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INSTITUTIONAL INNOVATIONS IN PUBLIC AGRICULTURAL RESEARCH IN FIVE DEVELOPED COUNTRIES

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All over the world, agricultural research systems are undergoing significant changes. Using an analytical framework, this Briefing Paper describes how research systems adapt to the changes in the context of agricultural research and also, how such adjustments have affected the effectiveness of the research systems in the following five developed countries: the USA, Australia, Switzerland, the Netherlands, and the UK. The conclusion is that the traditional "technology factories" are changing into flexible and versatile "sources of knowledge." The transformations have not come about easily, but they have helped minimize budget cuts. The new research systems are a reflection of the new conditions that society imposes on agriculture, science, and the management of the public sector.

Introduction

Public agricultural research systems the world over are to a large extent confronting the same challenges. Globalization, market liberalization, changes in scientific technologies, and evolving ideas on the role of the public and private sectors are affecting the vast majority of the world's nations. Some countries have developed responses that may be of use to other countries, and the description of the institutional innovations that have been implemented may offer useful suggestions. This Briefing Paper presents an overview of the main innovations in financing and organization of agricultural research in five selected countries; it also reviews the policies in use to see how these have contributed to the reorganization of agricultural research.

Developments are summarized and analyzed for the following five industrialized countries: the USA, because it has the world's most elaborate research system and is the world's largest exporter of agricultural products; Australia, because, though relatively isolated, it is oriented toward agricultural exports; Switzerland, because, being a small country that is not a member of the European Uniony, it is isolated from large markets; the Netherlands, because of its sophisticated agricultural sector, high productivity, and reliance on exports; and the UK, because of the changes in the organization of its public sector and its role in the generation of basic scientific knowledge.

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The Analysis of Institutional Innovations in Agricultural Research

The application of an analytical framework consisting of three steps facilitates the understanding of institutional innovations in the research context (Janssen and Wilks 1999). The first step consists in identifying the **changes** that occur in the context of agricultural research. These changes, which tend to call for a redefinition of the objectives and responsibilities of research, are divided into three groups, according to whether they relate to (1) the demand for knowledge and technology, (2) the ways in which knowledge and technology are produced, or (3) the roles of the public and private sectors (figure 1).

The second step looks at the **modifications** that the research systems undergo as they adapt to the external changes. Two types of typical responses can be observed: the first is to attempt to strengthen the existing institutional capacity, for example, by improving the management practices. This strategy does not affect the organization or structure of the research system; it concentrates on improving the functions that the system has to perform. The second response is to introduce institutional innovation: for example, by creating new institutes or new work methods. In this strategy, decision makers either consider that the required changes exceed the internal capacity of the research institutes, or they lack patience and cannot not wait until the existing organizations change their way of operating.

In each of the five countries of the study, the responses present a mix of the two strategies: in some cases, the main tendency was to strengthen the institutes' existing modes of functioning, while in others, the response was rather to opt for institutional innovation. Table 1 shows that the resulting changes can be evaluated by gauging the efficiency and relevance of the research systems.[1]

1. **Efficiency.** The degree of efficiency is determined by the relationship between the results produced and the inputs required. If many inputs are needed to achieve few results, efficiency is low; if little input is sufficient to obtain many results, efficiency is high. Often greater efficiency is obtained through strategies directed at improving the way in which existing institutions function.

2. **Relevance.** Relevance is high if the system's work focuses on important topics. Research systems are under constant pressure to respond to changes in the external context and must therefore continually adjust topics and themes. To increase relevance, new research modalities or models are often introduced.

Over the past 15 years there have been many institutional innovations in the countries under study, most of which were oriented toward improving the systems' relevance. Frequently the innovations were imposed by the government or through agreements between the government and the main stakeholders (farmers' organizations, food industry).

There are three categories of innovations. The first one comprises changes in governance, including such elements as scientific councils, governing boards, decentralization, changes in ministerial support, and, at times, privatization. Second are the changes in financing, such as competitive grant schemes, matching grants, surcharges, fixed contracts, and the separation between financing and implementation. Third, new modalities for research implementation have been created, such as joint ventures, research networks, integration of universities in research systems, and national programs or projects that are implemented by a wide range of institutions.

The third step consisted in evaluating the **effects of the changes.** A concise summary of the evaluation is included in this Briefing Paper (for more details, see the original document cited on the last page). Figure 2 provides a summary of the analytical framework used in this study.

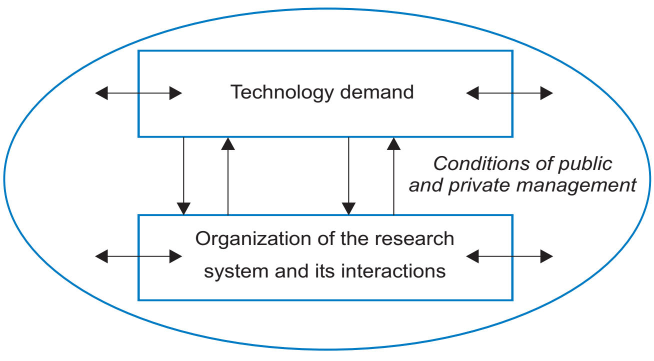

Figure 1: Three challenges in the context of research systems

Condition of the national research system		Internal efficiency: Low	Internal efficiency: High
External relevance	Low	Develop institutional innovations independent of the existing system	Develop institutional innovations within the research system
External relevance	High	Improve the functioning of existing institutions with emphasis on accountability	Continual improvement of management in existing institutions with emphasis on research support

Table 1: Strategies of institutional change or improved management

1. In the literature on institutional performance, the effectiveness of an organization is frequently defined in terms of its efficiency and its relevance.

Developments in the Research Context in Developed Countries

Changes in the demand for scientific knowledge and technology

The position of the agricultural sector. In Europe, the agricultural sector is losing the privileged position it had been given by the national governments, due to the concern with food security in the period—during and immediately after the Second World War— in which the quality and availability of food had been seriously lacking. Another reason for privileging the agricultural sector stemmed from the perception that agriculture was the guardian of the environment (Roberts 1999).

Political support for the agricultural sector is declining. Public agricultural research is now thought of as an instrument that can "guide" the sector rather than as a tool giving direct "support." Topics such as environmental protection, food safety, and animal welfare receive more support than agricultural productivity per se. The challenge is to promote socially and environmentally balanced developments in the agricultural sector. The change can be clearly observed in the UK, where funding from the Ministry of Agriculture fell by 50% and funding from the Ministry of Science and Technology grew by 40% between 1980 and 1995.

Focus on the environment and on food safety. Food safety and the environment have become topics of major importance. A considerable amount of research focuses on finding solutions to protect the environment and human welfare from the negative fallout of agricultural practices. In this area, questions often relate to regulation, e.g., norms on the use of chemicals, and the composition of foodstuffs. Another major area of research is policy, with concerns such as how to make the best use of the water available and what incentives might lead to a sustainable use of resources. These aspects are particularly noticeable in the UK and Switzerland. An example is presented in box 1.

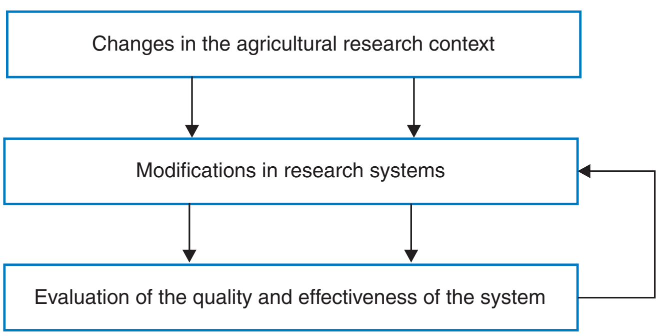

Figure 2: Analytical framework for describing and evaluating institutional innovations

Note: The arrows indicate the causal relationships between the different steps.

Agroindustry and agribusiness. The technological demands of this sector are not always directed to public institutes, as can be seen in the case of Nestlé in Switzerland. Indeed, though Nestlé invests considerable amounts in research, its relationship with the public sector is marginal. Changes in the legal framework (for instance, to allow the conversion of research institutes into independent foundations, as is done in the Netherlands and the UK) can give institutes the ability to freely contract and implement research with the private sector. As a result, activity in this area has increased considerably. In publicly funded research, considerable attention is given to basic research serving agroindustry (for example, organizational chain theory, food chemistry, and toxicity).

Knowledge or technology? The country-case studies showed that the demand for knowledge is growing. The current emphasis on knowledge is a widespread phenomenon, as recorded, for example, in the World Bank's 1998 Annual Report (1999). The explanation may be that the competitive position and the quality of a country's economy are defined in large part by the size and density of the country's "knowledge cloud," i.e. the body of knowledge that has the potential to affect the economy. If the knowledge cloud is dense (if many people possess knowledge), the economy is likely to reach a higher level of development (the "precipitation" of knowledge will "irrigate" development). The knowledge cloud therefore plays a major role in determining how likely countries are to develop technological innovations. Although nobody knows when a knowledge cloud will produce precipitation (innovations), a dense cloud is more likely to bring precipitation than a light cloud, and, of course, without a cloud there will be no precipitation at all.

Box 1. Switzerland: Establishment of the Research Institute for Organic Agriculture

The establishment of the Swiss Research Institute for Organic Agriculture is the most obvious recognition of the importance the Swiss attribute to the compatibility between agriculture and the environment. The institute was established by a private foundation in 1973 and currently has approximately 70 staff members. The major part of its funding comes from private sources; it is autonomous and responsible to a foundation for its actions, and it maintains a very critical position with respect to the government. The federal government, however, has begun to cofinance the institute (at US$1.4 million per annum) undersore the importance it attaches to this topic (Baur and Rieder 1999).

The shift in emphasis from technology to knowledge also reflects a new view on technological change. It is not research alone that is responsible for generating technological change. Rather, technological change results from the interaction of scientists, farmers, commercial agents, input providers, policymakers, etc., the comparative advantage of research residing in its generation of knowledge that can be applied by other parties. Box 2 summarizes the changes in this regard that have been observed in the UK.

Changes in the organization of science

Collaborative science. In response to new scientific developments that cannot be categorized within traditional sectors, collaborative research is growing. Certain new research techniques can be used for many different purposes; for example, geographical information systems can be applied in agricultural research as well as in rural or transport planning. The same is true of molecular biology, which has many biological, medical, and agricultural applications. The interest in collaborative research is explained as a function of the need to combine new specializations. Because of the high costs involved, many science institutes cannot maintain all of the new specializations available. So they seek alliances through collaborative projects. New means of communication (e-mail, Internet, cell phones) have greatly increased the possibility to carry out collaborative work.

International and regional collaboration. The interest in international collaboration is also notable. Switzerland and the European Union countries are oriented toward programs directed by the European Commission. Australia is seeking to reduce its isolation. In the USA, the trend is less marked but in a country of that size the potential to develop internal links is virtually inexhaustible. The interest in collaborating is centered around knowledge sharing. While collaboration does not necessarily result in lower research costs, the payoff is often access to new sources of knowledge.

Changes in the interaction between the public and private sectors

Emphasis on public goods. Nowadays, agricultural research is less readily accepted as a public good than it used to be in the past. The lack of organization among farmers—previously an important reason to justify public interventions—no longer constitutes a convincing argument in favor of supporting public research. And it is argued that there are sufficient opportunities for producers to finance research serving their interest. Public goods that are currently pursued are defined in relation to the urban citizen: food safety, environment, animal welfare, water quality, etc. Basic research is also generally accepted as a valid public good, being a factor that reinforces a country's knowledge cloud.

Financial pressure. In the case-study countries, the budget for public agricultural research has hardly grown, if at all (Alston et al. 1999). The earlier discussion provides some explanatory reasons, as does the budget deficit in many of the countries, which has put the entire public sector under financial pressure. Changed, but certainly not diminished, demands on the system have resulted in high expectations, but there has been no matching increase in resources. The response has been to look for new arrangements through which more can be obtained with less or to share responsibilities (see, for example, Osborne and Gaebler 1993).

Box 2. The UK: Focus on Basic Research in Universities

Though, traditionally, UK universities have played a limited role in agricultural research, their participation in public agricultural research grew from 2.9% of the total budget in 1981 to 14.7% in 1993. Universities have greater flexibility in adapting their research agendas than research institutions, and they are more concerned with basic research, which continues to be considered as a public responsibility.

In the UK, concern has been expressed on many occasions about the low impact of the scientific system on societal development. It was therefore felt that the role of basic research should be reviewed. In a study commissioned by the Treasury, the Political Science Unit of the University of Sussex observed that basic research leads to six major benefits:

- new information;
- new instruments and technologies;
- skills among researchers and especially among postgraduate students who later move on to other activities;
- access to information and networks of experts;
- ability to resolve complex technological problems;
- creation of new companies based on new discoveries.

This list shows that technological results form only a small part of research benefits and that, to obtain maximum benefits, it can be very useful to have a link with the university environment (Persley 1998).

Institutional Innovations in Response to Exogenous Change

Today's research systems face conditions that are very different from those of 20 years ago. The challenge they have to meet can be summed up as being the need for an identity change: the "technology factories" of the past (which produced research results in prescribed and predictable ways) must be transformed into "sources of knowledge."

Responses in governance and management

More clearly defined accountability. In all of the systems studied, the emphasis lies on accountability. The means to achieve accountability vary and can be divided into two main groups. The first group consists of changes in procedures. The Swiss emphasize new public management in institutes that continue to depend on the ministries. The US has introduced a system for planning and follow-up. The second group consists of changes in structures. The Dutch are "privatizing" their research institutes, and the Australians have, to a great extent, devolved responsibility to the research and development corporations that are managed by representatives of the (sub)sector (see box 3).

Stakeholder involvement. In Europe, the efforts to devolve decision making to farmers have largely come to an end. For public research, it does not seem evident that the power to make decisions should rest with producers or any other group of actors: such guidance is an obstacle to keeping a public focus. The government of the Netherlands no longer contributes to the cofunding of adaptive research projects, and increasingly devolves responsibilities and financing to the producers. In Switzerland, public officials and scientists determine the orientations in agricultural research, and there is a trend toward centralization. In the USA and Australia, more attention is paid to stakeholder participation. Australian agricultural producers have acquired a certain degree of influence through matching grants schemes, but the government is simultaneously discussing means to reduce its own contribution to these funds. In the countries under study, the principle appears to be increasingly that "the client must pay."

Flexibility in human resource use. To ensure more appropriate responses to the new research demands and new financial mechanisms, an attempt has been made to use human resources more creatively. This is most commonly achieved through short-term contracts, for example, for PhD projects. In the USA, the UK, Switzerland, and the Netherlands, short-term contracts play a crucial role in personnel management. The effect is ambiguous, however: on the one hand, there is greater mobility of researchers between professions, and a wider diffusion of knowledge, which leads to the creation of a broader knowledge cloud. And short-term contracts provide organizations with a mechanism to select the best researchers from the temporary personnel. On the other hand, reduced employment security limits the possibilities to carry out long-term research.

Financing

Separation of financing and implementation. In the USA, Australia, the Netherlands, and the UK, the distance between funding and implementation has widened over the past 15 years. In the USA, nonrestricted financing has dwindled (Huffman 1999); in the Netherlands, access to public funds for research is governed by the priorities of the Ministry; in Australia, producers' organizations decide and research institutes implement; in the UK, the Biotechnology and Biological Science

Box 3. Australia: The Cooperative Research Centres

Australia's Cooperative Research Centres (CRCs) were established in 1991 to create research programs that have a critical mass. Their focus was to maintain Austrialia's position on the frontier of international technological progress. The idea has been tested in other sectors, in particular in engineering. The CRCs bring together researchers from the public and private sectors with users from the agricultural sector and other parts of society. The CRCs require the participation of a university and attempt to provide multidisciplinary solutions for technological problems, within a limited period of time (in general, seven years). The CRCs also act as a platform for advanced training at the postgraduate level. Another purpose of the CRCs is to improve the interaction between the public and private sectors.

The Federal Government established the CRCs to cover research areas relating to agriculture, or not. In 1997, there were 65 CRCs, of which 15 for agricultural research, and another seven for natural resource management. On average, they received US$ 1.4 million in public financing per year. Currently, for every public dollar spent, two dollars are generated from other financial sources. The contributions from CRC partners are frequently in the form of personnel and equipment. The question is whether the size of the CRCs represents a critical mass in the current scientific world (Henzell et al. 1998).

The CRCS are financed through competitive funds. The competition is managed by the Federal Government's Department of Industry, Science and Technology. The CRCs receive financing only if they meet very strict conditions. Many applications to form CRCs have been rejected due to a lack of technical or socioeconomic merit. This contributes to a shift in attitude in the scientific system, from a position based on curiosity to one based on problem solving, and from one rooted in an institutional position to one rooted in cooperation.

Research Council rules on the funding of a number of institutions. More funds are available through the competitive grants schemes (USA and the UK). Separation is one of the best ways of managing pluralistic research systems.

The search for competition. In anglophone countries, there is a strong belief that the quality of research systems will increase when they function in quasi-markets. In these countries the emphasis on competitive funds has increased. High-quality portfolios have been developed with these funds. The effect, however, is not always positive. To a certain degree, one can compare the functioning of these competitive funds to skimming milk: the cream may well be the tastiest part, but if the milk itself goes to waste, one has made poor use of the overall product. In other words, there is concern about what happens to the scientific capacity that is not rewarded in the grants system. In addition, competitive funding may entail high administration costs.

The competitive funds system is the most useful if it directs researchers to new themes. Researchers who are not rewarded under the system will go on to tap other sources of funding, less attractive perhaps but still sufficient to function well. An example of this can be found in Australia, where the system finances the Cooperative Research Centres (see box 3).

Cofinancing modalities. Cofinancing between producers and governments has not shown much growth. In the UK, it has slowed down since EU regulations prohibit the existence of branch organizations that function like cartels. In the Netherlands, the government has abandoned cofunding and has decided to finance its own topics of interest, expecting that producers will do the same. In Switzerland, producers never contributed to public research. In Australia, the cofinancing formula was reestablished successfully in the mid-1980s. The tendency is to let producers decide what research is of interest to them, and pay for it. Where the technological impacts of research are barely noticeable to national consumers, while producers benefit through increased economic returns, it makes sense that the producer pays.

Private funding of research. This type of financing focuses on inputs, machinery, equipment, and processing industries. With the exception of Australia, private expenditures on research in the countries studied are higher than public expenditures. The growth in private research is defined by three factors: (1) the rapid development of the sector; (2) the legal framework in which they operate and the clarity that exists with regard to legal property rights; and (3) the density of the knowledge cloud. Industry invests in research when it finds itself in a conducive environment (Klotz et al. 1995).

Research implementation

Integration of universities. In Switzerland, the Netherlands, the UK, and Australia, the tendency to integrate research and education systems is increasing. Such integration has always been strong in the USA. Not only does it constitute a response to budget cuts, but it also reflects the importance attached to knowledge and the concern to ensure adequate diffusion of the research results. In addition, the use of scientists who also have educational responsibilities leads to greater flexibility and facilitates the development of a critical mass. Another positive element is the integration of nonagricultural disciplines into agricultural research.

Public-private research. In the UK, the Netherlands, the USA, and Australia, mechanisms—programs or institutes—are being established to carry out combined research, which interact with the agroindustrial sector more than with the producers. The collaborative mechanisms in the USA (Cooperative Research Development Agreements – CRADAs), the UK (the LINK program), and the Netherlands (Wageningen Food Center), have small budgets compared with the separate research budgets of the public and private sectors (Rutten 1999; Fuglie et al. 1999). These initiatives emphasize the joint generation of knowledge as well as of new technologies. Box 4 illustrates a controversial collaborative model in use in the USA.

Box 4. USA: Joint efforts between Novartis and the University of California, Berkeley

Novartis will supply US$ 25 million between 1999 and 2004 to finance research projects in the Department of Plant and Microbial Biology and will give scientists in the Department access to its germplasm collection. Funds will be channelled through a committee controlled by University professors with the participation of Novartis, which will evaluate research proposals. Novartis has priority in obtaining patents for the research results. This priority will be in proportion to its financial contribution to the Department. Novartis can negotiate licenses for patents that will remain with the University for a period of up to 60 days before research results are published. The professors and researchers who are working with Novartis funds cannot work for other companies.

The exclusivity clauses in the contract between Novartis and the University have caused a certain amount of surprise in the media, since they can be interpreted as efforts to monopolize scientific capacity. The open nature of the contract has also led to questions about the future independence of the University in terms of the definition of its research agenda.

International collaboration. The importance of international collaboration is recognized in all of the countries studied. Switzerland established the Swiss Centre for International Agriculture, Australia founded the Australian Centre for International Agricultural Research, and in the UK and the Netherlands, European collaboration is on the increase. All of these countries participate in regional fora too. Nevertheless, the approach is somewhat ad hoc and self-centered: the countries exploit opportunities that come along; they become involved when they see possibilities to improve their individual position, but they have not created any overall mechanisms for sharing research programs or facilities, such as the subregional organizations in the developing world.

Legal frameworks. Strong developments have taken place in the legal frameworks for research in the countries studied. The Swiss referendum on whether or not to authorize the use of genetic engineering, the strengthening of patent legislation pertaining to live organisms in the USA, and the change in the legal constitution by which the Dutch DLO became a private foundation, all these have had great impact on local research implementation. Legal management is becoming an essential condition for an effective research system.

Effects of the Changes on the Systems under Study

Relevance or efficiency. The case-study countries underwent very significant changes: innovations included changes in the legal constitution of research entities, the introduction of competition, the integration of universities, the strengthening of the legal framework, and the establishment of new collaborative mechanisms. Of all of the countries studied, the USA made the greatest effort to increase relevance, and now has a structure that can satisfy many of the new demands. In the UK, efficiency has been questioned as much as relevance. Institutes were closed and funds were reoriented to benefit the universities. Nevertheless, in almost all cases, the preferred strategy for change has been the transformation of the existing technology factories into sources of knowledge.

Degree and speed of change. The changes of the past 15 years have been substantial in all of the case-study systems, but the effects on the morale of personnel within the systems varied widely from country to country. A certain degree of demoralization was observed in the UK, whereas the effect on motivation is less evident in Switzerland, the Netherlands, and the USA. The reasons for this are, first, that the changes in the UK were rapid, not clearly directed, and inspired by market ideology rather than by the results of a performance assessment—while in the other countries, the changes occurred more slowly. Second, in the UK, there has been dissatisfaction with the efficiency of the system, whereas in the other countries the concern was more related to its relevance. In the UK, the government had less confidence in the research system than in the other countries.

Holistic or incremental change. At the outset, no country had an agreed, overall vision of what had to be modified in its agricultural research system. Some individuals may have had such a holistic vision, but in the political process to accomplish change, only some of the components were followed up on. And no additional, new changes were introduced in the following phase, so that a continuous process of merely incremental change has been taking place. Over a period of 20 years, the incremental changes added up to a rather radical reconfiguration of the research system. The final result is a hybrid of concepts and a compromise between various positions. In general, the research systems are not very stable. Restructuring to meet future challenges continues to take place (Lovett 1997).

From "hard" systems to fluid networks. In the process of change that is occurring in the developed countries, the boundaries of the agricultural research system have become more fluid: it is increasingly difficult to speak of an agricultural research system with a certain objective and specific participating institutions. The principal sources of technological change (information sciences, biotechnology) are partially or completely external to the agricultural sector, and agricultural scientists have had to seek contact with colleagues in other fields. The costs of the new methodologies are high and require collaboration between institutions. The technological demands expressed by the urban consumer do not respond to a vision of agriculture, but rather to the environment and food safety. Many of the institutes involved in agricultural research have activities in other areas (for example, the universities). It seems that agricultural research is no longer organized as a system but increasingly as a fluid network, where partners come together on an ad hoc basis in accordance with the needs of their projects. The network changes from time to time and gives access to a wider circle of experience than can be found in the agricultural sector itself. This way, the agricultural sciences become more integrated in science in general. To direct agricultural research that is organized as a fluid network, the government should concentrate more on policies than on the administration of institutes.

The future of the research systems. It is difficult to determine whether the research systems are healthier than before, since insufficient time has gone by to draw conclusions. Nevertheless, some tentative statements can be made. First, in countries that have seen dramatic changes, such as the Netherlands, Australia, and the UK, the funds allocated to agricultural research have not been reduced. Rather, the focus of activities has been reoriented—from production towards consumption issues. In Switzerland, however, where institutional changes have been less marked, funding has declined since 1992. The changes have made the systems more resilient and more flexible. Second, many of the changes in the countries under study have raised the interest of other countries. Third, it is increasingly difficult to imagine the old public institutes in the new world, in which the public sector has become more business-like and networks are the preferred strategy for research and development projects. The changes may have been painful, most of all for those who associate themselves with traditional, productivity-based interests, but they correspond to more general trends in society. The new agricultural research institutions are the result of the changing times.

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