problem identification can be built into both models. The Ecuador model may have potential to build political commitment and to become sustainable.

Box 6. Collaborative Research Support Programs (CRSP) in the United States

The CRSP programs are global alliances for long-term research that include 75 universities from America and developing countries, eight international agricultural research centers, and 43 research/extension institutions in developing countries.

These alliances seek to improve livelihoods and preserve biodiversity in natural and human-made ecosystems. The structure has proven to be a viable organizational model for globally-important collaborative research. Three features deserve special notice.

- *Multi-tiered organizational structure.* With the support of several policy, institutional, technical, and peer-review bodies, the central management entity provides strong, effective leadership to the many partners involved in the CRSPs. A strength of the CRSP programs is that they are flexible and can be readily reoriented to new priorities.
- *Organization of the collaborative model*. The multi-disciplinary approach to research helps avoid the narrow confines of any single discipline. Sharing financial resources, international participation in management, and long-term technical, professional interaction reinforces this collaboration; and
- *Long-term commitment demonstrated by participants*. CRSPs provide sustained support and opportunities for strengthening institutional capacity.

Source: John Yohe, CRSP, University of Nebraska, USA

Box 7. Modernization Program for Agricultural Services (PROMSA) in Ecuador

The PROMSA program in Ecuador, executed through the Ministry of Agriculture and Livestock with support from the World Bank, operates a competitive fund for agricultural research that aims to create a diverse and demand-driven national research system. Of the 121 approved projects, six were international education alliances and seven international research alliances.

The main benefits of the alliances have been:

- Improved future research capacity of Ecuador through improved research methodologies and strengthening of postgraduate education.
- Technology spill-ins (importation and adaptation of technologies) that are a cost-effective means to improve the technology base of Ecuador's agriculture.
- Alliances in research and education that allow local organizations to draw on resources and technical expertise from international centres of excellence, and encourage long-term relationships with institutions and client groups.

Intellectual property rights have been a crucial problem in the management and operation of international research alliances.

Source: Julio Chang, PROMSA, Ecuador

The main lessons learned from these case studies are:

1. Identifying relevant actors and sufficient resources is essential. Competitive funds can serve as good instruments to identify researchers, to help to understand the capacity of the research infrastructure and the level of commitment and resource requirements.

2. Well-defined research priorities will allow the country to identify and match national actors with appropriate international actors for future partnerships.
3. Capacity building in research management requires attention in most national institutes.
4. To consolidate sound partnerships, it is important to review the proposals and analyse the resources provided by each partner thoroughly.
5. A good Monitoring & Evaluation system should be included in the design of every competitive fund program.
6. The direct beneficiaries of the research should actively participate in all activities of the research process. Reference groups should be used to help monitor and evaluate progress of the research project.

KEY FEATURES IN PARTNERSHIPS AND ALLIANCES

Some of the key factors identified in the partnership and alliance programs are: (i) a long-term commitment of the partners based on mutual respect; (ii) a common and shared vision of the problems to be tackled and of the approaches to be utilized; (iii) a transparent partnership based on effective and open communication and equitable sharing of resources and benefits; (iv) a flexible structure of collaboration; (v) a balanced partnership where important decisions are taken with full consultation and consensus; and (vi) capacity building in management and negotiating skills, especially regarding IPRs. International partnerships and alliances are expected to further increase in number and complexity. Although there is an increasing body of recommendations on how to make such partnerships work, this understanding needs to be further strengthened.

8. Decentralizing National Agricultural Research Systems and Promotion of Participatory Approaches

WHY ARE DECENTRALIZED, PARTICIPATORY APPROACHES, AND SYSTEMS BEING ENCOURAGED?

The issues of decentralization of agricultural research systems and of promoting participatory research approaches are closely inter-linked and reinforce each other. To fully understand their potential benefits, challenges, and constraints, a clear definition and understanding of both approaches is needed. The following degrees of decentralization can be distinguished: (i) deconcentration, i.e., dispersing staff to regional offices without changing the central authority and control; (ii) administrative decentralization, i.e., the transfer of authority over regional staff to regional or local governments; (iii) fiscal decentralization, i.e., the transfer of funds and responsibility of fund-raising to lower-level government units; and (iv) delegation, i.e., the transfer of responsibility to user groups (e.g., producer organizations). In agricultural research, mechanisms for decentralization include the creation of autonomous regional research

organizations and the devolution of authority for priority setting and resource allocation. Decentralization reforms are being pursued in many countries with a view to improving public services. For research systems, especially in larger countries, these can serve to provide administrative flexibility and to make agricultural research more client-oriented and impact driven by bringing researchers closer to their clients. Hence, decentralization has the potential to increase relevance and responsiveness of service delivery, to strengthen accountability and improve sustainability through client support.

The decentralization process may also facilitate, but is not necessary[16] for, the introduction of participatory research approaches. Participatory research in agriculture can be defined as joint implementation between the intended beneficiaries and the scientists and technicians in charge of knowledge generation. Its goal is to increase the relevance of agricultural technology to farmers and therefore to increase the impact of science and technology on the welfare of society. Participatory approaches emphasize: (i) the importance of local knowledge; (ii) farmers' capacity to experiment and innovate; (iii) farmer-to-farmer diffusion of technology; and (iv) the need for a diversity of technologies, since farmers are not homogenous. The approach allows the generation of a diversity of technologies that respond closely to the needs of different types of farmers and their local conditions, which should translate into a greater potential for diffusion and adoption. Table 1 illustrates potential roles for farmers in participatory plant breeding.

Table 1. The modes of farmer participation in plant breeding

Mode of farmer participation	***Role of plant breeders***	***Comments***
Farmers are given finished varieties developed by plant breeders	▪ Set breeding objectives ▪ Select source germplasm ▪ Identify traits for improvement ▪ Determine breeding methodology ▪ Establish testing procedures ▪ Evaluate cultivars on station	▪ Little direct interaction between farmers and breeders ▪ Breeders knowledge of what farmers want is not based on organized and direct interaction with farmers
Farmers provide source germplasm on which breeding process is based	▪ Collect and characterize source germplasm ▪ Identify traits for improvement ▪ Determine breeding methodology ▪ Establish testing procedures ▪ Basis for developing new varieties ▪ Evaluate cultivars on station	▪ Well adapted material, hopefully with many traits farmers value ▪ Breeding process solely in the hands of breeders
Farmers identify traits to be improved and suggest	▪ Set breeding objectives ▪ Select source germplasm	▪ Better targeted varieties ▪ Varieties more likely to respond to

[16] For example, while the CGIAR research centers are rather centralized, they still apply participatory research methodology.

Table 1. The modes of farmer participation in plant breeding

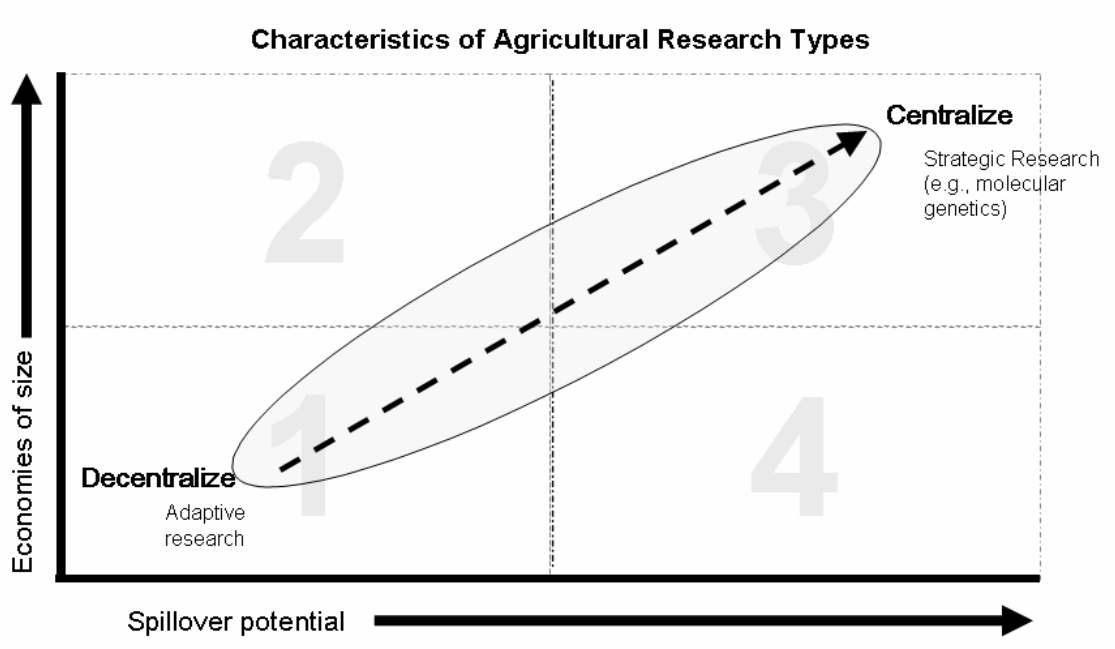
Mode of farmer participation	*Role of plant breeders*	*Comments*
selection criteria	▪ Determine breeding methodology ▪ Establish testing procedures ▪ Evaluate cultivars on station	farmers' needs and constraints
Farmers evaluate finished varieties on station or in scientist-managed on-farm trials and help select varieties to distribute	▪ Set breeding objectives ▪ Select source germplasm ▪ Identify traits for improvement ▪ Determine breeding methodology ▪ Establish testing procedures ▪ Finished cultivars evaluated on station or in farmers' fields but under breeders' management	▪ Farmers may be able to select for traits that they cannot easily describe in words ▪ Selection of germplasm shared between breeders and farmers ▪ Evaluation possible under a range of biophysical conditions

Source: Mauricio R. Bellon and Michael L. Morris. 2003. Linking global and local approaches to agricultural technology development: the role of participatory plant breeding research in CGIAR. Economics Working Paper 02-03. International Maize and Wheat Improvement Center, CIMMYT, Mexico D.E., Mexico.

WHAT ARE THE MAIN CHALLENGES AND KEY ISSUES FOR IMPLEMENTING DECENTRALIZATION AND PROMOTION OF PARTICIPATORY APPROACHES?

A key challenge for implementing both decentralized agricultural research systems and participatory research approaches is to maximize economic efficiency. In agricultural research, economies of size and scope in technology generation and economies of market size/spillover potential are of particular importance. Economies of size in technology generation depend mainly on the size of the target domain, the fixed costs, the degree of specialization and the potential to exploit scientific synergies. The potential for spillovers depends mainly on agro-climatic similarities and consumer preferences. Figure 4 illustrates the link between economies of scale and spillover potential and the optimal degree of decentralization.

Figure 4. Economies of scale, spill-over potential, and potential degree of decentralization



Source: Derek Byerlee, World Bank.

Two case studies illustrated the experiences of some countries with decentralization.[17] Major challenges related to decentralization include: (i) to balance demand-driven and supply driven approaches; (ii) to build the capacity of lower level organizations (e.g., for research governance, producer organizations, state and local government) and - at the same time - minimize the costs of establishing new organizations; (iii) to build capacity to meet the research demands of small, heterogeneous and spatially fragmented agro-ecological zones; (iv) to implement mechanisms for maximizing spill-ins (e.g., trade policies, IPRs, networking among local research organizations); and (v) to divide responsibilities and linkages among the different players (e.g., International Agriculture Research Centers, Sub-regional Research Organizations, National Agriculture Research Stations, states, communities). The key benefits and challenges of decentralization of agricultural research systems are shown in Box 8.

[17] Howard Elliott from ASARECA shared the Experiences of Decentralization of four countries in East Africa (Uganda, Kenya, Tanzania and Ethiopia) that showed the different levels of decentralization in each country. The case studies underscored the basic principles of decentralization, i.e., helping to increase research relevance, responsiveness, accountability, and sustainability.

Mr. Brahim Hafidi from the Institute of Agronomy and Veterinary Medicine Hassan II, Morocco, demonstrated that even in a relatively small country such as Morocco, decentralization can be an effective tool in increasing research relevance and efficiency, both strategic and adaptive.

Box 8. Decentralization in Agricultural Research Systems

Decentralization of research systems may:

- Bring researchers closer to its clients;
- Make research more client-oriented and impact driven;
- Increase accountability and improve sustainability through client support;
- Strengthen the link between research and extension; and
- Improve administrative flexibility.

Challenges of decentralizing – how to:

- Maximize economic efficiency;
- Balance demand-driven and supply-driven approaches;
- Build capacity at various levels for research implementation; and
- Change the mentality among scientists, research managers, extension workers, and farmers.

Source: Authors.

Cost considerations are also important aspects for introducing participatory research approaches. Participation has costs, both for scientists and farmers. Although the development of technological options that are well adapted and specific to farmers' local conditions is one of participation's advantages, it can also become a disadvantage if there is no commitment to generate multiple options. If only a few options with a narrow appeal are generated, then benefits would accrue to a reduced group of farmers. However, to produce diverse technological options is more expensive than to produce only a few.

The challenges of participatory research are closely linked to the challenges of the decentralization of research mentioned above, i.e., the issue of balancing supply and demand-driven approaches, capacity building at various levels, etc. In addition, the challenges of participatory research in agriculture include the need for a change in mentality among many scientists, research managers, extension workers, and even farmers. There is a need to develop new skills for participatory approaches among scientists and extension workers, as illustrated by the case study from Uganda.[18] Research and extension institutions may have to be modified institutionally to incorporate participation in their efforts. While farmers have great capacity to innovate, institutions need to be created that provide them with the necessary tools.

9. Key Steps in Decentralization and Participatory Approaches

Determining the appropriate strategy and level of decentralization is a complex task and depends on the component under consideration. The following recommendations were made during the

[18] Implementation of innovative institutional approaches for participatory research in Uganda emphasizing the importance of multi-stakeholder coordination, farmer innovation, and facilitation by a research team in a district level research station, presented by Peter Lusembo, NARO, Uganda.

workshop: (i) centralize administration to the extent possible to maximize efficiencies; (ii) decentralize governance to the extent possible to be responsive to demand; (iii) decentralize financing to the extent possible to diversify funding sources; and (iv) centralize or decentralize execution depending on the type and nature of research. However, the strategies for decentralization have to be adapted to: (i) the type of research; (ii) the size and type of the country; and (iii) the local institutional context. For adaptive research the typical locus is at the regional level within the country, whereas the typical locus for strategic research is at the center. Each country has a different environment conditioned by history, economic structure, and size. Hence, incentives, structures, and management mechanisms must be tailored to each country.

Changes should be introduced in an evolutionary way, based on piloting and learning. Introduction of fundamental changes, such as the decentralization of public services, takes time and requires intensive planning, widespread consultation with stakeholders, and capacity building.

Implementing participatory approaches requires an institutional system that links research activities with farmers as well as with diffusion and extension activities. This system should be based on the principle of linking the "formal" with the "informal" in a way that a feedback loop is created, e.g., linking scientific knowledge to local knowledge, formal experimentation with farmer experimentation, formal diffusion and extension systems with farmer-to-farmer diffusion of technology. Participation cannot be left to the end of the research process, but should be an integral part of the whole process. Farmers and scientists can link and interact in a number of ways.

One of the strengths of participatory research is its focus on the local level. Because of its high costs, it cannot be done everywhere. Another important issue is where to carry out participatory research to attain wide impacts while focusing on the local level. An option is to carry out participatory research in carefully located benchmark sites or decentralized research stations that reflect the conditions of the intended beneficiaries of the technology research process.

Applying any mode of participation requires paying as much attention to the "hardware" (the improved seeds, machinery, inputs) as to the "software" (knowledge, understanding, information). It is necessary to identify the knowledge that is needed for the technologies to be successful, emphasizing the "principles" (why one needs to apply nitrogen) rather than be "recipes" (apply 100 kg of nitrogen per hectare). This in turn mandates that the diffusion and extension services include a strong education component. Different modes of participation entail different costs and benefits to farmers and scientists. Therefore, there should be optimal levels of involvement. To identify those levels, however, may be difficult. At least it is necessary to identify the specific costs and benefits associated with different modes of participation and use this information to improve the effectiveness of participatory efforts, as well as to define the limits.

In conclusion, decentralization and participatory research in agriculture can be helpful mechanisms to increase the efficiency and the impact of agricultural science and technology. However, their effectiveness depends on the appropriate dose and sound implementation strategy.

10. Converging Views, Emerging Agendas, and the Next Steps

Converging views. Participants were optimistic about the potential of agricultural research to support increased competitiveness and to contribute to poverty reduction. This view is also based on the revitalized awareness of donors and borrowers of the important role of agriculture and rural development in reaching the Millennium Development Goals. However, participants generally agreed on the necessity of agricultural research systems to reform in order to play the anticipated role. In particular, there is a perceived need for better integration of agricultural research into the broader S&T system and global knowledge economy. This was seen as necessary to improve the ability of the agricultural sector to satisfy the changing demands placed on it. It would also guide investments towards building an agricultural innovation system that recognizes the innovative capacity of stakeholders, from producers to the marketplace. Monitoring and Evaluation (M&E) was generally seen as an important tool for project and program management, to track progress, and to make corrections as needed.

Emerging agenda. While there was clear consensus on the future directions necessary for agricultural research to be able to respond to changing demand, there was less agreement and experience on how to address the challenges of promoting reforms that can be sufficiently adapted to local socioeconomic, institutional, and political circumstances. Moreover, there is a need to refine and/or develop tools, including new models for PPPs and tools for M&E, which support the implementation of the recommendations. In more detail, the following are the main emerging issues:

- Understanding of the changes in the economic, political, sociological, technological, and natural environments and their impacts on the demand of the agricultural sector needs to be improved in regional and country-specific contexts.
- A new concept on Agricultural Innovation Systems is emerging. These link multiple sources of innovation and uptake pathways, along the continuum from basic research to technology adoption. There is a need to analyze the challenges and opportunities in promoting such a concept.
- M&E tools need to be developed that increasingly focus on outcomes and impacts and are able to capture the recent changes in Agricultural Research or Innovation Systems.
- Decentralization of agricultural research systems can be helpful in increasing efficiency and boosting the positive impact of agricultural science and technology. However, decentralization has to be analyzed case by case in terms of the appropriate 'dose': implementation strategies have to be identified based on country-specific circumstances.
- Competitive grants must be accompanied by a long-term strategy for research capacity development, and a carefully thought out balance between strategic and applied research, and between core and operational funding. Appropriate institutional mechanisms have to be identified to facilitate this process.

The Next Steps. The participants agreed that further steps and initiatives are needed to address the challenges identified during the workshop. Relevant activities and studies planned in this context are:

- The International Assessment of Agricultural Science and Technology for Development, which will assess the economic, environmental, health, and social implications of current and potential future technologies. It will also assess the effectiveness of institutional arrangements on which technology generation and transfer are based.
- Further studies are planned by the World Bank and its partners to develop an analytical framework for Agricultural Innovation Systems, and to consider the pros and cons relative to the more traditional conceptual structures of AKIS and NARSs. Application of a scenario planning approach, to inform investments in Indian agricultural science and technology in the light of the challenges and uncertainties that surround them, is also under way.
- Revitalized awareness of the importance of M&E for project management, better use of scarce financial resources, increased focus of donors and borrowers on outcomes and impact, and recent changes in the agricultural innovation systems, are currently leading to a high demand for expertise in M&E, including impact analysis.

Appendix A. Overviews, Case Studies, List of Authors and Presenters

Positioning Knowledge Systems for Changing Agriculture and Changing Science

- The changing knowledge demands of the agricultural sector – G. Edward Schuh, University of Minnesota
- The responsiveness of agricultural research to changing knowledge demands - Experience from Mexico - Jose Laborde, SAGARPA, Mexico
- Positioning agricultural research within the wider S&T scene – Lauritz Holm-Nielsen, World Bank

Challenges, Opportunities and Lessons Learned in Reforming Agricultural Innovation Systems – Regional Experiences in Reform Processes

- Experiences and lessons learned from Latin America – Matthew McMahon, World Bank
- Experiences and lessons learned from Sub-Saharan Africa – Sam Chema/Han Roseboom, Agricultural Research Foundation, Kenya

Public-Private R&D Partnerships for Market-Driven Development

- Overview of issues - Andy Hall, UN University
- The experience of Cooperative Research and Development Agreements (CRADAs) in the changing research environment - Kelly Day-Rubenstein, USDA
- Public-private partnerships in Latin America – Experiences and lessons learned – Veronica Gottret, CIAT
- EMBRAPA's experiences from public-private partnership – Maria Jose Sampaio, EMBRAPA, Brazil

Sustainable Development of Core Public R&D Capacity

- Overview Issues: Willem Jansen, World Bank
- Experiences from Spain – Casimiro Herruzo, Technical University of Madrid, Spain
- Experiences from India - Paul Sidhu, World Bank
- Experiences from Romania – Daniela Giurca, The Institute of Agricultural Economics, Romania

Promotion of Regional and International Alliances and Spill-Ins from a Country Perspective

- Overview of issues - Ola Smith, Global Forum on Agricultural Research (GFAR)
- North-South partnerships and networks in biotechnology research - Joanna Chataway, Open University, UK
- Experiences on regional and international alliances in PROMSA – Julio Chang, PROMSA, Ecuador
- Collaborative Research Partnerships for Technology Generation and Capacity Building - John Yohe, CRSP, University of Nebraska

Decentralization of National Agricultural Research Systems

- Overview of issues - Gary Alex, USAID and Derek Byerlee, World Bank
- Experiences of decentralization in East Africa, Seyfu Ketema/Howard Elliott, ASARECA
- Experiences of a national research center in North Africa - Brahim Hafidi, Institute of Agronomy and Veterinary Medicine Hassan II, Morocco

Promotion of Participatory Research Approaches

- Overview of issues - Mauricio Bellon, CIMMYT
- Implementation of innovative institutional approaches for participatory research in Uganda - Peter Lusembo, NARO, Uganda

Critical Issues and New Directions Identified in Developing Responsive Agricultural Innovation Systems

- Panelists: David Nielson, World Bank, Mercy Karanja, IFAP/Kenya National Farmers Association, Christian Hoste, CIRAD, Beyene Kebede, EARO, Jonathan Wadsworth, DFID, John Swanson, USAID

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