AGRICULTURAL COMPETITIVENESS: MARKET FORCES AND POLICY CHOICE

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DISCUSSION REPORT SECTION VII

D.D. Rohrbach (Zimbabwe)[1]

Alston, Anderson and Pardey remind us that the failure to account adequately for the consumption of natural resource stocks leads to the mismeasurement of agricultural productivity and the misspecification of priorities for agricultural research. In general, agricultural productivity levels are overestimated and research priorities are biased towards the development of technologies which more rapidly deplete a country's natural resources.

The paper suggests the need to conceptualize productivity change in terms of an intertemporal meta-production function incorporating a fuller specification of inputs and outputs over time. Efforts to measure competitiveness in terms of total factor productivity indices need to include consideration of changes in the natural resource stock and associated levels of productive capacity. In the context of research priority setting, the externalities associated with any given technology need to be more explicitly measured.

I find one of the more interesting propositions of the paper to be the suggestion that there is a necessary tendency to develop and employ technology which generates private gains through the creation of unfavourable externalities. The natural resource base is more rapidly depleted because we either do not accurately measure this cost of resource degradation or do not internalize the loss. According to the authors, there is an associated underinvestment in technologies contributing to the mitigation of negative externalities. While clear in concept, the issue becomes quickly complicated when we consider the trade-offs associated with the assessment of alternative technology paths. First, there is the difficulty of accurately measuring the value of natural resource stocks and environmental amenities. Debates persist throughout southern Africa about the carrying capacity of the range and the definition of overstocking. The value of resources can sharply change over relatively limited periods of time, depending on their relative scarcity and changing incomes. Over the past 50 years, small-scale farmers in Zimbabwe, for example, have widely shifted from a strategy of extensive to intensive use of crop residues – a change largely attributable to population growth and the rising value of livestock. The loss of residues has speeded soil degradation, though this has been partly offset by a rising intensity of manure use. The net effect is extremely variable and difficult to measure. As incomes rise, city dwellers have become increasingly concerned about the quality of their water and air.

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Evaluation of the costs of a decline in the natural resource stock is further complicated by different assumptions about our capacity to offset such losses with future investments. We may be prepared to accept the mining of soil nutrients under the assumption that these can be readily replaced if the value of the future farm product justifies the investment. Alternatively, we may assume the possibility of technological change allowing more efficient use of limiting resources in the future, for example through greater refinement in nitrogen application strategies and possibly the use of cultivars with greater nitrogen use efficiency. We now recognize that even severe problems of water pollution, deforestation and overgrazing can be reversed if we are willing to make the necessary investments. Once again, however, both the availability of trade-offs and the relative values associated with them are changing.

The combination of better measures of resource losses and firmer grounds for evaluating trade-offs between alternative resource-use strategies will improve our capacity to incorporate consideration of resource-stock changes into priority setting in both agricultural research and agricultural policy. In particular, there may be substantial scope for improving productivity gains by diagnosing resource limitations associated with historical patterns of exploitation of the resource stock. Recent analyses of micronutrient deficiencies in the soils of Malawi have highlighted gains to be derived from better fertilizer use in line with binding constraints in the soil nutrient stock. Farmers, scientists and policy makers are increasingly concerned about difficulties in maintaining productivity gains and the prospects of productivity losses associated with the long-term application of certain agrochemicals or ploughing practices. Resource sustainability issues are increasingly important, even in low-income countries, though, at least in the near term, we may need to consider resource stocks which can be readily measured and linked with the opportunity to achieve significant productivity gains.

As Alston, Anderson and Pardey suggest, we need to measure changes in the productive resource base more consistently, as we evaluate the costs and returns associated with the application of alternative technologies. In applying this advice, research plans need to incorporate more explicit strategies for the exploitation, and conservation, of natural resources. We need to improve our capability to measure changes in resources stocks and improve our ability to incorporate data on these changes into decision making. Strategies to resolve problems of resource degradation need to be coordinated with strategies to achieve continuing productivity growth.

K. Deininger (Germany) and F. Grohs (Germany)[2]

The papers by Alston, Anderson and Pardey and by Thirtle, Ball, Bureau and Townsend have what is essentially a common theme, namely the measurement, and to some extent the appropriate treatment, of externalities arising from the effects of research that are either unintended or unmeasured, or indeed both.

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The first paper, which is very conceptual in nature, argues that failure to account for consumption of the natural resource stock may lead to over- or understatement of agricultural productivity and, as a consequence, bias in research resource allocation may result from the difference between private and social benefits. An important contribution of the paper is to emphasize that the relationship can go both ways (that is, failure to measure accurately the non-monetary outputs from research, such as environmental quality, may understate perceived productivity, whereas failure to account for natural resource inputs will overstate the measured productivity growth rate).

In practice, however, the authors focus on factors that exaggerate measured factor productivity, emphasizing that the 'ideal' TFP measure ('ideal' in the sense that it would allow attribution of changes in output to changes in quantity or quality of inputs, and thus allow computation of the economic returns to investments aimed at improving input quality) should be as close to unity as possible. It is well know, however, that the issue is basically an accounting exercise, and that the sector where a productivity gain finally emerges depends on the ingenuity and energy of the agencies which report prices, the competitive structure of the industry, and the effect of property rights and government regulation taken in their broadest sense. It is correct to argue that problems of productivity accounting arise 'only' as a consequence of accurately dealing with the quality of inputs and outputs, but the details of such efforts are fraught with operational problems for which the paper offers few practical guidelines.

While the authors point out that conventional measures may overstate output growth and understate input use owing to inadequate incorporation of externalities, there is less than sufficient emphasis on the fact that environmental amenities can also constitute a desired output from agricultural production (or research), comparable with, for example, the output of wheat or dairy products. This is particularly obvious in Europe where agricultural policies now have the new objective of 'producing' amenity, either by reduction of unfavourable externalities of agriculture or by promoting the recreational use of landscape and of flora and fauna. This has induced a strong reorientation of research and extension priorities towards biological pest control, and other less harmful ways of plant protection, soil conservation tillage and the promotion of more extensive practices. Such changes suggest that an important agenda for future work will have to incorporate measurement of amenity values to add to the physical outputs of products.

While government regulation would be desirable if clear externalities are involved, and in cases of irreversibility when the appropriate value of the resource in question would be the productive value plus the option value, it is often not imposed because of the difficulty of putting a price tag on externality and option values. This is exacerbated by the fact that environmental amenities are luxury goods (that is, having an income elasticity of demand exceeding unity), which implies that their valuation may change considerably as countries become richer.

Given these problems of measurement, it is not surprising that the paper provides no empirical application which could illustrate the magnitudes likely to be involved. Nor does it examine the methodological assumptions which

will be encountered. Our belief is that there is a need for regulation to incorporate social costs into the planning of private-sector research by internalizing external costs and benefits and so provide more reliable incentives against which to work. This obviously also applies to public-sector research. The process involves the redefinition of outputs and inputs. It is also vital that public-sector research should anticipate shifts in the relative prices of different resources, part of which may stem from local or international changes in demand for environmental amenities or product quality characteristics. This will be of particular importance to the CGIAR system, where much of the empirical discussion of 'sustainability' and 'spillovers' originated.

The paper by Colin Thirtle and his colleagues also deals with externalities, though in this case the main thrust is to explain measured TFP growth in the presence of potential spillovers between public research systems. While there is some literature on both TFP measurement and spillovers in the United States, the paper is one of the first efforts to put data on European agriculture into perspective. As such, it deserves close attention, though unfortunately it is open to some criticism on three issues. The first relates to the choice of variables and their construction.

(1) The treatment of 'knowledge' at different points in the paper appears inconsistent. It is indicated that PIM (equation 2), with a 10 per cent rate of depreciation, is to be used in contrast to the inverted 'U'-shaped function that is more commonly adopted. However, it is not clear how the variable has been used. In the country regressions the lag length is determined using the (unexplained) Akaike and Schwartz criterion, which appears to require a rate of depreciation which is greater than the 10 per cent mentioned. There is then no attempt to explain the large differences in lag lengths between countries (ranging between four years for Greece and 15 years for the UK), while the significant and far from uniform changes in lag length for individual countries once spillovers are introduced are also obscure (the lag for Belgium drops from 13 to six years; for Denmark it increases from seven to 12 years). Finally, we are puzzled to find that both the PIM and country-specific lag lengths are thrown out in favour of simple linear averages of expenditures for research (lag 2) and extension or research (lags 9, 10 and 11) for the pooled regression. Given the centrality of the knowledge stock for spillovers and of the lag length for computation of rates of return, more detailed justification and possibly consistency would be desirable.

(2) For 'weather' use of the cereal yield deviation from a time trend is not a very good proxy. The deviation from the mean precipitation in the growing period would be more appropriate. Since good weather also implies higher input use (fertilizer and pesticide) and may affect output prices, it is not clear even then that an adequately defined weather variable should have an independent effect on productivity.

(3) Since most of the series are likely to be measured with significant error, it is not clear why the authors use cointegration analysis, rather than tested theories which are well established in the literature, to establish valid long-term relationships between variables. This is even more surprising

as they are well aware of the empirical limitations of cointegration tests for short time series and chose to adopt a more pragmatic approach.

(4) The inclusion of the terms of trade in the pooled regression is unmotivated, introduces endogeneity problems and does not support the causality implied in the 'technology treadmill' hypothesis which is put forward.

(5) The lack of a clear definition of the education variable makes it difficult to interpret its consistent lack of significance. Since that appears to raise major questions about the emphasis given to human capital in most recent theories of development, a more careful definition and examination of possible reasons for the findings would be desirable.

(6) We have doubts about the manner in which information relating to private patents is used only to account for failure to accurately account for input quality. Their significance in the case of the small but not of the large countries becomes puzzling. The authors also appear to take some liberties in switching between mechanical and chemical patents.

The interpretation of the results provides a second focus of criticism, particularly in relation to spillovers. The conventional approach is that they arise from the public good nature of knowledge, and the fact that techniques generated in one country may be applicable elsewhere. Usually, one defines the 'spill-in' as the benefits from research elsewhere, and the 'spill-out' as the non-appropriable part of returns from returns to knowledge produced by the home country. Given the knowledge stocks, the potential for such effects to occur is assumed to depend on their 'closeness' in 'technology space', which can be approximated by the similarity of outputs and inputs. In contrast to these measures which assume a technical basis for transferability of research results, other countries' TFP is used by the authors to represent the 'spillover pools'. This solely indicates the presence of a correlation, still unexplained, between TFP growth rates in the different countries (holding a set of other factors constant), which can come about for a variety of reasons other than research. Specifically, the variable used would be equivalent to the conventionally defined 'spillover pool' only in the unlikely event that TFP was perfectly correlated with the knowledge stock and the two countries were identical in the 'technology space'.

The policy implication of this is that spillovers, conventionally defined, indicate the presence of an externality rather than duplication and waste of resources, as asserted in the paper. This provides a rationale for central decision making and resource allocation because individual countries tend to invest, in the presence of less than full appropriability of research results, only up to the point where appropriable benefits equal cost, leading to underinvestment from a social viewpoint. In theory, social welfare would be maximized if individual countries were compensated for non-appropriable returns to their knowledge generation activity, typically in the form of a matching grant. The 'duplication' interpretation adopted here also appears to clash with the 'underinvestment' hypothesis ascertained later in the paper.

Thirdly, we make some suggestions for further research. On methodology a procedure that would allow issues to be discussed in a more straightforward way would be (1) to start with the pooled regression for the whole sample, (2)

to define the knowledge stock variable in a consistent way across countries, basing differences in lag length, if needed, on technical rather than statistical criteria, (3) to base the definition of the spillover variables on the technologically determined overlap in knowledge stocks between countries rather than on similar rates of TFP growth, and (4) to base estimates of the benefits of research on a cost or profit function framework which, under the assumptions of maximizing producer behaviour, would allow estimation of a system (including share equations) to reduce statistical problems. In this context, virtually all of the interpretations given in the paper could be formulated, and tested statistically, as linear restrictions on parameter combinations. Together with appropriate grouping of countries, this would obviate the need to rely on cointegration analysis in order to determine which variables to include in the regression, would facilitate the analysis, and would make the results more comparable with other studies.

Our other suggestion relates to the issue of convergence, or the fact that some countries with a low initial level of productivity should be able to catch up with leaders who, having to push technology at the frontier, will grow at lower rates. The TFP growth rates do not appear to suggest strong convergence of this type. This is surprising and unexpected theoretically, since it does appear, given the relatively high mobility of capital and knowledge in Europe, to be happening at the aggregate level. The unique data set collected for this study could be put to good use to investigate this issue and thereby enhance our understanding of the effects of agricultural research policy in European countries.

J. Oehmke (USA)[3]

The invited paper by Yougesh Khatri, Colin Thirtle and Johan van Zyl deals with South African agricultural competitiveness, while Derek Byerlee and Prabhu Pingali are concerned with agricultural research in Asia. The first paper is fun to read as it attempts to achieve the objective of explaining agricultural productivity growth in South Africa in the postwar period. I would argue that this objective is important for two reasons: it increases our positive knowledge of an economy, and it can provide lessons for future investment to increase productivity.

The profit-function econometrics used in the paper is a valid method of analysis for the problem in question, and it is applied appropriately. There are a number of minor points that can be argued, such as the confidence one places in the estimated cointegrating relationship between capital and interest rates estimated with only 32 annual observations, or the form of the research-to-knowledge transformation. However, these points do not detract greatly from the overall work. The exception to this would be if there were some problem with the education variable responsible for causing the surprising result that education is negatively related to productivity.

The application of the method yields a large number of results. Interesting findings include overcapitalization of agriculture, the positive and increasing

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effect of research, and the positive but declining effect of extension. A particularly striking finding is the size of the rate of return (ROR) to research investments of 44 per cent (the econometric model controls for separate effects of extension, patents and education). While the authors caution us not to place too much faith in this number, even if they have overestimated the true rate by a factor of four, so that the true rate is 11 per cent, there is still an argument to be made that research is at least marginally effective over the sample period. More importantly, this adds to the growing evidence on African research. Recall that in 1979, when Evenson, Waggoner and Ruttan argued for increased research support on the basis of high RORs throughout the world, none of the cited studies were on Africa. As of 1990, only three published, *ex post* studies were available. In the past few years, greater emphasis has been placed on examining the returns to African research, and so an additional piece of evidence is important.

The interpretation of the results does, however, need to be strengthened. There is an obvious lack of summarizing statements about implications for the future direction of research. With the recent enfranchisement of the majority and ensuing change, this task is daunting. But guidance for research strategy is more important than ever, and the results of the paper may have something relevant to say. For example, the labour-saving/capital-intensive orientation of public research may not be desired in previously black areas with high population densities and fragile lands. What does this mean for future research strategies? With the variety of results available in the paper, the authors should be able to address this question and make additional suggestions regarding future investment in productivity-enhancing activities.

The second paper is a brief presentation of the history of 'green revolution' rice and wheat technology in Asia, and a discussion of the challenges to research and appropriate responses currently and in the near future. While there are numerous historical descriptions of the 'green revolution' in Asia, Byerlee and Pingali do a useful job by highlighting issues that may not be salient in other summaries. For example, the importance of the 'green revolution' is presented in terms of a decrease in food prices, a perspective that implicitly recognizes that the major beneficiaries of research are consumers, both rural and urban, who spend some of their income on food and benefit from lower food prices. Another example is the explicit discussion of the labour-saving orientation of technical change during 1960–75 and the subsequent land-saving orientation from 1975–1990.

The more ambitious part of the paper suggests research and research system responses to current challenges. A recommendation that greater emphasis be placed on crop and resource management research (CRMR) is well supported by examination of increases in yield gaps, declining farm productivity, increased market development and environmental deterioration. The paper's call for institutional flexibility to reform the organization and management of research systems, to exploit regional complementarities, to work with the private sector and to seek sustainable funding is also appropriate.

Somewhat less compelling is the discussion of a de-emphasis of breeding research oriented towards marginal areas, based in part on the idea that improved varieties with only a modest yield advantage require other character-

istics, such as grain quality and fodder value. While this view recognizes that farm households are demanders of raw products as consumers and intermediate-good producers, it suggests that research will be less successful in achieving the characteristics desired by demanders of farm products. There is little support from crop-breeding literature which is brought into this argument, and there is little reason to believe that it will affect marginal farmers dramatically more than it will affect larger farmers.

A significant omission from the paper is the lack of discussion of the possibility of successful research on off-farm activities and the implications for research and research system management. For example, one of the rationales for CRMR activities is the extent of market development; yet, as markets develop, there are potential benefits from research on storage, processing, packaging and other post-harvest activities. Another example is the discussion of the need for a supportive policy environment. Most agricultural economists feel that examination of policy options and their impacts is a legitimate research topic. Yet there is no discussion of the incorporation of policy analysis or other socioeconomic analyses into the research agenda.

Despite this omission, I agree with the bulk of the author's recommendations, particularly the need for the research systems to be flexible in research programming and in seeking sustainable financial support. I suggest extending the flexibility in programming to include a serious discussion of increased involvement in off-farm, policy and socioeconomic research activities.

G. Feder (Israel) and Dina Umali (Philippines)[4]

The paper by Cesar Falconi and Howard Elliot on research development in Latin America and the Caribbean raised many interesting points, but also many suggestions and questions. Before listing these, there is a general comment to be made, which is that a paper of this nature would benefit considerably by being cast in the framework of the 'new institutional economics' involving transaction costs and principal–agent relationships. That would have helped the understanding of the motivations and performance of the different types of research institutes as well as the roles of associations. Our list is as follows.

(1) Set-up costs and economies of scale could also have been used to explain the incidence of contracting out research among different groups.
(2) The aggregation of private for-profit and private non-profit organizations does not allow a good picture to be presented about the extent to which public research expanded or not.
(3) The absence of statistics on basic research in commercial institutes in the three cases is due in part to the fact that the parent companies do that in the United States.
(4) It is asserted that when the market is small the public sector should take up the research. But what is the economic justification for the society to undertake this cost?

[4]Both attached to the World Bank, Washington, DC.

(5) The explanation of the higher number of PhD/MSc personnel in the public sector is not clear.
(6) Inference on quality of the research by private and public entities on the basis of differences in the ratio of support staff to research staff may not be appropriate, given the different composition of research foci.
(7) The composition of research costs (salary/non-salary) shows a large salary content in the public sector. How is this compatible with the smaller number of support staff (relatively) in the public sector?
(8) From a policy point of view, in the case of downstream research which the public sector is obliged to take on for staples and non-tradeables, the question is whether it is not better to focus the public effort on helping associations to be generated.
(9) It is argued that public involvement in research on hybrids (an appropriable good) is justified to control the price of hybrids. We find this a weak argument.
(10) In the list of various macro policies conducive to research, we feel that some of the attribution of merit to the actions is tenuous.
(11) It is not clear why high-risk fields are said to belong properly in the public sector.

The objective of Guy Henry and his colleagues is to determine whether the efforts of the government and the private sector to reduce cassava costs in Thailand have been successful. Here there are a number of issues relating to the adoption analysis.

(1) Production costs have gone up by 8 per cent and net profits by 41 per cent. This should be associated with much more adoption over the period 1986–91. The fact that overall adoption (including those who abandoned R3) is only 19.3 per cent, and a third of those who tried it later abandoned it, suggests that these profitability calculations may not have taken into account all indirect costs. Among the reasons for negative evaluation by farmers, sub-optimal storage properties and less adaptation to poor soils are mentioned.
(2) The choice of explanatory variables includes some which, in our view, are in fact endogenous variables, such as family labour, cassava area, planting only cassava and obtaining seed from specific sources.

At a more macro level, there are other issues on which more information would have been useful. The paper does not give much detail on the following:

(1) How was the cassava development fund implemented. What was the role of the public sector in the funds?
(2) Why should the public sector have dealt with technology transfer? Should this not have been done by the private sector (they have incentives)?
(3) The government is said to have committed large budgetary resources of the cassava transfer programme, but did the benefit accrue to the farmers or to the processors? What kind of market failure is implied?

Chairpersons: Michel Petit, Paul Heisey, Jock R. Anderson.
Rapporteurs: Thomas Reardon, Robert Townsend, G. Kundhlande, B.C. Barah.
Floor discussion: D.G.R. Belshaw (2), P.C. Sarkar, T. Reardon, J.-M. Boussard, D. Gale Johnson, R. Franco, C. Delgado, D.G.R. Green, L.D. Smith, W.P. Ntsekhe, M. Murphy, A. Nhlapo, M. Mekuria, M. Petit, G.E. Dalton, G. Feder, C.L.J. van der Meer (2), S.R. Johnson, E. Tollens.