POLITICOECONOMIC FACTORS AFFECTING PUBLIC AGRICULTURAL RESEARCH INVESTMENT IN DEVELOPING COUNTRIES

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It is now well established that agricultural research is an important contributor to technological change and hence economic growth (Arndt, Dalrymple, and Ruttan). It is equally well established that public support for many types of agricultural (especially biological) research is necessary because of the public good nature of these research findings. An important question for developing countries, then--especially those in which agriculture dominates the economy and where public funds are difficult to raise--is whether the optimal amounts and types of public research investments are being undertaken. This paper addresses this question by drawing on the emerging economic theory of politics. This theory shows that on a priori grounds one should not expect an optimal allocation of public resources to agricultural research. Rather, one should expect both underinvestment in agricultural research and an excessively labour saving bias in the types of technologies produced by that research. If this were supported by empirical evidence, it would have a number of important policy implications, as discussed in the final section of the paper.

Certainly the available evidence is not inconsistent with the paper's findings. As table 1 shows, virtually all studies on social rates of return to research have found average internal rates of return well above those of many other investments--typically more than 25 percent. True, they are not marginal rates of return, and inherent in them are numerous problems of measurement (Arndt, Dalrymple, and Ruttan, chapter 6). Nonetheless, the informed consensus seems to be that even if allowances are made for measurement biases, marginal rates of return are still extremely high, implying considerable underinvestment (to varying degrees between countries and commodities) in this important source of economic growth (Arndt, Dalrymple, and Ruttan, chapter 1). In addition, numerous scholars are concerned that there is an excessively labour saving bias embodied in new agricultural technologies in developing countries. They feel that perhaps lower yielding crop varieties which make less use of purchased inputs relative to labour would be more profitable for societies with relatively high labour to capital ratios, and in particular would be more profitable for the mass of small farmers with access only to expensive credit. If this is in fact so, the production of such technology would not only boost economic growth more but would tend to produce a more equitable income distribution than currently produced technologies.

It is not the purpose of this paper to evaluate the empirical validity of these alleged phenomena of underinvestment in, and excessive labour saving biases in the technologies produced by, public agricultural research in developing countries. Instead, it is to ask whether there are any a priori reasons as to why one might expect such phenomena. Government leaders are continually confronted with demands from various groups and individuals for policies of assistance and expenditure of public funds. Their job, in part, is to decide how to raise and then allocate the public funds to meet these demands. Following Downs, one might assume that government leaders are motivated by self-interest as much as any consumer or business person, and that this manifests itself in their seeking to remain in office by providing policies which favour their most supportive groups. Thus, any policy decision can be thought of as depending largely on factors affecting the incentives for various groups of individuals to seek that policy and for the government to provide that particular policy rather than, or in addition to, other policies. In the case of agricultural research expenditures, both the total amount of public funds allocated for research in agriculture as a whole and in individual industries, and the research projects on

Table 1--Agricultural Research Productivity in Developing Countries

	Country	Commodity	Time period	Internal rate of return Percent per annum
Sources of Growth Studies				
Barletta	Mexico	Crops	1943-63	45-93
Bal and Kahlon	India	Aggregate	1960-64	14
		Aggregate	1967-72	72
Evenson	India	Sugar Cane	1945-58	60
Evenson and Jha	India	Aggregate	1953-70	50
Arndt, Dalrymple, and Ruttan, chapter 5	India	Aggregate	1960-72	63
Tang	Japan	Aggregate	1880-1938	35
Cost-Benefit Studies				
Akino and Hayami	Japan	Rice	1915-50	26
		Rice	1930-61	74
Barletta	Mexico	Wheat	1943-63	90
		Maize	1943-63	35
Ayer and Schuh	Brazil	Cotton	1924-67	77+
Flores-Moya, Evenson, and Hayami	Philippines	Rice	1966-75	27+
Arndt, Dalrymple, and Ruttan, chapter 6	Colombia	Rice	1957-72	60-82
		Soybeans	1960-71	79-96
		Wheat	1953-73	12
		Cotton	1953-72	None
Hines	Peru	Maize	1954-67	35+
Kumar, Maji, and Patel	India	Dairy Cattle	1963-75	29
Pee	Malaysia	Rubber	1932-73	25
Scobie and Posada	Colombia	Rice	1957-74	79-96

which those funds are spent, depend on these factors in a direct as well as an indirect way. They depend indirectly on them in the sense that groups also demand and governments supply market intervention policies which have the side effect of influencing the eventual allocation of funds to research via the induced innovations mechanism.

Possible Causes of Underinvestment in Public Agricultural Research

Direct Factors

Agricultural research investment involves large government outlays which have an uncertain (even if high) payoff sometime in the distant future and which do

not provide as obvious a monument to development as, say, steel mills or roads. Public research expenditures are therefore likely to appeal relatively less to government leaders than many other public investment projects, especially in countries that are politically unstable, where politicians' planning horizons are short, and where government revenue is difficult to raise.

In addition, there is little effective demand for public agricultural research from most of the groups who would benefit from new technologies: urban businessmen and consumers seeking lower food prices, farmers seeking lower production costs, farm input suppliers seeking expanding markets, research administrators seeking bigger budgets, and research scientists seeking more publications. Urban consumers, for example, are unlikely to press the government for more agricultural research expenditures, given that any payoff to them individually from such investment is likely to be small and not forthcoming for many years (or not forthcoming at all if the commodity's export demand or import supply is very elastic).

Among those on the land, it is landowners who are likely to reap most of the producer gains from research, via higher land values (Herdt and Cochrane). Landless tenants and labourers are therefore likely to add little to the demand for agricultural research. This is especially so since they constitute probably the least educated, least politically articulate, and least organized group in any developing country, and partly because of the free rider problem of collective action among such a large geographically spread group of people. There is is little incentive for an individual to contribute toward his interest group's seeking of a policy which, if adopted, would benefit him regardless of whether he contributes (Olson).

The strength of demand from land owning producers depends on the numbers involved and the distribution of holding sizes. In some industries, such as rubber, there are two clearly defined groups of landholdings: a large number of small family farms capable of employing little nonfamily labour, and a much smaller number of large plantation estates capable of employing many labourers. The former group is unlikely to be actively demanding research funds, again because of the free rider problem of collective action. The latter group, on the other hand, would have much less of a free rider problem, both because fewer individuals are involved and because each has much more to gain in absolute terms from new cost reducing technologies. So one would expect more effective demand for public agricultural research from industries with a few large firms than from those with many small firms; and, where there is a dualistic industry structure, one would expect the demand to come mainly from large firms.

Indirect Factors

Perhaps more import than direct factors leading to underinvestment in agricultural research are factors affecting the price mechanism and hence the profitability of agricultural research investment as measured by domestic prices. The conclusion that emerges from the induced innovations literature is that the higher the price of a commodity relative to input and factor prices faced by farmers, the more researchers direct their research toward the production of new technologies for that commodity (Hayami and Ruttan; and Binswanger, Ruttan, and others). The well documented bias in trade policies of developing countries towards protecting the import competing industrial sector and often taxing the export of primary products ensures that agricultural production is discouraged relative to industrial production (Little, Scitovsky, and Scott). The reasons for this bias are no doubt complex, but they might include the following. First, there may be a need to raise government revenue via trade taxes, possibly for want of a politically or economically lower cost tax instrument. Second, the incentive for a minor manufacturing industry with a small number of geographically concentrated firms to lobby for import barriers is much stronger than

is the incentive for a dominant rural export industry with a large number of geographically spread farms to seek government assistance or less taxation. The free rider problem is much greater in the latter case, and while import competing assistance can raise government revenue via tariffs, say, assisting agriculture would generally require massive explicit government handouts or reduced government revenue in the case of lowering export taxes. Third, assistance to any one small manufacturing industry has little effect on factor or input prices in other industries, whereas higher prices for rice, say, may have a marked effect on wage rates in the cities of low income countries where rice absorbs a large part of an urban worker's income. Indeed, this effect on wages gives urban industrialists an incentive to lobby for low food prices and to encourage wage earners to do likewise via the threat or practice of street riots. For all these reasons, one might expect agriculture in developing countries to face a less favourable set of prices than the industrial sector, vis-a-vis the free trade situation. This in turn, would induce less agricultural research than would be the case in the absence of government intervention in the market.

Possible Reasons for Excessively Labour Saving Technologies

Direct Factors

Perhaps the most obvious reason one might observe a labour saving bias is that many new technologies are simply adaptations of technologies transferred from higher wage countries. Inappropriate though they are from an equity point of view, it may still be worthwhile adapting and promoting them from an efficiency viewpoint; that is, if the net return from doing so is greater than that from domestically producing more appropriate technologies. Similarly, if an industry's structure changes from mainly large to mainly small farms or plantations (due, for example, to land reform), it is conceivable that it still pays to continue at least some research begun earlier if a great deal of relevant human capital and knowledge is already available in the country's research institutes, even though such research may produce technologies less appropriate for the present than the past industry structure.

A further reason for biased new technologies may be that scientists and perhaps government planners and the ruling elite tend to be interested more in technical than in economic productivity indices, and, in particular, often look to increase output per unit of land or labour without considering the farmer's credit constraints. Their fallacious line of reasoning may simply be that given the amount of land and labour in the rural sector, the obvious way to increase food output is to inject capital into the sector both directly and via new capital using technology.

It is important to note at this point that technologies appropriate for large farm circumstances may well be unsuitable for small farm circumstances. This is because large farms may face different factor prices than small family farms. Hired labour for the former is more expensive than family labour for the latter because large farms have to cover the costs of recruiting and supervising labour and have to pay sufficient wages to cover the labourers' job search and commuting costs, which could be considerable if permanent employment were not offered. Capital for large farms, on the other hand, is generally cheaper than for small farms because there is often a fixed cost component to borrowing and a greater risk in lending to small farms with little or no collateral. For these reasons, large farms face a higher wage-rental ratio than small farms and so are encouraged to demand land augmenting technologies that are more labour saving and capital using than would be appropriate for small farms.

This difference in relative factor prices as between large and small farmers is important because large farmers have relatively more influence on research resource allocation, for a number of reasons. First, because they tend to be

more educated, they are likely to adopt new technologies better and faster than average (Chaudhri). They therefore have a greater incentive to demand agricultural research expenditures than smaller, less educated farmers because by adopting early they may reap quasirents from, say, increased yields prior to wide adoption and a consequent fall in product prices. Second, they tend to be far less numerous than small farmers and so suffer less of a free rider problem in acting collectively. Third, being more educated, they are more politically articulate and socially mobile and thus come in more contact with research scientists, both directly and indirectly via extension officers. Thus, researchers and extension officers tend to become more familiar with the constraints facing larger farmers and may well be unaware of any differences between these and the constraints of small farmers.

In addition, given that job promotion for research scientists depends heavily on their published research output, one would not be surprised to find scientists seeking funds for projects which make full use of their knowledge and skills and maximize their chances of obtaining publishable results quickly. This may well lead to a bias in research proposals toward projects which build on an existing body of literature, especially one with which the researchers are familiar. If that literature is related to more capital abundant countries or to a more capital intensive industry structure of earlier colonial times (as with plantation crops), this bias would lead to the production of more labour saving, purchased input using technologies than may be appropriate for the mass of farmers in today's developing countries. And, one would expect input suppliers such as the agrochemical industries to encourage such a bias.

Indirect Factors

The bias mentioned above would tend to be reinforced by the factor price distortions often present in developing countries. In particular, when credit is subsidized and then has to be rationed, it is usually the larger farmers with more collateral, lower transactions costs per dollar borrowed, and better abilities to bribe loan officers who are served first, leaving small farmers to borrow on the more expensive informal money market (Gonzales-Vega). Indeed, it is possible that subsidized credit policies are sought by the politically more influential large farmers because the distributional effects of such policies are so much in their favour. This is especially so when credit is restricted to investment purposes and excludes working capital needs, because large farmers have less need to borrow for short periods than do small farmers, and small farmers have relatively less use for capital to invest in tractors, pumpsets, or whatever. The resulting factor market distortion further induces the development of more capital using technologies than would be the case with free markets.

Some Policy Implications

The above theoretical discussion suggests that there may well be reasons to expect systematic underinvestment in, and excessively labour saving biases in the technologies produced by, agricultural research in developing countries. If this is so, a number of important policy implications follow. First, economists have a role to play as a pressure group in informing other pressure gorups and governments of any inefficiencies and inequities of present research resource allocation and pricing policies. Second, extension workers need to be encouraged to find out and pass on to scientists more details of the constraints facing the whole range of farmers, not just the larger ones. Third, given the economic and political realities which tend to exclude small farmers from formal (and especially subsidized) credit, it is particularly important from their point of view--and from the eocnomy's as a whole, given their significant contribution to production--that technologies be produced that are less dependent on purchased

inputs. Since for political reasons such technologies may not be forthcoming from national or state agricultural experiment stations, it is even more important that the international research institutes not only make up for any underinvestment in national research but also help to offset the biases against research for small farm conditions.

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OPENER'S REMARKS--E. Dettwiler

It is vital that people know about the discrepancy which exists between the goals in the developing countries and the goals of research activities undertaken in the developed countries to serve the needs of the developing countries. Anderson's paper is not very clear about this discrepancy.

To what extent do agricultural projects also benefit from research in private industry? Does Anderson's paper refer to basic research, applied research, and research projects that are financed through both the public sector and the private institutions?

I fully agree with Anderson when he talks about unilaterally directed research which benefits some large farms, with a view to labour saving technologies. However, this problem not only exists in the developing countries, but is a real problem in the disadvantaged areas of many developed countries. For example, when developing new agricultural machines, private industry often ignores the problems of these disadvantaged regions.

Khan gave us some interesting insights into small scale machinery development for labour surplus economies. What he said with respect to the needs of developing countries can be applied in some sense to disadvantaged areas in developed countries.

Some more general questions also arise out of Anderson's paper. To what extent can we allow the research to be autonomous? Are not many scientists seeking to illuminate their own scientific halos without regard to the public good?

One should be able to foresee the success of the research and know how to present it to the authorities concerned who should then support the project financially. This again raises the problem of estimating costs on the one hand and the specific returns on the other. Anderson identifies various measures and methods for assessing the success of research, but he does not evaluate them. I would be very interested to hear more about this, particularly with reference to the specific circumstances in the developing countries. It is well known that the procurement of information necessary for the development of a research project is sometimes very difficult and varies from one country to another.

Anderson supports the idea that research administrators need to be convinced about the potential contribution of economists to advance evaluation of research proposals. The agricultural economist has a very central position; the need is great but he cannot solve all the problems with mathematical models. His professional skill must be very broad, and he must be able to quantify the benefits of research. it is also important that he know his own limits and is prepared to collaborate with specialists in other disciplines.

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RAPPORTEUR'S REPORT--Bernard H. Sonntag

A similar analysis of international institutions would be useful. The approach is applicable to both developed and developing countries, but the empirical efforts

on the topic have been directed to the latter. International institutions face different political constraints than do national institutions and thus have some capacity to remedy defects in research programmes within countries.

Failure of researchers to sell their product to administrators is one factor in limiting research funding. Return to the whole research package may not be as high as some of the published estimates suggest--usually only the successes are reported.

There are varying time periods and high risks associated with agricultural research. There has been a lack of success to date on utilization of atmospheric nitrogen, despite considerable efforts. There is a tendency toward underinvestment in research with a long gestation period; for example, development of perennial versus annual crop varieties. High rates of return in nonagricultural research might explain underinvestment in agricultural research.

Contributing to the discussion were Judith Heyer, Howard A. Osborn, Ulf Renborg, Chandrahas H. Shah, and Juan Pablo Torrealba.