

# COMMENT: MAIZE RESEARCH IN MALAWI

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**Abstract:** Jonathan Kydd's analysis of the history of maize research in Malawi argues successfully that the reasons for the low rate of adoption of high yielding maize varieties lie in an insufficient appreciation of local processing and storage requirements. The analysis, however, raises further questions. In particular, Kydd's conclusion that maize research by multinational seed corporations might be more effective than public sector research is not supported by adequate evidence. The existing evidence suggests that though these corporations are likely to play an increasing role in developing countries, they are unlikely to direct their efforts to the needs of the poor.

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## INTRODUCTION

Jonathan Kydd's informative and well-argued analysis of the history of maize research in Malawi (1989) is a welcome addition to what might be broadly described as the literature on Green Revolutions. In this conception, the literature consists of studies of situations in which such revolutions both do and do not occur. However, Kydd's examination of what has happened in Malawi is not matched in strength and incisiveness by his conclusions. Briefly put, Kydd argues first that higher yielding maize varieties or hybrids<sup>1</sup> with acceptable processing, storage, and preparation qualities are the *sine qua non* of increased maize productivity in Malawi. The high yielding hybrids that have been produced to date have been dent-type maizes, and hence do not meet these standards in comparison to the local flint open-pollinated varieties. Second, since public sector research has proven 'ineffective in

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tackling a fundamental problem of the poor', private seed companies are likely to be 'more effective in assembling the necessary scientists and genetic material and in managing the research process'.

The first conclusion is certainly correct in that appropriate high yielding maize varieties are likely to be *the* key element in any conceivable breakthrough in maize productivity in Malawi. But there is a fundamental disagreement whether private sector research involvement is the key to achieving the development of these varieties. On the face of things, it appears more likely that the public sector would place more weight on equity goals and thus be more likely than the private sector to do research into varietal development, as well as accompanying agronomic practices, that would benefit the poor. This comment will focus on this issue through a review of some of the literature on public/private sector agricultural research, particularly as it relates to maize. Several other interesting questions raised by Kydd's article will also be noted.

#### PUBLIC AND PRIVATE INVESTMENT IN AGRICULTURAL RESEARCH

The theoretical economics literature suggests that a single supplier, public or private, of any good is, in the absence of other considerations, likely to underinvest in research and development (Dasgupta and Stiglitz 1980). Studies of rates of return to public agricultural research for the most part conclude that given the high rates of return to this research, there has indeed been an underinvestment. Underinvestment is explained in various ways, for example by the public good, or spillover effects of much agricultural research (Ruttan, 1982; Davis, Oram and Ryan 1987); or by lags in response by funding agencies to secular changes in the value of research (Oehmke 1986).<sup>2</sup>

Very few studies attempt to differentiate public and private returns to *public* investment in agricultural research and public and private returns to *private* investment in agricultural research.<sup>3</sup> In fact Norton and Davis' survey (1981) concludes that a major area in need of further methodological work is 'the study of private-public interaction in agricultural research, including transmission of research results to farmers'.

Ulrich, Furtan and Schmitz' (1986) case study of the Canadian barley industry is a notable exception to the lack of specific inquiries comparing the social and private rates of return to public and private agricultural research. Research is supported by both the private Brewing and Malting Barley Research Institute (BMBRI) and by public sector research. The majority of funds have been spent by the public sector, but the BMBRI has been able to influence the direction of research through strategic contributions to public sector institutions. Seventy-five per cent of total Canadian barley production is from barley varieties suitable for malting, but historically only 10-40 per

cent of malting barley production is sold for malting purposes. In an interesting reversal of the Malawi case, Ulrich, Furtan and Schmitz conclude that if all barley research had continued to concentrate on yield gains, regardless of malting quality, social rates of returns would have been substantially higher than they actually have been. In fact, under such a 'yield first' strategy maltsters and brewers could have been compensated for their losses and social rates of return would still have been higher than they have been in reality.

#### PUBLIC-PRIVATE INTERACTION IN THE DEVELOPMENT OF MAIZE TECHNOLOGY

The interaction of public and private research and development is particularly interesting in maize for two reasons. First, unlike wheat and rice, maize is a major grain crop for which with some exceptions 'Green Revolutions' have bypassed smallholder agriculture in less developed countries. Second, the revolution in maize technology that did occur in the richer countries was intimately related to the development of hybrid technology, in which control of the knowledge embodied in the parent inbred lines enables private seed companies more easily to maintain proprietary rights in the resulting hybrids.

This means that at the international level countries have several choices, not mutually exclusive, for obtaining new maize varieties: '(1) imported technology in the form of varieties or hybrid seed; (2) local research and seed production by multinational [private] companies; (3) research and seed production by local [private] companies; and (4) research and seed production by local government - sometimes with the assistance of international organizations' (Pray and Echeverria 1988). At the national level, there may be at least four ways of interaction between national public research institutions and private seed companies: (1) public organizations can evaluate materials developed by the companies; (2) these companies buy or obtain royalties for basic seed of public origin; (3) the seed companies fund some public research; and (4) scientists move across the two sectors (Echeverria, 1989).

Historical experience suggests that public sector research has played a major role in the development of hybrid maize technology. In the US, in 1970, 40 years after the introduction of commercial hybrids, 50 per cent of the total maize area was still planted to hybrids stemming from public sector inbreds. By 1980 this area had fallen to 40 per cent (Duvick, 1984). Similarly, Evenson (1985) suggests that public research has had a significant impact on maize yields in the third world.

On the other hand, Pray and Echeverria (1988) conducted a pooled regression analysis of maize yields in the fifty largest maize producing countries outside of the US, including both developed and developing countries. In none of their regressions was their measure of public sector research significant. In contrast, when a variable for local research done by a branch of one of the six major private multinational seed companies was *not* included, their seed import variable was significant. When the variable for local research by multinationals *was* included, it was significant and the seed import variable became insignificant, suggesting the importance of local adaptation.<sup>4</sup> Pray and Echeverria conclude that countries that restrict activities by multinational seed companies are likely to impose costs on their farmers and consumers.

In short, the limited evidence suggests that it is not a question of public vs. private maize research as such, but rather the correct balance between the two sectors. Even in the US, in addition to the initial research into hybridization and the production of the first inbred lines, the public sector remains important in such areas as basic research, germplasm development and training of scientists. The seed companies also do research, but they have specialized in the successful production and marketing of hybrid seed. The balance between sectors is likely to vary from country to country, as agroclimatic circumstances, economic conditions, and levels of trained manpower vary.

In this respect Echeverria's (1989) case studies of Mexico and Guatemala are instructive. In Mexico, Echeverria found the complementarity between public and private research to be much weaker than in Guatemala. In fact, he found coordination in the public sector also to be weak in Mexico. The major private sector research and seed production in Mexico is conducted by multinationals. In contrast, the smaller seed market in Guatemala is served by local private companies with good linkages to public sector research.

In both countries, private maize seed companies serve the best endowed areas and the medium- and large-scale commercial farmers. 'In Mexico, this means the irrigated and/or low altitude northern and western maize regions of the country'; in Guatemala, it again means lowland maize production. Echeverria argues that the proper role of public research is to provide 'certain seed types for particular regions and/or types of farmer', i.e., poorer areas or farmers. Instead, in Mexico, the public sector, like the multinationals, has tended to develop materials for the better endowed. In this case, by Kydd's analysis, *both* public and private sector maize research have 'failed', the farmers growing 1.9m hectares of maize in Mexico's Mesa Central, between 1800 and 2500 meters above sea level. In this area only 3 per cent of the total maize area is estimated to be planted with improved seed (Echeverria, 1989).

Zimbabwe is a striking regional example of the development of public-private sector interaction in maize breeding. Commercial (settler) farmers formed a Seed Maize Association in the 1920s. Complementary public sector maize improvement began in 1932 (Olver, 1988; Tattersfield, 1988). Zimbabwe became the first country after the United States to successfully produce hybrid seed, in 1949. The record from the 1950s is unclear (cf. Eicher, 1988; Muir-Leresche, 1984) but the evidence indicates some commercial farmland during this period was planted to double-cross hybrids. The noted single-cross hybrid SR52 was released at the beginning of the 1960s and constituted two-thirds of the commercial maize crop by 1968 (Muir-Leresche, 1984).

The late 1970s witnessed two events that helped to create a basis for the more rapid diffusion of high yielding maize varieties in the communal areas of Zimbabwe in the 1980s.<sup>5</sup> First, the research department released several lower-yielding but earlier maturing three-way cross hybrids for use in drier years or more marginal commercial maize farming areas. These later became the basis of hybrid maize technology in the communal areas. Second, the Seed Maize Association began to realize the potential market in the communal areas and started to market seed in small packets (M. Blackie, personal communication).

The Seed Maize Association, now the Seed Cooperative Company, has continued to support public sector research. In addition, it initiated its own breeding program in the mid- 1970s, which has expanded considerably from its initial small base (Tattersfield, 1988). In addition to its continuing breeding efforts, the public sector maintains its role in varietal testing, in mandating that the Seed Cooperative maintain a buffer stock of seed, and in negotiating seed prices with the Cooperative.

#### CAN MALAWI AFFORD PUBLIC SECTOR MAIZE RESEARCH?

Malawi is a poor country, with an economy that Kydd elsewhere (1988) has characterized as 'under siege.' Kydd's present reading of the history of maize research (1989) has perhaps suggested that the willingness of the government to commit resources to maize research has varied over time.<sup>6</sup> This may be one of the unstated arguments for the conclusion that private sector research would be more effective.

Certainly there is no doubt that maize commodity research for Malawi is justified. Eicher's (1988) listing of the six strategic issues facing agricultural research in Africa includes restoring the primacy of commodity-based research. Malawi probably has the highest per capita direct human consumption of maize of any country in the world (CIMMYT 1987), and without a doubt maize is one of the few commodities on which research

should concentrate. Brennan (1989) provides a complementary perspective on the economics of maize research in Malawi. He classifies countries by comparing the likely profitability of three strategies: testing of imported germplasm; adapting material to local conditions; and developing a full-fledged crossing program. Classification is based on the value of maize production. On this criterion, Brennan lists Malawi among the countries for which both local adaptation or in-country crossing would be economically viable, although local adaptation might be more profitable.

Four of Eicher's (1988) remaining strategic issues are related to the question of whether public or private research is equipped to carry out the tasks at hand more efficiently. Amount of funding, amount of resources spent on training, and size of the research programme are less important than the quality of the work that is done. In this respect private seed companies presumably have the advantage, as the sizes of their staffs and budget cannot grow too large without eroding profitability, although the theory of monopoly suggests that inefficiency is not solely a public sector problem. Productive public sector research *is* difficult to sustain. It is hard to see, however, how the current donor fashion for private efforts would lead to anything more sustainable unless they were substantial real private returns inducing companies to undertake the initial germplasm improvement and breeding necessary. As argued above, this runs counter to experience in almost every region where maize farmers are small and poor, and locally adapted material is essential.

#### DIRECTING RESEARCH TO THE NEEDS OF THE POOR

The cruel fact remains: just as the poor cannot influence the appropriate allocation of public research resources because they lack political voice, they cannot influence private research because they lack economic power. Research *may* eventually benefit the poor, as in the case of the development of earlier maturing hybrids in Zimbabwe mentioned above.<sup>7</sup> The set of circumstances that leads research to be directed to the needs of the poor needs to be more carefully identified. Research alone, however, cannot be directed to solve problems that other policies have failed to alleviate.

In Malawi, for example, let us assume the success of a programme of whatever origin to develop high yielding flint hybrids. These would probably spread to a larger portion of the farming population than that presently using high yielding dents, but it is still likely that the most impressive output increases would come from the farms currently marketing maize surpluses. Whether agricultural research contributes more to the poor by focusing on the technical problems of poor producers or by increasing food supplies from any sources is still an open question. Income generation for poorer

smallholders in Malawi, and thus the *command* of food, will remain a thorny issue under almost any conceivable scenario.

#### MAIZE RESEARCH IN MALAWI – FURTHER QUESTIONS

Kydd touches only briefly on several other interesting questions that are worthy of further discussion. First, a precise analysis of which factors were relevant in differentiating Malawi from Zimbabwe and Kenya would be informative. In these countries, were the local maize varieties historically less flinty than in Malawi? Were they less well adapted to local conditions? Were the indigenous methods of processing different? Was maize less predominant in the local diet? Did milling and marketing develop along different lines? Did the history of production and mass selection by settler farmers in Zimbabwe and Kenya have any importance? In other words, what factors *should* have convinced maize researchers in Malawi in the late 1960s and 1970s that the appropriate lessons to be learned were not entirely those from the development of high yielding materials in these other countries of the region?

Second, an explicit account of breeding strategies and their relationship to the development of appropriate agronomic practices would be useful. For example, what are the cost implications of developing open-pollinated materials, developing hybrids, or both? What are the seed production costs and the institutional aspects of marketing different types of seed? What are the agronomic factors influencing adoption of hybrids and composite materials? These comments are partially prompted by the data Kydd presents on yield-fertilizer relationships on farmers's fields. It is difficult to infer response curves from the data. Nonetheless, one can assume that appropriate flint composites and hybrids would yield approximately equivalently to present materials, that maize 'fertilized twice' is fertilized approximately at recommended levels, and that farmers require a minimum marginal rate of return on capital of at least 100 per cent to induce them to change practices. Under these assumptions, partial budgeting exercises using current input-output price ratios suggest that farmers planting local varieties with no fertilizer, or even moderate amounts, would be likely to find it profitable to adopt composites but no hybrids. Only farmers already applying recommended levels of fertilizer (at cost of MK 250/ha and above) would be likely to switch directly to hybrids. Clearly fertilizer responsiveness and likely future price ratios deserve further study.

#### CONCLUSIONS

On balance, it is unlikely that Malawi is exempt from Ruttan's (1982) conclusion that the 'argument for the development and support of a substantial public-sector crop-breeding effort is even stronger in the

developing countries than in the developed countries ... it is to their advantage to avoid subjecting themselves to restrictions that would limit or delay access to the results of advances in *either* (emphasis mine) private- or public-sector crop breeding in the developed countries or in other developing countries'.

Unless Malawi is so unique that it can follow totally unforeseen patterns of research development, the most likely *desirable* sequence might run somewhat as follows. First would be the consolidation of a small committed public sector maize research team, as exists today, with sufficient government backing to assure institutionalization. As appropriate varieties are developed, it is probable that strong private sector participation in seed production and marketing *will* become increasingly important. The likely size of the market makes it probable that multinational seed companies with temperate zone bases would not find it profitable to invest very heavily in Malawi. Local companies, drawing heavily in the experience and technical advice of other countries in the region (notably Zimbabwe and Kenya) would probably be much better placed to exploit market niches.<sup>8</sup> Private seed companies would probably also begin to draw on the talent pool of maize scientists trained in the public sector.

In conclusion, Kydd is correct that there can be no maize revolution in Malawi without varieties that are appropriate from a consumption as well as a production standpoint. To expect the private sector to take the initiative in *developing* such appropriate varieties, and to expect variety alone to solve the fundamental problems of the poor, is contrary to most past worldwide experience of agricultural research.

#### NOTES

1. For the remainder of this paper we will ignore the maize scientist's distinction between varieties and hybrids and refer to all improved material, of either type, as improved varieties.
2. There is some dissent about the general conclusion of underinvestment in public sector research, e.g., Fox (1985) and Wise (1986).
3. Studies of industry often indicate that social returns from private investment often outweigh the private returns (e.g., Griliches, 1980). Nelson (1982) argues that public and private investments in agriculture tend to yield much different outcomes than similar divisions of investment in industries.
4. Overall, the most important determinant of maize yields was an agroclimatic dummy separating temperate from tropical zones. The second most important was a variable for fertilizer usage.

5. Rohrbach (1988) describes and analyzes the increase in communal area maize production that occurred in the mid-1980s.
6. As Kydd notes, the donor track record has also been variable.
7. The case of wheat in Pakistan is also interesting. High yielding, 'Green Revolution' wheats were developed for higher potential, irrigated areas, and achieved their earliest adoption and widest diffusion there. Nonetheless they have benefited small farmers in more difficult rainfed or mountain environments in two ways. First, some of these varieties have proved widely adapted outside of the areas for which they were developed, and have spread into these other environments. Second, since these more difficult areas remain deficit areas, increases in wheat production elsewhere in the country benefit them by increasing availability and keeping prices down (CIMMYT 1989). Wheat research has not made these farmers rich; labour migration out of these marginal areas is still a major source of income.
8. Echeverria's study of Guatemala (1989) cited above notes the role of El Salvador in the development of the Guatemalan seed industry.

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