Discussion Paper

No. 98-16 **November 1998**

Will competitive funding improve the performance of agricultural research?

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ABSTRACT. *Competitive funding is one of several instruments to fund research. Competitive grants are increasingly being used in developing countries, especially Latin America, to fund research on agriculture and natural resources. Policymakers and donors see competitive funding mechanisms as effective tools to redirect priorities, lower research costs, and strengthen the participation of universities, foundations, and other nonpublic and private-sector research organizations. Research managers, in turn, see competitive grants as an additional source of income, especially of scarce operating funds, and as devices to develop joint ventures with other public- and private-sector research organizations. However, information on when the use of competitive funding is most appropriate, the complementarity of this type of funding to more traditional institutional funding mechanisms, and the development of benchmarks to measure its performance are still lacking. This paper intends to fill this gap by highlighting the potential advantages and disadvantages of competitive funding and by proposing guidelines to improve the performance of competitive grants. When competitive funding complements institutional funding, it has the potential to improve research performance. This paper describes the ways in which this can happen.*

This paper is the result of cooperation between ISNAR and the Inter-American Development Bank (IDB); a Spanish version will be published as an IDB working paper in 1999. Ruben G. Echeverría works in the Sustainable Development Department of the IDB, Washington, DC, USA. The interpretations and conclusions of the paper are those of the author and should not be attributed to the IDB or to ISNAR. Comments from Gary Alex, Julio Berdegue, Derek Byerlee, Diana Carney, Michael Collins, Howard Elliott, Cesar Falconi, Willem Janssen, George Norton, Paul Perrault, Lucio Reca, Han Roseboom, Carlos Seré, Kathleen Sheridan, Helio Tollini, and Eduardo Trigo are greatly appreciated. The useful suggestions of Howard Elliott in the preparation of the final draft are acknowledged.

Acronyms

ARF	Agricultural Research Fund (Kenya)
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CEPLAC	Brazilian cocoa research institute
CG	competitive grant
CIAT	Centro Internacional de Agricultura Tropical
CIP	Centro Internacional de la Papa
CONICYT	acronym for several Latin American national science and technology councils
FIA	Agricultural Research Foundation (Chile)
FONCYT	Fund for Science & Technology (Argentina)
FONDEF	Science & Technology Development Fund (Chile)
FONTAGRO	Latin American Regional Fund for Agricultural Research
FONTAR	Fund for Technology Development (Argentina)
FONTEC	Fund for Technology Development (Chile)
FUNDAGRO	Foundation for Agricultural Development (Ecuador)
IDB	Inter-American Development Bank
IDRC	International Development Research Centre (Canada)
INIA	acronym for several Latin American public agricultural research institutes
KARI	Kenya Agriculture Research Institute
NCAP	National Center for Agricultural Economics and Policy Research (India)
NSF	National Science Foundation (US)
ODI	Overseas Development Institute (UK)
OECD	Organization for Economic Co-operation and Development
R&D	research and development

1. Introduction

The concept of an "agricultural innovation *system*" is used today to underline that agricultural innovation can come from multiple sources, including those outside the agricultural sector. This indicates that agriculture seeks to be competitive in a global setting while preserving the productive environment and contributing to the alleviation of urban and rural poverty. This agricultural innovation system must, therefore, respond to growing demands for relevant, long-term, public-good research in areas such as applied crop management, yield improvement of food crops, natural resource management, and conservation of biodiversity, as well as research targeted to alleviate poverty in low potential areas. Such research has traditionally fallen to the public sector to fund and execute. Worldwide public funding for agricultural research has been growing at a slower rate in the 1990s than it did in the 70s and 80s, and in many cases it has even decreased. Unrestricted support to public research institutions is declining while an increasingly large portion of public support is taking on new forms such as project-based or contract research. As a result, competition among institutions for available public funds has grown. This has led to increased efforts of research organizations to find alternative sources of research funds and of funding agencies to find new mechanisms to effectively allocate these funds.

In recent years, public research organizations have been faced with greater demands on their research capacity, but at the same time they are confronted with a vicious circle of increasingly tight budgets and lower research performance. That is, with fewer resources, research organizations may become less effective and efficient and, in turn, attract less funding. It is possible that the decline in performance may be the result of an imbalance in the nature of spending in the research system. In the 1980s, the number of researchers grew at twice the rate of research funds. Since the large number of researchers weighed heavily on the government budget but lacked the operating resources to be productive, the image of low performance can be explained. The vicious circle may also be broken and, as economies recover, governments may increase funding for research to previous levels, at least in those cases where the capacity has not deteriorated completely.

In Latin America, where the decline in funding first became apparent, new approaches for funding and organizing research (such as joint public-/private-sector ventures, commercialization of research results, competitive schemes, and farmer-managed levies on agricultural production) have developed over the past two decades. There is a growing feeling that the traditional public block-grant funding to centralized suppliers of technology should be used more efficiently. As a consequence, future national research systems may exhibit considerable diversity in both funding sources and institutional plurality in conducting research (Echeverría, Trigo, and Byerlee 1996).

In addition to the factors internal to the research system that contribute to the decline in support, two overarching structural elements help explain the stagnation of public-sector funding for agricultural research: (1) the perceived new, reduced role of the state, which increasingly uses market mechanisms (e.g., financing) instead of getting involved in producing goods and providing services, and (2) the movement of the agricultural sector itself towards a commercial agribusiness sector linked to global markets. The first factor has led to budget cuts, recommendations for more demand-driven mechanisms for allocating research funds, increased use of contracts, and pressure on public research organizations to obtain a larger share of funds by competitive means. The modernization of agriculture, liberalized markets and trade regimes, as well as strengthened intellectual property rights have created expectations that private companies will become increasingly active in developing countries, mainly through the sale of agricultural inputs and marketing of commodities. Trade liberalization has also promoted the transfer of technology embodied in inputs, hence decreasing the need for local research in some cases.

There is scattered evidence that private-sector sales and research activities are increasing in developing countries (Pray and Umali 1998). The activities of the private sector are concentrated primarily in a few large economies (Brazil, India, China) but they are developing more slowly than in the more industrialized countries. Yet, the increased participation of the private sector in agricultural research in most cases complements rather than substitutes for public-sector activities (Thirtle and Echeverría 1994).

This paper distinguishes between the roles of the public sector and the private sector in financing and executing agricultural research. While the private sector may expand its role in *developing* agricultural technology, the public sector is still the main source of *funding* for agricultural research in developing countries. However, the more traditional form of direct appropriations for research institutes is changing, and other instruments for funding research are being created. This paper focuses on one such mechanism: *competitive grants* (CGs). It assumes that the trend to competitively allocate research resources will continue and that research organizations will have to acquire a greater share of their funding through competition in the foreseeable future. Therefore, a brief look at the potential advantages and disadvantages of CGs is timely.

Policymakers and donors see CGs as an effective tool to redirect priorities, increase accountability, as well as strengthen the participation of universities, foundations, and other nonpublic research organizations in national research activities. Research managers, in turn, see competitive grants as an additional source of resources—particularly of scarce operating funds—and as a device to develop joint ventures with other public- and private-sector research organizations. The growing attention given to CGs (in particular by multilateral and bilateral development agencies) has focused mainly on the development of such schemes. Less importance has been given to the circumstances under which the use of CGs can be most appropriate, the complementarity of CGs to other funding instruments, and their sustainability. Hence, because they're "in fashion," competitive grant systems are at risk of being seen as the panacea for several funding and institutional problems of national agricultural research systems, diverting the attention from the more crucial topics of lack of research resources and of national priorities to use them effectively in many of these countries.

In the USA and Australia, the trend towards CGs has recently been a matter of concern. Huffman and Just (1994) argue that the growing proportion of public funds to agricultural R&D allocated by CGs in the USA lowers economic efficiency because CGs have high transaction costs. Similarly, Tisdell (1996, 1995) drawing on Australian experience, has pointed out how competitive bidding for research funds can lead to economic inefficiencies by involving short-term processes "of a relatively destructive nature," and that competitive grants need to be supplemented by mechanisms for funding new researchers and institutions. In both cases, it has been argued that traditional institutional grants not only preserve the short-term stability of funding, but also allow for reallocation of funds in the longer term.

The principal objective of this paper is to summarize the perceived potential advantages and disadvantages of CGs for agricultural research and to propose benchmarks to measure their performance. While the paper focuses on CGs, it is worth noting that competitive funding is just one of several instruments to allocate research funds. This paper does not treat institutional funding and competitive funding as an either/or situation.[1] The question, still before us, is what is the appropriate mix of competitive and institutional funding for optimal research performance? (Ruttan 1982). To answer this question we need to look at the full range of funding mechanisms, depending on the type of research, its purpose, and the structure of distribution of research benefits (spillovers) in each

[1] Bredahl et al. (1980) when evaluating institutional and competitive funding of U.S. agricultural research (almost 20 years ago) concluded that research policy should be cast in terms of the relative mix of both funding mechanisms, not in the absolute merits of either scheme, and that given the high productivity of the U.S. system at the time it would be hard to justify that the shift from institutional to project support would either enhance research productivity or draw substantial new resources.

particular case (Schweikhardt and Bonnen 1997).

The overall context for this paper is provided by ISNAR's recently completed sourcebook on financing agricultural research in developing countries (Tabor, Janssen, and Bruneau 1998). This timely publication assesses the current worldwide research financing situation and reviews available policy options, strategies for improving resource mobilization, and means of enhancing financial management, stressing the need for research leaders to improve policies, to increase resource mobilization, and to upgrade the management of scarce financial resources.

There are two ongoing research efforts focusing on competitive funding for agricultural research in developing countries. The Overseas Development Institute (ODI) of the UK, in collaboration with the International Network for Farming Systems Research Methodology (RIMISP) in Chile, the National Center for Agricultural Economics and Policy Research (NCAP) in India, and the Agricultural Research Foundation in Kenya, is conducting a series of case studies on competitive funds in India, Chile, Colombia, Kenya, Tanzania, Mali, and Senegal (Gill 1998). The second effort is led by the Rural Development Department of the World Bank. It focuses on documenting the steps in the process of setting up and operating a CGS, including a comprehensive guideline with examples of existing schemes (Byerlee and George 1998). Results from both studies are expected in early 1999.

This joint IDB/ISNAR work complements the ODI and the World Bank studies with the goal of improving the development and the performance of CGs for funding agricultural research in developing countries. The following section provides a background for this discussion through a review of sources and mechanisms available for funding agricultural research.

2. Sources and mechanisms for funding agricultural research

Public- and private-sector research complementarities

At the national level, several public- and private-sector organizations fund and/or conduct agricultural research (**Table 1**). Public-sector research institutes, agricultural universities, commodity institutes linked with producers' associations, and private input companies are the main research organizations in developing countries. In addition, regional and international agricultural research centers play a key role by conducting strategic research with wide distribution of research benefits across countries.

A second group of research organizations are neither wholly public nor private; they are neither governmental organizations nor do they conduct research on a commercial basis. This category consists of several foundations and public-private corporations, as well as nongovernmental organizations and commodity research institutes that perform research without direct profit goals but for a specific clientele (associations of producers). Agricultural universities are also listed in this group, because in most cases they receive funding from both public and private sources. There are at least three types of private entities that conduct and/or fund research: those closely linked with the farm sector (such as plantations), agricultural input companies, and the agribusiness and food sector.

Table 1. Agricultural Research Organizations at the National Level

Sector	Organizations
Public	Departments of ministry of agriculture National institutes of agricultural research National research councils National science and technology foundations Agricultural universities Regional centers International centers
	Agricultural universities Agricultural development foundations Research corporations Community-based organizations Non-governmental organizations Cooperatives and producer associations Commodity research institute
Private	Farm sector (farmers; plantations and large firms; technical assistance consulting firms) Input sector (seed companies; livestock feed companies; veterinary pharmaceuticals; agricultural chemicals; farm machinery and equipment) Agribusiness and food sector (poultry breeding; agribusiness firms; food processing companies)

The degree to which research is "public" may be described in three ways: 1) by who pays for the research; 2) by who executes it, and 3) by who receives the benefits of it. The degree to which the government assumes responsibility for funding and executing research depends very much on the third element: the presumed beneficiary. We draw two further links. The expected beneficiaries of the research (and expected spillovers to others) determine the nature of the research (e.g., strategic or applied) as well as the research outputs (public goods or private goods). Once these are determined, the appropriate mechanism for research funding can be "negotiated" (beneficiaries may often disguise their interest in the research to get the government to pay for it directly).

During the past two decades, the somewhat reduced role of the state in the economies of many developing countries and a need for greater fiscal austerity have called into question the role of the public sector in supporting agricultural development in general and agricultural research in particular. Despite the renewed interest in the private sector and a relative decline of the role of governments, there are areas of research that must be funded (and probably also conducted) by the public sector. Otherwise, because of market failure, it is likely that crucial research activities will not be carried out. This so-called "public-good" research area (where there are fewer incentives for profit-oriented sources to conduct research) is dynamic and, in many cases, shrinking as new products and processes (where intellectual property rights can be appropriated) are being developed by the private sector.[2]

Because the research process is a continuum of activities from basic science to applied research to product development, research at the basic end of this spectrum is in general a public responsibility, while the private role increases as one moves towards product development for the market. In addition to the type of research, the nature of the technology also determines the public-private mix, since property rights are easier to obtain for technologies embodied in agricultural inputs, for example, than for new information on crop management.

[2] Depending on the level of excludability and appropriability there are public, common, toll and private goods.

Environmental and equity considerations also influence public-private sector involvement. Research on natural resource management or directed to small-scale farmers is less attractive for the private sector, given the low levels of appropriability, smaller market size, and higher research risks in these areas.

Because of such multiple, and complementary, roles for public- and private-sector funding of research, all the actors listed in table 1 may be present in varying degrees in any given country. Moreover, agricultural research in developing countries remains largely in the public sector, while most private-sector research is concentrated in the food industry, plantation crops, mechanical farm implements and chemicals, pharmaceuticals, and seeds. And most of this research is not done by local companies alone, but also by multinational companies on a worldwide basis.

Evolution of public and private funding for research: key indicators

Public-sector share in agriculture research. In Latin America in the mid-1990s, public-sector research represented close to 70% of the total agricultural research expenditure, while the shares of universities, private companies, and farmers' funding averaged about 10% each, with wide variation across countries (Echeverría 1998). By comparison, the private-sector share of agricultural R&D in the USA and the United Kingdom was close to 60%, with shares between 15% and 35% for public institutes and 25% and 5% for universities (Pray and Umali 1998).

Agriculture research investment as a share of agriculture GDP. Overall, governments in developing countries in the early 1990s invested only about 0.5% of their agricultural GDP in agricultural research, compared with about 2 to 4% in the more developed countries (Alston, Pardey, and Roseboom 1998). In addition, a large share of research resources in developing countries are spent on salaries.

Total agriculture research investments. Worldwide, public investments in agricultural research doubled in real terms during the 1970s and '80s, from about $7 billion (1985 international dollars) in 1971 to nearly $15 billion in 1991 (Alston, Pardey, and Roseboom 1998). More than half of that was spent in developing countries. However, growth rates of public research expenditures were lower in the 1980s than in the 1970s, and probably even lower in the 1990s. With a few notable exceptions (Brazil, India), public-sector funding for agricultural research in developing countries has been stagnant and unstable in the 1990s. Developing countries as a whole spent less than $2 (1985 international dollars) per capita per year in agricultural research in 1991, while the figure for developed countries was close to $9 (Alston, Pardey, and Roseboom 1998).

Role of multinational companies. Private-sector expenditures on agricultural research performed by multinational companies in developing countries was estimated at $36 million (1985 US dollars per year in the second half of the 1980s, with wide variation across countries (Pray and Echeverría 1991). Given the global nature of these companies, it is hard to assess how much of a given research program is actually performed where. Since most private, multinational-company R&D is probably conducted at headquarters, most of their developing-country research program would be aimed at adapting products to local conditions or for demonstration purposes. Alston, Pardey, and Roseboom (1998) report private-sector research expenditures in OECD countries of above $7 billion in 1993 (1985 international dollars) and an annual growth rate of about 5% for the period 1981-1993. With the globalization of agricultural markets, stricter intellectual property rights, and the advancement of biotechnology, commercial investments in food and agricultural research will also probably continue to increase in the less-developed economies, especially in improving crop and livestock productivity.

Evolution of funding mechanisms

Agricultural research at the national level, defined to include cropping, livestock, and natural resource management, remains largely in the public sector. Direct support from public sources (national and international), own resource mobilization, and revenues from commercial operations are the main sources of funding for agricultural research at the national level. Direct-block and earmarked transfers are the traditional public-sector funding mechanisms to national research institutes and public universities, respectively. Increasingly, public funds are being channeled through contracts and competitive funding mechanisms.

Mobilizing own resources is a second and increasingly important source of funding for research. Grants, revenues from endowments, charges for services and check-offs are used by research foundations and farmers' associations to fund their own R&D programs or to contract other public- and/or private-sector providers. This is the case with grants to research foundations and levies on output to fund commodity institutes or other organizations by contract. For instance, the Foundation for Agricultural Development of Ecuador (FUNDAGRO) was established as an endowment in 1986 to fund agricultural research, education, and extension.[3]

Revenues through the sale of products are, in turn, the most common source of funding for research done by the private sector, such as agricultural input companies, the agribusiness, and food-sector organizations. Tax concessions and joint-venture contracts as well as proceeds from user charges and projects supported by research foundations are also becoming significant funding sources for the private sector.

Funding mechanisms vary widely across countries and within countries over time. For instance, in Latin America in the early 1990s, direct government transfers ranged between about 80% in Brazil and Mexico and about 40% in Chile, where 26% of funding came from sales of products and services (Cremers and Roseboom 1997). The Brazilian cocoa research institute (CEPLAC) provides an example of funding variation over time: stable for over three decades, farmers' financing from a levy on production stopped after commodity prices plummeted and a serious disease affected production.

Financing agricultural research in the developed countries has also changed quite dramatically in the past few years. In the Netherlands, where the public sector funds about 40% to 50% of agricultural research, most public funding is done by contracts to suppliers, mainly to a recently created Dutch agricultural research organization that was formed by merging the Agricultural Research Department and Wageningen Agricultural University. Roseboom and Rutten (1998) cite the following funding trends in selected developed countries: an increase in public funds matching farmer levies through rural industry corporations in Australia; a switch from input to output financing and increasing reliance on private sources of funding (the Netherlands and New Zealand); and a decrease in institutional funding with an increase in CGs (USA).

As mentioned earlier, CGs funded from public sources are increasingly common in developing countries. The following sections focus on alternative types of such schemes, their perceived advantages and disadvantages, and potential measures of performance.

[3] See Hansen (1990) for a review of several agricultural development foundations established with USAID support in Latin America and the Caribbean; and Horkan and Jordan (1996) and Sarles (1990) for a review of lessons from USAID-funded endowments.

3. A typology of competitive grants

Competitive schemes can be classified according to three characteristics: 1) their national, regional, or international reach, 2) their stated objectives and governance, and 3) whether they are from endowed trusts or one-time depleting funds. The nature of support to research may be influenced by whether or not the funds are from annual grants or appropriations or from stable investment income. **Table 2** provides examples of CG schemes.

National funds

National CGs, of which several types exist, have a long tradition in both more- and less-developed countries. Regional schemes have emerged quite recently. There are several types of competitive mechanisms that support agricultural research at the national level. A first distinction can be made between science and technology (S&T) councils (multisectorial) and agricultural technology funds (agricultural sector).

National S&T councils, usually falling under the ministry of education or ministry of science and technology, offer CGs for the advancement of science, prioritizing basic research. To this group belong the more traditional S&T councils, where academic research is the norm and universities are the main customers. The defining criteria for research priority setting is the expected scientific progress, relatively independent from an application. They are more goal than sector oriented. For example, the Argentinean Secretary for Science and Technology has established two competitive funds, one for technology development (FONTAR) and another one for scientific research (FONCYT). Most science funds have agriculture-related programs.

The National Science Foundation (NSF) in the USA and the national science and technology councils (Spanish acronym: CONICYTs) in Latin America are examples of this type of organization. They fund research and education in science and engineering through grants, contracts, and cooperative agreements with colleges, universities, and other academic institutions. In Latin America, the creation of the science councils represents a second phase of the development of national innovation systems after research capacity was built in universities and other research organizations (Mayorga 1997).

In most cases, science funds support agricultural research. But because of the distinctive nature of the sector and its high demands for production technologies, specific mechanisms have recently been created. Complementing the S&T schemes, *agricultural technology funds* focus on applied research expected to contribute to developing the agricultural sector. Most agricultural funds operate on competitive principles and evaluate research proposals on their perceived merit according to predefined national agricultural research priorities. The defining criteria for such priorities is usually the extent to which the research project contributes (with a new technology) to the potential development of the sector.

Table 2. A Typology of Competitive Grants Systems

Type	Nature and objectives	Governance	Example
National			
Multi-sectorial	Development of science, academic research, including unspecified themes based on scientific merit and contracts for specific research topics	Science & technology council	CONICYT-Venezuela; FONDECYT-Chile
	Strengthening research links between universities and other organizations	Science & technology council	FONDEF-Chile
	General technology development, open to all sectors of the economy	Development corporation	FONTEC-Chile
Agricultural Sector	Agricultural technology development	Ministry of agriculture	FIA-Chile, NARF-Tanzania USDA-USA
	Applied research, transfer and training, small producers	Ministry of agriculture	PRONATTA-Colombia
	Agricultural technology development	Research council – National Institute	PRODETAB- Brazil, ARF-Kenya
	Specific commodity research, funded by producers and public-sector budget	Agricultural Develop. Corporation	GRDC-Australia
Regional			
Multi-sectorial	Regional strategic agricultural technology development, funds from member countries, depleting	Scientific council	European Union S&T funds
Agricultural Sector	Regional technology programs, funds from member countries invested in endowment	Board of directors (funds administered by IDB)	Latin American Regional Fund for Agric. Research (FONTAGRO)
	Regional transfer of technology for small-holders	Steering committee (USAID funds)	East/Central Africa Fund (ASARECA)
International			
Foundations	Strategic socioeconomic development research, endowments	Foundation	Ford, Rockefeller-USA
Development	Strategic economic development	International council	IDRC-Canada
Agriculture	Support to eco-regional activities, depleting resources	Advisory committee; Dutch government funds administered by ISNAR	Ecoregional Fund

National agricultural technology funds typically provide grants and operate on a depleting basis for five or six years, specially when the source of funding is loans from multilateral development banks. They may also have several other contributors, including the public sector, bilateral donors, and private-sector institutes. Most national funds are open to project proposals from national research institutes, universities, foundations, and private firms. They sometimes require collaboration among research organizations, including the private sector, and the cofinancing of research activities.[4] In

[4] Most national technology funds operate on the basis of a specific set of preselected research topics and with grant recipients selected competitively. Another type of national, more demand-driven, schemes are CGs that facilitate innovation by letting the recipients determine most of the content of the research project. This is more common in science than in technology funds. In some cases and given the size of a country, there are also subnational technology funds, such as in India. Gill (1998) categorizes national funds based on objetives,

general, national funds will finance up to a pre-defined percentage of specified direct research expenditures, such as labor costs for additional research personnel and consultants as well as salary supplements; travel and training costs; research inputs and laboratory supplies; the repair, maintenance, and in some cases replacement of research equipment; and diffusion of research results.

Several Latin American countries have developed agricultural technology funds during the past two decades. Some of these funds are managed directly by the ministry of agriculture, such as FIA in Chile and PRONATTA in Colombia, or they have a national board of directors presided over by the ministry of agriculture (as in Ecuador), while others are set up within national agricultural research institutes (as in PRODETAB/EMBRAPA-Brazil and FPTA/INIA-Uruguay).

Chile is one of the few developing-country cases where several national CG systems for agricultural research have been in place for more than a decade. Examples of multisectoral CGs are FONTEC and FONDEF, as well as one specific agricultural technology fund (FIA, table 2). Public funds allocated competitively to agricultural research in Chile have increased dramatically during the past 10 years: from less than US$2 million in 1988 to almost US$60 million in 1998 (MEFR 1998). Block grants to the national research institute, INIA, increased over the same period from about US$27 million to US$46 million. FIA, from about US$27 million to US$46 million with a current annual budget close to US$6 million, funds research projects of private companies (40%), universities (30%), and public institutes (30%). It also funds "technology tours" aimed at capturing best practices and technologies developed in other countries.

The Agricultural Research Fund (ARF) of Kenya, established in 1990 within the Kenya Agriculture Research Institute (KARI), is an example of a national technology fund that has the potential to supplement the work of the national institute by broadening its access to the scientific community, developing productive synergies between the institute and other organizations, encouraging private-sector participation, and promoting linkages between research and training. ARF supports research in almost all agricultural areas; it has been funded by USAID, the World Bank, the Kenya Seed Company, and the Agriculture Research Foundation of Kenya and plans to build an endowment.

The American National Research Initiative Competitive Grants Program, established in 1990 at USDA, is also an example of funding agricultural technology on a competitive basis. In 1995 it accounted for about 6% (US$103 million) of total federal funding for agricultural research and encompassed virtually all topics relevant to the agriculture, food, and environment sectors (OTA 1995).

Regional and international funds

At the **regional** level, the European Union has multisectorial regional scientific councils, and in Latin America there are agricultural CG schemes such as the Regional Fund for Agricultural Technology (FONTAGRO), created to fund regional and subregional research projects on a competitive basis (FONTAGRO 1998 and 1997). One of the fund's distinctive characteristics is that it is being constituted as an endowment (with a goal of US$200 million) with direct contributions from the expected beneficiaries themselves (the countries of the region), who also manage the fund through a board of directors. These two attributes (sustainability of funding and a demand-driven agenda) are expected to accelerate its consolidation. The fund also proves to be a valuable mechanism for the discussion of regional agricultural research priorities and technology policy issues.

The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) also currently explores the possibility of setting up a regional CG system with characteristics similar to those of FONTAGRO (Ellsworth 1998). The newly established research program on monitoring

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thematic and geographic coverage, and source of funds.

and evaluation methodologies for natural resource management initiatives in Latin America and the Caribbean, funded by IDRC and administered by RIMISP-Chile, is an additional good example of a regional CG scheme focusing on small grants for research on natural resources (RIMISP 1998). In Africa, the CIAT/SACCAR-sponsored Global Collaborative Post-Production Research Network Small Grants and the CIP/ASARECA Transfer of Agricultural, Livestock and Post-Harvest Technologies Grants Program are examples of CGs promoted by international agricultural research centers.

At the **international** level, ISNAR manages a Fund for Methodological Support to Ecoregional Research, an example of an international competitive mechanism with a very specific focus (ISNAR 1997).

All the above mentioned regional and international funds are depleting. In the case of ISNAR's ecoregional fund, the founders believe that there is a short-term task in elaborating a methodology but after two rounds of five years it should have completed its task.

Finally, there are examples of the more traditional development-assistant grant funding from international foundations with endowment funds (Ford and Rockefeller Foundations), as well as several worldwide environmental trust funds, such as the Global Environment Facility. It is not possible to study in one paper the many grant-making and institutional funding mechanisms, especially those of unstructured competition where, for instance, a donor organization sets priorities, informs potential beneficiaries of grant opportunities, and screens proposals. This paper therefore concentrates on the advantages and disadvantages of the more structured national CGs.

4. Key elements to consider when establishing competitive grants

Before establishing a CG scheme, it is essential to assess the advantages and disadvantages of using such a mechanism for the type of research one wishes to promote. Things to consider are the existence of a large enough market (research system), the scope of research eligible for the competition, the creation of a sound governance mechanism, and the potential sustainability of the system under consideration.

Potential advantages and disadvantages

Even though each CG scheme has its own nature and objectives, and its performance is affected by many factors, **table 3** attempts to summarize the main potential advantages and disadvantages of such schemes.[5] Typical advantages of CGs are that they usually provide greater accountability to the funding source and improve resource allocation and technology transfer by promoting effective linkages among research organizations. By promoting a more demand-driven system and by lowering the cost of conducting research, CGs can generate a net gain in research resources.[6] As they are open to competition, CGs can also increase research capacity in agricultural universities and research foundations, as well as provide opportunities to strengthen links among national and international research organizations.

[5] See Janssen (1998) and Beatie (1997) for a discussion of advantages and disadvantages of institutional versus project funding; and Byerlee and Alex (1998) for a brief analysis of CGs within an overall review of key issues and good practices in the development of national agricultural research systems in developing countries.

[6] The expected reduction in costs (from the perspective of the funding source) due to competition and co-financing, less duplication of efforts, better accountability and use of existing research infrastructure, can also be offset when (from the perspective of the agency conducting the research) bidders crosssubsidize or draw on core resources in order to get the extra funds, and/or when competitive funds are channeled to the low-cost alternative without taking research quality into account.

Table 3. Potential Advantages and Disadvantages of Competitive Grants Systems

Advantages	**Disadvantages**
Increases research **effectiveness** by directing resources to the most productive scientists, by merit (improves quality and accountability of research)	**Limited nature of funding** (funds only operation costs, lack of support to core budget salaries and maintenance of research facilities)
Increases research **efficiency** by reducing: direct costs via competition and cofinancing schemes, duplication of efforts, lack of accountability of research resources, underutilization of infrastructure by providing operating resources	**Short term funding**, lack of support for medium- to long-term research agenda
Promotes the identification of and consensus on national research **priorities**	**Low institutionalization**, lack of support to human capital development and to new research infrastructure
Increases **flexibility** to focus on newly emerging national/regional priority issues	Higher funding **uncertainty** could affect long-term projects and reduce confidence of research staff
Promotes a **goal-oriented** and demand-driven national research system	**High transaction costs** from grant seeking, proposal writing and implementation reports, less time for research
Strengthens **links** between research and extension organizations, agricultural production and agricultural policies	Reduces research **flexibility** to focus on additional (not open for competition) issues when researchers discover new research opportunities
Strengthens **links** among national, regional, and international public and private research organizations, promotes "spill-ins"	**Higher risks** involved when research consortia involves less-well-known organizations
More **diversification of funding** by involving scientists from outside traditional organizations, promotes "system"	**Low sustainability** of funding when national constituency is weak and external funding sources dry up (unless it's an endowment)
Induces **institutional change** in the national innovation system, separating research policy, funding and implementation	Needs a **minimum market size**, a research system with a minimum number of competitors (larger countries probable best suited)
May mobilize **additional funding**	Legal, financial, administrative and technical **costs of setting up and administrating**
Merit review process provides expert feedback to researchers' proposals and objectivity of the competitive process, **improving research quality**	May be **biased to strong research organizations**, increasing "equity issue" due to lack of competitive capacity of poorer/smaller organizations
	Possibility of "**rent-seeking**" in the process of allocating resources to research

One potential advantage of a competitive funding scheme is that it can generate for the funding source a wider set of research ideas, among which the most promising could be actually funded. In this situation, CG schemes may solve an information problem, focusing the competition on research topics and not necessarily on research costs. This may be of particular importance in more basic research areas, where funding agencies depend more on their interaction with scientists to develop a research portfolio. At the more applied end of the research spectrum, a CG scheme may have a better defined set of research topics to be funded and the mechanism could therefore be used in order to find the lowest cost research provider. In this case a CG mechanism may solve an efficiency problem, focusing on the lowest cost alternative (Roseboom 1998).

In some cases the perceived advantages of CGs can be a source of debate, such as the possibility of

CGs strengthening links between research and extension organizations, since institutional block funding often has built links between research and producers. The potential advantages (and disadvantages) of CGs will depend on the management of the schemes. Some of the perceived advantages are not obvious and more in-depth research is needed to clarify how these programs operate.[7]

When the source of funding is an endowment, resources are secured on a continued basis. However, relatively large up-front investments are needed to generate sufficient annual income to fund a significant research program. In addition, policymakers may feel they have less control over decisions on resource allocation. In a time of dwindling resources for public research, it would be difficult to find large sums to invest in an endowment, unless there is the possibility of selling property (for example, land from a research station) or of a development grant. Endowment funds have the additional advantage that they may attract additional funds from local as well as external sources.[8]

One of the major *disadvantages* of current agricultural research CGs is lack of funding for human and physical capital. In order to be able to conduct research (and to compete for grants), research organizations must have a minimum budget to cover the costs of a critical mass of staff and for the maintenance and upgrading of physical and human resources. Given the nature of agricultural sciences, both elements depreciate quite rapidly. Moreover, a medium-term research agenda requires continuity of funding over several years (e.g., animal and plant breeding, natural resource management), and CGs used on a short-term basis may not be advantageous. Unless longer-term projects are funded, more basic research may be neglected at the expense of short-term applied research.

As the use of CGs increases, there is a need to analyze the *costs* of establishing and operating such mechanisms. Overhead costs of administration of a national CG could be substantial if activities such as (1) identifying priorities and developing procedures (manuals of operation), (2) evaluating proposals, and (3) contracting and following up project execution are taken into account. In addition to these basic activities of a CG, there are significant costs associated with: preparing project proposals, panel and peer reviews for screening proposals, meetings of boards of directors, and publishing calls for proposals, results, annual reports, and medium-term plans.

Moreover, and in spite of the fact that CGs could provide better accountability, CGs are not immune to lack of transparency in the identification of priorities, the allocation of resources, and the use of funds. Managers of CGs could bias priorities towards less-productive research activities, and if funding priorities are too rigid, a scientist's initiative to pursue promising new research activities can be hampered. In this sense, CGs could become less client-driven than traditional institutional funding, and they could quickly redirect scarce funds to research priorities defined by technology funds managers. In addition, Huffman and Just (1995) examine the possibility that, given the high transaction costs of CGs in the USA, they could increase rent-seeking activities by scientists relative to block grants or formula allocations, reducing both the real funding available to research and the

[7] For instance, if decisions on funding research proposals are based only on recommendations from a scientific panel review, it may end up being a less demand-driven mechanism than institutional funding. The assumption in this discussion is that a national CG scheme relates to national research priorities identified in a technically sound and participatory manner, and that several (weighted) criteria are considered when ranking proposals. An example of a more demand-driven system based on CGs is Australia, where farmers participate in decentralized regional screening committees. Moreover, the greater accountability usually achieved by CG programs is based on the assumption of a transparent process of evaluation of project proposals and on the monitoring and evaluation mechanisms that are part of CGs.

[8] For instance, endowed organizations can build links between government, the nonprofit sector, and the commercial sector by including leaders from those sectors on their boards, offering the possibility of investing private funds to support social and environmental demands, investing endowment funds in local capital markets, and supporting high risk research leading to commercial activities.

productivity with which research resources are used.

Given the particular conditions of the agriculture and S&T sectors, probably every country would need a somewhat different competitive system. The following issues are not intended to be rigorous recommendations but minimum requirements to be considered when establishing CGs. As discussed earlier, competitive grant systems are one of many mechanisms for funding agricultural research, the importance being in the mix with other funding alternatives. Thus care should be taken when promoting CGs at the expense of other alternatives and objectives, such as long-term research, infrastructure, and human capital.

Market size

In a competitive research market, a substantial number of competitors are needed for CGs to work. That is, a minimum research capacity and a level playing field are required for competition to operate. This will assure a wide supply of high-quality competing research proposals.[9] When a potential market exists, a CG scheme can actually enlarge the market, creating competitors, for instance, by providing resources earmarked for consortia of research organizations.

Because of market size, CGs may be more appropriate for the larger national agricultural research systems than for the smaller ones with few research organizations and a small number of scientists in relevant disciplines. Competition is effectively limited in countries with only one relatively large research organization (only one provider in the market). In fact, a competitive system may lead to decreased competition and increased inequality because of the lack of the capacity of smaller institutions to compete. This has occurred in countries where research institutions in relatively poor states compete with stronger institutions in the wealthy states and “scientific quality” is the sole criterion for evaluating proposals.

The size of the market should be an important factor in the consideration of the scope of research priorities open for competition. A sharply focused call for proposals on natural resource management research issues cannot claim to be very competitive in an environment with a small number of potential contestants. This could be relevant for instance in most countries in West Africa, except Nigeria (Perrault 1998).

In addition, market size is a key element in defining the magnitude of the pool of resources available in a CG. Given the significant costs associated with implementing competitive schemes, it’s essential that enough resources are available to satisfy demands. More analysis is needed to identify the amount of funds that a CG should make available in a given system, relative to total resources available for research. In both cases (scope of research priorities and significant pool of resources available), the size of the market could be expanded by open competition to providers from outside the country, and/or by setting up regional competitive funds.

Scope of research priorities

The identification of a small set of truly national priorities is crucial for CGs to work. It is important to note that not all national priorities need to be included in a CG. A limited number of priorities (which can gradually increase over time) will assure the consolidation of such a system. This highlights the fact that a CG should be part of an overall national science and technology policy strategy, and not a “stand-alone” instrument with its “own” priorities. In addition, it seems reasonable to begin with a relatively modest scheme, which, if successful, could be developed over time.

Research priorities on a competitive program should not only be targeted and technically sound, but

[9] The size of the market relates to the relative number of scientists in any given discipline and the pool of potential reviewers of proposals, which in smaller systems may be limited.

also defined in a participatory manner in order to build national consensus on strategic goals. Maintaining a medium-term research focus will also help to avoid politically based allocations. Moreover, CGs can be an effective instrument to promote research collaboration in new applied research areas that require multidisciplinary efforts. The more traditional, short-lived CG schemes being implemented in developing countries are less appropriate when the need to strengthen research infrastructure is great and when the results are of a long-term nature.[10]

Governance

A transparent management system for CGs is also critical. It should be clearly explained how priorities have been identified, as well as how proposals are going to be evaluated. Requests for proposals need to be precise and widely distributed. Priorities and procedures should be publicized well in advance and not subject to unexpected annual changes.[11]

A sound evaluation system based on merit should include at least the following criteria: technical quality, institutional capacity, expected socioeconomic impact (including efficiency and equity considerations), and environmental impact. Also, minimizing conflicts of interest and establishing an efficient system of awarding contracts should be part of the governance of a CG program.

Institutional sustainability

It is essential that the life expectancy of a CG be long. The costs of setting up and consolidating a CG are high, and the impact of CGs in redirecting priorities and allocating resources can also be strong. CGs should therefore be sustainable and become an important and stable mechanism for funding. Unless this stability is accomplished, depleting funds are usually at risk of nonreplenishment.[12] Moreover, the relatively high cost of setting up, consolidating, and reaching institutional maturity of CG schemes must be met, in order to assure their sustainability.

Several other factors, such as those discussed in this section under market size, scope, and governance, also influence the sustainability of CGs. Its sustainability can be enhanced by increasing technical autonomy and transparency and by implementing sound monitoring and evaluating performance systems. This assures not only continued funding but also probably attracts additional sources of funding. An appropriate legal framework for the operation of CGs and its gradual implementation are also key factors.

Above all, the improved performance of agricultural research funded via CGs will assure its sustainability; hence, the importance of defining criteria to measure such performance.

5. Criteria for measuring performance

[10] On the other hand, outside developing-country agriculture, CGs are quite common within the long-term research establishment. Whether or not CGs have a long time horizon to invest in more basic research depends more on the mandate of the funding agency than on the mechanism as such.

[11] In addition, farmer participation is essential at the level of governing bodies of national technology funds (and of research organizations in general) in order to insure farmers'interests. This participation could of course extend to farmer financing (or co-financing) specific research projects.

[12] Endowments, on the other hand, have the advantage of financial sustainability. There are intermediate models between perpetual endowments and depleting funds, where for instance a combination of the investment income and the fund itself is used to support research activities over a specified period of time, say 10 to 15 years ("sinking fund").

The performance of agricultural research is determined by the effectiveness and efficiency of the research. Relevance and quality of research affect effectiveness, while costs of research affect efficiency. Two other key factors influence performance: sustainability of relevant funding and the institutional setting in which research takes place.

Given the importance of agricultural research and the funding mechanisms to support that research, it is worth defining benchmarks to measure their performance. Four key indicators of performance of CGs are identified in this paper: (1) increased effectiveness, (2) increased efficiency, (2) additionality of research resources and sustainability of funding, and (4) the promotion of favorable institutional change. **Table 4** lists such criteria with examples of indicators that could be used to measure performance of CGs.

Although each criterion is in some way related to the others (additional resources and institutional change may have a positive effect on research efficiency and effectiveness, and vice versa), the challenge is to be able to measure the performance of CG-funded research projects vis-a-vis the performance of projects funded by other mechanisms. The criteria and indicators listed in table 4 are not specific to CGs but general measures for research performance, irrespective of the funding mechanism.

Increased effectiveness

The impact of research relates to the economic, social, and environmental effects of the research project being considered. Irrespective of the funding source and mechanism, several indicators can be used to measure performance of research projects funded through CGs. An increase in land and/or labor productivity due to research is measurable, as is a decrease in natural resource degradation attributed to a new agricultural practice (product of research). The number of years for adoption of new results by a given share of potential adopters as well as the more indirect measure of a reduction in poverty rates (income increase) due to research are other indicators to measure the impact of a research project. In so far as competitive funding promotes new forms of institutional partnership, it might help raise the adoption rate of new technologies.

Increased efficiency

By promoting competition it is expected that CGs will lower total research costs. Basically, a CG program promotes a contractual arrangement based on outputs (results), not inputs (research costs), hence the expected decreased in real costs for a given quality of research output. Costs could be lowered as a result of: research collaboration (joint ventures); acceleration of research results as partnerships can for instance shorten the process of selection and testing of new technologies; and increased accountability to funding sources.

Table 4. Criteria and Indicators for Measuring Performance of Competitive Grants

Criteria	Indicator (benchmark)
Impact of research results (*effectiveness*) attributed to research projects financed by competitive grants	Factor productivity (crop yields, labor productivity)
	Trend in natural resource degradation (soil erosion rates)
	Social rate of return to research (percentage)
	Rate of adoption of research results (shape of adoption curve)
	Absolute and relative poverty rates (percentage)
Costs of doing research (*efficiency*) attributed to research projects financed by competitive grants	Share of contracted research within project activities (% of total)
	Number of projects terminated within a year after the planned date
	Number of projects that have achieved the planned results
	Ratio of realized and planned time for project execution (%)
	Length of project cycle (number of months)
	Total cost of CG program management and administration (as a % of total CG funds for research)
Additionality and sustainability of resources	Increase of total national agricultural research budget in real terms over a defined period of time (annual growth rate)
	Percentage contribution to CG scheme from different sources (over time)
	Share of total amount of funds of CG program over total national agricultural research budget (% over time)
Institutional change	National, regional and international research joint ventures in a given year (number)
	Trend of national research budget allocated to CGs and to direct institutional funding (% over time)
	Share of private-sector funding of total research expenditures (%)
	Share of CG funded projects that are national research priority subjects (%)

Additionality of research resources and sustainability of funding

CG schemes may promote new (additional) funding by increasing flexibility and accountability of research projects. As with all indicators, there will be attribution problems because, for example, a real increase in the national research budget can be the result of many factors. This criteria is particularly relevant for the complementarity between funding sources, discussed earlier in the paper.

Promotion of favorable institutional change

Although this is the most difficult criteria to measure, potentially, CG programs promote more pluralistic research systems and increase the overall scientific quality of agricultural research activities. This, in turn, will have a positive effect on effectiveness and efficiency.

It is expected that the increased participation of other actors into the research system (farmer organizations, universities) in problem identification, research priority setting, and involvement in the R&D process itself, will be part of the positive institutional change promoted by CGs. The increased access and collaboration would materialize via institutional links in the research consortia competing for funds.

As a result of CGs, research quality will increase as the scientific basis of research activities is improved, given the increased input of scientific institutes participating in research consortia. In a more direct way, CGs will often increase the quality of research by requiring the preparation of detailed proposals, and that these be subject to rigorous review.

6. Conclusions

The relative decline in public-sector funding for agricultural research in developing countries can be partially alleviated by "doing more with less"; that is, by allocating available scarce resources to programs with higher expected impact and by improving the mechanisms by which research funds are allocated.

CGs can improve the existing research capacity in a country (region and/or theme) by providing scarce operating funds. On the other hand, because CG schemes for agricultural research usually only fund operating costs on a short-term basis, they can only complement traditional institutional funding that covers salaries, research infrastructure, and basic expenses of medium- and long-term programs. It is necessary to maintain a body of researchers capable of competing in a market of research funding. Precisely because of this complementarity between institutional funding and competitive project funding, the key is to find an optimal mix of funding mechanisms in each case. Moreover, in many developing countries the central funding issue to address is still at the insitutional level. This will in turn determine the efficiency of future CG schemes.

Competitive schemes, particularly those that fund more basic research, can lower transaction (information) costs by targeting the most promising scientific proposals offered by the research community. Moreover, and particularly for the more applied research and technology development activities, CGs can lower total costs as they find the cheapest research provider in a given market. CG mechanisms also have the potential to promote the inclusion of a wide range of participants into focused priority research areas by fostering collaboration among research organizations. In addition, competition may increase research quality and lower costs. On the other hand, CGs have several potential drawbacks as discussed throughout this paper. It is therefore important to carefully consider their potential advantages and disadvantages, the size of the market in which they will operate, the scope of research priorities that will be funded, as well as the management and institutional sustainability aspects of competitive mechanisms.

Of special importance is the potential contradiction in setting up short-term CGs targeted for basic research, which is often of a long-term nature. Another potential conflict, especially in developing countries, is to replace institutional funding with competitive funding on a large scale, without adding new funds. Hence, it is important to look at a full range of funding mechanisms in each particular case, instead of promoting a "one size fits all" model.

Although more applied research is needed to define a suitable level of resources devoted to competition in a given research system, there is clear evidence of the need to maintain public institutional funding for a basic research infrastructure and human capital, and for higher-risk research activities. Such allocation of scarce research resources should probably occur in a broader context of science policy, with less focus on specific agricultural research issues, aiming at wider and more basic research questions.

Given the particular conditions of the agriculture and S&T sectors, each country probably needs a somewhat different CG program. If farmers, consumers, and governments can find ways to finance competitive systems that are truly competitive, sustainable over time, and accountable to demands, then research performance should improve. The use of indicators to assess research performance based on the effectiveness and efficiency of research under CGs, plus the additionality of resources and institutional concerns as suggested in this paper, will help to address the issue of increased research performance in a rigorous way.

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