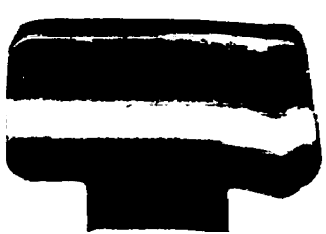
Guidelines for designing new organizations and funding ways for agricultural and agroindustrial innovation systems in the Southern Cone

Pautas para diseñar nuevas formas de organización y financiamiento de los sistemas de innovación agropecuaria y agroindustrial en el Cono Sur

Cooperative Program for Technological Development in Agriculture in the Southern Cone - PROCISUR

Programa Cooperativo para el Desarrollo Tecnológico Agropecuario del Cono Sur - PROCISUR



COOPERATIVE PROGRAM FOR TECHNOLOGICAL DEVELOPMENT IN AGRICULTURE IN THE SOUTHERN CONE
PROGRAMA COOPERATIVO PARA EL DESARROLLO TECNOLÓGICO AGROPECUARIO DEL CONO SUR
PROCISUR

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IICA Instituto Interamericano de Cooperación para la Agricultura

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Este documento contiene trabajos preparados para el Seminario "Modelos Institucionales de los Institutos de Investigación Agropecuaria del Cono Sur", realizado en Asunción, Paraguay, los días 1 y 2 de diciembre de 1997. El seminario fue organizado por el Subprograma Desarrollo Institucional del PROCISUR en el ámbito del Proyecto Global PROCISUR/BID: "Organización y gestión de la integración tecnológica agropecuaria y agroindustrial en el Cono Sur".

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PROLOGO

A fines de 1995 el PROCISUR promueve cambios en su estrategia para dar respuesta a las nuevas demandas agroindustriales, ambientales y sociales. Intenta lograr una mayor articulación interna y externa, tanto técnica como institucional, con el sector de los conocimientos y el sector productivo. Pretende específicamente transformar el "modelo reducido" de articulación inter-INIAs en un "modelo ampliado" con base en los sistemas nacionales de innovación, en el sistema internacional de ciencia y tecnología, así como en el sector empresarial y de la pequeña producción articulado a las cadenas agroindustriales. Queda planteada además la necesidad de avanzar sobre las fases de intercambio por productos y cooperación por áreas estratégicas, ampliando la intervención a través de proyectos de investigación en temas específicos de alta prioridad para el bloque regional, que aseguren un impacto sustancial en la competitividad agropecuaria y agroindustrial con eficiencia ambiental y social.

Para viabilizar la concreción de estos cambios, el Banco Interamericano de Desarrollo (BID) aprobó el Proyecto "Organización y gestión de la integración tecnológica agropecuaria y agroindustrial en el Cono Sur", que, atento a su alcance, pasó a denominarse Proyecto Global PROCISUR/BID. Este Proyecto cuenta con cuatro componentes: prospección subregional a nivel del MERCOSUR, proceso de innovación y mercados; articulación de la demanda y oferta e identificación de áreas estratégicas de investigación para la subregión, acompañada del inventario de la oferta tecnológica disponible; formas de organización y financiamiento que se muestren eficientes para resolver las demandas planteadas; y, por último, institucionalización, capacitación y gestión de la integración tecnológica a nivel del Cono Sur. Se espera que este proyecto ofrezca un aporte importante para dinamizar las transformaciones que están llevando a cabo los Institutos Nacionales de Investigación Agropecuaria (INIAs), ayude a consolidar los sistemas nacionales de innovación y permita concluir con la reingeniería del PROCISUR.

Como primera actividad de este proyecto, en el marco del tercer componente, y respondiendo a demandas de los propios INIAs, en diciembre de 1997 el Subprograma Desarrollo Institucional organizó un seminario sobre "Modelos Institucionales de los INIAs del Cono Sur". El Subprograma aportó al seminario un documento que desarrolla este tema central desde

PREFACE

At the end of 1995 PROCISUR promote strategic changes to meet the new agroindustrial, environmental and social demands, addressing to achieve a major internal and external -technical as well as institutional- articulation with the scientific and productive sectors. In this context, the aim is to turn the "reduced model" of articulation inter-INIAs into a "broaden model" based on the national innovation systems, the science and technology international system, as well as on the entrepreneurial and small production sector, which is involved throughout the agroindustrial chains. There also arises the need of advancing over the phases of exchange by products and cooperation by strategic areas strengthening the intervention through specific research projects with high priority for the regional bloc, which ensure a substantial impact in the agricultural and agroindustrial competitiveness with environmental and social efficiency.

In order to facilitate these changes the Inter-American Development Bank (IDB) approved the Project "Organization and management of technological integration in agriculture and agroindustry in the Southern Cone", which became called "Global Project PROCISUR/BID in relation with its scope. This Project is integrated by four components: subregional prospection at the MERCOSUR level, innovation process and markets; demand and supply articulation, and identification of research strategic areas for the subregion, jointly with the inventory of the available technological supply; organization and funding ways that show efficiency to resolve the risen needs; and, finally, institutionalization, training and management of the technological integration in the Southern Cone. This Project is expected to provide an important contribution to stimulate ongoing changes in the National Agricultural Research Institutes (NARIs), as well as help to consolidate the national innovation systems, and to conclude PROCISUR's reengineering process.

As the first activity of this Project, in the framework of the third component, and in response to the NIARs' demands, in December 1997 the Institutional Development Subprogram held a seminar on "Institutional Models of the National Agricultural Research Institutes of the Southern Cone". The Subprogram presented a document developing this

la perspectiva de la organización, financiamiento, planificación, recursos humanos, metodología de la investigación y propiedad intelectual.* Tomando como base este documento, y a través del Proyecto Global PROCISUR/BID, se solicitó al Dr. Helio Tollini del ISNAR y a los Dres. Uma Lele y Derek Byerlee del Banco Mundial reflexiones sobre los desafíos que enfrentan los INIAs y el propio PROCISUR para insertarse en el proceso de transformación que el sistema científico-tecnológico está experimentando, tanto en el nivel global como regional y nacional, con énfasis especial en los aspectos de organización y financiamiento.

Con el aporte de estos distinguidos profesionales se ha pretendido identificar las grandes pautas que deberían ser consideradas a nivel de los INIAs y del PROCISUR en sus actuales procesos de cambio. Dando continuidad a esta acción se profundizará el nivel de resolución de los estudios sobre formas de organización y financiamiento de la innovación agropecuaria y agroindustrial a través del Proyecto Global, dando respuesta a las informaciones que surjan del relevamiento de las demandas tecnológicas a nivel subregional, en el ámbito de la expansión del MERCOSUR.

Los trabajos de los Dres. Helio Tollini, Uma Lele y Derek Byerlee son dados a conocer en el presente documento.

Es una inmensa satisfacción para el PROCISUR que el Banco Interamericano de Desarrollo, el Banco Mundial y el ISNAR estén apoyando con singular interés y compromiso las transformaciones institucionales que se buscan promover y consolidar en el desarrollo tecnológico agropecuario y agroindustrial del Cono Sur.

Roberto M. Bocchetto
Secretario Ejecutivo
PROCISUR

issue from a perspective of organization, funding, planning, human resources, research methodology, and intellectual property rights.* Based on this document, and through the Global Project PROCISUR/BID, Dr. Helio Tollini from ISNAR and Drs. Uma Lele and Derek Byerlee from the World Bank were invited to bring some reflections about the challenges the NARIs and PROCISUR are facing to insert in the transformation process underway in the scientific-technological system, at global level as well as at regional and national levels, with special emphasys on organization and funding aspects.

With these experts' highly esteemed contribution there was sought to identify the major guidelines that should be considered by the NIARs and PROCISUR in the current change processes. Continuing this action the studies on organization and funding ways for the agricultural and agroindustrial innovation will be strengthened in the Global Project context, in response to the inventory of the technological demands at a subregional level, in the context of MERCOSUR expansion.

This document presents the papers by Drs. Helio Tollini, Uma Lele, and Derek Byerlee.

Finally, it is a great pleasure for PROCISUR that the Inter-American Development Bank, the World Bank and the ISNAR are supporting with singular interest and commitment the institutional changes intended to be promoted and consolidated in the technological development for agriculture and agroindustry in the Southern Cone.

Roberto M. Bocchetto
Executive Secretary
PROCISUR

* PROCISUR. Subprograma Desarrollo Institucional. Modelos Institucionales de los Institutos Nacionales de Investigación Agropecuaria del Cono Sur. Ed.: Marcial Abreu. Montevideo, Uruguay. Noviembre, 1997.

INDEX

ORGANIZING RESEARCH SYSTEMS FOR NEW CHALLENGES

Helio Tollini

Organizing Research Systems for New Challenges[1]

Helio Tollini[2]

This meeting of PROCISUR addresses important problems for national agricultural research systems in this time of transition. Transition seems to be everywhere. It is found in the move to more open political and economic systems, to more participation of common people in the discussion of issues of social interest, to increased awareness about the need for governmental efficiency, effectiveness, and transparency, to raised concerns with the environment and the need to conserve the production capacity for future generations. It certainly is in the minds of research system managers throughout the world, who are being asked to deal with a more demanding research agenda, to improve govemance, to use new and more complex methodologies, and to be financially more independent from the State's purse.

Technology innovation systems face new challenges coming from additional demands created by new concerns, new technologies, new options. The nature of the products that society has come to expect from national research systems has grown more complex, and these systems are now required to do more and to do it in a more efficient way. But it is not enough to be more efficient, it is also necessary to be seen as more efficient. Accountability is a required characteristic of public agencies in many parts of the world now. These new demands faced by research systems raise many questions in the fields of research policy, organization, and management.

These new conditions are particularly true in the PROCISUR region, but unlike many regions -and from an international perspective- this region seems abie to analyze and find solutions for its own problems. One aspect of the project jointly prepared and implemented by the PROCIs, the NARS, IICA, and ISNAR, and financed by the IADB, dealing with Natural Resource Management and Agroindustries, is the recognition of the analytical capacity existing in the region. This of course does not mean that PROCISUR and its member NARS do not need or deserve support.

The expectation is that the results of the discussion about reorganization of NARS in this part of the world may be an important input into discussions elsewhere. The question of organization is an issue all over the world, from the transition economies of Central Asia and the Caucasus to South and Southeast Asia, the Near East and Northem and sub-Saharan Africa. Even developed countries are going through organizational changes.

It is fortunate that this meeting can build on the paper by the Institutional Development Subprogram of PROCISUR.[3] It has been able to cover a lot of ground in a short paper and has provided us with a broad view of the main features that characterize the PROCISUR NARS with respect to several important

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[1] Paper presented to the PROCISUR's Seminar on Institutional Models of the National Agricultural Research Institutes of the Southern Cone, Asunción, Paraguay, December 1-2, 1997.

[2] Helio Tollini is Director, Policy and System Development Program, International Service for National Agricultural Research (ISNAR), The Hague, The Netherlands.

[3] PROCISUR - Subprograma Desarrollo Institucional. Modelos Institucionales de los Institutos de Investigación Agrícola del PROCISUR, Ed.: Marcial Abreu, Montevideo, Julio, 1997.

areas. For this meeting, ISNAR has been asked to focus on the organizational aspect of research systems. An ISNAR book on the implications for NARS of structural adjustment programs[4] and another forthcoming ISNAR book on financing agricultural research[5] may also be helpful in thinking about the issues addressed in this meeting.

The organization question is part of research policy. To be able to design an adequate organization, research systems must be very clear with respect to the objectives of the system, its financing conditions, and its priorities; that is, they must have a clearly defined policy. Organization is thus linked to financing, and both have to be taken into consideration simultaneously. That is one of the strong points of this meeting, since both subjects are treated here. The possibilities created by regional research mechanisms like PROCISUR, based on cooperation, and by processes like globalization, based on competition, have implications for the organization of national agricultural research systems. Cooperation may be seen as a way to face competition.

This paper is organized in four parts. The first part deals with the major exogenous forces affecting NARS. The second part discusses some of the implications of these major exogenous forces to NARS research policy and governance. The third part presents specific country cases for comparison. The final section emphasizes some ideas about the organization of agricultural research in the region.

Major Exogenous Forces Affecting NARS

Major changes have occurred in the world in a little over a decade. The international political scenario has changed significantly, national states have redefined and focused their roles, economic systems have moved in the direction of market rule, communication has expanded exponentially with sharply decreasing costs. These changes have been induced by a changed political and economic philosophy, but in some parts of the world, as in most of Latin America, they have been accelerated by the economic crisis of the eighties.

National agricultural research systems are going through these unstable transition times knowing that adjustments to the new world can not be postponed. In general, the forces affecting NARS are classified into three classes: changes in the economic situation (with requirements for good management), increased awareness about quality of the environment and the sustainability of production capacity, and progress in science (with the need to incorporate new technologies in order not to lag too far behind). Just coping with these "disturbances" may be considered a major accomplishment.

Changed economic situation

The new global political configuration is leading to a change in economic philosophy all over the world. In the Latin American region, this change has been reinforced by a long economic crisis, abundantly discussed in many publications. The ensuing economic restructuring programs and the new economic philosophy have led to the liberalization of economies and to the acceleration of globalization processes. Liberalization, globalization, and changes in political and economic philosophy are in different stages and move at different speeds in different countries and regions, but all countries are affected by these processes.

The economic crisis. The new economic philosophy has led to revisions in the role of governments, and the economic crisis has reduced the possibilities for action by governments. One has reinforced the other, with the consequence that governments are increasing the privatization of their economies and pushing research and other organizations to greater independence from the fiscal budget.

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[4] Tabor, Steven R. (ed.), Agricultural Research in an Era of Adjustment, EDI Seminar Series, World Bank and International Service for National Agricultural Research, Washington and The Hague, 1995.

[5] Tabor, S.R., W. Janssen, H. Bruneau, 1998. Financing Agricultural Research: A Sourcebook. The Hague: International Service for National Agricultural Research.

Liberalization. The opening up of economies and the reduction of government financial capacity have been important forces in the direction of cooperation. Programs like PROCISUR have become more interesting for member countries for two reasons: (1) increased specialization in production due to liberalization and increased trade and (2) reduced costs due to the elimination of duplication and the greater efficiency and effectiveness of research resulting from cooperation. In a way, regional mechanisms like PROCISUR do through cooperation what processes like globalization do through competition, except that in the case of research and technology in developing countries, gains from cooperation seem safer than gains from competition. Again, the division of labor brought about by cooperation and by competition have implications for the organization of research systems.

Globalization. Some of the markets for innovations in agricultural technology have always been global markets. An example includes the markets for agricultural machinery and chemical inputs. A few firms supply the world, and as economies open up, concentration on the best providers increases. These global suppliers are the "winners" of the competition. As intellectual property rights and patents increase in different areas of the agricultural research spectrum, globalization may spread to other parts of the broader research spectrum. These present NARS with new opportunities and risks that have to be evaluated every time that the objectives, the financing, and the priorities of research systems are reviewed.

The fact that the firms that gain the market are called "winners" may lead to the idea that the countries whose research organizations "lose" the competition are overall "losers." Those countries may actually gain from a better and lower priced supply of technology for some sectors of their agriculture, and from the possibility of concentrating resources in other priority areas of the technology spectrum or in other social needs. This has always happened in some sectors, as in the supply of fertilized eggs for the broiler or egg-production industries.

Some developing countries want to see the private sector operating in new technological areas before they feel confident enough to renounce work in those areas by their public research organizations. Intellectual property rights are now being implemented in many countries and therefore the research areas that fall in the private goods category will expand; however, not all these new research areas will be profitable enough to attract private investments. Developing countries therefore may take a wait and see attitude.

Increased awareness about the environment

Soil conservation and water management, mainly irrigation and drainage, have been on the agendas of agricultural scientists for years. However, it was only recently that society has developed serious concerns about the environment. The conservation of the environment, its protection and recuperation, the sustainability of production over generations (the idea that the Earth has not been inherited from previous generations but borrowed from future generations, as it was well put by someone), biodiversity, biosafety, and other issues are all relatively new public concerns.

In response to this new concern, science is trying to come up quickly with solutions to these problems, with information on the problems, or with methods or tools to deal with the problems. The "economics of the environment" has moved quickly to adapt economic concepts and analyses to address environmental questions. Other disciplines are doing the same. Geographical information systems are a step forward in addressing issues at the agro-ecological scale.

It is evident that no discipline by itself can properly address the needs of society in terms of good environmental analyses. The efforts of multidisciplinary teams are required. National agricultural research systems in developing countries, many of them still struggling with the basic economics analyses of simple experiments, are now being requested to deal with these much more complex problems, as pointed out by Tollini.[6] What to do? What

[6] Tollini, Helio, Policy and Research: Loops of a Spiral?, "Closing the Loop" Expert Consultation, Maastricht, 10-11 November, 1997, ISNAR/ ECDPM, The Hague/Maastricht, The Netherlands.

can be left for the private sector so that scarce public resources can be focused on the new questions?

Progress in science

Progress in science is normally believed to be a slow process. That is true in the sense that other areas seem to change very rapidly, but the fact is that scientists consider science to be evolving so rapidly that it is difficult even for some of the best endowed research organizations and scientists to keep up with developments.

National agricultural research systems face the dilemma of trying to keep up as well as they can with the new concepts and tools developed by science or of lagging further behind the capacity of developed nations. This choice is not simple, and the costs of following one route or the other may be high in the long term. With globalization, options are wider and research systems have to make hard decisions.

Of course, these decisions will be very much influenced by the way countries deal with the opportunities and risks of global competition and with the promises of regional cooperation. Information theory and information technology are among the areas of new science and technology. Another is molecular biology. System theory is still another area, as well as simulation. Management theory also continues to offer new concepts and tools for consideration.

Implications for NARS of these External Factors

These changes have many implications for the external environment with which national agricultural research systems must deal. The first and most obvious case is that of the changed emphasis countries put on different commodities as the flow of trade and income shifts, along with the liberalization and globalization of markets for agricultural products. Collaboration in research is both the effect and the cause of economic restructuring and of liberalization and globalization. As a matter of fact, a regional mechanism may be a first step towards globalization, or a (perceived as safer) form of moving from closed systems protected from competition to more open competition behind the shield of cooperation. It may be a proactive action of searching for economies of scale and scope to increase efficiency—or a reactive action to hedge against the perceived risks of globalization.

Little is known about the specific tendencies and processes by which globalization may occur and may affect national systems. The task now is to try to develop a framework of analysis that developing countries can follow when looking for ways to deal with the globalization of markets for agricultural technology. The possible effects of globalization have to be evaluated when research systems are examined from a strategic point of view. Benefits and risks are involved, and each country will have to analyze its own position with respect to the possibilities of globalization in different parts of the market for agricultural technology. As a matter of fact, even regional mechanisms will have to evaluate the possibilities and risks created by globalization and whether a regional cooperative effort will be better than alternative global suppliers of technology.

Two Country Cases

The two examples chosen are from Indonesia and the Netherlands. Although these countries share part of their histories, they are different in cultural, social, and political characteristics, and in their natural endowment. Both are important countries. Indonesia is a large developing country with a large population. The Netherlands is a small developed country with a small population but high population density. In both countries agriculture is important, but the support that each government is capable of providing to its agricultural sector is very different.

In the case of agricultural research alone, and considering 1985 PPP (parity purchasing-power) dollars, by the mid-1990s the Netherlands was investing 21 times more per agricultural hectare and

125 times more per agricultural unit of labor than Indonesia. These are huge differences, and they sort of counterbalance the differences in land and labor available in the agricultural sectors of the two countries: Indonesia has an agricultural area 155 times larger than that of the Netherlands, and an economically active population in agriculture 21 times greater.

The results are in line with the investments in technology generation. Output per hectare in the Netherlands is nine times that of Indonesia, and output per worker is 68 times. Agricultural policies and general support for agriculture are also different, as are the relative prices of land and labor, and in part explain and are explained by the differences in the results.

Indonesia

Rapid industrialization since the 1980s has significantly accelerated the rate of expansion in food demand, making food import, even of rice, where self-sufficiency had been achieved during the Green Revolution, necessary again.

The Government of Indonesia decided to reorganize its public research system to bring it closer to farmers and farmers' needs. A basic principle of the reorganization was a decentralization process and the creation of a local capacity for technology assessment.

To this end, 17 provincial institutes for technology assessment were established, either through the adaptation of old research stations or the creation of new ones within the Agency for Agricultural Research and Development. This process is still going on and the recent financial and economic crisis will probably affect its rhythm. Important questions have yet to be solved. The linkages of these regional technology-assessment units, where more adaptive research will be done, with the more centralized units, where more basic research is conducted, is such an issue.

ISNAR has supported the Indonesian national team charged with the responsibility of developing strategic plans for the new research system. Each of the 17 regional technology-assessment institutes has developed its own strategic plan within the framework of the general plan.

The reorganization of the public agricultural research system had strong support from Indonesian policymakers in the Ministries of Agriculture and of Planning. Policymakers required a reorganization plan and provided political and financial support to it.

The important lesson is that this was a genuinely Indonesian affair. They decided that they needed to strengthen their system, they defined the basic features the new organization should have, they designed the system, they developed the strategic plans. ISNAR provided technical backstopping and helped the process with some training and participation of resource people in planning workshops.

The question now is: Is more decentralization of research and more technology assessment needed elsewhere? Is it needed in the PROCISUR region? If it is needed in this region, do the member countries want to move in this direction? If they do, in what form can decentralization best be done and a capacity for technology assessment developed under the conditions of these countries? These types of decisions are in part political decisions and have to be taken by national authorities. But when taken, PROCISUR can be very helpful in technically supporting the process.

An aspect to monitor in the future is how institutes for technology assessment that are separate from institutes for technology generation will work. If the division of responsibilities is basically between more adaptive and more basic research, with the adaptive being more locally focused, this is not very different from what already exists in many places. If the one is generating and the other assessing, the challenge will be to find mechanisms that enhance programmatic cooperation and avoid negative competition that results in conflict and inefficiency. Another issue is the evaluation of the cost effectiveness of this organization in relation to the more traditional one of having technology generation and assessment, or adaptive and basic research, together in the same research teams.

The Netherlands

Agricultural research in the Netherlands has always been an important activity and a factor in the impressive development of its agricultural sector. With an admirable past of wresting production space from the sea, this country offers an interesting example of evolution of objectives for the agricultural sector and organization of its public services for the generation and transfer of agricultural technology.

One century ago, the Netherlands faced an agricultural crisis and responded by building its capacity in research, extension, and education. Fifty years ago, the problem became food security, and research and extension were given the primary objective of increasing yields to hold down food prices and improve access to food. Fifteen years later, international competition threatened the viability of Dutch family farmers and they became the focus of the agricultural support services.

In the early eighties, the problem became overproduction and pollution, and the government response was to introduce production quotas and other regulations. By the late eighties, the role of government, as everywhere in the world, began to be questioned, the extension service was privatized, and the concept of "IKC" (the information knowledge center) was established.

In this decade, the dominant idea has been that of a competitive knowledge market, extension has become completely commercial, with the focus turned away from agriculture *per se* to rural development, "IKC" has begun to be questioned in the Dutch Parliament, and the agricultural University of Wageningen is being merged with the DLO, the national agricultural research organization.

The process of merging is still going on. It started by merging the boards of the two organizations, which is also a development to monitor because some think that this is the path for the future. In countries with many universities and research organizations, the task might be more complex.

The Netherlands is now dealing with an excessive bureaucracy in programming and has come to the conclusion that the market can not be expected to solve all the problems of agricultural support services. The Ministry of Agriculture now has to address issues related to recreation, nature, and viable rural areas, besides agriculture itself. It is a more diversified agenda than in the past. In some developing countries, ecotourism is becoming a solution for the management of natural resources and an important source of additional income.

The case of the Netherlands may not be an example for the PROCISUR countries at this moment of their histories, but can it be a map for the future? Given the differences in the context of the Netherlands and of the PROCISUR countries, this future may be far away for some of the countries, but closer to others.

Concluding Remarks

This is a period of transition. The political and economic transformations going on all over the world will sooner or later influence the way agricultural research systems are organized.

Adjusting to this changing context will not be instantaneous. Two basic processes underlie this transition: competition and cooperation. Competition comes from globalization trends; cooperation, from the need to be more competitive. Both processes have financial, political, social, and even cultural costs.

One possible scenario is that agricultural research systems will move from an unstable organizational equilibrium point to another before a more stable equilibrium is eventually reached. In reorganizing, systems have to specifically deal with questions like what and how much to leave for the private sector, where to focus the public capacity and how to avoid the pendular changes common in transition periods.

This is a process characterized by uncertainty. The expected benefits and costs of competition and of cooperation are difficult questions. Because there is so much uncertainty in the key variables, decision making usually follows a sequential process, which is the reason for the systems to move to some intermediary unstable equilibrium point before coming to more stable positions.

There are no global recipes on how to organize research activities in a country, although experiences from other

countries are invaluable as guiding ideas. There are however principles or characteristics that the new generation of organizations should have.

One important thing to remember in the search for directions is that a country should not see itself as isolated in the world and pursue a solution without considering potential gains from collaboration. Collaborative mechanisms like PROCISUR gain in importance in this situation, mainly because the solution to some of the technological problems of one country may be found in another country. Collaboration builds conditions for formally promoting, creating, and disseminating "spillovers" in research that may be economical and may have sustainable implications for the organizations involved. This is what PROCISUR has been doing. Communication among members on programs and organizations produces information to support the decision-making process within any individual country.

As mentioned before, there are some characteristics that research organizations should have or develop to be able to adjust to the new global context.

First, research organizations have to sharpen their ***focus***. This means having clear policy objectives and priorities for the resources available. This is more difficult than it seems at first sight. Usually researchers and their managers develop policy statements on their own. They try their best to have their policy statement in line with the objectives of agriculture and overall development. However, these statements do not represent good policy because they are not the result of political agreement where all stakeholders participate.

A second characteristic to observe and improve is ***governance***. In a simple way, governance has to do with accountability, transparency, and inclusiveness of interests. This requires the involvement of stakeholders not only in policy definition, but also in program formulation and evaluation. To this end, planning, monitoring, and evaluation processes have to be defined and implemented in a transparent way. Transparency in all these levels is important for improved accountability.

A third characteristic of the new generation of research organizations is increased ***efficiency and effectiveness***. This is what lies behind the idea of reorganization. One way to improve efficiency and effectiveness is the introduction of competitive mechanisms in all possible management processes, from grant allowances to staff promotion to selection of managers and leaders. This is also the reason to bring researchers closer to their clients, the farmers, so that better mechanisms for feedback and evaluation are created to sharpen focus at the programmatic level, to improve accountability, and to create conditions for increased impact and better impact assessment.

A fourth desirable characteristic is improved ***creativity***. Creativity is enhanced by proper incentives, like promotion of staff for competence, productivity, and creative work—not only by seniority, or worse, politics or nepotism. Another way to enhance creativity is by avoiding excessive programming of research activities. Researchers must have the opportunity to try their own ideas and test their own hunches about technological problems, even when these problems do not appear important at first sight. In moving from an organization where researchers do whatever they want to one with more focus and better programming, it is recommended that programming to the level of the smallest and most specific activities be avoided.

The search for a research organization where these characteristics are present is the task countries will have to face in coming years. There are several forms organizations can take, while still having all the desired characteristics. PROCISUR will be an invaluable instrument in these efforts, making the level of information among the countries homogeneous, providing examples of possible solutions, uncovering opportunities for increased technological spillovers and better focus through collaboration among national research organizations. In the end, the best organization will be the one that develops the best human resource base and provides conditions and incentives for excellence in performance, but which does not create an illogical structure that promotes conflict and inefficiencies.

BUILDING REGIONAL COOPERATION FROM THE BOTTOM-UP AND TOP DOWN: THE CASE OF SOUTHERN CONE COUNTRIES

Uma lele

Building Regional Cooperation from the Bottom-Up and Top Down: The Case of Southern Cone Countries[7]

Uma Lele[8,9]

This paper addresses the issues of regional cooperation from two perspectives: First, it provides a case study of a PROCISUR[10] member country, Brazil, which has embarked on one of the most ambitious programs of reform of its national agricultural research system (NARS), and second, it addresses issues involved in developing true regional *research* cooperation among countries of different size and capability.

From INIAS to NARS: The Case of the Brazilian ongoing Transition

The Changing Global Context

Whereas among the PROCISUR members Chile has already gone through a substantial transformation of its research system, Brazil has just commenced its own transition. It has nearly 7500 researchers, about equally divided among the Federal entity EMBRAPA (Empresa Brasileira de Pesquisa Agropecuaria), the state research (and extension) organizations and the universities, or about 5,400 full time research equivalents (FTEs) if only the research time of the teaching faculty is considered. With such a large agricultural scientific community, Brazil is the third largest agricultural research system among developing countries, next to China (with nearly 50,000 researchers) and India (with nearly 26,000). It is the largest system in Latin America (See Map 1). With annual research expenditures at 0.9 percent of the agricultural value added, Brazil's agricultural research system is also well funded relative to that of China or India. Their annual research expenditures stand at around 0.3 to 0.4 percent of their value added in agriculture.

Research expenditures in Brazil are of course much larger per capita population engaged in agriculture ($149) than either China ($2.5) or India ($1.5). This is because Brazil's per capita income is much higher. It was $3,640 in 1995, with a population of 159 million. Twenty three percent of the population, or about 35 million people were engaged in agriculture. In contrast per capita incomes are $640 and $340 respectively in China and India, and 74 to 64 percent of their national populations of 1.2 billion and 930 million respectively are engaged in agriculture. Brazil also has a larger share of its agricultural scientific community trained in advanced industrial countries than either China or India. EMBRAPA estimates that nearly 70 percent of its scientists hold U.S. Ph.D.s EMBRAPA's annual budget in 1997 was at nearly $550 million, and it has

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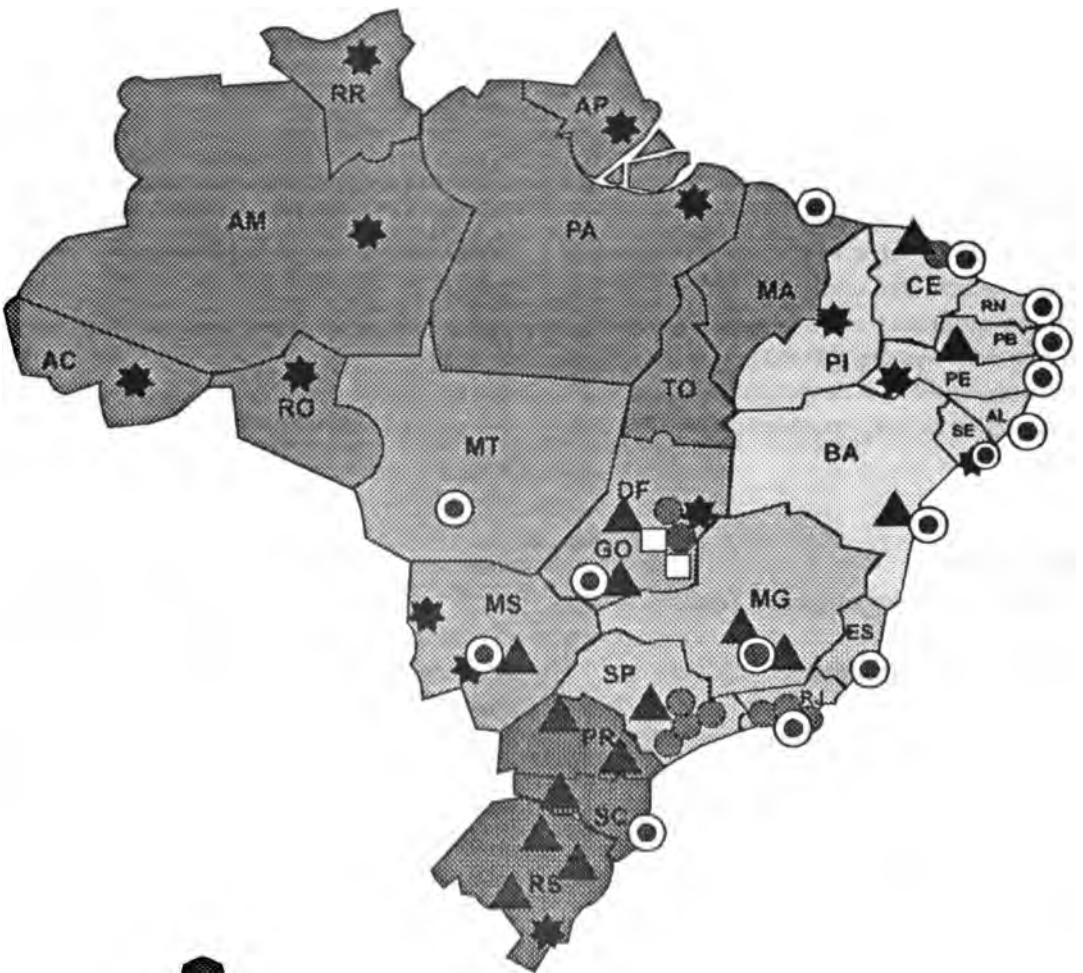
[9] The views expressed in this paper are those of the authors and do not represent the views either of the World Bank or the Government of Brazil.

[10] The PROCISUR cooperative research program is a collaborative research arrangement involving Argentina, Brazil, Chile, Uruguay, and IICA which began in 1978.

Map 1

Embrapa

MINISTRY FOR AGRICULTURE AND FOOD SUPPLY



HEADQUARTERS

ECOREGIONAL RESEARCH CENTRES 13

NATIONAL PRODUCE CENTRES 15

NATIONAL THEMATIC CENTRES 9

SERVICES 2

STATE ENTERPRISES 15

MAPAS(pauta)

a critical mass of 2200 scientists. In addition, the combined budgets of the state research and extension systems amount to another $350 million with scientific staff of 2,300 (See Figures 1 and 2). Brazil's scientific establishment is thus more than five times as large, and its annual research budget is more than three times that of the CGIAR. With the range and quality of the physical facilities, combined with this human capital and financial expenditures, Brazil has perhaps the most well equipped and modern research system among developing countries.

Yet Brazil's research expenditures are small both in absolute terms and compared to the advanced industrial countries with which it must increasingly compete in the context of the liberalized world trade regime through WTO, and other regional trading arrangements such as MERCOSUR and NAFTA. Besides, there is great variation in the levels of funding and human capital among Brazilian states and many difficult decisions in strengthening the overall national research system as can be seen from figure 2. Some states altogether lack long term investments in critical

Figure 1 Evolution of EMBRAPA's budget (in 1996 US$)

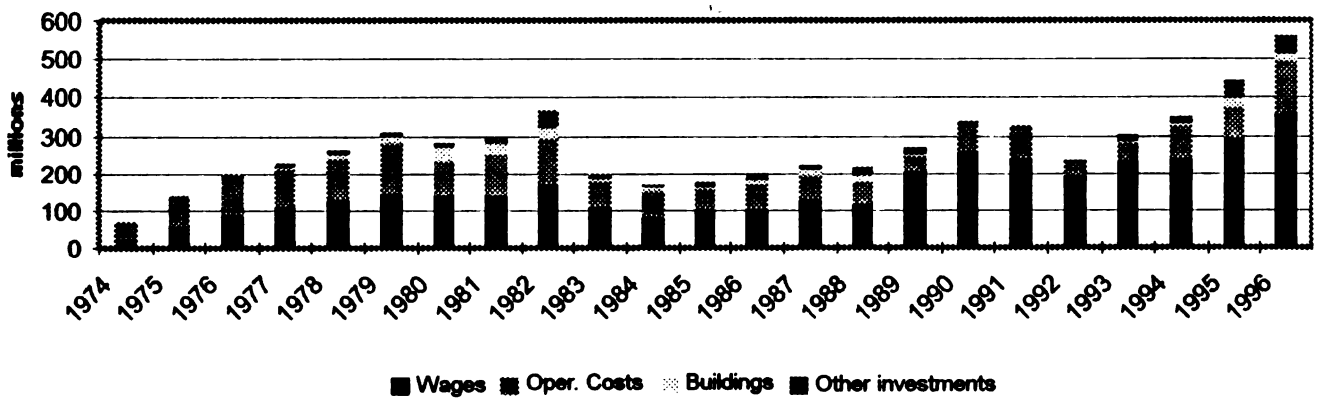
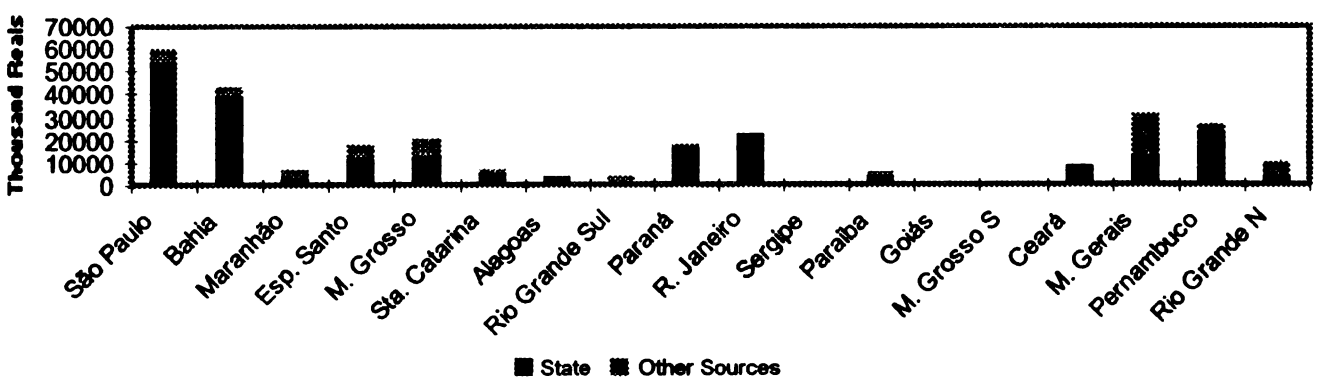


Figure 2 Budget of State Research System (1996)



facilities needed to conduct or upgrade research or to generate technology of direct reference to end users. Dependence on EMBRAPA is much greater in the weaker states such as Alagoas and Sergipe. Where neither the federal nor the state research and extension services are present, in this current period of severe budget constraints other existing institutions in the states need to be supported to undertake research, technology development and extension functions perhaps jointly with EMBRAPA, rather than creating new state research and extension systems. Other stronger state research and educational institutions or farmers' organizations need to help the weaker states, instead of either creating new state research centers or expanding EMBRAPA centers. With such increased state activity in research and extension, EMBRAPA would be able to reduce its research staff support to the states from the $9 million devoted in the form of support of EMBRAPA research scientists to the state research and extension systems in 1996. By establishing strategic partnerships with the stronger state research systems to aid the weaker states EMBRAPA can also shift those resources upstream to focus on strategic pretechnology problems, and in developing the broader incentive system for mobilization of additional research resources.

These issues have now become more pressing in the context of international competition when research expenditures of industrial countries are considered. In the U.S. they constitute more than 2% of the value added with total (public and private) expenditures for the latest year for which data were available for the early 1990s of over $7 billion. With rapid global advances in science in such areas as biotechnology, GIS and informatics, U.S. private sector expenditures have increased considerably since the early 1990s and may now be about 8 to 10 times those in a country such as Brazil. Research expenditures are 4% to 5% in Canada and Australia. It is imperative that developing countries partake in the new and exciting scientific revolution by mobilizing substantially greater funding for agricultural research.

The new WTO rules also call for environmental regulations on internationally traded agricultural commodities. If not followed the rules threaten the increased use of non-tariff barriers (NTFs) as a way of dealing with the likely environmental consequences of poor domestic practices with regard to the use of chemicals. Countries such as Brazil must guard against NTFs by following sound and documentable environmental practices in their agriculture.

Privatization of intellectual property derived from these new investments is another challenge. The situation developing countries face today is in sharp contrast to that just a few decades ago when much of the technology and know-how were available to them through public sector collaborations with advanced countries via foreign aid. These factors together provide major challenges to developing countries in maintaining their own agricultural productivity growth in a sustainable manner through the application of science and technology. In addition, developing countries must create productive employment for their small farmers, who increasingly see themselves as victims of globalization, and face the prospect of extinction as agriculturists unless research and technology increase their competitiveness.

The U.S. and other industrial countries, e.g. Canada, Australia, New Zealand, and Spain offer a variety of *institutional* models from the viewpoint of diversifying sources of research funding and technology development. These models range from predominantly budgetary support and block grants in the U.S. to commodity based financing and competitive grants in Australia, or a blend of the two in Malaysia. With a customer-driven approach typical of their modernized agricultural sectors, these countries display at least five characteristics of diversification, leading to many different sources of research and technology for users, a transition which developing countries are also trying to achieve, namely:

- the share of private sector agricultural research, technology development and transfer increases relative to that of the public sector;

- the share of agricultural research in agricultural GDP increases, typically from less than 1% in developing countries to between 2% to 4% as in Canada, U.S., Australia (Pardey et al. 1995), meaning substantially greater investment in research, technology development and transfer relative to developing countries both in absolute and relative terms;

- the role of universities increases *vis-à-vis* that of public sector research systems;

- the relative (not absolute) share of the public sector declines over time, with the public sector increasingly focusing on the "quintessential public goods research," i.e., research the benefits of which are long term, broadly derived and difficult to capture for the private sector;

- the role of the local and regional research and technology transfer systems increases in applied and adaptive activities relative to that of the federal/central government, with the latter playing a more strategic, catalytic role in stimulating research in overall national research system (Lele, 1996).

The U.S. took over 100 years to achieve such a transition which developing countries are trying to achieve in a period of one or two decades. Establishment of intellectual property rights (IPR) and plant variety protection (PVP) was an important stimulus to the growth of private sector research investments in industrial countries. These developments have often been closely linked with the spread of technology associated with the sale of inputs, information and services. As both domestic and international private sector have begun to make increasing inroads in developing countries, an important question in the spread of technologies is the extent to which the private sector will offer superior technologies and accelerate technology transfer. For example, Monsanto's zero till technologies involve genetically improved plant material and the use of herbicides in Indonesia. The locally produced low input no-till technology spreading in Brazil and Mexico use few chemical inputs. These choices will have significant implications for the health of human and natural resources as well as the extent and the type of growth of the input industries, production, employment and trade involving developing countries.

With accelerated privatization, the experience of industrialized countries is also important in understanding the rapid spread of new technologies on the farmers' fields. These new technologies tend to be heavily intensive in information, knowledge and human capital. In contrast investment in information and training in developing countries is often neglected. Instead under-utilization or misallocation of available trained people is often cited as a reason why further investment in either information or human capital is uncalled for.

Brazil's Transition from a NARI (National Agricultural Research Institution) to a NARS (National Agricultural Research System)

National Level Reforms

To address the challenges listed above, the Government of Brazil has recently embarked on a major program of reform to enable it to build a truly effective national agricultural research system. An Inter-Ministerial Council presided by the President of the Republic (the Coordinating Council for Science and Technology) was established in January 1996, with the broad mandate to formulate science and technology policy. The Federal government is considering doubling the research budget share of GDP from 0.8% to 1.6% in the next few years in which agriculture is expected to receive its legitimate share. The regulatory environment is now more conducive to private sector investment in R and D with the passing of the IPR legislation. The Biosafety Law was approved in January 1995 and the National Technical Biosafety Committee began work in July 1996. The Plant Variety Protection (PVP) Legislation under consideration by the Congress is expected to pass soon. This legislation together with a more liberal stance towards collaboration with private firms including multinational corporations paves the way for increased domestic and international private sector investment in research. So far the private sector has been more active in commercializing research results (e.g., through maize seed production) than in undertaking new research. EMBRAPA sells its technologies to the private sector for commercialization, the maize seed industry which earns EMBRAPA nearly $2 million in royalties for its single hybrids being a good example of this public-private partnership. EMBRAPA's revenues from the sale of products, processes and services can however, be increased substantially. They amounted to 7% of EMBRAPA's research revenues in the mid 1990s compared to about 14% in the U.S. universities. To increase public-private partnerships will require increased trained personnel in IPR issues, and the capacity of the publicly engaged scientists to negotiate and implement contracts with the private sector and

private sector confidence in the protection of IPR. The latter in turn will need legislative and implementing capacity.

Agricultural Research Level Reforms

To address these challenges the Brazilian agricultural research establishment has recently embarked on one of the most ambitious programs of agricultural research modernization among developing countries which is being supported by a World Bank loan of $60 million over a five year period. The World Bank's contributions are matched by contributions of another $60 million
by a combination of the Government of Brazil, EMBRAPA and the participating research and application entities (e.g., multinational and small scale private sector, farmers' organizations, etc.).

The project involves:

- **a competitive grants program (60% of the total resources)** in which all Brazilian institutions concerned with agricultural research and technology transfer can participate;
- **institutional development, training, international research linkages,(35% of the total resources);** and
- **administration, monitoring and evaluation (5% of the total resources).**

The loan amount of $12 million annually, constitutes just over 2 percent of EMBRAPA's annual budget, stressing the catalytic nature of the project. Five high priority areas are selected for enhancing partnerships through collaborative research, technology development and transfer:

1. Biotechnology;
2. Natural Resource Management;
3. Small Farm Development;
4. Agri-business; and
5. Strategic Studies.

Using new partnership modalities through a competitive system Brazil proposes to achieve a transition in its National Agricultural Research System (SNPA) from the country's current heavy reliance on the publicly funded, and predominantly public sector executed, research carried out by EMBRAPA, to a more diversified and integrated system of agricultural research, technology development and transfer (ARTDT) in which EMBRAPA, as the designated leader of the SNPA, is playing a catalytic role. Such a transition is intended to:

- reduce the current estimated 90 percent reliance on the budgetary resources, most of them provided by the federal government, by mobilizing new sources of financing, including increased state and local government funding, the private sector, farmers' organizations, commodity and environmental groups;

- increase the range of research actors (e.g., universities, international and advanced countries' research and teaching institutions, international and domestic private sector, state research and extension organizations, farmers' organizations, NGOs, etc.);

- increase the role of clients in the definition of research and technology transfer priorities and their implementation, thereby increasing the relevance of research;

- refocus the public sector research on the quintessential public goods (e.g., research which offers few immediate profits which can be appropriated by the private sector and research which therefore is typically not attractive to the private sector, such as research on family farms, natural resource management and pretechnology activities); and

- help EMBRAPA to reorient its current structure to address issues of decentralization and diversification of the SNPA.

The current World Bank funded project in support of the Brazilian reforms is different from the traditionally designed agricultural research project in several ways: previous agricultural research projects in Brazil concentrated support on staff training, physical facilities and equipment for EMBRAPA. Issues of research policy, management, partnerships and competition with other public and private agricultural R&D institutions were addressed to a limited extent. The current project is designed to make a qualitative difference, i.e. by increasing the linkages among domestic, regional and international R&D institutions conducting applied, adaptive and basic research and extension.

- The current project has **a national coverage**: With the exception of the first project, two previous World Bank-supported agricultural research projects were geographically restricted to the North and Northeast Regions (with IDB supporting the rest of the country). Its purpose is to address the issues posed by the maturity of the 23-year-old SNPA coordinated by EMBRAPA; the need to strengthen and reform EMBRAPA's own planning system (SEP) which provides the foundation for institutional integration of R&D projects; within Brazil the need to promote linkages and balance between the more developed southern institutions with their weaker northern partners; the need to avoid duplication of the R&D activities, promoting complementary; and increasing competition and efficiency among the well-established R&D institutions.

- The current project **combines a competitive grants program with institutional and human capital development**: Due to differences in regional capabilities and requirements referred to earlier, an exclusive reliance on a competitive grants program for the totality of research in Brazil is not desirable. It would not allow the Government to provide support to the development of the previously weak, but now emerging units and centers of excellence in the North, Northeast and specific Central areas of Brazil (Tocantins, North of Mato Grosso and Northwest of Goias). Additionally, it would inhibit EMBRAPA's need to focus its own research on long term and public goods (natural resources management, integrated pest management, technology for the resource-poor, etc.) which may not be attractive to other R&D institutions.

- The current project is **a catalyst and a pilot**, intended to learn lessons which can be incorporated in the mainstream of EMBRAPA and SNPA operations: At the end of the project, the program would be incorporated into the mainstream of EMBRAPA's research activities, and a significant share (30%) of the national research budget managed by EMBRAPA would then be operated on a competitive grants basis.

- **There are no earmarked resources for research units and programs**: EMBRAPA's new policy, in accordance with federal reforms being implemented by the Cardoso administration, is to avoid earmarked resources. Instead it has moved to link budget to performance at all levels (research center, research program, and staff). However, to ensure that more research is stimulated on family farm development and natural resources management, up to 45% of the resources allocated to the competitive grants program would be set aside as a goal, the demand for that share as well as the quality and nature of participation in ARTDT competition would be carefully monitored, and the program adjusted according to the experience gained (e.g., increase promotional activities such as advertising, training and fostering collaborations in ARTDT areas which do not approach the expenditure goals).

The World Bank participation in these reforms is significant because, unlike in small low income developing countries, external assistance constitutes a small proportion of the total financing of agricultural research in Brazil. During the 1992-97 period it constituted only 4.6% of EMBRAPA's research expenditures, and virtually all of it came from multilateral and regional banks. In the 1960s, bilateral donors played an important role in financing agricultural research, particularly in training and institutional development of EMBRAPA. Indeed Brazil's spectacular success in the expansion of soybeans and citrus production is in large part due to the research and technology transfer capacity developed through U.S. bilateral assistance in EMBRAPA. Today bilateral donors are not providers of financial support for agricultural research to advanced developing countries such as Brazil. Involvement of industrial countries has shifted to true partnership through collaborative research with EMBRAPA researchers. More such partnerships with research institutions of advanced countries, and the CGIAR centers, are being fostered through the current World Bank project. EMBRAPA has entered into collaborative arrangements with five CGIAR centers, the USDA, several U.S. universities as well as with a number of European countries.

Indications of Brazil's commitment and ownership

Brazil's strong commitment to reforms is illustrated by several factors:

- Project preparation was completed in record time. The project was identified in late April 1996, prepared, appraised and presented to the World Bank's Board of Directors in June 1997. First competitions were announced by EMBRAPA in early September 1997.

Awards would be announced in the first week of December 1997.

- It involved an unusually high degree of Brazilian participation in the project design. EMBRAPA has utilized substantial amount of its own funds and human capital for project preparation.

- In consultation with the World Bank, EMBRAPA contracted national and international scientists of outstanding reputation (e.g., from the advanced countries' research institutions) for the preparation of key project components such as biotechnology, public-private partnerships, and natural resource management.

- EMBRAPA adopted major administrative reforms consistent with project objectives and activities including: downsizing; a performance based incentive system; greater integration with universities, state research institutions, and NGOs; a larger role for the private sector in technology generation and transfer; reorganization of EMBRAPA to avoid costly duplications of research administrative tasks; and greater decentralization, autonomy and accountability of research units.

- GOB made budgetary provisions for the project in the forthcoming year's budget while the project was being prepared, thus avoiding costly delays in counterpart and matching recurrent funding availability.

- EMBRAPA undertook extensive consultations with potential research and technology transfer partners and beneficiaries, by organizing: (1) a teleconference of over 750 institutions throughout Brazil involving the private sector, universities, state research and extension agencies and farmers' organizations, chaired by the President of EMBRAPA, involving World Bank participation on November 28, 1996, (2) a major inter-ministerial conference on public-private partnerships in agricultural research, co-sponsored by EMBRAPA and the Minister of Science and Technology on December 4, 1996, involving domestic and international journalistic and legislative participation, (3) a workshop of EMBRAPA's 37 center directors on November 26, 1996, (4) consultations with the National Advisory Council on the project on November 27, 1996, and preparation of several working papers as inputs into project preparation.

- EMBRAPA's President uses his bimonthly television conferences, with national coverage, to routinely report progress on the project, highlighting the importance of competitive systems and partnerships in agricultural research.

- EMBRAPA has placed its operational manuals for the competitive grants system and calls for proposals on the internet, giving it wide circulation, and invlting a strong response of proposals from throughout the country including from small farm organizations.

Value added of Bank support

- World Bank support and EMBRAPA's discussions with the Bank's Agricultural Research and Extension Group (ESDAR) facilitated interaction with some of the best scientists in the institutions of advanced countries in project preparation, and resulted in the incorporation of global experience on agricultural research at a time when Brazil is searching for alternative approaches.

- EMBRAPA has viewed incorporation of global experience as being more important than simply the provision of extemal finance.

- The World Bank's support to small farmers in the Northeastern and Southern Regions of Brazil through rural poverty alleviation loans, and to natural resource management and environmental protection through other projects in the country can facilitate linkages between the research community and the end-users of agricultural technology.

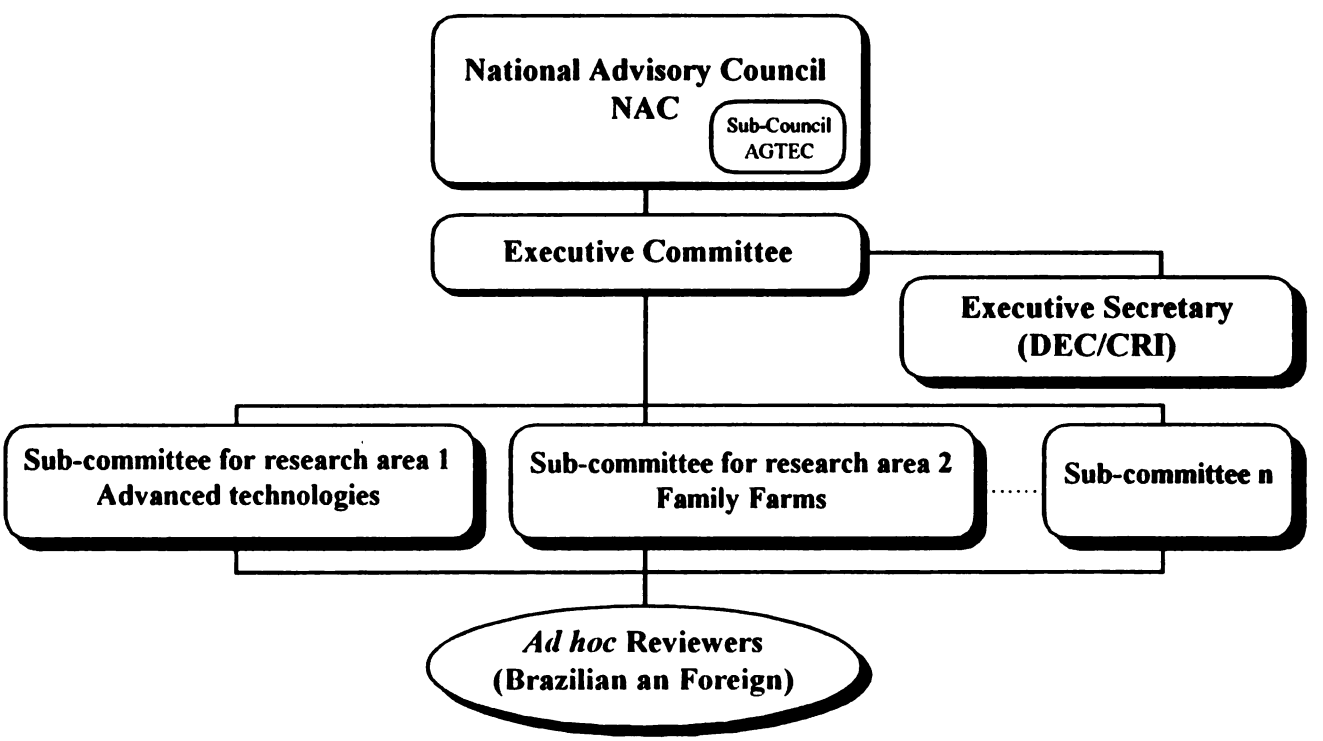
- World Bank support of other research programs involving a competitive grants in Brazil (PADCT) has resulted in the Bank facilitating cross fertilization across sectors.
- The World Bank's involvement allows better transparency and accountability in the utilization of funds to the research clients, of special significance in the competitive grant component, in view of the Bank's stringent procurement and disbursement procedures.

The Executing Agency

Project management builds on the existing organization and management of the SNPA, but introduces several significant modifications in key areas, simplifying the system and making it more outward looking and accountable to the clients of

research (see figure 3). The **National Advisory Council (NAC)** of EMBRAPA, headed by the President of EMBRAPA, which had a limited role in setting the overall direction and management of the National Agricultural Research System, has been transformed under the project, into the **NAC for the SNPA.** It is headed by the Secretary General of the National Ministry of Agriculture, second in command of the Ministry of Agriculture for Brazil, with substantially greater responsibilities and greater (in terms of numbers) and stronger non-governmental representation of the clients and actors of research. The **NAC Sub-Council,** also established under the project, is headed by the President of EMBRAPA. It works closely with the **Executive Committee (EC)** established under the project to manage the Competitive Grants Program, consisting of 8 members, each with proven track record in research and research management. The EC which also has substantial non EMBRAPA representation of the Brazilian scientific and technology transfer community, and a multidisciplinary background, is headed by a **Chairman,** with clear leadership qualities and a proven record in research and management. The EC manages the competitive grant program. The Chairman of the EC has the overall coordinating responsibilities for project implementation. Each priority area identified for research financing has its own sub-Committees with a Chair. Where EMBRAPA's current **Project Technical Committees (the CTPs) are relevant to the specific areas of research,** they manage the technical project review process. As necessary, these existing CTPs have been restructured to widen and improve non-EMBRAPA representation. For research areas where CTPs do

Figure 3 Organization of SNPA



not currently exist, new committees have been established. Project proposals are reviewed by a panel of external reviewers which advise the CTPs on the quality of proposals. Each sub-committee is supported by a wide pool of national and international reviewers representing a range of research and technology transfer experiences. The list of reviewers has been expanded to include reviewers from the Brazilian, regional and advanced countries' scientific and technology transfer institutions to improve the quality and objectivity of reviews.

Institutional Development and Training to Enhance Internal Competition

In addition to the competitive grants system which uses 60% of the resources, the project provides 40% of the funds for institutional development, training and strategic studies in a variety of areas to enhance capacity of domestic institutions to compete and to establish domestic, regional and international partnerships. Although state and other local research and extension institutions and farmers' organizations are eligible to compete in the competitive grants program, both short-term ameliorative investments and long term solutions to the problems of state financing and capacity for agricultural research, technology development and transfer are needed to increase their ability to compete which the institutional development component supports.

From a True NARS to Regional Cooperation

As the preceding discussion indicates, many large and medium size developing countries now constitute important players in the global research system. Together developing countries contain 90 percent of the world's population and most biodiversity. Many share ecological and economic conditions with their neighbors. Through regional collaborations they can cost effectively develop and transfer technological and institutional solutions among one another. Some fourteen developing countries have NARS research staff equal to or exceeding that of the CGIAR. The NARS of Nigeria and South Africa in Africa; Indonesia, the Philippines, Turkey, Iran, Pakistan, Bangladesh, and Thailand in Asia; Mexico, Brazil, and Argentina in Latin America all have 1,000 or more full-time researchers working in agriculture. Strong NARS are already leaders in tropical research, e.g., China in hybrid rice, Thailand in baby corn, India in semi-arid crops, Brazil in acid soils. The vast sizes and impressive capacities of several developing countries' NARS in the 1990s are in contrast to the situation in the 1970s when the CGIAR System was established.

A parallel paper by Derek Byerlee to this paper discusses the reasons for the declining rate of growth of research expenditures and the increased tendency on the part of governments to generate revenues through the sale of their products, services and research results. A positive aspect of this development is the need for research centers to connect with their customers. The negative result is the growing tendency to increase income earning activities, often at the cost of research.[11] Those countries' NARS that are not undertaking reforms and mobilizing additional research funding, or are donor dependent have become financially more hamstrung by their inability to effectively retain their researchers, notwithstanding the improvement in their human capital.

Misallocation of research resources within NARS is also a problem. Maredia and Eicher (1995) argue that the average size of the wheat breeding research program budget per ton of wheat produced in developing countries is nearly twice as large as that of industrial countries. This means that developing countries are either investing more in research when they could capture spillovers, or investing in inappropriate research, i.e., devoting more resources to breeding when they could be spending more on testing others' research outputs. In India and Brazil, wheat programs make use of CIMMYT

[11] The operating budgets of industrialized countries have also decreased, directly impacting the agricultural research budgets.

germplasm in more than 75 percent of their releases, either through direct CIMMYT transfers or through a CIMMYT parent used to produce an adaptive variety (Byerlee and Traxler 1995). Smaller countries could also be pooling their resources to minimize diseconomies of scale in their operations.

There is also much scope for improvement in the division of labor among the CGIAR centers and the NARS. For instance, nearly 40 percent of the total wheat varieties released in developing countries in the last three decades came from CIMMYT-NARS collaborative research, 25 percent from indirect transfers and 10 percent from country-to-country spillovers (Maredia and Eicher 1995). For crops such as wheat, where international transferability of research is large, should developing countries allocate more resources at the margin to the search for international research outputs, so as to maximize spillins? How would the response vary for large and small NARS since the former already undertake considerable strategic and even some basic research? This implies an increasingly important role for both regional research collaborations and NARS in building sufficient capacity to capture spillins.

Is there perhaps also similar scope for the CGIAR System to move upstream and to leave many of its applied and adaptive tasks to the national and regional organizations? IPM research is a case in point. IPM can increase input efficiency while maintaining yield levels, with positive impact on the long-term quality of natural resources as well as on human health. But given the highly location-specific nature of the IPM technology, what is the comparative advantage of the CGIAR centers vis-à-vis NARS in undertaking IPM research? Is the unit cost of conducting IPM research at the international level as favorable vis-à-vis national levels, as Maredia and Eicher argue for wheat? What specific methodological, analytical or research related knowledge transfers occur by conducting IPM research at the CGIAR centers which cannot be realized by leaving such research exclusively to the NARS? Donors tend to support IPM technology at international centers because research on such issues at the global level may give it the respectability among traditionally minded CGIAR and NARS scientists so as to stimulate more such "good" research at the NARS level. But there is often insufficient analysis of the genuine value added in the conduct of such research at various levels.

Whereas the above studies focus exclusively on the efficiency of crop breeding, following Coase, the study by de Souza e Silva et al. of the 37 Brazilian research centers is beginning to address the issue of the efficiency among research institutions within countries. Using Data Envelopment Assessment (DEA) methodology they have measured research center performance quantitatively, measures which EMBRAPA is using for research allocation among research centers in the following years. An advantage of the EMBRAPA model is the possibility it offers of international comparisons of research efficiency using a common framework. One disadvantage is its fixed coefficient linear programming approach. Another is the problem of developing standard measures to achieve comparison of different outputs and inputs needed to produce different research products and the weights used among them. A follow-up study to quantitatively measure research performance across countries is proposed by EMBRAPA jointly with the World Bank. A sound quantitative approach which addresses these methodological weaknesses might also be applied to the CGIAR centers, particularly to assess the relative costs and benefits of conducting different types of research and development activities at the CGIAR System vis-à-vis NARS of developing and developed countries. The World Bank is currently exploring the possibility of developing EMBRAPA research methodology further for possible testing in several countries.

Reemergence of the Regional Agricultural Research Organizations

The many and rapid changes taking place at the global level are leading to increased exploration of collaborative research arrangements among developing countries (e.g., SPAAR, ASARECA, APARINA, APAARI, and the various PROCIS in Latin America, (CARDI) in the Caribbean and (CATIE) in Central America). In many cases regional research collaborations were initially top down, the result of external initiatives, e.g., FAO in Asia, OAS and the U.S. in Latin America, colonial powers and later bilateral and multilateral donors in Africa and Latin America. Nevertheless, regional organizations have reemerged since the early 1990s due to the growth in regional and global trade, growing awareness among

developing countries of the advantages of learning from each other, playing up to their respective comparative advantages. Donors (as well as the CGIAR System) are interested in developing strong national and regional capacity and benefiting from scale economies in international cooperation in view of the increased emphasis on ecoregionally based research, in which national systems must play an important role. In Latin America and Africa, regional banks and bilateral donors are also actively promoting regional funds for agricultural research (Echeverría et al. 1996). These initiatives can be self-sustaining when they reflect *regional* priorities, which in turn must reflect national priorities. They must receive *domestic financial support from member countries and result in increased internal capacity–both human and institutional–to address the complex problems of technology development as well as transfer. Those in turn call for the kinds of internal institutional reforms which countries such as Brazil have embarked on and Chile has more or less achieved.*

A variety of efforts are currently underway (e.g., SPAAR, WARDA) to develop sustainable financing of agricultural research at the regional level (see World Bank 1996 OED report on NARS). By taking a leadership role PROCISUR could potentially become an important model for regional *research* collaboration.

Regional collaboration offers scale economies in research for countries with similar agroecological conditions, so that spillovers and spillins can be captured in a more cost effective way. Evenson and Cruz have estimated high rates of return to regional research investments by PROCISUR (Evenson and Cruz 1992). They estimate that PROCISUR research in wheat, maize and soybeans yielded an internal rate of return of 110 percent, 191 percent and 179 percent, respectively. **They argue that, even if the rates of return to PROCISUR are overestimated by a factor of four, returns would still be higher than those estimated for research by the International Agricultural Research Centers (IARCs).** Other examples of past effective regional research collaborations include the French and British-led research for export crops in Africa (Lele, Van der Walle, Gbetibouo 1989) and a variety of CGIAR initiated or led networks for rice (INGER) based at IRRI, TAMNET of maize based at CIMMYT, ASPRAD based on Potatoes by CIP, the Lentil Network initiated by ICARDA, etc. Developing countries have begun to play an active role in driving the functioning of these networks to meet their own needs. Most past regional collaborations, including networks, have been geared to sharing germplasm for commodities. They have not yet addressed the complex issues of ecoregionally based research successfully, although increased emphasis on environmental sustainability calls for a more regionally based research even in the case of commodities.

PROCISUR has become a more active regional research organization in the past two years, and it expects to become an important player in Latin America, mobilizing both domestic and international resources to conduct research and technology transfer of mutual interest to the NARS in the Southern Cone countries. PROCISUR has the potential to become a model of regional collaboration for environmentally sensitive research.

The Rice Wheat Consortium in South Asia is important from an environmental perspective. Unlike the above listed networks, it is ecoregionally based and is explicitly intended to lead to *collaborative research* at the regional level, involving the NARS of India, Pakistan, Bangladesh and Nepal, the CGIAR centers (CIMMYT, IRRI, ICRISAT, CIP and IMMI) and advanced countries' research institutions (e.g., Cornell University), leading to *region specific* solutions to address high priority problems of sustainable productivity growth. The RWC has the potential to extend new resource management-sensitive technologies to farmers to address their pressing problems of peaking productivity growth.

A number of questions, however, are yet to be addressed by the Rice Wheat Initiative, issues which also face PROCISUR. For example:

- the extent to which it would be an information network as distinct from becoming a genuine collaborative research effort;

- who sets research priorities in view of the fact that vertically organized research programs of NARS do not fully reflect the true concerns of the farm populations, the research projects are not sufficiently problem solving and interdisciplinary, and have been slow in undertaking the kinds of reforms that Chile and Brazil have embarked on;

- how quickly are priorities set, so as to minimize the high transaction costs of regional collaborative research;
- how and where is management and accountability of such regional research efforts and technology transfer vested, what role, not just the INIAS, but other partners play in research including the universities, the state research and extension systems and the farmers' organizations;

- who finances regional research; and

- what mechanisms are put in place for monitoring, evaluation and impact assessment.

Letting international agencies such as the World Bank, IDB or the CGIAR centers control the management of regional research efforts sometimes diffuses the thorny regional political issues, and increases the convening power of regional research collaborations, particularly where regional organizations are nascent, or when sometimes even obtaining visas for scientists of warring neighboring countries can be a problem, a problem happily not faced by PROCISUR members. Yet international control (whether de facto or de jure) raises regional concerns about relevance (whose research agenda?), political commitment, leadership, and long term financial viability. Leaving their management to the countries in the region raises another set of questions, such as the domination by large countries, regional competition in trade and jobs. India, China, Brazil, Argentina, and Chile have a great deal to offer in their regions, and even across regions technologically and institutionally, than has currently been tapped by the regional organizations and the international system. But who should pay for the cost of strong NARS playing such a role in their own regions and sometimes even across continents?

A more fundamental problem is that regional initiatives have often *preceded* a problem-driven research or technology transfer agenda leading to varying degrees of bureaucratization, high transaction costs in the form of international meetings involving donors, CGIAR and NARS officials and scientists, problems which also affect the CGIAR System's ecoregional initiatives. After having agreed to cooperate, researchers have often been in search of a common substantive research agenda which enables collaboration. Not surprisingly, these efforts have tended to be weak on regional research collaborations with characteristics of internationality, and potential for spillins and spillovers, and strong on organization of meetings. An important challenge for the international and regional research systems is to undertake collaborative research of high priority while keeping its transaction costs low. What forms of regional and international organizations are likely to be most successful?

An Interest Group-Driven Model of Agricultural Research Allocation

Interest group theory suggests that groups or entities form to capture welfare transfers through lobbying for more public resources (Tullock 1967; Stigler 1971; Guttman 1978; Huffman and Evenson 1993). Groups form around common interests and exert pressure to influence public research expenditures and public policies that are beneficial to them. The interest group model suggests that there is no such thing as «optimal allocation of research funds,» or «objective methods of priority setting.» An evolving system emerges, where the movement from one period to the next is a function of previous commitments and present negotiations among and between different actors (e.g., donors, governments, research centers, private sector, NGOs, agri-business firms). From such a perspective, it is difficult to reduce the complex priority setting process into simple economic indicators.

Interest groups operate on the principle that they can obtain significant benefits by effecting public policies; however, when the cost of organizing becomes large relative to the perceived benefits, the incentive to mobilize a group is lost (Olson 1965). In a democracy, interest groups compete for favorable public policy. The enacted policies then tend to be based on the weighted average of the positions taken by the interest groups. The weights are determined by the relative strength of each group. The strength of the group, in turn, is derived from its organizational skills and wealth (Becker 1983). Several variants of interest group theory, such as the *median voter behavior model* (Borcherdind and Deacan 1972), *benevolent government model* (Huffman and Evenson 1989), and *autocratic government model* (Khanna et al. 1990) are applied to examine funding of agricultural research in the U.S.[12] The empirical evidence tends to support

the competitive interest group theory of funding agricultural research in the U.S. (Huffman and Evenson 1993). It further suggests that the conflicts among farm groups, agricultural scientists and agribusiness firms in sharing the scarce public resources are often resolved through compromise. Guttman (1978), Evenson and Rose-Ackerman (1985) and Marcus (1987) support the above findings.

The close linkages among research, extension, and teaching all directed to meet the demands of the interest groups constitutes one of the great strengths of the U.S. land-grant system, which it has transported with varying degrees of success to some developing countries, e.g., India, Philippines and Kenya (Lele and Coffman, eds. 1994, 1995). Whereas agricultural research pioneered such a customer-oriented approach, customer orientation has acquired currency in a variety of U.S. public institutions as a means of allocating resources, assessing effectiveness and measuring impact (Moore 1996, Lewis 1996).

Of course, the interest group-driven competitive model has its limitations. Critics argue that powerful groups benefit and outcomes are short term oriented, disregarding long-term environmental or equity considerations (Libby, 1993). Nevertheless, a consensus exists that like democracy itself the model is perhaps the best among alternatives and has served U.S. agriculture well (Guttman 1978, Evenson and Rose-Ackerman 1985, Marcus 1987, Huffman and Evenson 1993). Public research expenditures in the U.S. increased at 4 percent annually for nearly 100 years contributing to annual productivity growth of 4.3 percent (Huffman and Evenson 1993). The recent change in the content of U.S. public sector research and in the agricultural research of other industrial countries toward resource management, food safety and biotechnology reflects the changing weights of competing interest groups (e.g., the increased power of consumer and environmental groups relative to the agricultural producers and processors, the new technological possibilities opened up by the advancing science, globalizing markets and increased opportunities for public-private partnerships).

PROCISUR has an opportunity to address these various issues through developing true regional research collaborations, based on reforms of NARS of its member countries such that they genuinely reflect the interests their true constituents, namely the farmers, processors, exporters and consumers of products as well as the rich natural resources of Latin America. Chile and Brazil's examples pave the way.

[12]One extreme of interest group theory is the *capture theory* where one group will obtain all the benefits from a public policy. In that case the group's position will have a relative weight of one (Huffman and Evenson 1993).

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FINANCING THE NATIONAL AGRICULTURAL RESEARCH INSTITUTES: INTERNATIONAL PERSPECTIVES

Derek Byerlee

Financing the National Agricultural Research Institutes: International Perspectives [13]

Derek Byerlee[14]

Several factors converged in the late 1960s and early 1970s to stimulate rapid growth in investment in agricultural research. First, the success of the Green Revolution demonstrated the potential of science-based agriculture in the developing world. Second, the Green Revolution was closely followed by the world food crisis of the 1970s which further underlined the need to stimulate rapid growth in food production. Third, several pioneering economic studies showed the high payoff to investment in agricultural research and the role of rapid technical change in agriculture in stimulating overall economic growth. Together, these factors spurred an increase in public investment in agricultural research between 1966-70 and 1980-85 of 6 percent annually. Rapid growth in agricultural research expenditures occurred in all regions with the fastest growth in developing countries.

Beginning in the 1980s and becoming more pronounced in the 1990s, the growth of public investment in agricultural research slowed and in many cases declined. The change has been felt most seriously by the public sector national agricultural research institutes shortened here to the spanish acronym, INIAs who have been forced on the one hand to consolidate, downsize and restructure, and to seek news sources of funding. While research expenditures stagnated, the number of scientists employed in most public research institutes continued to increase, resulting in a steady fall in the expenditure per scientist, a rise in the share of expenditures allocated to salaries, and a squeeze in operating costs to conduct research.

The reasons for declining public sector priority to agricultural research are complex and will be explored later in this paper. Contributing factors have been fiscal austerity in many countries with structural adjustment and policy reforms, resulting in generally lower fiscal outlays for all sectors, a perception among some of the lack of cost-effectiveness and relevance of much agricultural research, growing competition from other sectors, such as the environment, for scarce public funds, and a desire to privatize activities previously performed in the public sector.

The emerging crisis in public funding of agricultural research has led to a search for new ways of doing business. One response has been to stimulate private sector research and development (R&D). Many countries are experimenting with various forms of joint private-public sector ventures to exploit complementarity of resources and skills. Yet others are asking farmers themselves to pay more of the bill

[13] Paper prepared for the PROCISUR's workshop on Institucional Models of the National Agricultural Research Institutes of the Southern Cone, Dec 1-2, 1997, Asunción, Paraguay.

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for research. Finally, all are seeking ways to convince policy makers that public funding for agricultural research continues to be an essential high payoff activity.

There are thus several institutional mechanisms to augment public funding of research with funds from other sources. These mechanisms are also important in influencing the way research is organized and the productivity of research itself. For example, involving farmers in the funding of research may generate additional funds, but more importantly, it may improve the relevance of the research. Thus any examination of the issue of research funding must be cast in the broader framework of the institutional organization and linkages in the total R&D system. In addition, it is important to distinguish the funding of research from the execution of research. While there may be a strong case for public funding of research, this does not imply that the public sector has a comparative advantage in executing the research.

This note is developed in four parts. First, we provide an overview of recent trends in public and private investment in R&D globally. Second, we review recent changes in financing of agricultural research in selected industrialized countries, especially Australia, USA, and the Netherlands. In particular, we note the changing policy perspectives that have motivated these changes. Third, we review the situation in the Southern Cone countries within this international perspective. Finally, we analyze some policy issues for choosing among alternative mechanisms for sustainable funding of agricultural research in the INIAs, and other public sector organizations.

Global Trends in Investment in Agricultural R&D

Public sector investment trends

Globally, public sector investment in agricultural research reached US $15 billion in the early 1990s (in 1985 purchasing power dollars), excluding the countries of the former Soviet Union for which no recent data are available (Alston, Pardey, and Roseboom, 1997). Just under half (46%) of this investment is in the industrialized countries. Asia accounts for a further one third, and Latin America, West Asia/North Africa, and Sub-Saharan Africa each accounted for 6-7% of the global total (Figure 1).

There have been sharp differences in growth in public funding for agricultural R&D by region. Investment in developing countries increased by 5.1% annually from 1971 to 1991, more than double the rate in industrialized countries. The share of investment by developing countries has grown within two decades from 41% to 54%. By the far the most rapid growth occurred in Asia, with annual growth rates averaged about 7%. The slowest growth was experienced in Africa and Latin America.

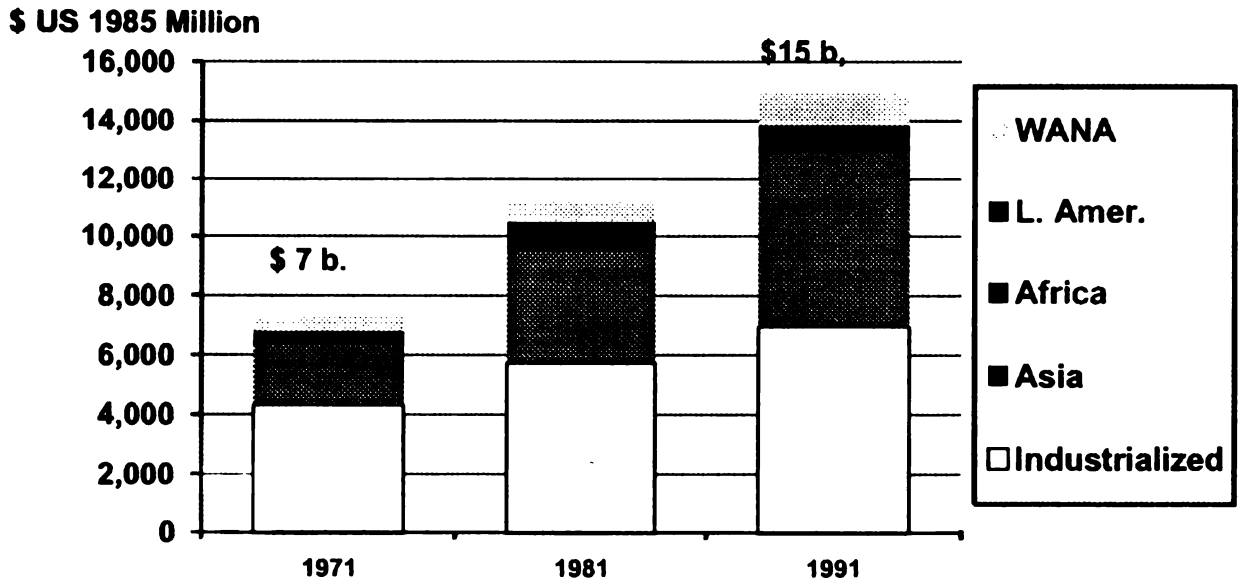
However, during the most recent decade for which data are available, there has been an almost universal trend toward a slowing of the growth in public funding for agricultural research. Globally the growth rate has slowed from 4.3% in 1971-81 to 2.9% in 1981-91. Growth slowed in all developing regions, with Asia the least affected, and Africa and Latin America recording negligible growth in the more recent decade (Figure 2). Although more recent data for the 1990s are unavailable, it is likely that aggregated public investment in these regions has declined in the 1990s.[15]

Similar trends are apparent in the industrialized countries (Alston, Pardey, and Smith, 1997). There, growth rates have been maintained only by continued steady growth in the USA. In countries that have sharply restructured their public sectors, such as the UK and New Zealand, public funding for agricultural research declined in the most recent decade (Figure 3).

Finally at the international level, funding for the CGIAR centers has experienced similar trends with rapid growth in the 1970s followed by a slowdown in the 1980s and stagnation in the 1990s. These trends occurred despite a broadened mandate and the expansion of the system in terms of number of centers.

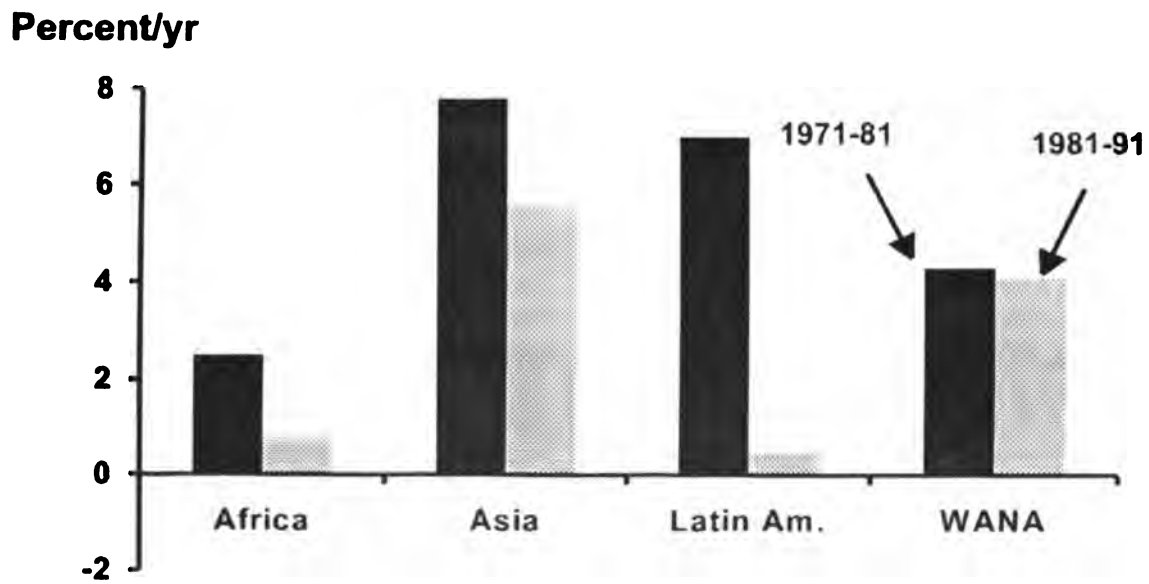
[15] Coupled with the lack of funds is the problem of extreme volatility in public funding. Uncertainty in funding is especially damaging in agricultural research because of the long-term and continuous nature of much research.

Fig. 1 : Public Research Expenditures by Region, 1971-91



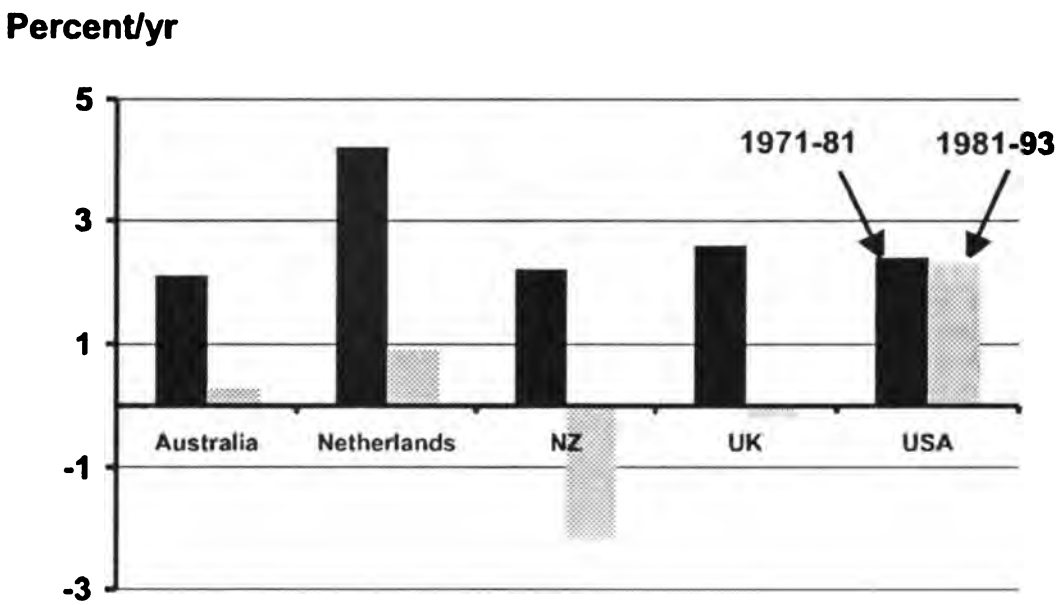
Source: Alston, Pardey, and Roseboom, 1998

Fig. 2: Growth of Public Agricultural Research Expenditures, Developing Countries, 1971-91



Source: Alston, Pardey, and Roseboom, 1998

Fig. 3: Growth of Public Agricultural Research Expenditures, Industrial Countries, 1971-93



Source: Alston, Pardey, and Smith, 1998

Comparative R&D investment intensities

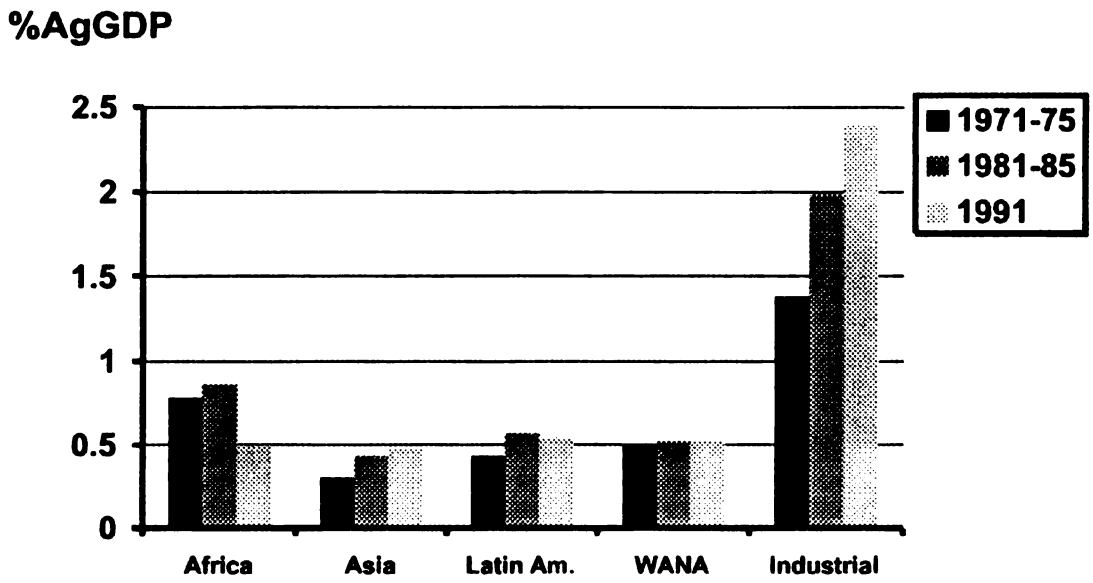
Research intensity, which measures public R&D spending as a percentage of sectoral output is a useful measure of *relative* investment in agricultural research. In developing countries, research intensity averages 0.50 percent of agricultural gross domestic product, and is surprisingly uniform across regions (Figure 4). It is highest in Africa, in part because of heavy donor support to agricultural research in that region (nearly half), and the large number of small and medium-sized countries in the region.[16]

Average research intensities in developing countries are significantly lower than those in industrialized countries (over 2 percent--Figure 4). This difference is even more dramatic when private sector R&D is included, since private investment in R&D is much important in industrialized countries (see below).[17] Another relative measure is public spending on research per person in the agricultural sector. Using this measure the difference between developing and industrialized countries is even more dramatic, averaging $350 in industrialized countries, against an average of $13 in the developing countries ($27 in the USA). Over the most recent decade, research

[16] Research intensity is usually higher in small countries because of economies of size in research

[17] Differences in real research intensities are lower since the cost of undertaking research is less in developing countries. Measures of the number of scientists per unit of agricultural output usually show developing countries in a more favorable position.

Fig. 4: Agricultural Research Intensity by Region and Period



Source: Alston, Pardey, and Roseboom, 1998

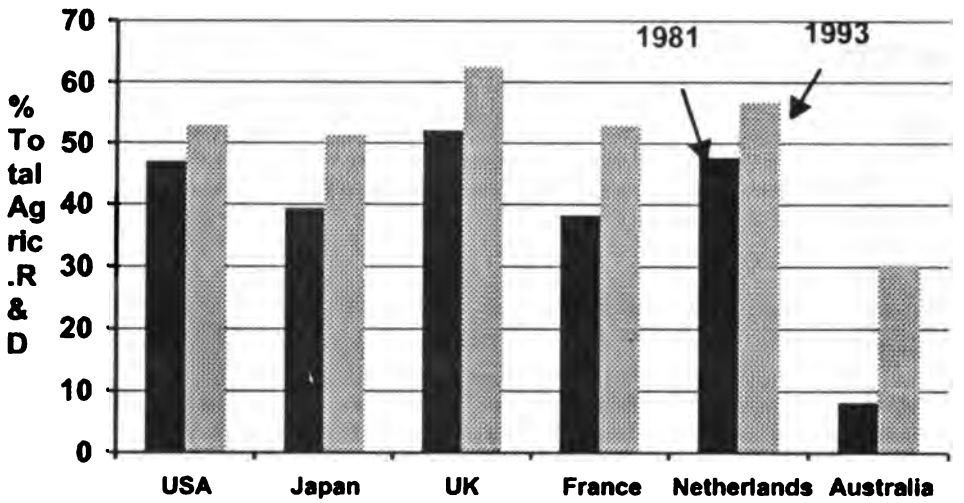
intensities for public funding have stagnated in the developing world, while continuing to steadily increase in the industrialized countries.

The lower research intensity in developing countries in part reflects the lower tax base and the high share of agriculture in developing country economies. Poorer countries typically allocate an equivalent proportion of the agricultural sector budget to agricultural research as do richer countries (Elliott and Pardey 1988), but spread over a relatively large agricultural sector, this results in low research intensity. However, the lower research intensities in developing countries also often imply a low priority for agricultural research. It seems clear that if developing countries are to maintain a competitive and dynamic agricultural sector, investment in R&D whether from public or private sources, will have to be increased.

Private sector investment in R&D

While private R&D is expanding, is it filling the gap left by the public sector? In the industrialized countries, the answer is probably yes. Private funding for agricultural research in the industrialized countries averaged half of total R&D spending in the agricultural sector in 1993, a sharp jump from 41% in 1981 (Figure 5). This represents a growth rate of over 5 % during this period, and more than double growth in public

Fig. 5: Private R&D Share of Total Agricultural R&D in Industrialized Countries

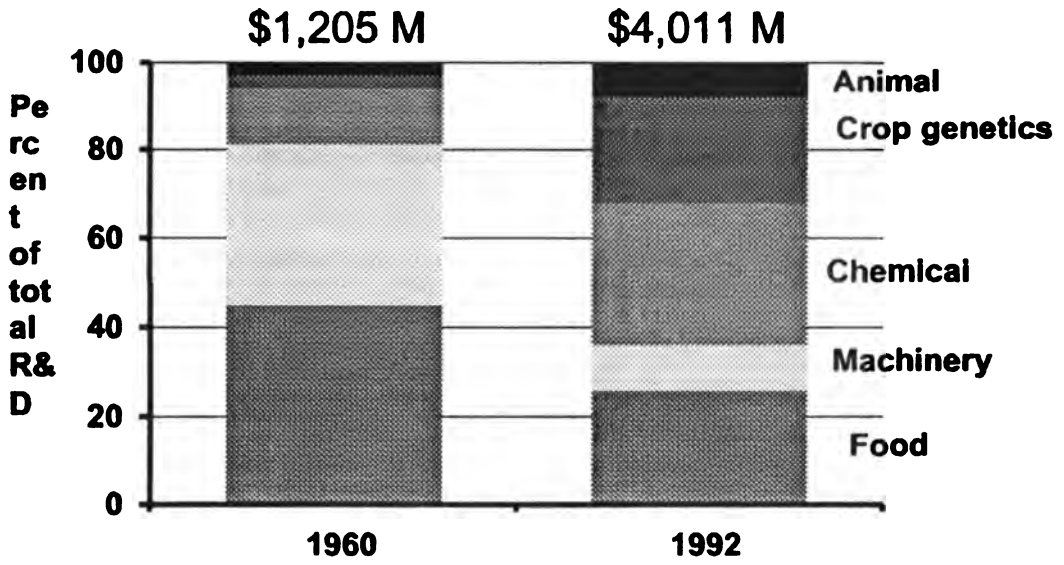


Source: Alston, Pardey, and Roseboom (1998) and Alston, Pardey and Smith (1997)

funding. Private funding is of course, concentrated in technology areas where there are opportunities to appropriate benefits, especially food processing, machinery, chemicals, and hybrid seed. With changes in opportunities for intellectual property protection, private investment in biological technologies has increased especially rapidly (Figure 5). Private funding of research is lowest in countries which depend on imported food processing, chemical and machinery technologies. Thus private R&D is relatively low in Australia and New Zealand where there is also strong public support for agricultural research (Figure 6).

Data on private investment in R&D in developing countries is especially scarce and unreliable. Available evidence for a number of countries suggests that investments average around 10% of total agricultural R&D expenditures, but in some cases are as high as 30% (Figure 7). Private research expenditures in developing countries are distributed differently across technology types compared to industrialized countries. For example, for private R&D by multinationals, the share of investment in plant breeding and plantation agriculture which are much more location specific technologies than for chemicals, food processing, and machinery, is two thirds. That is, while agrochemical, machinery and food processing industries continue to be largely located in the US and North America, it is unlikely that private R&D in

Fig. 6: USA Private Research Expenditures by Sub-sector, 1971-91



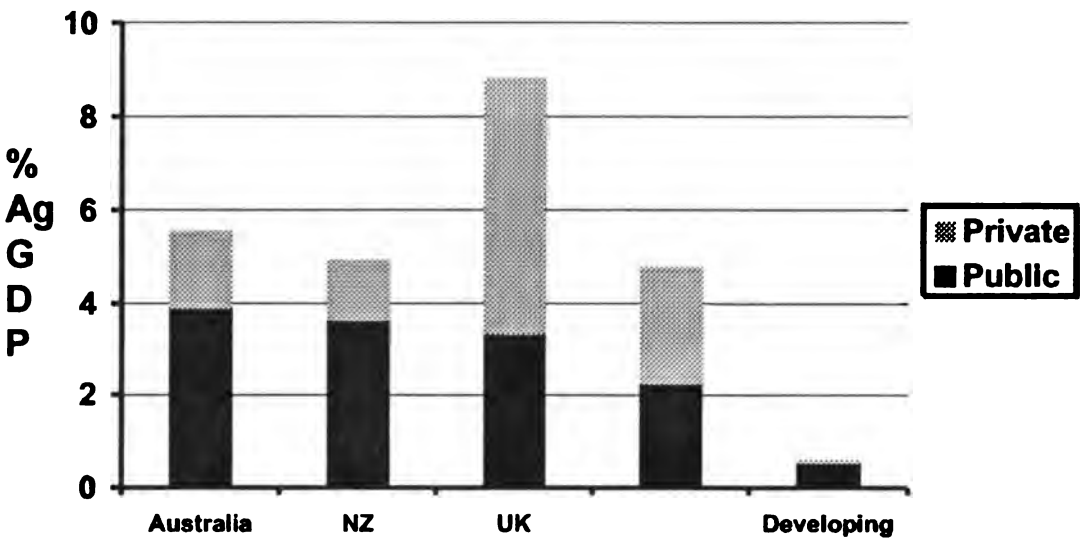
Source: Day-Rubenstein and Fuglie, 1997

Fig. 7: Private Sector R&D Investment in Developing Countries

	Annual rate of growth private R&D	Percent of total R&D
India	5.7	16
Philippines	5.3	32
Argentina		6
Colombia	3.7	8
Brazil		8
Mexico		28
Peru		5

Source: Pray and Umali, 1998

Fig. 8: Agricultural Research Intensity, Public and Private, 1993



Source: Computed from Alston, Pardey, and Smith, 1998

developing countries (and Australia and New Zealand) will ever reach the share found in Europe and North America.

Private sector investment in developing countries is expanding rapidly, but does not yet seem to be sufficient to fill the gap left by declining support from the public sector. In fact, including both public and private sector funding, research intensities in industrialized world average 5 to 8% compared to an estimated 0.6 % in developing countries--Figure 8 (assuming that 15% of the R&D in developing countries is in the private sector). This implies a ratio of about 1:10 in relative spending on R&D between the developing and industrialized countries, a gap which is widening.

Reasons for the funding Crisis

The reasons for the funding crisis are varied and include the following interrelated factors which have different weights in different countries:

- A redefined role for the government, with government roles being questioned and being tied more closely to the concept of public goods. However, there has often been a lack of appreciation by policy-makers of the public-good nature of much agricultural research, resulting in premature efforts to privatize agricultural R&D.

- Undue dependence in public research organizations on a single source of funds (that is, annual appropriations from general tax revenues). Most public sector research organizations depend on government tax revenues for over 90% of their budgets.

- Lack of evidence of the impacts of research, or failure to communicate that evidence to policy-makers due to poor links between NARS managers and policy makers responsible for budget allocations.

- Disenchantment by policy makers and the public at large with public sector organizations because of their perceived inefficiency.

- Lack of a political constituency for research from farmers, farmers' organizations, and agribusiness.

- A decline in agricultural commodity prices leading to complacency about food security and agricultural productivity and a consequenet reduction in research funding.

Some of these trends will be difficult to reverse while others provide opportunities to strengthen funding of the INIAs.

Toward a new NARS paradigm: Examples from industrialized countries

The sharp shift in thinking in the 1990s about the role of governments, and how government organizations can be made more efficient and effective has led to an emerging perspective on how NARS should evolve to meet the funding crisis. The eight key elements of this new paradigm are as follows (Byerlee and Alex, 1997).

1. The institutional separation of research *policy and funding* from research *execution*, each of which require distinct skills and inputs. Research funding and the setting of broad priorities for research is a policy issue, while research execution by alternative suppliers is an efficiency issue.

2. A recognition of the role of a *pluralistic institutional structure* of a NARS that includes universities, the private sector, farmer organizations, and non-governmental organizations (NGOs). Such a structure allows additional scientific skills to be tapped and matched with needs, thus increasing research efficiency.

3. Increased used of *competitive approaches* to the allocation of funds among alternative research suppliers, especially openly contestable competitive grant programs.

4. A sharper focus of public funding for research on *public goods* and *diversification of funding* support for public research institutes. There is a strong case for public-sector funding of basic and strategic research (long term research with uncertain payoffs and high spillovers), research on problems of small-farm agriculture (high transactions costs for farmers to organize their own research), and research on natural resource management (positive environmental externalities).

5. A recognition of the complementary roles of public and *private sector R&D* and the potential efficiency gains through *private-public sector collaboration* in both the funding and execution of research due to the complementary skills and resources available in each sector.

6. Increased *institutional autonomy* in public research institutions to provide flexibility to seek new funding sources, and institute private-sector like financial management practices. Institutional autonomy must be combined with increased *accountability* often through *contractual* relationships on delivering agreed on outputs. That is, emphasis in funding has shifted from funding inputs to funding expected outputs.

7. The *involvement of stakeholders*, especially the clients of the research system, in research governance, priority setting, execution, financing, and evaluation so that institutions within the NARSs become more responsive to their needs. The institutional models for achieving this may range from full or partial funding of research by farmers and other clients, to involvement of farmers and farmers' organizations in governance of research organizations, or various contractual relationships with farmers for

executing research.

8. New models for technology transfer that move beyond the traditional research-extension link to involve farmers, NGOs and the private sector in a variety of formal and informal partnerships, and information dissemination and feedback mechanisms.

These eight elements are being increasingly employed in restructuring research systems and their funding everywhere. The following case studies of selected elements of three NARS in industrialized countries, the Netherlands, Australia and the USA, illustrate how they have influenced recent changes in research funding for public sector organizations.

Recent evolution of the Dutch system

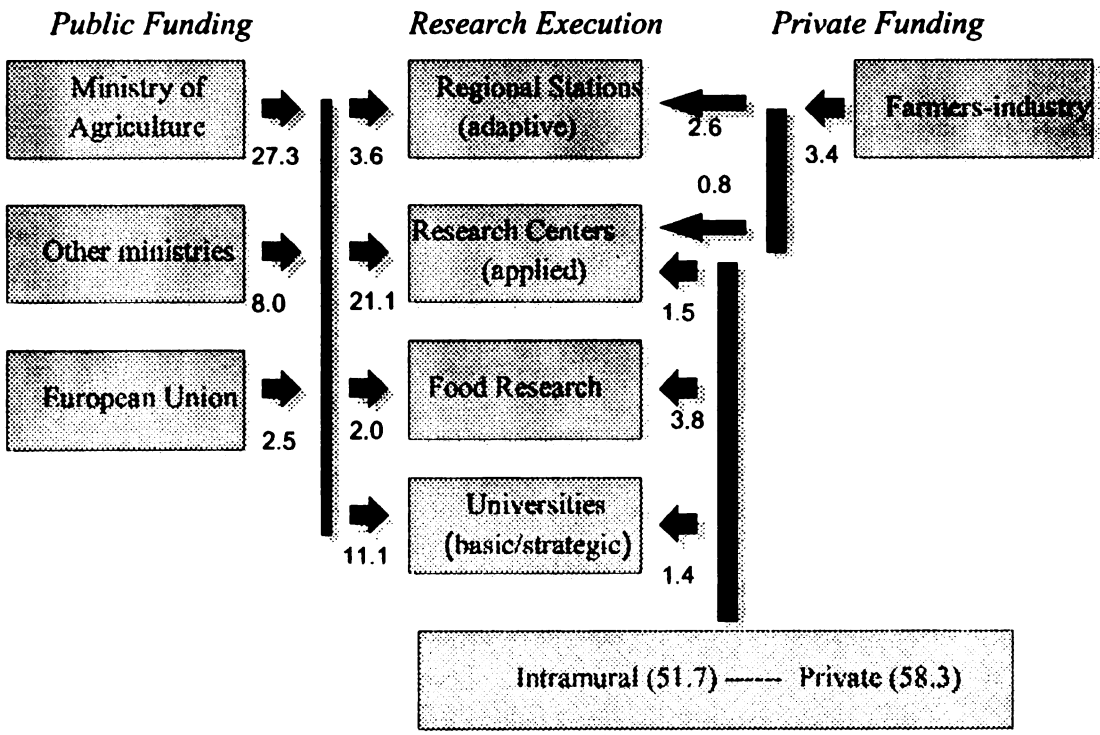
Roseboom and Rutten (1997) provide an excellent overview of the recent evolution of the Dutch system. Figure 9 shows funding flows for the system in 1993.

The following points illustrate the implementation of several of the above elements as Dutch policy makers strive to evolve a more client-oriented and efficient NARS.

1. The private sector accounts for over half of the funding of agricultural research, the bulk of it in the food processing sector. Most private funding is "intramural" that is, private agribusiness funds and executes its own research. However, the private sector also funds research in public research centers, especially on food processing where the main public sector institute receives about two thirds of its funds from the private sector.

2. Another component of private funding of agricultural research is the contributions or levies paid by farmers and agro-industries to commodity boards. These tend to fund adaptive research in regional experiment stations.

Fig. 9: Flow of Funds for R&D in the Dutch NARS (% of total)



Source: Roseboom and Rutten, 1998

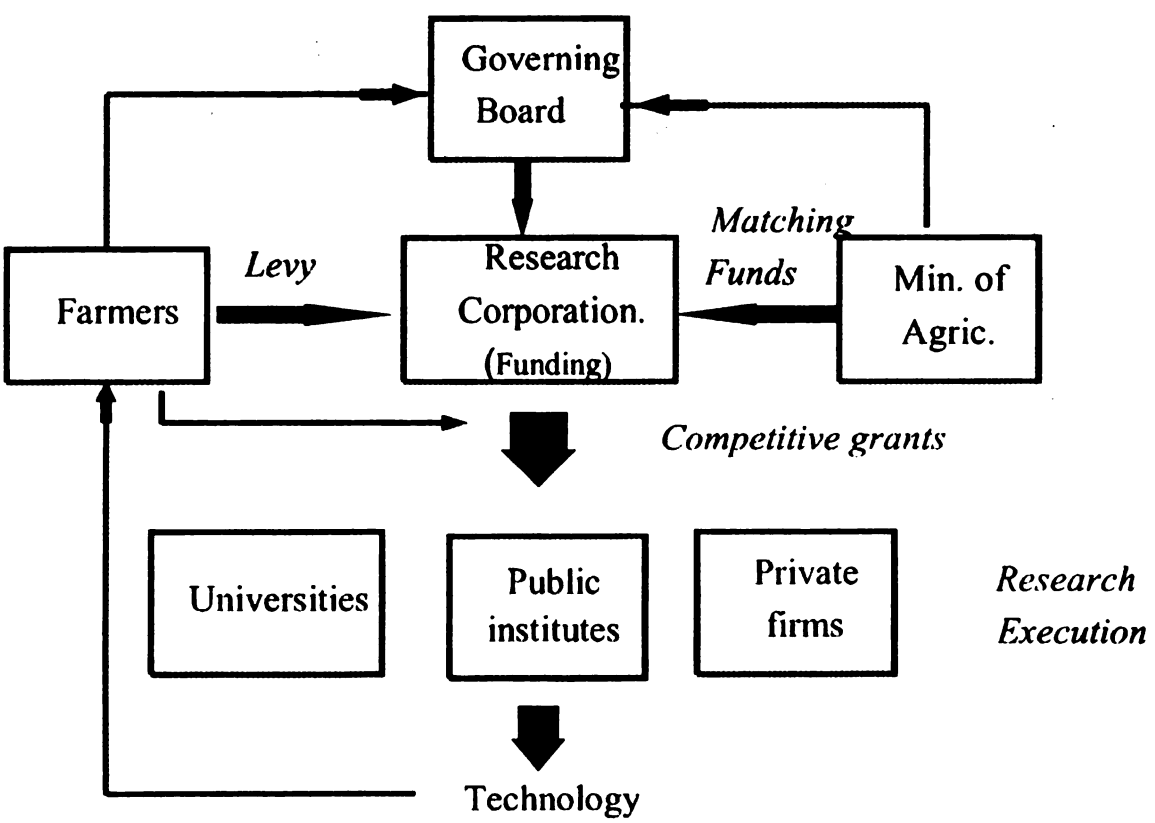
3. The ministry of agriculture is the principal source of public funds for agriculture. It disburses funds through a variety of contractual and competitive mechanisms, and emphasizes strategic and applied research of a public good nature.

4. Other public bodies, such as the environmental ministry, a science council, as well as the European Union are also providing funds to agricultural research.

The Dutch system has clearly evolved toward an institutional separation of research funding from research execution. This has allowed all public research organizations to diversify funding away from the ministry of agriculture which was their traditional source of funds (Figure 10). The agricultural university and the experiment stations have been especially successful in diversifying their funding sources.

Coupled with diversified funding support has been the decision to privatize the execution of most research in the experiment stations and a significant part of the research centers. The privatization of these research organizations has provided them flexibility to explore a variety of new funding sources, including contracts with the private sector, and contracts with foreign public and private organization to execute research. It is expected that the experiment stations that carry out near-market research will depend largely on funds provided by the agricultural industry, especially commodity boards funded by farmers. The universities which undertake basic and strategic research will remain the main publicly-owned agricultural research organization. While considerable restructuring of the Dutch NARS has taken place, funding levels have been maintained.

Fig. 11: The Australian R&D Corporations



The Australian Research and Development Corporations

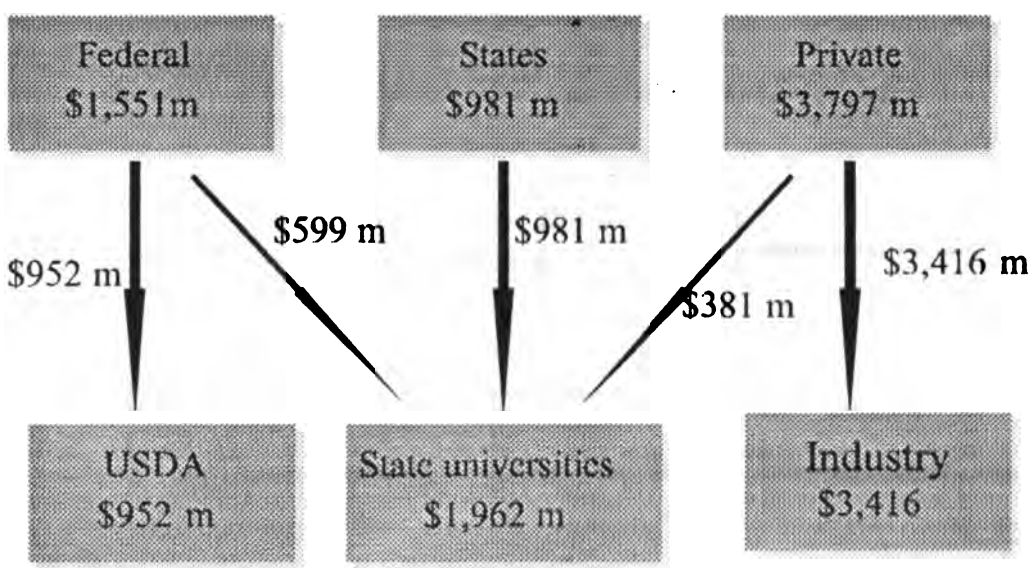
Although private agribusiness investment in R&D is low in Australia (averaging about 10% of total research) farmers have had a long history of financing research through levies on agricultural production. Since 1985, this has been formalized with the establishment of 16 research and development corporations (RDCs) to manage funding for different commodities and factor research (Figure 11). The commodity-oriented RDCs receive funds based on a levy on output, matched by government funding up to 0.5% of output. Although the RDCs only account for about 20% of total agricultural funding, they provide a large share of the operating costs (non-salary costs) for applied and adaptive research in public research organizations. Salary costs are largely paid by the research executing organizations from appropriations from state governments (for state research organizations) and federal government (for universities and the CSIRO). Basic and strategic research as well as applied factor research (e.g., land and water management) is funded largely from public funds administered through various block grants and competitive and contractual funding mechanisms.

The RDCs are interesting for a number of reasons:

1. The RDC model clearly separates the funding and execution of research. RDCs essentially set policies and priorities and purchase research services.

2. The major stakeholders, the farmers, are heavily involve in the governance of the RDCs, especially the screening and award of proposals. For example, for the largest RDC, three regional committees and one national committee made up of farmers and scientists develop overall priorities for funding, and members of these committees also sit on sub-committees that review and recommend research proposals for funding in each major program.

Fig. 12: Flow of R&D Funds in the USA NARS, 1992



Source: Fuglie et al., 1995

3. Farmer contributions are matched by funds from the government. The government explicitly recognizes that there are often substantial externalities of agricultural research for other sectors, and for the public at large that justify these matching funds.

4. Most funds are administered through openly contestable competitive grants, although in recent years, the RDCs have moved toward negotiated

Fig. 13: USDA Technology Transfer Activities

Patents awarded	No.	53
Royaltics	$ M	2.1
CRADAs	No.	258
CRADAs value	$ M	98.9
Est. annual income from CRADs	$ M	4.0
Commercialization as % of total budget		1

Source: Day-Rubenstein and Fuglie, 1997

contracts with preselected organizations to support some types of research activities such as plant breeding. Most grants are awarded to the traditional research suppliers the state research organizations, the universities, and the CSIRO (a federal organization). However, some 32% of grants of the Grains RDC in 1996 were made to the private sector and to overseas research suppliers.

5. The RDCs stress accountability by developing detailed output-oriented work plans with each research supplier.

6. The RDCs are semi-autonomous public organizations that have substantial flexibility to manage their financial, human and physical resources.

The RDC model has been successful in increasing both the total funds for research, through the levies and matching grants, and at the same time, increasing client involvement in research decision making. However, there is still considerable discussion of the appropriate role of government funding for the RDCs since much of the research funded is not of a public good nature.

Commercialization of research in the USDA

The USA has a complex NARS with the major players as the USDA, the state universities, and private sector agri-business. The private sector now dominates funding; most of this is for R&D conducted intra-murally although over $400 million annually flows from the private sector for research undertaken in the public sector (Figure 12). In the public sector, the federal government is still the most important source of funds, while state agricultural universities are the major executors of research. Federal funds are largely provided through block funds (based on a formula), although the share managed through competitive funds is increasing.

The USDA increasingly focuses on basic and strategic research; this proportion rose from 40% in 1981 to 47% in 1993 (Fuglie et al., 1997). In recent years, it has emphasized commercialization of technologies through patents and plant variety rights, and through joint ventures with the private sector (Figure 13). Patents which are used for technologies which are relatively finished, are licensed to private firms with royalties returned to USDA. Since 1986, USDA has implemented joint ventures for technologies that require further research and where needed skills are likely to be available in the private sector. This has been formalized in the Cooperative Research and Development Agreements (CRADA) in which a formal contract is signed between USDA and a private firm. This contract spells out resource contributions of each party and the sharing of revenues. Cooperating firms have first right to patent any technologies developed.

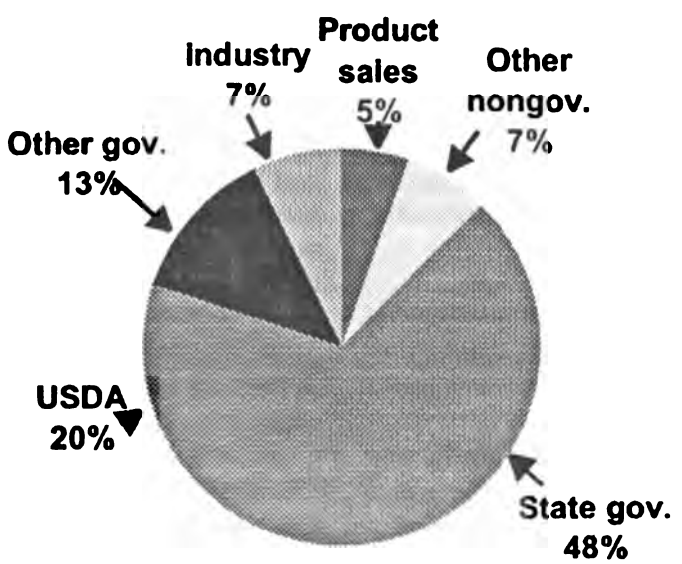
CRADAs have expanded rapidly and presently over 200 are active with a total investment of over $60 million. USDA has established an Office of Technology Transfer to facilitate such joint activities and has placed technology transfer coordinators in each major center.

A recent evaluation of the CRADAs concluded that CRADAs, while providing only a small share of the total USDA budget, had made important contributions to development work in specific research areas, especially crop and animal protection, and post-harvest research (Day-Rubenstein and Fuglie, 1997). Similar commercialization has taken place in the state experiment stations, where royalties and private grants now account for about 15% of total research budgets (Figure 14). However, many have yet to recoup the considerable investment in setting up an office for technology transfer and acquiring relevant business and legal skills.

Financing INIAs in the Southern Cone

Abreu (1997) describes the current situation with respect to funding of research in the region. Although few quantitative data are provided, it is clear that all of the INIAs are seeking to diversify their funding base along the lines described above (Figure 15). The summary provided in Figure 15 suggests a number of general observations.

Fig. 14: Sources of Funding for State Eperiment Stations, USA, 1994



Source: Fuglie et al., 1996

1. Some INIAs have diversified much more than others. INIA-Chile with a large budget share from commercialization of products and services, and Uruguay which has a levy on agricultural output are the most diversified. By contrast, EMBRAPA and DIA-Paraguay appear to be still largely dependent on state funds (over 90%), and IBTA is largely dependent on donors. In the case of EMBRAPA, close links to the ministry of finance appears to have been quite successful in providing a reasonably stable budget. It would be particularly useful to discuss how other countries in the region are and could develop public awareness activities and strengthen relationships with ministries of finance.

2. There are good examples of commercialization of research products and services throughout the region. These vary from licensing of varieties and hybrids developed by the public sector, to major joint ventures with private agri-business and other firms. Commercialization of technologies is likely to grow rapidly, although it is still too early for it to account for a significant share of the budget. INIA-Chile is the most diversified.

3. Almost all countries are moving toward more competitive mechanisms for managing public funds. Competitive funding have been critical in making universities important participants in the research system, especially in Chile. It is likely that the INIAs will increasingly have to compete for funds with other suppliers through competitive mechanisms.

4. The degree of institutional restructuring to separate funding from execution of research and to provide greater financial and management autonomy to public research institutions is relatively less in the region than in the case studies provided above. INIA-Uruguay probably enjoys the most flexibility in research management, especially in the management of research funds.

Fig. 15: Financing Mechanisms for INIAs in PROCISUR

	State	Commercialization	Prod. Levy	Private sector	Competitive funds
INTA	**	**		**	
IBTA	Donor				
EMBRAPA	***	*			**
DIA-Par	***				
INIA-Chile	*	***		*	**
INIA-Ur	*	*	***		*

Based on PROCISUR (1997)

Policy issues in selecting among alternative funding mechanisms

In looking to the future, there is little doubt that the INIAs of the regions will have to be even more aggressive in diversifying and stabilizing their funding base. This section discusses some general issues in developing sustainable funding mechanisms.

The funding problem for INIAs can be tackled at two levels:

1. by building political support for public funding, and

2. by diversifying away from dependence on public funds by tapping alternative sources of funding

Donors may provide funding for a specific period for some types of activities but they are not a substitute for developing sustainable domestic funding support.

Building political support for public-sector funding

The first order of business must be to restore political support for public funding of agricultural research. The current slowdown in funding should be seen only as a temporary aberration in what should be a long-term trend toward increased public investment in agricultural research. The US is an example of how long term public investment in agricultural research has enabled the development of a strong national research system. Investment by the public sector in agricultural research grew in real terms at 4 percent annually over a hundred-year period (Fuglie et al. 1996; Alston and Pardey 1996).

The main task is to ensure that *both real research budgets and research intensity are increasing over time in a consistent and sustainable manner*. As we have seen, almost no country in the region complies with this objective.

Despite the clear rationale for public-sector funding, few countries have built an adequate political base for agricultural research over the long term. There is no universal recipe for developing such a support base, but better communication of the needs and benefits of research is critical. Some potential elements of a strategy to build a support base are:

- Documenting and publicizing the impacts of research. Although agricultural research is integral to achieving the national objectives of competitiveness, poverty reduction and environmental conservation, research leaders have often done a poor job of presenting the case in a form readily understandable to political leaders and administrators. Research institutes must put more emphasis on advocacy and public awareness for policy-makers, farmers, and other constituents, backed up by studies of the impacts of agricultural research. Attractive annual reports, summaries of impact studies, regular field days for farmers and policy makers, and regular newsletters are all part of the task of "marketing" public sector research organizations.

- Developing strong and articulate client organizations that have a political voice and that can act as lobby groups for agricultural research. While organizations of commercial farmers are common and in many cases contribute directly to research funding, they could do more to develop political support for public funding of research. Organizations of small-scale farmers with political influence are rare. Agribusiness and environmental groups can also be important supporters of research programs.

- Reforming the management and effectiveness of public-sector research institutions to make them attractive to investors. While this issue is addressed in detail elsewhere in this seminar, it must be recognized that the lack of funding support often reflects perceived inefficiencies and lack of impacts of research organizations.

- Developing close relationships and good communication between INIA administrators and policy makers charged with budget allocations. In countries where links to finance ministry officials are strong, research budgets have suffered less. Having policy makers and clients of the research system on the boards of research institutions is one way to improve communication.

- Broadening the stakeholders in agricultural research beyond the traditional agricultural base. Research programs can exploit funding from other

ministries, such as environment, science and technology, and commerce and trade. The recent increase in funding for environmental issues offers an opportunity for agriculture to persuade environmental groups that agricultural research can contribute to solving environmental problems.

Commercialization of research products and services

There are alternatives for increasing funding of research in public research institutes through commercialization of research products and services, including: sales of research products and services (e.g., sale of basic seed), sales of non-research products and services (e.g., soil tests), and various forms of joint ventures. The benefits of these options are contingent on revenue from commercialization being returned directly to research institutions (and being additional to their budgets) rather than being returned to the general treasury.

The sale of *research products* from the public sector, through some form of royalties and backed by adequate intellectual property rights, has sometimes been successful in funding research operating costs as shown by numerous examples from the region (for example, the funds received by the EMBRAPA maize program from the sale of basic seed to private seed companies (Lopez-Pereira and Garcia 1997)). A research institute may enter into a joint venture with a private company to develop, test, and market a promising technology, especially for products which require considerable investment and business skills to get onto the market. Another approach is for research institutes in the public sector to enter into some type of contractual arrangement with private firms for the performance of a specific piece of research. Such contracts exploit the considerable and highly specialized human and physical resources at some public research institutes on the one side, and the demand for a research product from the private sector, which does not have the required capacity. In some cases, such contracts may be administered by a foundation which raises money from private firms and contracts the research to efficient suppliers (see Box 1). While currently affecting only small segments of the overall research system, such schemes are bound to grow as market mechanisms become more prevalent in guiding agricultural development and R&D activities.

Research systems can also generate revenues through sales of *non-research products and services*,

Box 1: Research Foundations

One approach that has been used both to manage research funds from the private sector and to commercialize technologies, has been establishment of a research foundation, especially in Latin America. One rationale for private-sector interest in foundations is that they allow private firms that do not have sufficient resources or skills to establish their own R&D programs to pool resources (Trigo, 1987). The creation of many foundations has also responded to the frustration with rigid rules for the financial management of INIAs. Usually the foundations have considerable flexibility to raise and administer funds, and even to create endowments to ensure longer term funding stability. Despite their obvious attraction, there is still considerable doubt about whether foundations will be a sustainable longer run addition to the tool-kit of NARSs. Emerging problems include the following (Sarles, 1990):

- Foundations have found it difficult to raise funds from domestic sources, so that their long-term viability is in doubt.
- Foundations that depend on agribusiness and farmer support are only likely to address the needs of commercial farmers rather than the smallholder sector.
- Foundations are often not well linked to the rest of the NARS, so that duplication of effort or lack of complementarity is a problem (Jarvis 1994).

such as soil and chemical testing, diagnostic tests, sale of commercial seed and vaccines, staff consultancies, and even commercial agricultural production. Such activities can sometimes be justified, where there is surplus capacity in research establishments, and revenues from commercial activities can help maintain the basic research infrastructure. However, in the longer run, the most efficient approach will be for the public sector to sell off excess research infrastructure.

Commercialization of public sector research products and services will clearly be significant in future funding in the Southern Cone region. This also represents a means for INIAs to serve the needs of expanding agribusiness. A reasonable expectation is that 20-25 percent of the budget might be generated through these means. Although these funds can potentially provide an important share of operating costs, they are often linked to specific topics or commodities and to commercial agriculture and do not resolve the problems of funding other types of research, especially for small-scale agriculture.

The main policy issue for such arrangements is to ensure that public-sector research remains, and is seen as being, motivated by broader societal objectives and is not perceived as having "sold out" to industry. For this reason, commercialization of technology should be approached with *caution*, as it can quickly distort program priorities and attention. Before engaging in commercial activities, each public sector institute should develop a clear and transparent policy for: ensuring that such commercialization is consistent with the public interest, applying intellectual property rights to protect technologies developed fully

Box 2: Five key questions to ask on cost-recovery in public research institutes

While there may be potential for generating significant additional funds from sale of research products (especially in areas where commercial agriculture is important), a number of critical questions have to be faced in establishing a policy for commercializing research.

- If the sale of research products is feasible and profitable, why should the public sector be involved in the research in the first place? The private sector should be encouraged to take over these areas of research directly. Indeed public-sector participation in such activities with support from the public purse may undermine private sector entry into the R&D activity.
- If the public sector is motivated by financial rewards, will its research be directed to more favored regions and farmers at the expense of small-scale farmers and more marginal areas that may be the primary target of national policy? Reliance on the sale of research products will also bias research away from crop- and resource- management research, where there is little opportunity to earn revenues from the sale of research products.
- If a public institution sells non-research products, will this reduce research outputs? Sales of research products may complement research efforts, but the sale of non-research products and services can quickly distract scientists from their main task of developing new knowledge and technologies, and result in research institutions acting as state farms and businesses.
- If technologies are to be protected by intellectual property rights (IPRs), research managers must ask what is the cost of collecting revenues from contracts and royalties relative to the funds generated? A research institute that seriously pursues intellectual property protection will need to establish a specialized office with the appropriate legal and business skills for negotiating with private companies. The revenues raised from these sources often do not pay the extra costs incurred.
- If research is successful in the sale of new technologies, should some of the funds received be used as incentives for rewarding the scientists responsible for developing the product? This provides a logical incentive mechanism for researchers, but immediately raises issues of equity and incentives for public sector employees.

or partly with public funds, providing free access to protected technologies to other researchers, and sharing revenues between the central administration of a research institute, the department that undertook the work, and the scientists generating the technology. Special caution is needed in commercializing non-research products and services to ensure that this is a complementary, not competitive, activity to the main business of research institutes (See Box 2).

A major constraint on commercialization is the need to have access to legal and business skills to identify potential products to commercialize, to select private partners and to negotiate contracts with them. This will involve some combination of in-house expertise and contracting of other skills from outside. The costs of acquiring these skills can be considerable and research managers need to carefully evaluate costs against expected benefits. Costs of establishing an office for technology commercialization might take several years to be recovered, especially since only a small proportion of products with IPRs are ultimately commercially successful (Kalaitzandanakes, 1995). This argues for use of contractual services until sufficient demand has been established. Research managers and scientists will need training in several aspects of commercialization of technologies including intellectual property rights, and regional organizations might be the appropriate vehicle for doing this.

Farmer financing of research through industry levies[18]

Direct funding of research through group action by farmers to place a levy on farm output has obvious appeal for a number of reasons:

1. Farmer contributions internalize funding to the initial consumers of research products and may reduce public outlays on research.

2. Those who benefit most from research pay more and therefore the system is equitable.

3. Direct funding of research can be linked to decision-making power on the type of research that is conducted, contributing to a demand-driven research system.

4. From an economics perspective, research levies can be an efficient way to fund research relative to the use of general tax revenues (Alston, Pardey and Roseboom 1997).

Levies work best for commercial products that pass through a concentrated marketing channel making it administratively feasible to collect the contributions or levy. The most common examples are for crops produced commercially, crop or livestock products with strong producer organizations, and basic food staples produced by small-scale farmers, where the product passes through a narrow marketing or processing channel (e.g., a few large grain mills).[19] It is least appropriate for traditional food crops (e.g., cassava) that pass through informal marketing channels, and for non-commodity or factor research. To be effectively implemented a levy should be *initiated and supported by farmers* who see it as in their interest, as beneficiaries, to contribute to funding agricultural research. However, legislation is usually needed to ensure that the levy is obligatory on all farmers and to avoid "free riders".

While farmer financing represents a valuable potential source of funds for public research institutes, its real value is only realized if *farmers' contribution to funding is combined with farmers' participation in setting the research agenda*, thus producing a more demand-driven research system. Where funds are collected through producer associations, the association can determine or influence the research priorities for expenditure of the funds. In other cases, some type of research board or corporation in which farmers and other industry representatives have a controlling or major vote can be the vehicle for distributing funds (e.g., as in the Australian RDCs or the Dutch commodity boards).

[18] Levies include also cesses and check-offs (as used in the U.S.). Such research financing mechanisms vary from what is essentially an additional tax to finance government research programs to funds collected (with government assistance) on behalf of producers themselves for use by a non-governmental producer organization to fund research and promotional activities (Gilles 1997).

[19] In this case, the method has the advantage that the levy is paid in proportion to farmers' marketed surplus and is likely to be strongly progressive in terms of farmers' incomes.

Levies for research should be encouraged with appropriate institutional means to ensure farmer participation in determining the level of contribution as well as setting priorities for the research to be funded. This approach will work best with *matching government funds*. This is because farmers will typically focus on short-term research priorities and will not invest at socially optimal levels in more basic and longer-term research, or research with broader societal benefits (e.g., food safety or protection of the environment). Government provision of matching funds can be accompanied by scientists, policy-makers, and the wider community joining farmers in determining research priorities, to represent these longer-run and broader interests.

A practical issue is whether to assess such a levy on the basis of volume or value of output. Assessment on a volume basis is administratively easier.

However, there are two major advantages of assessing the levy on the basis of value. First, production value is typically more stable than production volume, since prices are negatively correlated with volume. But even in the case of a value-based levy, there is a strong case to allocate part of the levy to a stabilization fund for use in years with adverse weather or prices, since research requires long-term stable funding. Second, a value-based levy will increase in line with general price inflation. However, since research costs have typically risen at higher than the inflation rate, even for a value-based levy funding levels may fall behind needs.[20]

Finally, there is the issue of who executes the research funded through levies. We have already noted that the funding of research and the execution of research can generally be separated. Producer organizations who collect research levies may execute research themselves. However, there is no reason to expect producer organizations to be the most efficient suppliers of research services, except for adaptive research to test and refine technologies on farm. The most efficient alternative is likely to be some form of competitive grants system that is open to all parties, including public research institutes and the private sector.

Role of donors and international development banks

Donors[21] who have been important contributors to the growth in investment in agricultural research over the past three decades. Donor funding of agricultural research programs will undoubtedly remain an important element of development assistance programs, as research investments offer high rates of return and provide mutual benefits to donors and developing countries.

Long-term high dependence on donors can have negative impacts on INIA development (Byerlee and Alex 1997). To minimize the negative effects of donor support, assistance should be based on well-developed national research strategies, long-term support for targeted research programs, development of mechanisms for sustainable financing for research, and flexible linkage of research funding to institutional and policy reforms. This implies reducing total dollar contributions and giving greater emphasis to improving research quality as opposed to expanding programs. Second, donors must closely co-ordinate their activities with each other and with NARS priorities to ensure that the support is complementary and addresses key strategic technological and research management issues.

Competitive financing of research

Competitive grants are now being used widely to manage research financing. Competitive grants[22] (CGs) can help co-ordinate research across different institutions in line with national priorities as well as generate efficiencies and stimulate innovation in research programs. Competitive funds can also be

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[20] For example, private sector research on maize in the USA has increased from —% of output value in — to —% in —.

[21] The term "donor" is used here to include international lending agencies.

[22] Though this discussion uses the term "competitive grant," the principles are equally valid for competitive contract research. The difference between the two is simply the degree of control the funding agency exercises after the work is awarded.

used to consolidate funding from different sources to address national priorities.

Competitive grants have a number of potential advantages. They can:

- Allow funds to be channeled to the most productive researchers (as judged by the peer reviewers). They can thus improve the productivity, job satisfaction, and commitment of scientists.

- Enhance the quality of research by requiring detailed proposals from scientists and by technical review of the proposals prior to funding.

- Draw a wide range of participants into the research system by making competition open to all, including NGOs, universities, and the private sector.

- Mobilize established research infrastructure and human resources, which might otherwise be under-used because of shortage of operating funds.

- Promote partnerships in research by encouraging collaborative research proposals across institutions, including joint public-private sector research.

- Reallocate research resources in the short term by tying grants to high priority research areas and types of research (e.g., biotechnology, multidisciplinary research).

Several potential difficulties with competitive grants (CGs) that should be recognized:

- Most grants are for a fixed period (usually no more than three years) and are less appropriate for supporting longer-term research.

- It is often difficult to establish an independent peer review system in situations in which a research culture is subservient to seniority and administrative hierarchies.

- In small NARSs there may be few potential competitors for funds, so CGs may fail to promote competition. It may also be difficult to find peer reviewers who do not have personal interests in the projects being reviewed.

- Administration of competitive grants may get mired in the normal bureaucracy of government civil service, resulting in long delays, and administrative barriers to access to funds.

- Competitive grants systems are generally more costly, since scientists may spend considerable time in writing proposals that are not funded and peer review is a time-consuming and skill-intensive activity.

- Competitive grants usually only fund operating costs and essential equipment. Undue reliance on CGs may be at the expense of maintaining existing research infrastructure.

Competitive grants have become popular in recent years , but CGs are not a substitute for institutional development and longer term investments in developing research infrastructure. In countries with under-used research capacity, CGs can be an efficient means for financing research, though CG programs may become less effective over time, if research infrastructure (both human and physical) depreciates and if grant managers and recipients become "entrenched" so that the programs are less competitive.

CGs are most appropriate in mature and larger NARSs seeking to widen participation in the research process and provide incentives for increasing productivity.[23] CGs should not be the sole mechanism for funding, but should be used to complement funds from regular budget appropriations. CGs are most appropriate to fund new research areas and research and development that requires collaboration, such as public-private partnerships. Longer-term research requiring continuity (e.g., a plant breeding program), as well as the building and maintenance of research infrastructure are best funded through annual budget appropriations.

[23] Even in such systems, some recent evidence questions the productivity of CGs (Huffman and Just 1994).

Finally, management of a CG scheme should have maximum flexibility and independence from political and bureaucratic interference. Where this is not possible within the public sector, a special Board or Foundation may be needed to administer the CG.

Concluding comment

This note has highlighted the rapid changes taking place in the financing of agricultural research world wide. While the role of the private sector is increasing, public funding for agricultural research will continue to be crucial to support research on public goods, especially the more basic and strategic research and research aimed at societal objectives of increasing small farmer productivity and conserving natural resources.

The case studies discussed in this note show that some public agricultural research organizations have restructured to maintain overall support to research. In many cases this has involved the development of new tools such as autonomous research corporations, public-private partnerships, commercialization of research, greater participation by farmers in research governance, financing and execution, and a much wider participation of government and non-governmental organizations in public sector funding and execution of research.

Countries in the Southern Cone are undergoing a similar restructuring of their research systems. Each INIA will have to develop its own models to deal with its specific institutional and historical situation. They have much to learn from each other and from experiences in other regions. However, some of the broad principles of the new NARS paradigm, such as separation of research funding from research execution, and greater stakeholder involvement in both, are applicable in all countries.

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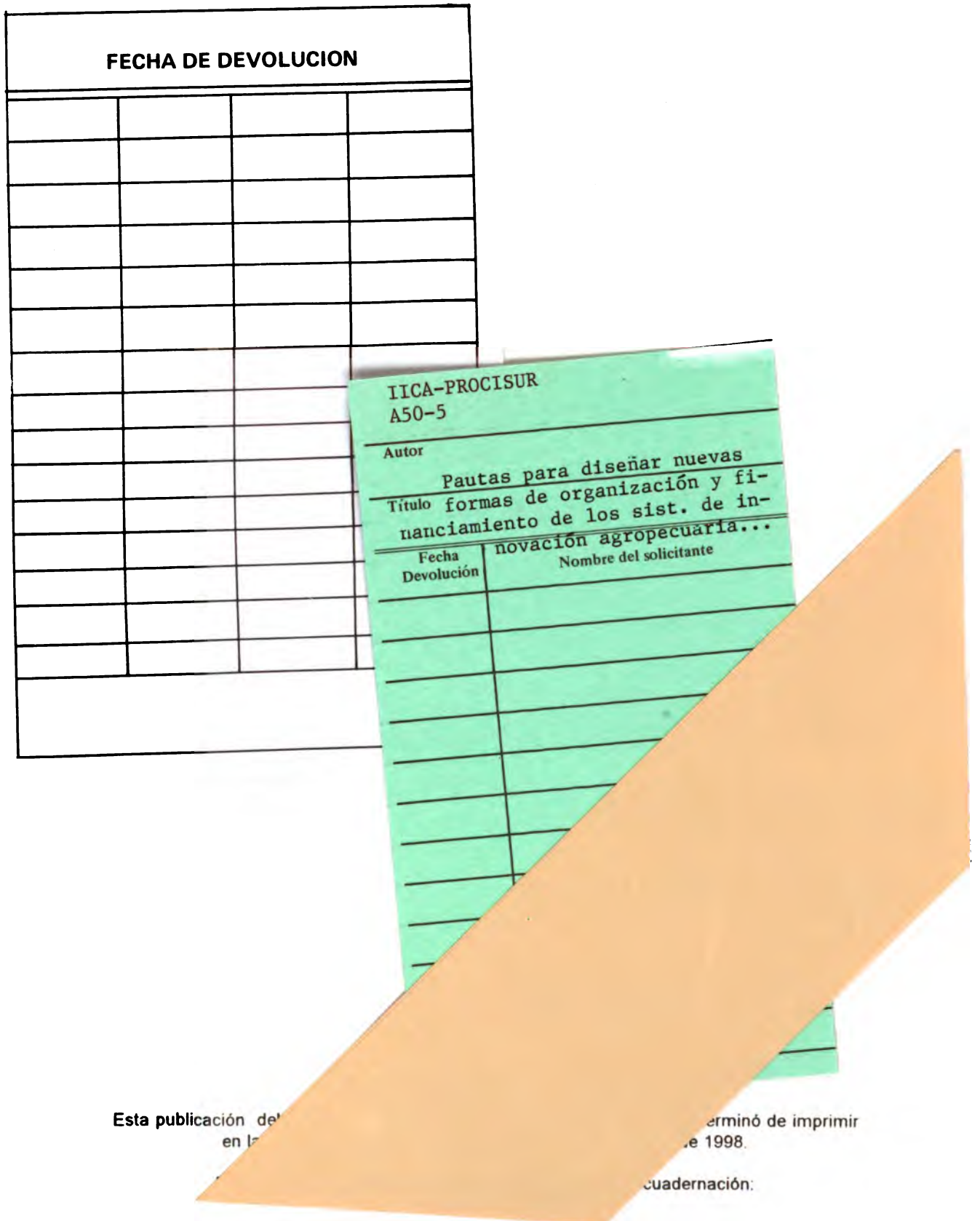

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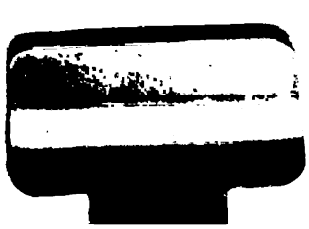

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