The Search for a New Paradigm for the Development of National Agricultural Research Systems

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**Summary:** This paper first reviews trends in the recent evolution of investment in national agricultural research systems. It then synthesizes the major elements of an emerging paradigm for viewing the future evolution of research systems. This paradigm has arisen in response to the funding crisis in public research organizations in the 1990s, and the declining capacity of many of these organizations. Key elements of this new paradigm; are a pluralistic institutional structure, a growing role for the private sector, new mechanisms for research funding, improved efficiency and effectiveness of public research organizations, and strengthening of global scientific links.

**Key words:** Agricultural research, institutional change, private sector

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1. INTRODUCTION

The papers in this volume trace the recent evolution of national agricultural research systems in the developing world, highlight current research policy issues, and provide some indications of the future evolution of research systems into the 21st century. After 25 years of rapid expansion of national and international research systems in developing countries, it is appropriate to review a broad range of policy issues that impinge on the performance and relevance of national research systems in the late 1990s. After rapid growth in these systems from 1970 to 1985, the past decade has seen a period of stagnation of funding accompanied by a search for new paradigms for financing and executing agricultural research.

The six papers in this set were originally presented at the 21st International Agricultural Economics Conference in Sacramento, USA in August, 1997. Together they provide an overview of major developments in agricultural research systems at a global level, in three developing regions, in one industrialized country, and an analysis of policy issues for private sector research and for international research. This overview highlights trends and policy issues that emerge from these papers.

2. TRENDS IN R&D INVESTMENTS

Alston et al. provide global figures of their best estimates of total investment in agricultural research in national systems and in the international system over the past 25 years. Growth in research investments was very rapid in the 1970s, averaging over six percent annually in the developing world. This period of rapid growth resulted in a sharp expansion in the size of research systems, accompanied in many cases by a proliferation of research institutions and programs. Mruthyunjaya and Ranjitha, for example, describe the development of the Indian NARS into a complex web of hundreds of national institutions, state agricultural universities and their zonal research stations, and a variety of other governmental and private institutions, that now employ tens of thousands of scientists. Similarly Africa experienced rapid growth in the number of scientists in the post-independence period, and the replacement of expatriates with national scientific staff (Rukuni et al.)

However, in the 1980s, the growth of public investment in agricultural research slowed and in many cases, especially in Latin America and Africa, investment declined. Almost everywhere, expansion of staff has been more rapid than funding, resulting in a growing proportion of research funds being used to pay salaries and an acute shortage of operating funds for undertaking research.

This funding slowdown reflects the decline in both domestic support and donor contributions over the past decade. The decline in donor support for agricultural research was especially felt in the Consultative Group for International Agricultural Research (CGIAR) system, which witnessed a stagnation of funding in the 1990s, despite an increase in the number of centers and

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1 The Consultative Group for International Agricultural Research (CGIAR) which led to the expansion of the international system, was established in 1972.
in the scope of its mandate. However, in Africa, donor contributions to national systems have increased in relation to domestic support, so that nearly half of the agricultural research investment in Africa is from donors, including development banks. Rukuni et al. argue that high donor dependency in Africa has undermined efforts to develop domestic political support for sustainable funding of agricultural research, especially for the smallholder sector.

The paradox of this funding crisis is that it has occurred against a background of continued accumulation of evidence of high payoffs to past investments in agricultural research, now documented in hundreds of studies. Part of the reason for this paradox is the re-examination almost everywhere of the appropriate role of government, and a world wide-move to privatize public-sector activities.

The private sector has, in fact, sharply increased investment in agricultural R&D in recent years, but this has only partly alleviated the gap in public sector funding (Pray and Umali-Deininger). Even after a period of rapid growth in private investment, private R&D typically accounts for only 10-15% of total agricultural R&D in developing countries, compared to about half in the industrialized countries (Alston et al.).

The result of these trends is that research intensity (R&D investment as a proportion of agricultural GDP) in developing countries remains low and has hardly increased over the past 25 years. Including both public and private sector R&D, research intensities in industrialized countries now approach 5%, compared to about 0.6% in developing countries, a gap of almost tenfold. These figures dramatically underline the challenge to developing countries if they are to promote rapid agricultural growth and compete in global markets, through the application of science and technology.

This challenge is further heightened by the increasing demands being placed on research systems everywhere. During much of the 1970s and 1980s, investment in agricultural research was largely motivated by concerns about growing population, a finite resource base, import substitution, and food security at both the global and national levels that required a clear focus on increased food productivity. In the 1990s, natural resource management and environmental preservation received much higher priority in the research agenda, as well as food safety in industrialized countries. At the international level and especially in the CGIAR system, poverty alleviation is now the main rationale for investment in agricultural research (Anderson). Thus research systems are being asked to do more with less. Also the political constituency for these new priorities is usually outside of the traditional clientele of the research system, the farmers. Thus the broadened agenda for agricultural research provides new challenges for developing domestic political support.

3. THE EMERGING PARADIGM FOR NARSs

Accompanying these trends in research investment has been a parallel shift in the institutional make up of the national agricultural research systems (NARSs). During much of the past 25 years, public sector research investments and research policy has focused on the national agricultural research organization (NARO) model. In this paradigm, public funds were provided as a block grant, usually through the ministry of agriculture, to a centralized research department
or institute who then set research priorities and executed research through a network of research centers under the control of the NARO. In the 1990s, this paradigm has been challenged, since it failed to consider a variety of other public and private organizations that can research funding and participate in research policy making and research execution (McMahon, 1992; Echeverria; Reifschneider, Lele, and Portugal, 1998).

A new paradigm is now emerging for thinking about national agricultural research systems. The main elements of this new paradigm that emerge from the following papers and summarized below.

**a) Pluralistic institutional structures**

The first essential element of the new paradigm is the recognition of the variety of organizations that can potentially participate in agricultural research, both for funding and execution. The papers in this volume illustrate this diversity, such as the universities (India and the Netherlands), non-agricultural ministries such as environment and science and technology (the Netherlands, Latin America), various non-governmental organizations (farmer organizations in Africa, foundations in Latin America), and, of course, the private sector. The inclusion of this wider range of organizations in the conception of a NARS enhances the quantity and quality of financial and human resources that can be potentially tapped—for example, potential new funding sources from non-agricultural ministries or farmer organizations, and the considerable scientific talent available in universities.

Coupled with this growing institutional complexity has been a trend toward the separation of policy making, funding, and execution of research since each requires different inputs and skills. This is most advanced in the Netherlands where the Ministry of Agriculture now only concerns itself with research policy and funding; research execution takes place in wide variety of organizations, many of which were previously under the control of the Ministry but are now being privatized (although they will continue to be eligible to bid for public funding through various competitive and contractual arrangements). A similar arrangement is evolving in Zimbabwe (Rukuni et al.) where the newly revamped Agricultural Research Council is focusing on policy and funding issues, while much of the execution of research is carried out in the Ministry of Agriculture, universities, farmer organizations, and the private sector. Even in India, where the Indian Council of Agricultural Research has grown into one of the largest research organizations in the world, the Indian Council of Agricultural Research (ICAR) is being restructured to allow its headquarters to focus on policy and funding of research, while decision making on research execution is being decentralized to research organizations operating under the ICAR umbrella.

**b) The growing role of the private sector**

Pray and Umali-Deininger document the growing role of the private sector in R&D. The worldwide trend toward market liberalization and privatization combined with much stronger intellectual property protection for biological technologies, have been major stimulants to private investment in agricultural research. However, they point out that even with these favorable trends, there are still many factors that limit private sector investment in R&D, including poor...
agroclimatic potential, small market size, and restrictive policies on technology imports and release. In addition, several of the papers note that private sector research depends to a large extent on using knowledge, methods and technologies developed in the public sector, especially products of basic and strategic research that, because of their long run and uncertain payoffs and the difficulty of appropriating benefits, are less attractive to private firms. Hence strong public support for research, especially basic and strategic research, may be one of the major stimulants to private investment in R&D.

The bottom line is that, even with suitable policies in place, private sector research has the potential to fill the gap caused by dwindling public support, only in certain cases, especially in mature NARSs and in areas of commercial agriculture. Many countries are now discussing what research that is currently conducted in the public sector could be devolved to the private sector. However, policy makers are often hesitant to allow the public sector to withdraw completely from these research activities, especially in light of the growing dominance of multinational corporations in certain types of agricultural research. This concern has been heightened by several recent mergers of biotechnology, seed and chemical companies that have strengthened the market position of a few large multinationals (Pray and Umali-Deininger, Mruthyunjaya and Ranjitha). A strong public sector focused on more strategic research is seen as a stimulus to the development of local private R&D capacity and a competitive private sector.

A parallel development is the increasing trend toward public-private sector partnerships in agricultural research. These take many forms including joint ventures of public organizations with the private sector to commercialize their technologies, and private funding of research in the public sector to utilize available infrastructure and scientific skills. There are other institutional models such as the establishment of foundations by the private sector, especially in Latin America, to fund research, much of it in the public sector. And farmer organizations are becoming more active as a source of funding for public sector research, through the use of levies on commodity output, especially for export crops.

This rise in private sector research allows the public sector to focus more sharply on public goods and other areas where there are market failures in the provision of technologies. Alston et al. define such market failures as arising from several causes, especially lack of appropriability of much agricultural technology, the long-term and uncertain payoffs to research, and environmental externalities of much agricultural technology. The nature and importance of these market failures will vary from country to country, but they leave little doubt that, in all countries, the extent of market failures is likely to be substantial. However, Alston et al. also caution that market failures are a necessary but not sufficient condition for public sector intervention since many such interventions, such as the use of general tax revenue to fund research, also incur considerable welfare costs.

The regional and country case studies show how countries are struggling with these issues. The Netherlands is attempting to shift as much of the responsibility for applied ‘near market’ research to the private sector, including farmer organizations. In India, ICAR is committed to reducing its role in applied and adaptive research and encouraging the states to take on this type of research.
(c) New mechanisms for research funding

The mechanisms for public funding of research have also evolved. There has been a universal move away from providing block grants toward the use of competitive and contractual arrangements to funding research. A large number of countries are shifting funding to competitive grants that are open to public-sector organizations, including universities, and often to private organizations. Alston et al. argue that such competitive arrangements, although more costly to manage, are likely to improve the allocation of research resources. The CGIAR system continues with block funding but Anderson argues that it too should pilot a competitive system of funding that would encourage partnerships and participation of stronger NARS that have a cost advantage is some types of research.

The rapid expansion of competitive funding deserves a word of caution, however (Echeverria). Competitive funds largely support operating costs, and not the investment in research laboratories and facilities or human capital. In the long run, a sustainable research system requires regular block funding to maintain and update this research infrastructure.

Even where competitive funding is not used, contractual arrangements between research funder and research provider are becoming more common. Essentially this reflects broader government efforts to enhance accountability, and monitor outputs rather than inputs in government-provided services. Such arrangements are managerially intensive and are most widely used, and perhaps most appropriate, in industrialized countries such as the Netherlands (Roseboom and Rutten).

(d) Efficiency and effectiveness of public research organizations

While research systems are becoming more pluralistic, public research organizations (the NAROs), where most research infrastructure and human resources are concentrated, will continue to play a key, but no longer the central role, in the national research system. All countries are searching for ways to improve the efficiency and effectiveness of their NAROs. In most cases (e.g., India and Zimbabwe), this includes consolidation and rationalization of the existing network of research stations, and in some cases (e.g., the Netherlands) significant downsizing. Even the CGIAR centers have embarked on consolidation and Anderson notes the potential for more. In addition, highly centralized systems such as the ICAR, are exploring options for decentralization, by devolving full decision-making authority to center directors.

Most public research organizations are also attempting to reform their management and governance to allow them more flexibility in financial, human resource, and asset management. Many NAROs are attempting to shed their old bureaucratic style of management and organization, and are taking on more of the characteristics of private firms in their management styles. In some cases, such as in the Netherlands and in several countries of Latin American, NAROs have been set up essentially as private corporations with a board of governors that represents their major stakeholders (see below). In other cases, reforms are being attempted from within the existing civil service structure, as in Malawi, where task forces are being constituted to focus research on specific high priority activities (Rukuni et al.)

One of the main reasons for reform of public research organizations is to allow them greater flexibility to seek diverse sources of funding support. A common strategy is for research
institutes to commercialize research products and services, applying intellectual property protection as needed. All of the case studies present evidence of moves in this direction. While commercialization can provide valuable funds for operating costs and incentives for scientists, there are also limits to which a public organization can commercialize its products, especially if it is redefining its role to focus more sharply on public goods which by definition are not “commercializable” (Byerlee and Alex, 1998).

Commercialization can not be a substitute for the development of a local political constituency that will support public funding of agricultural research. Rukuni et al. in particular, argue that the major challenge for NAROs of Southern Africa is the development of a political constituency among smallholder farmers, that have been often bypassed by the research system in the past. The mechanisms for achieving such political support are varied and include organization of smallholders to give them greater voice, stronger relations between NAROs and ministries of finance, and greater efforts by research organizations to “market” their achievements.

Within these general reforms, public organizations are also much more concerned about setting priorities to better utilize their existing resources to achieve stated policy objectives. Alston et al. argue that, while research organizations may have multiple objectives, they should focus on the efficiency objective. Agricultural research may be a blunt instrument for directly addressing objectives such as poverty alleviation directly, although indirectly, broad-based productivity growth in the smallholder sector is surely one of the major instruments for achieving both growth and equity objectives.

One approach that is being advocated to guide research allocation is the use of formal economic approaches to analyze tradeoffs in research resource allocation, and set priorities (Alston et al.). Many NAROs have applied such methods in recent years although there are as yet, few examples of effective institutionalization of such capacity.

Another approach is to involve stakeholders in the governance, priority setting, research execution, and even financial support of public research organizations in order to promote more demand-driven and responsive organizations. To this end, governing boards of NAROs are being broadened to include major stakeholders and various types of mechanisms are being utilized to seek farmer input into priority setting—for example, the regional farmer committees in Zimbabwe. Similar trends are apparent at the international level, where a secretariat of the Global Forum on Agricultural Research is being established to represent NARSs in global research policy issues. Developing countries are also becoming members and contributors to the CGIAR, a healthy trend in strengthening both financial and political support and improving effectiveness, given the growing evidence of donor fatigue (Anderson).

(e) Global scientific linkages

Finally, a common thread in all of the papers is the globalization of agricultural research and the need for all research organizations to develop strategies to keep abreast of global advances in knowledge. Spillovers of technologies and scientific knowledge across subnational and national borders have always been important, and indeed the CGIAR system was established to foster such spillovers and spillins. Spillovers are, of course, specific to technology type and
agroclimatic and socioeconomic circumstances, but for some types of technologies, especially germplasm products, spillovers have been pervasive (Byerlee and Traxler, 1996).

The rapid advances in recent years in biotechnology and informational sciences, have reinforced the global agricultural research system, if they are to keep abreast of these advances and maintain a competitive agricultural sector. The fact that many of these advances have occurred in the private sector, considerably complicates access to much of the emerging knowledge and technology. This has important implications for developing countries for implementation and enforcement of intellectual property rights, as well as for the CGIAR centers that might play an intermediary role in helping client countries gain access to the new technologies.

The development of strong national capacity, public and private, in the agricultural sciences will be necessary for countries to exploit these scientific advances. Investment in human resources will be integral to this strategy. Even a strong NARS, such as India, has seen its human resource quality decline in recent years (Mruthyunjaya and Ranjitha). Another approach is to establish national centers of excellence in basic and strategic research. In the Netherlands this is being done by the merging of the agricultural university and the previous national research institutes into a large research complex at Wageningen for basic and strategic research in the agricultural sciences. In India, centers of excellence with links to the global scientific community are being established for specific strategic research areas.

One implication of the growing complexity of science is the need for research organizations to develop partnerships to gain access to complementary skills, and to participate in research networks that promote exchange of knowledge. Such partnerships and networks are rapidly increasing at both the national and international levels. The CGIAR centers no longer look on NARSs as simply clients for the utilization of their research products, but increasingly as partners in the generation of these products (Anderson).

4. LOOKING TO THE FUTURE

The low and stagnating intensity of research investment in developing countries is especially worrying in light of the large and widening gap between R&D intensities in developing countries and industrialized countries, and the increasing globalization of agriculture in which technological advances will be critical to competitiveness (Echeverria). Recent perspectives on the world food situation also highlight the critical role of investment in agricultural R&D to meet future needs for food, feed and fiber (Pinstrup-Andersen, Pandya-Lorch, and Rosegrant, 1997). There is an urgent need to find ways to reverse the current trends in funding for agricultural research, as well as more efficiently utilize current funds.

As we enter the next century, private-sector research will become ever more important as technological and institutional innovations allow what were previously public goods to be treated as private goods (e.g., new forms of intellectual property protection or ways to enforce them). However, there is little doubt that strong public support to agricultural research will be needed for many decades into the future, to provide the public goods that are so important to private R&D. Ways must be found to foster domestic political support for agricultural research and beneficiaries themselves, especially farmers, must be prepared to play a greater role in research.
funding (Bingen, 1998). These needs are especially critical in Africa where the problems of food security, poverty alleviation, and environmental conservation are most challenging. Dependence there on donor support to agricultural research is high and increasing so new mechanisms must be developed to generate domestic political support to agricultural research.

Global advances in science will continue at a rapid pace, and the agricultural sciences will need to be positioned to tap these gains. It is likely that the distinction between agricultural science and general sciences will be increasingly blurred over time, especially at the more basic end of the agricultural science spectrum. The appropriate mechanisms for developing a critical mass of local capacity will also undergo considerable evolution. One model that is emerging in some countries is the formation of ‘science centers’ to bring together relevant expertise in the universities, state research institutes, and the private sector. A more productive linkage between agricultural research and post-graduate education will be one important outcome of such mergers. These and the other changes discussed above make this an exciting time to contemplate the agricultural science policies that will take us forward into the new millennium.

REFERENCES


