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Grain Quality and Crop Breeding when Farmers Consume their Grain: Evidence from Malawi

Abstract: When farmers consume much of their grain output, end-use quality, in addition to standard production characteristics, affects farmers' seed choice and the economic returns to investment in crop breeding. Evidence from Malawi suggests that despite a lengthy research lag, emphasizing grain quality in recent years will amplify returns to research. Yet the story of that research breakthrough also suggests that when market signals are weak, physical and the social scientists who seek to play an informative role must be especially cautious in their assessment of research priorities.

INTRODUCTION

In some countries of sub-Saharan Africa, such as Malawi, markets for industrially processed grains are relatively unimportant. Farmers consume the grain they produce or grain obtained from other farmers through purchase or exchange. Farmers' cultivar preferences are then conditioned by a range of socio-economic factors that are related to both the production and the consumption characteristics of the grain. For example, farmers-cum-consumers are concerned about quality in end-use, such as the performance of the grain in home processing, cooking, and on-farm storage.

When farmers both produce and consume their grain, scientists' and farmers' assessments of new crop varieties can diverge because yield is the foremost criterion for research and development (R & D) in conventional crop breeding programs. Typically, scientists are not formally trained or encouraged to use farmer's knowledge or recognize the diversity of farmers' objectives. Further, the historical evolution of political and economic institutions in sub-Saharan Africa has usually meant that small farmers have no public voice as either consumers or producers. Their only market signal to researchers, observed dimly through a haze of regulated prices, structural adjustment policies and institutional variables, is the decision to adopt or not to adopt the new cultivar. Finally, nascent private seed companies, when they exist autonomously from parastatal organizations, have little money to expend on comprehensive marketing research.

There are two simple but important consequences for crop breeding. First, social scientists can serve a valuable function as intermediary market informants between farmers and breeders. At the same time, in an era of diminishing international funding sources for plant breeding, crop and social scientists must carefully evaluate the panoply of claims to the research dollar. Unless each farmer is willing to finance his or her own R&D, not every small farmer's idiosyncratic preference can be included in the research budget.

This paper highlights some grain quality and crop breeding issues in the context of a sub-Saharan agricultural economy where industrially processed grain occupies a small share of the active grain market. In Malawi, where most maize moves from the field to the farm household or between farm households, grain quality has played a pivotal role in determining the time-to-release of maize cultivars suitable for widespread adoption and the

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rate of economic returns to maize research. Here, we compare the farmers' rate of return to maize hybrids under various research strategy assumptions, and, in the absence of market data expressing quality differentials, use a simple method to estimate the rate of return to investment in grain quality research. Although evidence suggests that Malawi will obtain a substantial economic return to quality research in maize, the history of maize research there underlines the fact that when market signals are weak, both physical scientists and the social scientists who seek to play an informative role must be especially cautious in their assessment of research priorities.

ISSUES IN GRAIN QUALITY AND CROP BREEDING

Until recently, the emphasis in most conventional crop breeding programs was to select for cultivars with maximum harvest yields, although many programs have lent increasing importance to yield stability factors. When farmers consume a large portion of their crop output, the performance of the cultivar in on-farm processing and storage, as well as particular taste or cooking characteristics, may also be important. Improving the relevance of crop breeding for research clientele (and increasing economic returns to investment in crop breeding) therefore depends on incorporating selection criteria that are not related to harvest yield. Yet 'plant breeders cannot respond to every quirk of farmers' circumstances' because costs increase, and progress slows as the number of selection criteria increases (Haugerud and Collinson, 1990, p.357). In fact, costs are thought to increase exponentially with the number of traits for which breeders select (Arnold and Innes, 1984).

Assessing the problem of choosing selection criteria in markets for industrially processed grain, Brennan (1992) cautions that researchers much recognize the high opportunity costs of tailoring grain production to market requirements such as end-use quality characteristics. Necessary conditions for a change in breeding strategies in such markets are that breeders possess the technical and genetic means to achieve it, and the market niche is robust enough to sustain the research investment and stable enough over time to survive the initial research lag. A point of departure is to posit the same set of necessary conditions for a change in breeding strategies in markets for non-industrially processed grain. Two examples illustrate what can occur if only one or the other of the the necessary conditions noted by Brennan holds, or if one interest group controls too much of the market niche.

CIMMYT's effort to breed Quality Protein Maize (QPM) is an example of a research experience in which, at the outset, the constraints were believed to be technical and the 'market niche' robust. On the contrary, developing QPM was no more costly in terms of selection, evaluation, testing, and seed multiplication than other maize types but much more costly in terms of farmer and consumer information[1]. Based on the rapid diffusion of wheat and rice HYVs, physical and social scientists believed that maize with improved protein quality could dramatically alter the plight of undernourished farmers, and of rural and urban consumers. Yet there was little effective demand for QPM because quality was not observable to consumers (Cantrell, 1989). In the case of QPM, contrary to what was initially believed, breeders possessed the technical and genetic means to achieve the change in breeding strategy (condition 1), but the market niche was not robust (condition 2).

The case of barley breeding in Canada illustrates the dangers of emphasizing one grain trait (malting quality) even when a market niche (private brewing companies) is robust (Ullrich *et al.*, 1986). The relatively large sums of research money that were furnished by one important private interest group contributed to a shift in public research emphasis from yield to quality varietal research. Redirection of funds was associated with a high social opportunity cost.

GAUGING THE 'MARKET NICHE' FOR GRAIN QUALITY

Ex post or *ex ante* rates of return to quality research can be estimated, given that quality differentials are reflected in market prices. In developed countries, economists have used hedonic pricing models to test whether the implicit value of an attribute of an agricultural commodity, such as end-use quality, is adequately reflected in competitive market prices and/or grading systems (Espinosa and Goodwin, 1991; Perrin, 1980). Unnevehr's (1986) application of a hedonic prices model to the study of returns to research on improving the physical and chemical quality of rice in Southeast Asia is unique. Her findings implied underinvestment in quality improvement, although returns to quality improvement research were not as large as returns to rice yield improvements.

Many developing countries in sub-Saharan Africa have neither the market prices nor testing facilities to enable such research to be conducted systematically. Often, grain prices established by the official marketing boards are pan-territorial and uniform across cultivars. Price premia reflecting grain quality may appear in informal markets but because those markets are thin and irregular, they may be difficult to measure with reliability. Depending on the attribute and crop, laboratory tests may be required to accurately assign a quality rating. The propensity of maize to cross-pollinate, for example, probably contributes to relatively high variability in attributes even within one maize type. Under such circumstances, do farmers-cum-consumers recognize small quality differences when they exchange or purchase grain?

Viewed from the perspective of the issues raised above, the long gestation period before the release in Malawi of maize hybrids with improved grain quality is understandable. The next section interprets some of the factors contributing to the lengthy research lag.

GRAIN QUALITY AND MAIZE RESEARCH IN MALAWI

Flint and Dent Maize Types

From Malawi's independence in 1964 until 1990, all the maize hybrids imported or released by the national research system have been dents, a term that refers to grain texture. Denty, as compared to flinty, grains have a lower density of hard starch granules. The adoption of dent hybrids has been limited by the fact that with on-farm methods, the flinty, open-pollinated maize varieties Malawians call 'local maize' can be processed more efficiently into the fine white flour (*ufa woyera*) they prefer to use in preparing their staple food (*nsima*). The hard flinty varieties are also more resistant to weevils in storage than the denty hybrids that have been introduced or released in the past.

Given their preferences and the uncertainty of obtaining local maize for consumption through the marketing system, small farmers in Malawi have typically grown local maize for home consumption. The higher-yielding, denty hybrid varieties have been grown for sale — when they have been planted at all. In 1987, the national maize team initiated their flint hybrid program. Not until 1990, nearly thirty years after independence, were high-yielding flinty hybrids released by the national research system. Grain quality was not emphasized in hybrid maize research before 1987. In retrospect, this research lag can in part be understood by appplying Brennan's two basic criteria.

The Technical Feasibility of Flint Hybrids

Development of a conventional maize hybrid from scratch requires seven years or more, depending on the availability of germplasm collections. Suitable genetic material for developing flint hybrids in Malawi has not been easy to obtain. Inbred lines developed from Malawi's local flint landraces are too tall and their growing season is too long (Zambezi, 1992). Most breeding efforts for maize hybrids in other parts of the world have emphasized dents because of the belief that dent maizes have higher yield potential than flints (Blackie, 1989). Dents are also more suitable than flints for most industrial processes. Regional germplasm collections already consisted primarily of dent types by 1950. South African, Zimbabwean and Kenyan commercial farmers had begun mass selection and breeding programs with white, dent, open-pollinated maize types they introduced from the US in the early part of this century (Karanja, 1995; Rusike, 1994). Although Malawi's colonial agricultural department tested some materials imported from South Africa and Zimbabwe, the department concluded, on the basis of poor field performance, that improvement of local flint landraces was a better breeding strategy (Rusike, 1994.). By the time Malawi attained independence in 1964, the highest yielding materials in the region were white dents bred in South Africa, Zimbabwe and Kenya.

Despite the recognition of the need to improve local landraces, the colonial government in Malawi did not begin to devote resources to maize breeding and maize agronomy until after the Great Famine in 1949. The first breeder, R.T. Ellis, was posted to Malawi in 1953. Although several flint hybrids and synthetics were available for release to farmers on a pilot basis by the early 1960s, Ellis then took a position with Malawi's tea breeding organization and was subsequently able to devote only occasional time to the maintenance of maize breeding lines. From independence until 1970, the post of plant breeder in Malawi was filled intermittently by a series of expatriates on short-term contracts who split their research time between maize and tobacco. Breeding lines deteriorated because of vacancies, shortage of supplies, and funds (Zambezi, 1992). In 1967, the hybrid maize research program was officially 'discontinued'. Although the program was restored in 1977, all three national breeders left for advanced training in 1981, returning only intermittently through the next decade. Staffing discontinuities reduced the total breeding capacity and compounded technical difficulties.

When the decision was made to breed flinty hybrids in 1987, the national research team used non-conventional top-cross method to speed the development process. For each of the two flint hybrids they developed, an existing dent Malawi hybrid was bred with another parent from a flint population in CIMMYT's collection. The idea of using the top-cross breeding technique, having a national team with the qualifications and decision-making authority to use it, and access to public (CIMMYT) germplasm, relaxed the technical constraint to breeding flint hybrids in Malawi. An important factor in this process was the close, field-based collaboration with CIMMYT scientists after the establishment of the mid-altitude station in Harare in 1985.

A 'Market Niche' for Flint Hybrids

There are a number of reasons why the potential market for flint hybrids in Malawi has never been and is not yet adequately assessed. In the colonial period, officials in the agricultural department recognized the significance of the flint grain trait when they rejected the strategy of using exotic maize germplasm in part because of insect resistance problems (Rusike, 1994). However, neither the colonial administration nor commercial farmers in Malawi devoted resources to the improvement of local landraces, maize breeding, or maize agronomy until the 1950s. Two main causes of this can be identified.

First, Malawi never developed the settler economy or class of commercial farmers that emerged in Zimbabwe and Kenya during the early part of this century. In sheer numbers and composition, Malawi's European farmers were few relative to the African population and only a small proportion of them were engaged in staple crop production. Most ran large estates for the production of tobacco, cotton, and tea for export. Malawi's African farmers produced the major share of the tobacco crop from the late 1920s to independence, on customary land or as tenants.

Secondly, African farmers also produced the nation's maize. Even on the European estates, maize was cultivated by African tenants on land allocated to them for that purpose. Malawi's population remained predominantly rural throughout the colonial period, without an urban-based labouring and landless class to feed (Smale, 1994). After a brief flurry of interest over the potential of maize as a export crop before World War I (Rusike, 1994, op. cit.), maize remained a subsistence crop produced or exchanged by Africans to feed themselves. Questions of maize self-sufficiency and the need to invest in maize improvement did not assume policy importance until the Great Famine of 1949.

Following a brief period that was overtly supportive of smallholders (1962–65), the independent government embarked on a policy during the late 1960s and early 1970s to fuel economic growth through promoting estate production of export crops, including tobacco, tea, and sugar. A combination of pricing policies, marketing institutions and banking arrangements favoured these crops and their production by estates over smallholder cash crops and maize. On estates, maize was grown only as a secondary crop to feed labourers or sell to urban markets. The corporate estates established during this period were often managed by Zimbabweans hired on short-term contracts. The maize hybrid they knew and valued was Zimbabwe's high yielding, extremely popular, denty hybrid SR52. Malawi's estate owners had no interest in flint grain texture (Smale, 1994).

At the same time, the widely accepted perspective in international development organizations was that hybrids were too costly for small farmers. Breeding efforts in the IARCs have emphasized until recently the development of improved open-pollinated varieties. During the 1970s, a British Overseas Development Team led by Bolton was posted to the Malawi research system, with Bolton's time devoted exclusively to maize. In a series of trials comparing the performance of various hybrids and improved open-pollinated varieties, Bolton concluded that the dent Zimbabwean hybrid SR52 and the semi-flint composite UCA (of Tanzanian origin) were most promising. Bolton described SR52, the highest yielding cultivar in the trials, as appropriate for the few

Malawian commercial farmers who could produce it for sale under high-management conditions. National breeding efforts could then be concentrated on the development and adaptation of semi-flint composites for consumption or sale by small farmers (Bolton, 1974). During the late 1970s, the government adopted a two-pronged strategy of importing SR52 for commercial farmers and breeding flint open-pollinated varieties for small farmers. The two-pronged strategy reduced breeding costs through utilizing research 'spillover', and reflected the reigning wisdom about appropriate seed technology for small farmers, but also coincided well with the dualistic agricultural policies advocated by government during that period. Because smallholders were not considered as part of the market for maize hybrids, there was no perceived market for flint hybrids.

There were also arguments for promoting the consumption of dent rather than flint hybrids. Most nutritionists since the colonial period have insisted on the superiority of the coarse, whole-meal *mgaiwa* to the refined *ufa woyera*. Another argument was that the prevalence of mechanical mills in rural areas would change consumer preferences through reducing women's labour time in processing. Instead, rural women continue to use traditional hand-pounding methods, substituting the mill only in the final stage of processing. Some researchers assumed that with urbanization, roller mill operators, who prefer dents to flints as less injurious to their machinery, would become the major market for smallholder maize surpluses. By contrast, Malawi's population remains predominantly rural, most rural households are maize deficit producers, and a large proportion of marketed maize still circulates through small traders and farmer-consumer or farmer-farmer transactions.

Finally, the absence of the physical seed production and marketing infrastructure needed to diffuse flint hybrids among Malawi's several million smallholders was real. From the beginning of the maize breeding program until the organization of the National Seed Company of Malawi in 1978, seed multiplication and distribution were the responsibility of the Ministry of Agriculture and the Agricultural Development and Marketing Corporation (ADMARC). ADMARC was the sole official supplier of inputs and sole official buyer of smallholder produce, using a pan-territorial, uniform price for all maize grain types. The recent entry of profit-making seed enterprises and the gradual liberalization of the domestic grain trade have increased the incentives for hybrid seed production and marketing, although these incentives are still limited, particularly in some regions of the country.

In retrospect, it is not clear that either of Brennan's criteria for shifting breeding strategies to emphasize end-use quality have ever been met in Malawi. On the other hand, evidence suggests that emphasizing quality over yield in recent years is likely to amplify the economic rate of return to research. The next section provides rate of return estimates to illustrate this point.

THE ECONOMIC RATE OF RETURN TO GRAIN QUALITY RESEARCH

Farmer Objectives and the Rate of Return to Adoption

Table 1 shows how assumptions about farmers' objectives and the role of maize breeding in meeting those objectives affect whether or not hybrids appear worth the investment for

Table 1 *Marginal Rate of Return to Grain Quality for Malawi Farmers*

	Assumptions about Farmer Objectives							
	High Management Grain Sold		Low or Medium Management Grain Consumed					
Maize type	Local	Dent hybrid	Local	Dent hybrid	Local	Flint hybrid	Local	Flint hybrid
Fertilizer (kg/ha)	40–10		0	96–40	0	0	40–10	40–10
Benefits								
Yield (kg/ha)	1852	3788	1071	3788	1071	1578	1852	2484
Management adjustment (kg/ha)	1667	3409	857	3030	857	1262	1482	1987
Less processing losses (kg/ha)						2273		
Price	0.43	0.43	0.58	0.58	0.58	0.58	0.58	0.58
Less harvest/ transport cost	0.37	0.37						
Less insecticide costs					0.55			
Total	617	1261	497	1250	497	732	859	1153
Costs that vary								
Fertilizer	128.2	337.9		337.9				
Seed	9.25	91.25	14.5	91.25	14.50	91.25	14.50	91.25
Labour								
Land preparation	50.7	58.5	50.7	58.50	50.7	58.5	50.7	58.7
Fertilizer application	4.46	8.91		8.91				
Planting	1.60	1.87	1.60	1.87	1.60	1.87	1.60	1.87
Total	194.2	498.4		498.4	66.80	151.6	66.8	151.6
Net Benefits	422.6	763.0	430	751.6	430	580.6	792.5	1001
Marginal rate of return (percent)		112		75		177		246

Data sources: MOA/FAO/UNDP Fertilizer Demonstration Programme 1992–3; CIMMYT/MOA Maize Variety and Technology Adoption Survey 1989-90.

Note: Benefits and costs are in Malawi kwacha/ha.

small farmers, and why grain quality mattered in breeding Malawi hybrids. In Malawi, as in many other environments, both flint and dent hybrids outyield local maize varieties even when unfertilized (National Maize Variety Trials; MOA/FAO/UNDP Fertilizer Demonstration Program). The first panel compares the partial budgets for the medium and larger smallholder, to whom dent hybrids might have been promoted during the 1980s. As a rough indicator for purposes of comparison, a smallholder falling into the medium and largest size categories in Malawi would operate from 1.5 to 6 ha and would usually produce enough maize to market a surplus. About 26 percent of Malawian smallholders fell into these size categories in 1980, the year of the last National Sample Survey of Agriculture (NSSA). The farmer represented by the figures in the first panel applies recommended fertilizer rates, uses high management levels, produces a surplus of local maize and sells hybrid maize. In this case, even though the farmer produces maize for home consumption, the relevant maize price at the margin for both maize types is the producer price. The estimated marginal rate of return to the adoption of fertilized hybrid seed (111 percent) justifies the investment, especially for the well-informed 'model' farmer who is acquainted with the technology. In fact, however, only about 10–15 percent of Malawian smallholders were served by the credit and extension service in the mid-1980s (Sofranko and Fliegel, 1989), and less that 10 percent grew hybrid maize.

The figures in the second panel, composed of six columns, represent the vast majority of smallholders in Malawi. In all columns, the farmer produces maize for home consumption but does not market a surplus, and the relevant maize price is the consumer price. The first two columns of the second panel show why dent hybrids are not particularly attractive for smallholders with low management levels, who consume their maize and do not market a surplus. Given the heavy on-farm processing and storage losses associated with dent hybrids, the estimated marginal rate of return (75 percent) is probably insufficient to cover the costs and risk of investment in an unknown technology. By contrast, the third panel shows how even with low management and no fertilizer, adopting a flint hybrid is economic for smallholders who consume their maize. Unfertilized dent hybrid maize would have similar harvest yields, but by the time processing and storage losses were deducted, the farmer household would face a negative rate of return on the investment. The figures in the fourth panel illustrate the remarkable marginal rate of return (246 percent) associated with moderate management levels and the adoption of a flint hybrid. Clearly, with Malawi's maize hybrids, the emphasis on high-yielding dents requiring a great deal of management and high fertilizer levels limited the potential demand for research output.

ESTIMATED RATE OF RETURN TO RESEARCH ON GRAIN QUALITY

In the absence of market price information that reflects quality differentials, a set of assumptions about prices faced by farmers, management levels, and adoption paths to estimate the *ex ante* rate of return to quality research. The benefits associated with research investment in dent hybrids were substracted only from the benefits associated with investment in both dent and flint hybrids. Dent hybrid research simplistically represents investment in 'yield', while research on both dent and flint hybrids represents 'quality' as well as yield investments. The resulting benefits stream from adopting hybrids as a farmer-cum-consumer were compared to the weighted average of net benefits from fertilized and unfertilized local maize production. Some basic assumptions are listed in Table 2.

Table 2 *Assumptions Used in Calculating Internal Rates of Return to Maize Research in Malawi*

Variable	Assumed level
Benefits (Hybrid Maize Only)	
Proportion of aggregate maize planted in hybrids	25 percent dent hybrids only 75 percent flint and dent hybrids
Aggregate maize area	1.4 million hectares in year 2012
Population in 2002[a]	12.332 million
Maximum per capita consumption	230 kg/year
Maize yield	
hybrid	3.0 t/ha
local	1.1 t/ha[b]
Maize price	
Semi-flint hybrid	(i) 1992 ADMARC consumer price (ii) 1992 ADMARC producer price
Local maize	1992 ADMARC consumer price
Dent hybrid	1992 ADMARC producer price
Seed and fertilizer prices	1992 ADMARC smallholder prices
Initiation of adoption path with imported hybrids only	1985 (five year lag)
Ceiling adoption rate for imported hybrids only[c]	15 percent
Costs (All Maize Research)	
Per professional research officer	
1977–1984[d]	1977-1984 actual real level
1985–1990	1980-1984 average real level
Research implementation	average costs per maize researcher do not differ from DAR average
Number of maize researchers[e]	full-time weight 1; part-time weight 0.5
Conversion factors to 1992 prices[f]	GDP deflator

Notes : [a] House and Zimalirana (1992). Population increases are assumed to counteract possible downward pressure on maize prices caused by increased output.
[b] Weighted average of fertilized and unfertilized local maize yields under low management conditions, assuming, based on National Crop Estimates and survey data, that one third of local maize area is fertilized.
[c] Benefits from imported hybrids are deducted from total research benefits.
[d] Pardey and Roseboom (1989).
[e] GON; GOM/DOA; GOM/DAR.
[f] World Bank (1992); Reserve Bank of Malawi (1992).

In the first calculation, per hectare net benefits from adopting dent hybrids were determined by adjusting downwards the yield of hybrid maize fertilized at recommended rates by 20 percent, and valuing output at the producer price. In other words, dent hybrids are produced under low or medium management conditions but fertilized according to the package currently promoted[2], and sold rather than consumed. The adoption ceiling was projected by estimating a logistic function with data on the proportion of maize area planted to dent hybrids up to 1993. If adoption rates had continued to climb according to the observed pattern, about one-quarter of Malawi's maize area would eventually have been planted in dent hybrids. Per hectare net benefits from adopting flint hybrids were determined by the same yield adjustment and valuing output at the consumer price. The logistic function applied to the data through 1993 predicts that adoption of both flints and dents will reach 100 percent of all maize area in 2011. Forcing a lower adoption ceiling (75 percent of all maize area) to express unknown socioeconomic or institutional impediments[3], the total value of quality research is then the extra value of a 75 percent adoption ceiling to a 25 percent adoption ceiling, plus the assumed difference per hectare in the value to the farmer who is also a consumer.

In the second calculation, for a more conservative estimate of the per hectare benefit from adopting hybrids, the producer price was used to value output of both dent and flint hybrid maize. This assumption reflects the difficulty in generalizing farmer objectives and preferences when quality differentials are not expressed in market information. The only effect on research benefits from quality investments is then the higher adoption ceiling projected from the observed adoption pattern.

Direct and indirect costs of all maize breeding were calculated for each year from 1977 to 1990, overstating the costs of quality research by including yield research. The years of breeding adapted dent hybrids were necessary for developing local inbred lines that were suitable to use in the top-crosses. On the other hand, the flint germplasm for the top-cross was 'free' from the viewpoint of the national research system.

Given the assumptions invoked and the data up to 1993, the estimated internal rate of return to research investment in the grain quality of maize hybrids is 53 percent. With the more conservative pricing assumption, the estimate falls to 32 percent.

CONCLUSIONS

There seems no doubt that by emphasizing grain quality in recent years, the impact of Malawi's maize research program has been magnified, with some positive distributional consequences. That impact will depend over time on complementary investments in seed production and distribution systems, as well as continuity in the maize research program. The relevance of research output for Malawi's many smallholders is much greater than ever before — a laudable accomplishment for the scientists and institutions involved. Incorporating end-use quality in breeding objectives when farmers consume their maize makes economic sense.

On the other hand, the story of this accomplishment reveals some potential dangers associated with expanding selection criteria in crop breeding. Suppose Malawi's maize breeders had emphasized flint quality over yield in allocating their scarce research resources during the 1970s, using the money spent importing dent hybrids to developing flint hybrids or open-pollinated varieties. At that time, how long would it have taken them, with limited staff and fewer breeding techniques, to overcome the shortage of (a) exotic flint inbred lines and (b) suitable local material to breed inbred lines? Without a yield advantage, flinty, improved open-pollinated varieties would not have been attractive. In either case, the seed production and marketing system was not sufficiently developed to diffuse new seed types.

Even in 1987, the effective smallholder demand for hybrids was difficult to assess in Malawi's agricultural economy. Under pressure from the donor community, the research system gambled, and the opportunity cost of the gamble was reduced through utilizing a nonconventional breeding technique and public (CIMMYT) germplasm. The gamble appears to be paying off — but may not in other similar cases. Shifts in donor views on development priorities can become flights of imagination, and as Cantrell concluded with reference to the QPM program, 'imagination...is not necessarily a reliable guide to assigning priorities' in a crop breeding program. If any category of germplasm is to receive exceptional treatment, its special status must be based on a cool assessment of needs, benefits, and costs (Cantrill, 1989, p.9). In countries like Malawi, cool assessment requires special insights.

NOTES

[1] QPM seed was, however, more costly to produce commercially because of the need for isolation.

[2] Lower fertilizer levels may be more realistic as adoption of hybrid seed becomes more widespread and the distribution system becomes more flexible.

[3] For example, in the 1993–94 cropping season, credit was not disbursed because of repayment problems that accompanied major political changes in the previous year. As a result, the use of hybrid seed and fertilizer dropped precipitously after a seven-year pattern of rapid increase.

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Smale and Heisey's paper raises interesting issues concerning the Hobson's choice confronting plant breeders and policy makers in making research investment decisions given the conflicting needs for providing for future food requirements through emphasis on yield augmenting varieties in crop breeding research as against those emphasising quality improvement which cater specifically to farmers' tastes and preferences. This problem is not peculiar to Malawi but true of crop breeding research in most other countries as well. These questions assume importance since there are trade-offs involved between costs and benefits to farmers, plant breeders and country as a whole. Funding for crop breeding research being limited, there is need to make optimum and rational use of scarce research funds and other resources which also has to be justified by the expected returns. In evaluating research investment decisions the important question is to what extent the research priorities reflect development goals. Concerns about reducing poverty and attaining self sufficiency in food prompted many Asian and Latin American countries to emphasize yield augmentation in crop breeding programmes during the green revolution phase. Subsequent concerns about extending the benefits of growth to lagging regions and ecologically fragile areas led to research efforts in evolving location specific crop varieties that were tolerant of droughts and other environmental constraints.

Sub-Saharan Africa faces severe economic problems, with food production unable to keep pace with population growth. An idea of the projected demand for maize and other foods in Malawi and the demand-supply gaps would have indicated the broad parameters and constraints within which policy makers and plant breeders have to make decisions about priorities in crop breeding research. The paper doesn't shed much light on this.

Further, although the authors suggest some positive distributional consequences of quality improvement oriented crop breeding research in Malawi (in terms of wider participation by small farmers) the crucial questions are how far has this emphasis on quality improvement led to an improvement in nutritional levels of the poor and a reduction in poverty.

Secondly, allocations of available funds should be justified by the expected returns. The authors note that unlike in South-East Asia, where rates of return from quality improvement based research were lower than yield-based ones, in Malawi quality improvement based breeding research yielded high returns. The IRRs using alternate assumptions and sensitivity analysis ranged between 32 to 53 percent. It would have been interesting to know how changing prices and tastes and preferences, apart from other factors would alter these rates of return. Also it is important to know what are the social opportunity costs in terms of yields foregone or food imports required, etc.

Thirdly, the results obtained by the authors pertain to an economy like Malawi, characterized by weak market signals and a highly regulated market which have distorted the structure of incentives for plant breeding research. However, liberalization and structural adjustment policies in Malawi would change the incentives for plant breeding research and facilitate a greater role by private seed companies. The question then is what are the likely impacts of this changing policy environment on crop breeding research in Malawi, as also in other similarly placed countries.

Fourthly, the efficiency and viability of crop breeding research programmes also depends upon an effective extension system. In this connection the authors suggest a role for social and physical scientists in bridging the information gap between plant breeders and farmers. It would be interesting to discuss the parameters of this role and similarly of other agents like farm leaders, NGOs and local level institutions, and the media.

Lastly, as is the experience of many developing countries, in Malawi there is going to be greater commercialization of the food sector as the economy grows. That will change the incentives and policy environment for crop breeding research in Malawi. This is another issue which merits discussion. Thus there are both general issues and issues specific to Malawi which merit detailed discussion.