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# THE CHANGING DYNAMICS OF GLOBAL AGRICULTURE

A Seminar/Workshop on  
Research Policy Implications for  
National Agricultural Research Systems

DSE/ZEL Feldafing  
Germany  
22-28 September 1988

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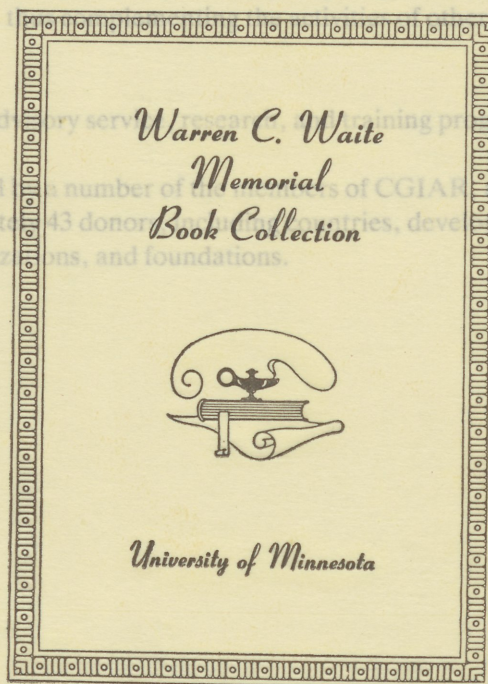


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Of the thirteen centers in the CGIAR network, ISNAR is the only one that focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on research policy, organization, and management issues, and assistance to research agencies.

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# **THE CHANGING DYNAMICS OF GLOBAL AGRICULTURE**

## **A Seminar/Workshop on Research Policy Implications for National Agricultural Research Systems**

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# **Determinants of Support for National Agricultural Research Systems**

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## **Introduction**

Leaders of national agricultural research systems (NARS) in developing countries are often told that they must increase their agricultural research effort if they are to have an impact on agricultural productivity in their countries. This is usually expressed as a need to raise the ratio of expenditure on agricultural research as a proportion of agricultural gross domestic product to levels approximating those of current high-income countries. System "doctors" keep confidently recommending their medicine in the form of a "2% solution".

This paper discusses and identifies new ways to improve the level of support for NARS. Most of ISNAR's work has been to help improve the organization and management of agricultural research. However, system leaders have often wanted ISNAR to help them improve the policy environment within which they must operate. One of the ways ISNAR can do this is to generate new information about the funding and operation of NARS which can improve the basis on which decisions are made. Another is to investigate structures which facilitate increased support and mechanisms for mobilizing resources. The policy dialogue must then involve national policymakers, NARS leaders and their clients, and stakeholders.

Over the last 2.5 years, ISNAR has been collecting and putting into commensurable form, time series data on human and financial resource commitments to agricultural research throughout the world (Pardey and Roseboom, *in press*). These data permit a preliminary analysis of support to research by countries at different income levels, and the development of expenditures through time.

In this paper, we consider the target ratio often used as a standard of adequate effort. Then, by looking at the components of this ratio, we attempt to identify the points of intervention and possible mechanisms which can help increase the level of support to NARS. From a discussion of points of intervention and mechanisms, we bridge the theory of public finance with issues of research organization and management. It is, therefore, at this early stage of analysis of the data, that a discussion of research directions is appropriate.

### **The Agricultural Research Intensity Ratio (ARI)**

The Agricultural research intensity ratio measures public-sector expenditures on agricultural research as a proportion of the value of agricultural gross domestic product (AgGDP). The 1974 UN World Food Conference suggested that developing countries should aim for a 1985 target of 0.5% of AgGDP on agricultural research (UN, 1974:97). It was with the publication of the World Bank's Agricultural Research Sector Strategy that the "2% solution" was enshrined: a "desirable [agricultural research] investment target . . . would be an annual expenditure [recurrent, plus capital] equivalent to about 2% of agricultural gross domestic product" (World Bank, 1981:8).

In practice, comparisons of research intensity ratios have been useful to make policymakers aware of the importance others attach to agricultural research, particularly when their ARI ratio is significantly below those of similar countries. It also raises the question of why governments tend to underinvest in research when they expand their bureaucracies in all other respects.

However, such ratios may be misleading for a number of reasons:

- They are inherently unstable and can vary because either the numerator or denominator changes.
- Over time, the ratio should be expected to rise and fall as systems go through periods of investment and reinvestment.
- Countries with different resource bases and agricultural potential need not adopt the same strategy for agricultural development, nor be expected to give the same emphasis to research relative to other forms of intervention in the agricultural sector.

The result is that many research leaders are unnecessarily apologetic about their failure to reach the target, when in fact the target is a moving one and their effort is considerable for countries at their levels of income.

### *A decomposition of the agricultural research intensity ratio*

It is worth decomposing the ARI into a number of components which have analytical significance. We create an identity in which the ARI is expressed:

$$ARI = ARE/AgGDP = (ARE/AE) \cdot (AE/BUD) \cdot (BUD/GDP) \cdot (GDP/AgGDP)$$

where

ARE = Agricultural Research Expenditure

AgGDP = Agricultural Gross Domestic Product

AE = Agricultural Expenditure

BUD = Total Government Budget

GDP = Gross Domestic Product

The expression on the right side is clearly identical to the original ARI ratio, but each component has some meaning in terms of agricultural development or public finance.

ARE/AE expresses the priority that is given to agricultural research as a share of total government intervention in the agricultural sector. We have called this the relative research expenditure ratio. It may be taken as a measure of the importance that the country attaches to research as part of its agricultural development strategy.

AE/BUD expresses the importance that intervention in the agricultural sector is given in the national budget. A careful monitoring of this ratio is important, especially if agriculture is represented as the "priority of priorities".

BUD/GDP may be either a measure of the fiscal capacity of the country or the fiscal effort of a country. In countries at an early stage of development, the fiscal capacity may be very weak and taxes concentrated on a few (often agricultural) commodities with a limited ability to generate revenue. However, as a country moves up the income scale, both its taxable bases and its administrative capacity to collect taxes improve. This makes the fiscal effort a matter of political will rather than good fortune.

GDP/AgGDP is the inverse of the share of agriculture in the gross domestic product, a good indicator of the structure of the economy and highly correlated with per capita income.

We use one additional ratio in our tables, the public agricultural expenditure ratio:

AE/AgGDP measures the public expenditure on agriculture in relation to the size of the agricultural sector itself. It encompasses several of the other expressions.

$$PAE = (AE/BUD) \cdot (BUD/GDP) \cdot (GDP/AgGDP)$$

Improvements in the ARI ratio, therefore, will be a result of efforts to increase the share of research in agricultural expenditures, the share of agricultural expenditures in the national budget, and the share of the budget in national income, while rising incomes will produce a declining share of the agricultural sector in the total national product.

### ***The evolution of support: Evidence from the ISNAR Indicator Series***

The data in this section are drawn from Pardey et al. (1988). Table 1 presents a vivid picture of what is happening to research expenditures through time and across countries at different income levels.

The data used in these comparisons have been carefully prepared to the following standards:

- The institutional coverage is comparable in all periods.
- Public support for agriculture, livestock, forestry, and fisheries is included.
- Calculations were originally made in constant currency units so that distortions were not introduced by currency conversions.
- The units were deflated to constant 1980 values using country-specific GDP deflators before performing any growth-rate calculations.

There are a number of stylized "facts" which are evident in these figures:

- There has been a divergence in the ARI ratios with high-income countries raising their ratios faster than the low- and lower-middle-income countries.
- Public agricultural expenditure ratios (expenditure on agriculture relative to the size of agricultural product) rise significantly across income classes as countries move from net taxation of agriculture to net subsidization of agriculture. Note that the burden of this large expenditure on agriculture by high-income countries remains modest when spread over the non-agricultural population.



**Table 1. Mean Agricultural Research Intensity, Public Agricultural Expenditure, Relative Research Expenditure Ratios, and Share of Agriculture in Total Public Expenditure by Time Period and Income Group (in Percent)**

Income Group <sup>4</sup>	Agricultural research intensity ratio <sup>1</sup>		Public agricultural expenditure ratio <sup>2</sup>		Relative research expenditure ratio <sup>3</sup>		Share of agriculture in total public expenditure 1970-85
	1970-85	1980-85	1970-85	1980-85	1970-85	1980-85	
Low	0.51 (21) <sup>5</sup>	0.55 (15)	5.08 (29)	5.73 (22)	10.10 (21)	10.34 (14)	9.53 (30)
Lower-middle	0.79 (32)	0.93 (26)	12.55 (37)	9.28 (29)	10.60 (31)	11.32 (24)	7.01 (41)
Upper-middle	1.00 (20)	1.09 (16)	14.83 (25)	18.00 (19)	10.36 (18)	10.96 (14)	5.00 (25)
High (General)	1.93 (19)	2.24 (18)	29.41 (19)	29.37 (17)	8.22 (18)	9.38 (16)	4.02 (20)
High <sup>6</sup> (Central)	1.91 (19)	2.24 (18)	23.21 (19)	23.98 (18)	11.18 (18)	14.72 (16)	4.00 (20)
Total	1.00 (92)	1.20 (75)	12.90 (110)	15.30 (87)	9.94 (88)	10.59 (68)	6.70 (116)

SOURCE: Authors' calculations based on data from Pardey and Roseboom (1987).

NOTE: Excluded from all calculations: Eastern European nonmarket economies, high-income oil-exporting countries (Kuwait, Libya, Oman, Saudi Arabia, Bahrain, Brunei, Qatar), and People's Republic of China.

1. Agricultural research intensity (ARI) ratio = public agricultural research expenditure/agricultural gross domestic product.

2. Public agricultural expenditure (PAE) ratio = government expenditure on agricultural/agricultural gross domestic product.

3. Relative research (RRE) ratio = public agricultural research expenditure/government expenditure on agriculture.

4. Income Groups are defined using the World Development Report (World Bank, 1985) classification (per capita GNP in 1983 US\$), where low = \$400; lower-middle = \$401-1635; upper-middle = \$1636-6850; high = industrial market economies.

5. Figures in parentheses denote number of observations.

6. For comparative purposes, the ratios calculated using central government level expenditures only are included.

- The relative research expenditure ratio ( $ARE/AE$ ), which measures the priority given to research within the agricultural budget, remains fairly constant across income classes.
- The share of agricultural expenditures in total government expenditures ( $AE/BUD$ ) falls across income classes.

An attempt to draw conclusions from these stylized facts can be summarized: low-income countries appear to be making a consistent effort in terms of their budgetary allocations to agriculture and in terms of the share of the agriculture that is going to research. Their failure to raise their ARI ratios may be attributed to their limited fiscal capacity and the large size of their agricultural sectors relative to the total economy.

The importance of being able to spread the cost of agricultural research over a large nonagricultural population (often the primary beneficiaries), is demonstrated in Table 2. This table shows public spending as a proportion of economically active agricultural and nonagricultural populations (Pardey et al., 1988).

The total public agricultural expenditure per person in the agricultural population rises exponentially as incomes rise, while expenditures spread over the nonagricultural population remain modest. Agricultural research expenditure per person in agriculture rises modestly, while agricultural research expenditure per person in the nonagricultural sector scarcely rises.

The results of these analyses by Kang (*in press*) and Pardey and Roseboom (*in press*) suggest that the fundamental limitation to increased public support to agricultural research in developing countries may well lie in the financial and political constraints imposed by overall spending capacity, and agriculturally specific levels of public-sector spending. It suggests that we should be moderate in our expectations about the potential for large increases in public-sector funding of agricultural research in low-income countries.

### **Points of Intervention: Structural and Fiscal Improvements**

Having recognized the difficulty of achieving increases in the ARI because of the structural and fiscal difficulties facing low-income countries, we still believe there is room for improvement if the right policy environment can be created, if the right mechanisms can be put in place to tap potential funding for research, and if resources are used in ways that encourage additional efforts by national governments. However, the need for continuous donor support is evident, particularly at the level of the low-

Table 2. Public Spending as a Proportion of Exonomically Active Agricultural and Nonagricultural Population (1970-85 Average)

	Economically active agri- cultural population	Total government expenditure per capita	Total agricultural expenditure per		Total agricultural research expenditure per	
			Agricultural population	Nonagricultural population	Agricultural population	Nonagricultural population
	(%)		1980 U.S. dollars			
Low	76.9 (37) <sup>1</sup>	245 (29)	30 (28)	125 (28)	2.6 (28)	10.9 (28)
Lower- middle	51.5 (49)	1093 (44)	164 (41)	157 (41)	16.7 (42)	14.6 (42)
Upper- middle	29.0 (71)	2966 (61)	656 (57)	232 (57)	58.5 (59)	14.4 (59)
High	9.5 (20)	7100 (20)	3294 (19)	296 (19)	239 (20)	19 (20)
Total	47.1 (137)	2311 (120)	768 (111)	188 (111)	61 (112)	15 (112)

SOURCE: Authors' calculations based on data from Kang (*in press*) and Pardey and Roseboom (*in press*).

NOTE: All expenditure figures first deflated to 1980 constant local currency units using country-specific implicit GDP deflators, then converted to US dollars using 1980 purchasing power parity indices from Summers and Heston (1988).

1. Figures in parentheses denote number of observations.

and lower-middle-income groups which are experiencing structural changes in their economies. The need is to "help them over the hump" to the point where rising fiscal capacity and growing nonagricultural sectors make sustained support to research easier.

Moving from the stylized facts, we turn to the need for research into the structures and the mechanisms which will improve the policy environment, and increase the flow of resources to agricultural research. Recognizing that it is virtually impossible to make a neat separation, there are structures and mechanisms that appear to be aimed at three types of improvement:

- improving the fiscal effort of the government, which enables it to carry out more of all development activities;
- improving the policy environment for agriculture: raising the ratio of public agricultural expenditures in the national budget;
- improving the policy environment for agricultural research: raising the share of agricultural research within the agricultural budget.

### *Increasing the fiscal effort*

It is arguably beyond the competence and the mandate of agricultural research leaders to concern themselves with general questions of public finance. However, public finance issues are intimately bound up with the success of technology generation and transfer efforts. Distortionary taxes or exchange rates, deficit-induced inflation, and debt-imposed austerity directly affect the path of agricultural development.

Although low-income countries are hard pressed to meet claims on their resources, and there are recent indications that the real value of government's share in the national income is declining in recent years after a period of secular increase, there remains some scope for increasing the share through improved fiscal practices. It is important to note that even small increases in the percentage share of the national income that come to government can mean large increases in the development effort if they are reserved for this purpose. Assume, for example, that a low-income developing country succeeds in raising its fiscal share from 13% to 15% of the national product. If it was previously investing 30% of its budget in development activities, an additional two percentage points of national income would raise the investment rate from approximately 4% to 6% of national income — a 50% increase in development effort. It is for this reason that we should not ignore improvements in fiscal capacity as crucial to improving support for research.



Table 3 shows the pattern of central government revenue as a percentage of gross domestic product by level of income and over time. The low- and middle-income countries have been making efforts to increase the share of the government in national income over time. Moreover, as a country rises from a lower to a higher income class, its fiscal effort rises. The critical increases take place in countries in the lower-middle-income group. It is here that special efforts must be made to ensure attention to agriculture in the expenditure priorities of governments. The conclusion must be that there is still room for "political will" to play a role in raising development efforts.

**Table 3. Total Current Revenue of Central Government as Percentage of GDP**

Income group	1972	1986
Low income	—	15.4
Lower-middle income	16.7	21.4
Middle income	19.1	24.0
Upper-middle income	20.3	25.0
Industrial market economies	21.6	24.1

SOURCE: World Bank (1988).

### *Improving the policy environment for agriculture*

The principal lesson for agricultural research managers seems to be that the agricultural research system must devote some of its scarce resources to analyzing the policy environment. Where decisions are made by economists and planners in ministries of finance and planning, agricultural research institutes must contribute to decision making through improved information, analysis of alternative strategies, and building political support for its activities. There are several activities which are directly in the research mandate of the institutes:

- Analysis of macroeconomic policies which distort the type of technology demanded by producers and impinge on the success of adoption of appropriate technologies. CIMMYT's work on domestic resource costs of wheat versus livestock and potatoes in Ecuador is a good example of the policy dilemma facing research leaders and the role of economic analysis in making decisions.

- Analysis of the rate of return to investment in research to document both the high returns gained historically, and provide some guide to potentially high returns in the future. It is as important to be able to identify what activities should not be undertaken as to make a case for more resources in general.
- Documentation of invisible returns to research. These are the cases where research has prevented major losses to disease, drought, and insect pests, gains which are not always recognized as the equivalent of production increases.

In short, if agricultural research does not invest in the policy dialogue, it cannot complain that its message is not being received.

At the present time, we are not able to make any categorical statements about the impact of organizational structure on the allocation of public resources to agriculture. Some preliminary hypotheses to be tested, however, are:

- Where agricultural development is fragmented across many ministries or parastatal organizations, and where livestock, forestry, and fisheries are competing with cropping to the neglect of conservation and natural resource management, the sector as a whole may suffer from a weak and fragmented message with a negative effect on the resources it receives.
- Large systems which can support decentralized taxing and expenditure power to a degree may encourage increased levels of total support to the agricultural sector. Decentralization associates taxation more closely with the benefits of research, and makes taxpayers more willing to bear the costs.

These are hypotheses which over time we hope to be able to study in greater depth. There is still a need to examine the determinants of agriculture's share in the national budget and the political and organizational factors which affect this ratio. Of particular interest should be the lower-middle-income economies where the fiscal base of the economy is changing rapidly, and the share of agriculture in the economy is declining.

It is with these countries that a commitment to agricultural research and development must be built into the tax and budgetary system so that the public agricultural expenditure ratio can be raised.

## ***Improving the level of resources to research within the agricultural budget***

In this section we look first at structural improvements which increase the support of client groups to agricultural research. This is followed by a consideration of fiscal mechanisms to tap new funding sources in the agricultural sector.

Attempts to increase the share of public agricultural expenditures going to research may not be separable from measures designed to increase the overall level of resources going to agriculture. Public finance specialists have noted that raising the share of a particular item may require new sources of revenue. Averch (1985:179) said:

The budget procedures currently used by S&T (science and technology) bureaucracies rest far more on historical shares and constituent pressure than they do on the most primitive notions of the marginal productivity of research dollars in alternative uses. In part, this is why the bureaucracies are always demanding new resources; their ability to do anything new depends on receiving new inputs, since they are unable to reallocate the resources they have.

***The role of constituent pressure.*** The need for research to establish the support of its constituents was expressed strongly by Dr. W.K. Gamble (1984:51) before a group of Latin American research leaders:

Experience suggests, however, that the long-term viability of agricultural research systems depends on the emergence of organized producer interest groups who are willing and able to exert influence on the legislative and executive processes. This is because the support of agricultural research forthcoming from finance and planning ministries, given the pressures under which these ministries must operate, is not dependable.

To assure reasonable domestic levels of fiscal support on a regular basis, national research program leaders and program beneficiaries have to commit themselves to a sustained political development effort.

This statement fits the Latin American environment and reflects a political economy approach expressed by many Latin American writers. Dr. Eliseu Alves has argued convincingly that periods of crisis provide opportunities for research institutions to gain the commitment of policymakers if they find and use the best strategy for their own situation (Alves, 1987).

The question of whether or not coalitions of agricultural groups always succeed in raising support to agricultural research is seen in a different light by Browne (1987:83,

87), writing about the land-grant system. Although most has been written about the responsiveness of the land-grant institutions to their constituents, where more than 80% of the land-grant system's resources come from sources within the state, Browne notes:

The most extensive and detailed statements of support (for research) come from those interests that are some part of the research effort . . . . Policy positions critical of agricultural research are surprisingly extensive and broad based.

The criticisms of agricultural research, coming from agricultural groups themselves, are diverse and often contradictory. Research is seen as benefiting universities rather than farmers, producing products suitable for industrial processing rather than food which is tasty and nutritious, and introducing technologies which neglect the environment. The conclusion of Browne's thesis is that the veto power of offsetting coalitions will prevent any change in the research agenda since nothing will be seen by all groups as an unambiguous improvement. Meanwhile, the negative chorus of voices may adversely affect overall appropriations.

***Institutionalizing support.*** The move which took place in Latin America to create autonomous institutes in the 1960s and 1970s was intended to make research more responsive to its clients and stakeholders. The move was generally aided by long-term institutional support from USAID, which saw them as a new flexible way of getting research out from under the bureaucracy of the ministries. However, there was a tendency for the institutes to behave as if their constituency lay in the donor community and not in the domestic political structures. USAID began to suffer donor fatigue after many years of declining national support, caused in part by the political isolation of the autonomous institutes.

The latest trend in Latin America is the creation of private research *fundaciones*. They are characterized by the predominance of private-sector agricultural interests on their boards, an attempt to establish endowments to ensure a stable resource base for research, and a mandate to support new agricultural efforts. Through their boards they are expected to become closer to producers, and be responsive to the need for research on nontraditional crops that national research institutes historically are poorly equipped to handle.

The establishment of foundations was one way of overcoming donor fatigue, and fit well with the philosophy of the donor government, which was stressing private-sector initiatives in all areas. Unfortunately, their rhetoric of being a "private-sector alternative to failing national systems" went beyond the reality. They use public-sector funds (coming from aid donors), few of them have their own research capacity, and they must rely on human resources that they draw away from the national institutes.



Whether they represent an increase in total funding to the system (by preventing a decline in aid), or a diversion of resources which would otherwise be available, is yet to be seen. They will face a test of sustainability when the aid-funded projects which initiated their activities arrive at term (Sarles, 1988).

***Tapping sources of funding within agriculture.*** The agricultural sector, however, may often have untapped sources of research and development funding that can be reinvested in the sector. These include support by producer groups for research, production cesses levied by industry councils or authorities, earmarking taxes to research, and formula funds that tie increased government contributions to commitments by donors and other sources of funds.

Production cesses, often voluntarily levied by the producer organization in support of research and development activities benefiting its members, have been valuable sources of research funding for many commodities. They have been credited with at least two advantages:

- They provide an autonomous core of resources which can be used to ensure continuity of the research cadre.
- They are linked closely to producers and ensure that the system is responsive to their needs.

They have proven to be most feasible when the commodity (usually an export crop) faces an elastic demand, when producers can organize themselves to capture the benefits from research (either by appropriating the land suitable to the crop or through marketing the output), or when the industry is facing a crisis and mechanisms are created for an orderly diversification out of the crop.

Research funded by cesses, however, has certain disadvantages. The cess may have a disincentive effect, the base to which the cess applies may be shrinking secularly, and market instability may make forward budgeting uncertain. However, as the case of coconuts in Sri Lanka demonstrates, an institute funded by cesses can still enjoy the advantages of an autonomous core without ceding their right to get additional support from the general budget (Senanayake and Herath, 1981).

The earmarking by the government of certain sources of tax revenue for specific research purposes has not been tried frequently, although earmarking taxes for development is common. Earmarking tends to work well under certain conditions:

- where the objective of the expenditure is universally accepted as "good" (such as health or education);

- where the benefits of the research are recognized and can be appropriated by those who must bear the tax.

Earmarking may also be attractive because many of these characteristics may be present:

- It may substitute for decentralization of tax and expenditure authority where governments are highly centralized. (Taxes on a highly region-specific commodity which are spent on that commodity may prevent the feeling that the region's wealth is being siphoned off to the central government.)
- Once established, an earmarked tax obviates the need to engage in annual political infighting for a budget, although establishing it may require a major political effort.
- It may provide a stable funding source where the tax is linked to the export (foreign exchange) value of the crop and the domestic currency is unstable.
- It may control a tendency for central government to absorb all revenues where a region or sector lacks confidence in the central government's use of discretionary income.
- It may increase donor commitment to a particular activity through some form of linked support.

However, earmarking has certain disadvantages which may arise at some stage in the process:

- It introduces rigidities into the fiscal system. Expenditures may be too rigidly tied.
- Administrations controlling such receipts may build power bases from which they can refuse to relinquish their funding even after the objective for which the tax was earmarked has been achieved.
- They may become a permanent taxing authority outside of the regular public finance system which prevents a reallocation of resources to higher priority uses.
- They may not provide elastic sources of revenue for the sector they are funding either because the sector is facing a declining market or the tax itself has significant disincentive effects.

Earmarked taxes do not necessarily have to come from the commodities they fund or even the agricultural sector. Other candidates include imported articles for mass consumption, luxury goods, and excise taxes on alcohol or tobacco (demerit goods). The condition for success seems to be that the objective is accepted by those who must bear the tax and they have few ways of avoiding it.

### ***New sources of domestic support – Private-sector investment***

Up to this point we have stressed methods of increasing public support to agricultural research. There is now the reemergence of what is being called the "private interest" view of the public sector. It recognizes the imperfections in the public sector's allocation of resources, and argues that the government should invest its resources in a way which encourages a maximum contribution from the private sector. The essential complementarity of public-sector and private-sector research must be exploited in a way which draws additional resources from the private sector (World Bank, 1988).

As Echeverria (1988) concludes from his study of maize:

Complementarity between public and private research contributes to the rate of technical change in agriculture. Farmers will benefit by a larger role of the private sector in developing, transferring and marketing better maize seeds. Public research and regulatory policies should be directed to stimulate private involvement in R & D and seed production by strengthening the public research programs, by training scientists, and by keeping research, production, and marketing regulations to a minimum in order to assure quality and competition.

In order to develop and capitalize on this complementarity, a number of preconditions need to be met (IICA-EDI, 1988):

- New legal arrangements need to be developed which provide for public- and private-sector cooperation, if only to overcome decades of competition and mutual suspicion.
- Incentives need to be provided for industrial support to agricultural research, carried out by, or in association with, the public sector.
- Structure changes need to be made which facilitate private-sector participation in decision making.

Once these preconditions are met, a number of mechanisms which help implement an enlarged commitment of the private sector can be developed. These include public/private-sector consortia for research, contract research by national research institutes and provincial development corporations, and private foundations.

## Conclusion

Bringing the various elements of this paper together, we may argue:

- Developing countries have been making progress in raising their fiscal efforts, in allocating public funds to agriculture, and in assigning importance to agricultural research.
- A particular effort is needed to help lower-middle- and middle-income countries to maintain their concern with agriculture during periods of structural change in which the taxable bases are increasing and the share of agriculture in gross domestic product is falling. It is in this group of countries that the opportunity to raise the ARI is greatest, if only by taking advantage of the structural changes, and without insisting on an increase in the share of the agricultural budget going to research.
- Research leaders have a responsibility to understand the fiscal trends at work, to build political constituencies that support their claims to resources, to contribute resources and political efforts, to participate in the policy dialogue, to propose new sources of resources to meet their needs, and to use the resources so obtained for widespread social objectives and not priorities set by special interest groups.
- Including these functions in the tasks of the research system has important implications for the way research is organized in a country. New structural forms to exploit the complementarity of public- and private-sector research are required.

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