Staff Papers Series

Staff Paper P90-9

February 1990

Agricultural Research and Technology Policies - Their Relevance to Today's Issues

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This staff paper is the first in a series published under the auspices of the Center for International Food and Agricultural Policy on issues of relevance to the public policy community. These papers are designed to develop and explain issues in non-technical language with an emphasis on the international role of agriculture and natural resources.

In this paper, Burt Sundquist reviews some of the key policy issues affected by agricultural research. This research is largely conducted in the Land Grant universities of the U.S. and in research centers of developing countries. Such research will determine the future impact of agricultural technology on the environment, on human health, and on food productivity in developed and developing countries. Dr. Sundquist raises a number of points relevant to future public and private sector research priorities, and details the work of the Center for International Food and Agricultural Policy contributing to setting these priorities. We hope that this information will help to inform the larger community concerning the impact of academic research on the welfare of citizens in the United States and abroad.

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Agricultural research and technology policies are terms which denote different things to different people. As a practical matter, some caution should be exercised in defining their content too narrowly, lest one exclude from consideration some of the important contemporary issues to which effective public policies can make significant contributions. Although agricultural research and technology policies are generally regarded as a subset of agricultural policies, they are often also related to other sectoral and macroeconomic policies as well as to broader policies for science and technology.

As examples, of research and technology policies, excessive use of toxic chemicals in some farming systems suggests a critical need for policies designed to promote the development and testing of agricultural technologies which are both safer and more environmentally friendly. Emerging biotechnologies such as bovine and porcine growth hormones (BGH and PGH) and a wide range of soon-to-follow products of genetic engineering elicit strong producer and consumer reactions which need a credible and multi-faceted research response if appropriate technology policies are to be developed. Policy issues relating to intellectual property rights have become critical ones, particularly for research conducted in the private sector but for public research as well. Private firms understandably want to protect the products and processes resulting from their R&D discoveries. But some fear monopoly exploitation of technology users if the technology is over protected. Critics charge that large farmers and agribusinesses have been the principal beneficiaries of publicly funded agricultural research. And in many developing countries, there is a widespread conviction that staple food crops, so critical to the living standards of poor people, get inadequate research attention as compared to export crops. A number of important issues relate to the funding of public sector agricultural research and to interaction between agricultural policies (e.g., taxes, subsidies, output controls, etc.) and the economic benefits derived from research. The above listed issues are only a small sample of those requiring substantive evaluations and enlightened research and technology policies for their satisfactory resolution.

In the past, good research and technology policies were generally thought to include anything which encouraged R & D to increase efficiency and

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output in the farm production sector. But this was always an excessively simplistic perspective, even though efficiency and output were, and continue to be, important objectives of much agricultural research. In recent years, however, the scope of acknowledged research and technology policy related issues has expanded tremendously in both the developed and the developing countries. And, as a practical matter, credible policy responses to the types of critical contemporary issues listed above require extensive data base development and evaluations of a broad base of more generic research policy issues as well. Fortunately, data bases are being developed and an expanded set of effective analytical procedures are now available for professionals working in the areas of research evaluation and technology assessment. Several key current research and technology policy issues are illustrated in the paragraphs which follow.

1. Despite high economic returns to most agricultural research, constraints on public research funding are curbing the ability to initiate and/or sustain important areas of agricultural research. Funding constraints arise form several sources. In many developing countries the disastrously high level of external debt is a major contributor as is the demand for funds to provide consumer food subsidies, health and education services, housing, infrastructure and expensive imports including oil. As a result, despite the continued high measured payoff for agricultural research, and despite the existence of hunger, malnutrition, and even starvation, many developing countries are grossly underfunding their agricultural research enterprises. For example, in Uruguay during the period 1965-85, investments in research and extension for a major staple food crop (rice) yielded an annual return on investment in excess of 50 percent. Yet this country invested less than 0.5 percent of its agricultural GNP in agricultural research (Echeverria, 1989). One of the more devastating examples of inadequate funding for agricultural research is that of Brazil where a once highly productive national research system (EMBRAPA) is incurring major adverse effects because of funding constraints. The burden of the country's heavy external debt is a major contributing factor to this problem. These stories of gross underinvestment in agricultural research is repeated over and over again in the developing countries. Moreover, it is the hope that the recent inclusion of forestry into the CGIAR supported system of international agricultural research centers will provide an opportunity for expanding the global forestry research effort from its' currently very low level.

Within the developed countries, a major cause of funding constraints for agricultural research is the heavy competing financial requirements for funding entitlements and other mandatory programs, national defense, space and science programs, transportation, education and social services, health research, economic subsidies, law enforcement and others. As a result, the real investments for publicly funded agricultural research have declined in recent years in a number of countries.

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Ruben G. Echeverria (1988). Public and Private Sector Investments in Agricultural Research: The Case of Maize.

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In order to strengthen existing research policies and to develop effective new ones, a key need is for analyses to measure the size and distribution of the benefits stream (pecuniary and other) which is expected to flow from research programs (projects) and to estimate the expected research costs. This is necessary in order both to evaluate the consequences of inadequate research funding and to design alternative strategies for increasing and stabilizing research support. Also, documentation, in an ex post fashion of the benefits from past research investments is useful to increase the political commitment to future research.

2. A number of critical research policy issues relate to the distribution of research benefits and costs. In the U.S. and Australia significant progress has been made in evaluating the incidence of research benefits between producers and consumers and among producers by regions, commodity groups, size and income classes of farms, etc. But these measures are almost exclusively for commodity related research for which market quantities and prices are readily available. Crucial externalities such as environmental quality and health and safety effects of both new and established technologies have gone largely unmeasured. Also, the distribution of

research effects at different levels in the production-marketing chain have received little past attention.

An important issue in a number of developing countries is the incidence of research benefits accruing to the poor and the wealthy and to the producers and consumers of staple food commodities versus those for export commodities. And, with respect to export commodities, there is a question of the distribution of research benefits between domestic and foreign consumers (and producers).

Much of the analytical methodology is already in place to evaluate the incidence of R & D benefits and costs for market commodities. But improved procedures are needed for evaluating research benefits for non-market goods and services and for evaluating important externalities including environmental interactions with agriculture and forestry. Moreover, little research has been done at all on the incidence of research benefits and costs for most developing countries. The output of such analysis can play a vital role in improving the establishment of research priorities and in determining how the research can be most appropriately funded.

3. The question of who should fund public sector agricultural research and by what funding mechanism(s) are issues flowing rather directly from issues 1 and 2. An often cited principle of research funding is that the beneficiaries should pay the bill. But this principle encounters difficulty, for example, when low income consumers are a primary beneficiary of agricultural research. A second question of long standing consideration is the one of whether the procedure of allocating Federal Hatch Funds to State Agricultural Experiment Stations on an historical formula basis (or something akin to this procedure) or a system of competitive grants best serves the public interest in producing high quality, relevant research. Among the questions raised are those of the value of peer evaluation of research proposals, on the one hand, and the continuity of research funding for Land Grant institutions, on the other hand. A second question is the one of the appropriate uses of commodity check-off funds to support public research. And there are numerous other questions relating to the appropriate bases for financing agricultural research.

4. With a major increase in private sector agricultural R&D and with severe budget constraints on public research, a number of important issues have been raised relative to the appropriate mix of private and public research. A key issue is the extent to which important basic research must be conducted by public sector institutions if it is to be conducted at all. A second issue relates to the extent to which public and private research are complementary (or competitive) in the production of agricultural technology. A third issue is whether public institutions should completely relinquish research in areas that private firms can do for profit, such as hybrid corn research. There is a concern that if this is done, fewer people will be trained in these areas to work in the private sector. Still a fourth issue relates to the appropriate set of policy incentives to induce private research (the granting of proprietary rights and tax benefits are key examples) and to curb the development and implementation of technologies with adverse effects.

In developing countries, a complex set of national, regional and international research institutions operate with limited public funding. But recently, private agricultural R&D has grown in importance. Unfortunately, there is little quantitative data on how much private agricultural research is being done or what its' impacts are. This lack of information can lead to poor decisions by government research administrators and other policy makers. Moreover, excessive regulatory mechanisms in a number of countries stifle technology development and/or transfer as does the inability of private firms to protect intellectual property rights.

5. The multitude and diversity of possible agricultural research projects and programs coupled with limited research resources makes it imperative to establish priorities from within the portfolio of possible research options. Such prioritization is a key prerequisite for the development of more effective research programs. But until recently, aside from some work on congruence analysis (which compares the ratios of gross revenues from individual commodities with the research investment made in these commodities), few attempts to develop operational priority setting procedures have been undertaken. Although some procedures were developed in the late 1960s and early 1970s (Fishel, 1971), their scant adoption may have been in part related to the rapidly expanding research funding available at that time. Now however, a number of additional analytical procedures have been applied in research priority setting. These include refined scoring models, benefit-cost (expected economic surplus) analysis, mathematical programming, simulation analysis, and others (Norton and Pardey, 1987).

Priority setting for agricultural research is a particularly acute policy issue in many developing countries, particularly in Africa, where funding from external donors is poorly coordinated and lacks priority planning. There are, in fact, some developing countries in which research priority issues probably exceed in importance the constraints on total research funds, as witnessed by the excessive

fragmentation of research effort funded largely by external donors in numerous developing countries. Within the developed countries, effective procedures for research portfolio selection are needed to shift research funding from an historical funding base to one more in line with current day societal priorities including those related to food safety, environmental quality and the emerging biotechnologies. This points up the importance of concentrating on "ex ante" rather than "ex post" procedures for research evaluation. And, the research evaluation process needs to incorporate multiple evaluative criteria, not just narrow economic criteria such as rate-of-return on research investment.

Although the allocation of research investments can be greatly improved by effective analysis for priority setting (particularly in developing countries), two additional key requirements are of vital importance. First, a credible information base must be developed to undergird the analytical process. This includes information on research alternatives, including their costs and benefits, their operational feasibilities and their probable outcomes. This requires the integration of research scientists into the process. Second, research policy makers, those who actually control the allocation of research resources, must generally be integrally involved in the priority setting analysis. Otherwise they are not likely to have the first hand knowledge or the personal commitment required to support and implement the results of the priority setting analysis.

6. There is overwhelming evidence that the organizational structure for and the delivery capability of agricultural research institutions and systems are, in many cases, critically ineffective. This is particularly true for national-level research systems in many developing countries, most notably in Africa. Such ineffectiveness occurs for several reasons including (a) a shortage of trained professional research staff, (b) lack of an effective research strategy, (c) lack of adequate state-of-art research equipment and facilities, (d) lack of strong research leadership and administration, and (e) lack of effective inter-institutional communication, planning and coordination.

Although the above listed categories of issues are not independent of those of funding and priority setting, they do require specific data development, analysis and policy implementation for their resolution. For example, it is generally necessary to conduct an inventory and evaluation of existing institutions in the country before arriving at conclusions about needed remedial policies. Another need is to provide improved rationalization for the organization and structure of the global agricultural research system (Ruttan, 1986) and to evaluate a broad set of issues of research effectiveness and efficiency relative to the centralization and decentralization of research.

7. For developing and developed countries alike, a number of questions pertain to the issue of manpower, planning, recruitment, training and management of research personnel. As the economic importance of agriculture declines in the developed countries, so does the visibility and professional status of agricultural scientists. Even now some applied agricultural disciplines are experiencing shortages of well-trained scientists. And, in the basic sciences, scientist interests in plant and animal research must compete with interests in human medicine, electronics and other fields. In short, well-designed policies are needed for effective recruitment and retention of agricultural scientists. For a number of developing countries, a common key need is to develop a long-term staffing program and then to provide the training programs necessary to implement the required upgrading of human resources.

In a number of developing countries, particularly in Africa, the shortage of well-trained agricultural scientists is often cited as an even more critical constraint than that of funding for the implementation of effective agricultural research programs. In any event, additional trained manpower is a critical need which must be backed with an evaluation of specific disciplinary requirements, training needs (including funding support) and retention policies. The latter very often relate centrally to personnel policies for salary and related benefits and to opportunities for professional advancement. Finally, effective training programs are needed to prepare current scientists for their future roles in research management and administration.

8. Interrelationships between agricultural research and technology policies and other areas of public policy have become so complex as to almost defy enumeration. But of clearly emerging world-wide importance are the trade-offs between specific areas of research (technology discovery) and policies relating to environmental quality, human health and safety and international trade and development. It is clear that agricultural research and technology must increasingly pass requirements for environmental friendliness and human safety. Thus, these requirements need to be placed in the forefront of agricultural research policy along with traditional goals of income, production efficiency and food security. Although key interrelationships between research and technology policies and policies for commodity supply control, price supports, resource subsidies and trade have long been apparent, little has been done to measure these interrelationships or to propose strategies for minimizing the conflicting results of these policies. A key example of conflicting

policies in developed countries is that of public policies which support output enhancing commodity research while implementing long-term commodity supply controls. Another is that of implementing high commodity price supports while supporting research to increase the trade competitiveness for the same products in world markets. In developing countries policy interrelationship issues often include those of trade-offs between output expanding research and low food price policies and/or commodity export taxes which reduce farmer incentives. Although some continuing conflicts between research policy and other policy areas are probably inevitable, improved information on policy trade-offs and intersectoral linkages (e.g., agriculture and forestry) is essential in reducing welfare losses from inconsistent policies. Moreover, effective research can also identify areas where positive policy interrelationships can be articulated and implemented.

9. Agriculture has in recent years become increasingly science and technology oriented. As a result, science and technology policies now overlap heavily those of agricultural research and technology policies. The extent of this overlap was increased greatly with the major expansion in use of chemicals, particularly pesticides, in agriculture in the 1960s and 1970s. It became even more pronounced with the recent advent of the emerging biotechnologies which have induced major research efforts on plants and animals of economic importance to agriculture.

The extensive use of toxic chemicals exposed agricultural research and technology to the broad policy areas of human health and safety and those relating to environmental quality. Extensive contamination of ground water supplies by agricultural chemicals is an issue of critical importance. So is the issue of chemical residues on food supplies. Some of these issue areas have been operating under the evaluative scrutiny and regulation of institutions outside of agriculture (e.g., EPA, FDA, and others) for some time. Research policies related to agricultural biotechnology have quickly become intertwined with a broad set of issues relating to intellectual property rights, to environmental quality and human health and safety and to international technology transfer. Thus, not only does agricultural research policy interrelate to other agricultural policy areas, it now interrelates with broader policy areas of science and technology as well. For example, policy issues relating to use of animal biotechnology products such as BGH and PGH relate to those for hormone use generally.

The issues are both domestic and trade related. Further expected developments in the form of genetic transformations will broaden even more the exposure of agricultural research (and the agricultural production sector) to broader science, technology and trade policies. And, issues relating to agricultural biopesticides include, for example, those of release into the environment of products with potential adversity to naturally occurring biological populations. The recent controversy over the release of so called "ice minus" bacteria was only the first in a long list of likely research and regulatory policy issues which will be resolved in large degree within the context of broader science and technology policies. But agricultural research interests need evaluation and articulation as a key input into these broader policies.

What are the implications for future agricultural research policy of the above mentioned issues? Clearly the future research policy agenda will include a number of ongoing issues relating to research funding and organization, priority setting, distributional effects of research and appropriate policies for the emerging biotechnologies, but it will also include a number of new issues including some not mentioned here. And the resolution of a number of these issues can be expected to impact heavily on the performance of the food and fiber system in both the developing and developed countries. Much policy analysis is needed, for example, on the relationships between research policies and their impacts on trade and development (and conversely). And, the welfare status of both producers and consumers world-wide will be impacted by the amount and content of future agricultural research. Positive impacts for the poor can be greatest in those developing countries where the food-population balance remains precarious and where a high proportion of the population is still engaged in agriculture. But welfare issues are also great in those countries where economic affluence permits extensive choices relating to environmental quality, food safety and other dimensions of the quality of life.

If the above listed and other research related policy issues are to be debated with informed judgement relative to their economic, social and technological implications, an extensive information base must be developed. And resulting information must be transferred to decision makers via effective advisory and training activities.

A summary of collaborative arrangements between CIFAP and ISNAR is presented in the Appendix.

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APPENDIX

Collaborative Arrangements Between CIFAP and ISNAR

The following paragraphs describe briefly historical and ongoing agricultural research policy work at the University of Minnesota and the joint program of work between The Center for International Food and Agricultural Policy (CIFAP) and the International Service for National Agricultural Research (ISNAR) located in the Hague, Netherlands.

The Department of Agricultural and Applied Economics at the University of Minnesota has historically had a major research and training program involvement in agricultural research evaluation and policy. This includes research conducted by Philip Pardey, Willis Peterson, Vernon Ruttan, G. Edward Schuh, Burt Sundquist and others. A number of graduate students have written theses on related topics, both on domestic and on international topics. Although it is difficult to establish an initial date for initiation of this work, Willis Peterson's Ph.D. thesis at the University of Chicago, "Returns to Poultry Research in the U.S." in 1966 was an early contribution followed by the 1969 Symposium held at the University of Minnesota which resulted in publication of Resource Allocation in Agricultural Research, edited by Walter Fishel. This was followed by the International Conference at Airlie House, Virginia in 1975, which resulted in the volume, Resource Allocation and Productivity in National and International Agricultural Research, edited by Arndt, Dalrymple and Ruttan. Subsequently a Regional Research Project (NC-148) "Analysis of Returns to Agricultural Research" and later an Interregional Research Project (IR-6) on evaluation of agricultural research were developed with major inputs from this department. Burt Sundquist has coordinated the program of IR-6 for the past 5 years.

In 1980, ISNAR came in to being as one of the International Agricultural Research Centers established by the Consultative Group on International Agricultural Research (CGIAR). Its particular responsibility is that of working with individual developing countries in an effort to upgrade their national-level agricultural research systems. The major program of ISNAR is that of providing advisory services to developing countries but they also have responsibilities for training and research. Vernon Ruttan was an early supporter of ISNAR and served on its Board of Trustees from its inception until 1986. Also, for several years, under the leadership of Vernon Ruttan, the Department, ISNAR and USAID collaborated on a series of training programs for research leaders (both from the U.S. and from Developing Countries) on issues and policies of research policy and administration. In 1985, Phil Pardey joined the staff of ISNAR while completing his dissertation with Willis Peterson and continuing a strong involvement in research on U.S. agricultural research policy. For the past several years Phil Pardey has been jointly funded by ISNAR and the IR-6 project in the department while dividing his time between the Hague and St. Paul. This arrangement has provided an excellent opportunity for joint work between the department and ISNAR, and in early 1989, during Burt Sundquist's single quarter leave in the Hague, CIFAP and ISNAR signed a cooperative agreement for a future program of joint research and training on research policy related topics.

Since Phil Pardey has working relationships through ISNAR with the Australian Center for International Agricultural Research (ACIAR) in Canberra, we are in a position to have close communication with that Institution, with other Australian institutions and with selected Asian countries as well.

The employment of Ruben Echeverria by ISNAR upon completion of his Ph.D. at the University of Minnesota in 1988 and the impending employment of Shenggen Fan at ISNAR under the three-way linkage between CIFAP, The Rockefeller Foundation and ISNAR (to do research on the Chinese agricultural research system) also brings us in closer contact with agricultural research institutions and developments in Latin America and China. Also, collaborative research between ISNAR, CIFAP and The Instituto Nacional de Technologia Agropecuaria (INTA) of Argentina is currently being negotiated.

One of Phil Pardey's major efforts at ISNAR has been to initiate the development of an International Data Base for Agricultural Research. The initial data base volume has been published (Pardey and Roseboom, 1989) by Cambridge University Press and a contract has been signed for a second volume entitled, "Agricultural Research Policy and Issues" which will include policy analyses based heavily on the initial data base volume. The third volume entitled, "Priority Setting For Agricultural Research" is already in draft form.

Concurrent work has been aimed at upgrading our domestic data base on agricultural research and conducting evaluative analyses drawing on this data base. Comprehensive work on U.S. agricultural deflators has already been published (Pardey, Philip G., Barbara Craig, and Michelle L. Hallaway. "U.S. Agricultural Research Deflators: 1890-1985." Research Policy, 1989.) and a report tentatively titled, "A Statistical Compendium of Agricultural Research Activity in the U.S.: 1889-1986" by Hallaway and Pardey should be published during 1990. CSRS has also contributed to the funding of the latter work. Finally, in terms of U.S. focused research, drawing on the data base developed by Pardey, Hallaway and Craig, Phil Pardey and Barbara Craig are now working on a set of econometric analyses which should be in draft manuscript stage in early 1990. The Minnesota IR-6 project is providing modest financial support for Barbara Craig to help complete this work at an early date. Several journal articles are expected to result from this effort.

On the training front, CIFAP contemplates continuing joint efforts with ISNAR for training research leaders and administrators from the developing countries and we will be discussing a next possible training effort at an early future date. In addition, planning is underway to initiate a new graduate-level course in agricultural research policy.

Clearly CIFAP linkage with ISNAR has been a highly productive and visible one which should be continued for our joint benefits. And the agreement between CIFAP and ISNAR facilitates such a continuing program of joint work.

In the longer term, we probably need to broaden our program of work in research and technology policy (including research evaluation) to give attention to important new research objectives (and externalities from existing technologies) relating to environmental quality, food safety, structural effects on the agricultural sector (both economic and social), and international trade. Thus, a broad range of technology assessment work deserves future attention.