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Revamping Agricultural R&D

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Agricultural research and development (R&D) is big business. Worldwide investments in public-sector agricultural R&D totaled about US$17 billion in 1990: US$8.5 billion by developed countries and $8.8 billion by developing countries. The international research centers of the Consultative Group on International Agricultural Research (CGIAR) spent an additional $286 million on agricultural research. Private-sector spending is substantial, too; for example, U.S. firms alone spent a further $2.8 billion on agricultural research in 1990.

But "business as usual" may not be sustainable. As governments trim budgets, public support for national and international research is coming under closer scrutiny. Budget makers are asking whether the current R&D institutions are still needed. How should they adapt to accommodate changes in science (such as modern biotechnology), changes in scientific institutions (such as plant variety rights), changes in society (demands for both a protected environment and safe, cheap food), changes in agriculture itself (fewer but better-educated farmers in some countries, increasing numbers in others), changes in the markets for agricultural products (including more international trade and an evolving product mix), and changes in the economy in general (the declining relative importance of agriculture)?

Although the details of the debates concerning research policies differ from country to country, many of the fundamental questions about the public role in agricultural R&D are common to most countries. Certainly the perception is widespread that agricultural R&D needs to be revamped and revitalized. There is also a growing awareness that simply seeking more dollars is not the answer. The financing, organization, and management of public-sector R&D will have to be dealt with in an integrated way.

Investment Trends and Intensities

Global investments in public agricultural R&D have increased more than threefold since the early 1960s. Over the past three decades, R&D expenditures in the developing countries grew faster than in the developed countries, so that by the late 1980s the developing countries spent more on agricultural research than the developed countries. This contrasts sharply with 30 years ago when developed countries accounted for over 65 percent of the world's public-sector research. By the end of the 1980s, however, the growth in agricultural research investments had slowed considerably, particularly throughout the developing world, where research investments had even begun to shrink in real terms in many countries.

Sub-Saharan Africa exemplifies these developing-country trends. Over the past three decades, the development of research staff has been impressive. There were significant increases in the number of researchers (a sixfold increase if South Africa is excluded), in Africanization (from about 90

percent expatriates in 1961 to 11 percent in 1991), and in education levels (over 60 percent of national researchers held a postgraduate degree in 1991). Developments in agricultural research expenditures were less positive. After reasonable growth in spending throughout much of Africa in the 1960s and early 1970s, growth largely stopped in the late 1970s. As a consequence, real spending per scientist has fallen by 2.6 percent per year since 1961, with the rate of decline accelerating from 1.6 percent a year during the 1960s to 3.5 percent a year during the 1980s.

For comparative purposes it is often more meaningful to relate agricultural research expenditures to the size of the agriculture sector (Table 1). From the early 1960s to the mid-1980s, these research intensity ratios almost doubled for developed and developing countries alike. Since then, China's research intensity ratio has stagnated, while research intensity ratios have shrunk considerably for many national research systems throughout Africa. In contrast, the intensity ratios for public spending on agricultural research in the United States and Australia continued to climb throughout the 1980s.

Table 1--Agricultural research intensity ratios

Region or Country	Number of Countries	1961-65	1971-75	1981-85	Latest Year
				(percent)	
Developing regions					
Sub-Saharan Africa, excluding South Africa	17	0.42	0.67	0.76	0.58(a)
South Africa	1	1.39	1.53	2.02	2.59(a)
Asia and the Pacific, excluding China	15	0.14	0.22	0.32	. . .
China	1	0.57	0.44	0.42	0.42(b)
Latin America and the Caribbean	26	0.30	0.46	0.58	. . .
West Asia and North Africa	13	0.28	0.50	0.52	. . .
Developed countries	18	0.96	1.41	2.03	. . .
United States	1	1.32	1.36	1.93	2.22(c)
Australia	1	1.54	3.56	4.52	4.42(d)

Source: Updated data from J. R. Anderson, P. G. Pardey, and J. Roseboom. 1994. Sustaining growth in agriculture: A quantitative review of agricultural research investments, Agricultural Economics 10: 107-123.

Note: Agricultural research intensity ratios are research expenditures expressed as a percent of agricultural gross domestic product.

(a)1991 estimate (b)1993 (c)1992 (d)1988

The Payoffs to Agricultural R&D

The payoff to research can be summarized either by measuring the private rate of return (private costs and benefits to the investors in the research) or measuring the social rate of return (costs and benefits to society as a whole). Most studies of the private and social rates of return to agricultural R&D have concluded that they have been very high--typically more than 20 percent per year--compared with 3-5 percent per year for the long-run, real rate at which governments borrow money.

Some policymakers are skeptical of these reported rates of return, and there are grounds for questioning the evidence. Most studies did not adjust for the effects of price-distorting policies on research benefits, nor did they take full account of external costs such as the degradation of natural resources as a result of research. These omissions could lead to over- or understatement of the benefits and the rates of return. Most did not adjust for the effects of the social costs of market distortions arising from the taxation to finance the R&D, nor the costs of enforcement, compliance, collection, and administration of taxes. This will lead to an understatement of the social costs and an overstatement of the social rate of return.

On the other hand, a number of factors could lead to underestimated rates of return to agricultural R&D, including the omission of benefits from agricultural R&D that spill over into nonagricultural applications and the consequences of, say, environmental, food safety, and social science research that are not reflected in conventional productivity or rate-of-return measures.

While there are grounds for questioning individual study findings, a careful reassessment of this body of evidence should not change the main result: rates of return to both private- and public-sector agricultural R&D are high. The data support the view that such investments are a particularly productive use of scarce resources. These high rates of return justify the governments' past involvement in agricultural R&D, and since the rate of return to R&D is much greater than the borrowing rate, investment in agricultural research, in general, has been much too low.

The Rationale for Government Involvement

Without government involvement, too little agricultural R&D would take place. Underinvestment by the private sector arises from both the nature of agriculture (typically, individual farm businesses are too small to undertake effective R&D) and the nature of R&D (often individual inventors cannot capture all of the benefits from their inventions). These twin sources of "market failure" in agricultural R&D are endemic, but may be especially important in developing countries. Their effects on R&D may be exacerbated by other developing-country problems, such as pervasive distortions in commodity and capital markets. Therefore, government intervention is

warranted to correct the market failure and to promote a greater total investment in agricultural R&D, especially in research areas with relatively low private R&D incentives and relatively high social payoffs.

This is usually interpreted to mean use of more taxpayer dollars to finance more public-sector R&D. Other government policies might also be used to improve the economic efficiency of agricultural R&D in terms of the total resources devoted to R&D, the allocation of those resources among research areas and research institutions, and the efficiency with which the resources are managed and utilized. Thus going beyond "more dollars" raises hard questions concerning the appropriate mix of private- and public-sector R&D activities and the use of economic principles in the management of resources to finance R&D in the least-cost way and to allocate the resources to the areas with highest social payoff.

Appropriate Government Intervention

What should governments do? There are few easy answers. In many developing countries governments have stifled innovation. Government interventions in commodity markets have often reduced the payoff to improved productivity in agriculture. Any movement in the direction of freer trade in agricultural goods is likely to enhance private incentives in developing countries to finance and conduct agricultural R&D and to adopt the results. Uncertainty about the future in countries with unstable political regimes also discourages long-term investment in knowledge and other capital. That such distortions are likely to persist adds to the reasons for further interventions to promote a more economic quantity and mix of agricultural R&D investments.

The ideal intervention by governments would be to combine their own investments in R&D and other incentives to private R&D so that the net social benefits would be as great as possible. This entails getting the total amount of investment right as well as the right mix of projects and programs, financing arrangements, and R&D executing agencies. While the ideal mix may not be achieved, movement in the right direction could be highly beneficial.

Increasing the total R&D budget is clearly a good idea, but it must be done so that benefits are sure to outweigh costs. Least-cost sources of funds must be found. And since public funds will always be scarce, especially in developing countries, those funds that are available for R&D ought to be allocated to the use with the highest social payoff. This is because agricultural R&D is generally best used to foster long-term economic growth rather than to pursue shorter-term redistributive objectives. Agricultural R&D priorities that do not emphasize the net social payoff can be unduly expensive sources of scarce public resources.

How much is enough? Many developed countries have for some time invested over 1ápercent of their agricultural GDP in agricultural R&D. They have even increased their research intensities over recent years while apparently preserving the healthy rates of return of the past. But the fixed factors that condition these rates of return--such as the institutional, policy, and farming contexts within which the research investments are made--vary markedly from country to country. Hence rules of thumb, such as the one that says that 2 percent of the value of agricultural production should be invested in R&D, are far from adequate. The answer clearly must depend on the nature of the research and on other opportunities that must be forgone in order to finance R&D investments. The prospect of famine alone does not justify a large research investment. The investment must also have a chance of alleviating the problem. Different research intensities will be appropriate for different research programs, in different places, and at different times, depending on the expected costs and benefits.

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