USING THE COMMODITY SUBSECTOR APPROACH TO DESIGN AGRICULTURAL RESEARCH: THE CASE OF MAIZE IN MALI*

by

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ABSTRACT

This paper applies a subsector perspective to analyzing the design of agricultural production and processing technologies. The framework stresses how conditions at one level of a subsector influence constraints and opportunities for technical and institutional innovations at other levels. The paper also stresses the need to combine insights from the subsector and farming systems perspectives when developing an agricultural research agenda. These points are illustrated by drawing on results from a recent maize subsector study in Mali.

Keywords: subsector, marketing, farming systems research, agricultural technology development, maize, agricultural research systems, liberalization, Mali

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1. INTRODUCTION

African National Agricultural Research Systems (NARS) are under pressure to demonstrate that agricultural research is a worthwhile public investment. The rate of adoption of improved technology at the farm level is an important factor affecting the level of economic returns to agricultural research. Farm-level technology adoption rates are determined in part by constraints and opportunities in the off-farm economy, communicated through agricultural input and output markets. The introduction of market liberalization policies in many countries changes these opportunity sets, sometimes radically, for example by the withdrawal of guaranteed producer prices and subsidized marketing services. National planners and donors are therefore urging that publicly funded agricultural research take more account of market opportunities and constraints in the design of research (USAID, 1992).

NARS such as the Institut d'Economie Rurale (IER) in Mali that want to incorporate market considerations into their research agendas face two challenges. First, a conceptual framework is required that integrates market considerations with (more familiar) farm-level production concerns. Second, analyses of farming system and market constraints and opportunities must be brought together to ensure that research programs exploit potential synergies between the different stages from farmer to consumer. Given the dynamic nature of farming and marketing systems, an important function of such analyses will be to help prioritize research activities over time in response to evolving constraints and opportunities. The purpose of this paper is to present a conceptual framework for integrating commodity subsector and farming systems perspectives and to illustrate how this framework is useful in setting research

priorities. We draw on the example of a maize subsector study currently being carried out in Mali by IER, in collaboration with Michigan State University.

2. TOWARDS A CONCEPTUAL FRAMEWORK FOR INTEGRATING COMMODITY SUBSECTOR AND FARMING SYSTEM PERSPECTIVES[1]

The relationships between farming and marketing systems can best be understood in relation to the food system as a whole. The food system has been defined as "the entire set of actors and institutions involved in input supply, farming, and the processing and distribution of agricultural products (including their links with international trade)" (Staatz and Bernsten, 1992). Both farming and marketing systems are components (or sub-systems) of the food system.

A simple but effective tool for organizing analysis of a food system is a matrix of agricultural products and functions (Figure 1). Originally conceptualized by Shaffer (1973), and further developed by Holtzman (1986), each column of the matrix represents a commodity subsector (i.e., the entire range of productive processes and services associated with a specific commodity or group of closely related commodities). The rows of the matrix represent individual stages or functions in the production and transformation of commodities.

Interdependencies, or system interactions, are common to both vertical and horizontal dimensions. At the farm-level production stage (horizontal dimension) different crop enterprises compete for limited household resources of land, labor and capital, while livestock enterprises enhance crop productivity through increased soil fertility. Similarly, in the vertical dimension, transport costs to urban centers play a key role in determining which products can be cultivated profitably, while investment in cooperative processing facilities may provide a means to overcome high transport and storage costs associated with bulky and/or perishable commodities. Interdependencies between stages in a subsector can thus either help or hinder technical innovation and hence should be taken into account from the outset.

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[1]This and the following section draw heavily on Boughton and Témé (1992).

Figure 1. FOOD SYSTEMS MATRIX

PRODUCTION/DISTRIBUTION FUNCTIONS	COMMODITY SUBSECTORS						
	Millet	Sorghum	Maize	Rice	Cotton	Livestock...	Off-farm
Input Distribution	^						
Extension	| S	Farming Systems Approach					
Farm-level production	| u	<---------->					
Processing	| b						
Storage	| s						
Transport	| e						
Exchange, transactions	| c						
Finance	| t						
	| o						
	| r						
	|						
Coordination functions	| A						
- Prices	| p						
- Quality control	| p						
- Regulations	| r						
- Property rights	| o						
- Contracts	| a						
- Risk management	| c						
	| h						
	|						
Consumption	v						

Source: Adapted from Ndoye and Newman (1984).

Historically, agricultural research has tended to focus on a single stage (often production) for a single commodity (Staatz and Bernsten 1992). Interactions with other stages in the commodity subsector, or other commodities at the same stage, were frequently overlooked. Farming systems researchers have consistently stressed the need for a holistic approach to the design of farm-level technology in order to take account of the range of constraints and interactions confronting the farmer (Collinson 1982). This concern has not been limited solely to the farm-level production stage. Other stages with which the farmer as client is concerned (e.g., own consumption taste preferences, on-farm processing technology) have also been taken into account. But is this enough?

Agricultural development beyond semi-subsistence requires specialization, and this inevitably draws the farmer into a greater degree of exchange with other stages in the food

system. An increasing proportion of inputs are obtained off-farm, and an increasing proportion of farm-level products and services are sold or exchanged. Farmers may even choose to purchase food in the market place rather than produce it themselves in order to devote their limited time to other agricultural or non-agricultural activities (Staatz and Bernsten, 1992). The adoption of technology at farm-level will increasingly depend on the extent to which it enables farmers to respond to evolving off-farm client preferences for different product characteristics (e.g., quality, seasonal availability, lot size) as expressed by market prices.

In this context of increasing specialization and exchange, a commodity subsector perspective broadens the scope for productivity gains. Instead of limiting the search for possibilities to drive down unit costs of production only to the farm level, researchers can examine possibilities at several or all stages in the commodity subsector. As Staatz and Bernsten (1992) observe, if marketing costs represent 50% of the final product value (as is commonly the case in developing countries) then a 10% reduction in marketing costs has the same effect on the overall productivity of the subsector as a costless 10% increase in crop yield. For farmers, a reduction in marketing costs would be preferable to a yield increase since it requires no additional inputs or risk and would have an upward rather than a downward effect on farm gate prices if any. In the case of export crops such as cotton and groundnuts, driving down unit costs at multiple stages may be the only way to maintain real incomes in the face of declining real world market prices.

A commodity subsector perspective provides researchers with additional options in the search for innovations. Increasing specialization and exchange in the food system requires coordination between economic agents at different stages in the subsector. Technological innovation by itself may fail to achieve all potential productivity gains within a given commodity subsector because of inadequate coordination. Institutional and policy innovations can

complement technological innovation by reducing barriers to the effective communication of consumer preferences and market opportunities to farmers, and by increasing the ability of private-sector participants at all stages of a commodity subsector to respond to those opportunities.

3. INTERACTIONS BETWEEN FARMING SYSTEM AND SUBSECTOR INTERVENTIONS: MAIZE PROMOTION IN SOUTHERN MALI

The historical development of maize in southern Mali illustrates the potential impact of institutional and policy innovations on technology adoption at farm level, as well as the interdependence between different commodity subsectors. Maize is a relatively minor crop in Mali, representing about 5-10% of the total cereal area of the country and about 10-15% of cereal production. At a 7% rate of growth of output, however, it is the most rapidly growing cereal subsector. Approximately 80% of the total Malian maize crop is grown in southern Mali, where rainfall ranges from an average of 1200 mm in the south to 700 mm in the north.

The promotion of intensive maize production in the early 1970s was undertaken by the Compagnie Malienne pour le Développement des Textiles (CMDT) in a context of chronic food deficits.[2] Initially promoted among farmers using small tractors, the program was quickly expanded to include farmers using animal traction. The rapid rate of adoption from 1979 through 1985, when the area planted to improved maize varieties in the CMDT zone increased from under 10,000 ha to nearly 50,000 ha, can be attributed to both institutional and technological innovations.

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[2] The terms "improved" and "intensive" are used synonymously here, reflecting the use of the term "maïs amélioré" in CMDT annual reports, and refer to the use of improved varieties, management practices and chemical fertilizer.

The key institutional innovation was the application to maize of the same integrated approach to technology delivery that was already successfully in use for cotton. The CMDT ensured that all stages in the subsector both prior to production (seed multiplication and distribution, fertilizer and credit delivery, extension advice) and post harvest (purchase and collection, transport, storage, wholesaling) were coordinated through the administrative decisions and technical resources of a single organization. This approach was made possible by a policy innovation that from 1981 gave rural development agencies such as the CMDT the right to purchase of cereals at a guaranteed price on behalf of the national grain board (OPAM). The guaranteed price facilitated credit repayment by farmers for production inputs, and the resale price to OPAM included a margin that partially defrayed the CMDT's marketing costs.

The rapid adoption of maize technology was also facilitated by the prior development of the cotton subsector in southern Mali. Since the late 1950s, the CMDT's predecessor (the CFDT) had been introducing mechanization as part of its program to expand cotton production. Over the period 1975 - 1990 the number of oxen and related equipment trebled, paid for by farmers out of their cotton profits. Mechanization is crucial to farmers' capacity to adopt intensive maize because of the need to plow and weed frequently in a timely manner. Not surprisingly, the area of improved maize is highly correlated with mechanization levels over the period 1975-90 (Boughton and Témé, 1992).

An additional contribution of the cotton subsector to maize technology adoption was the availability of residual fertilizer on the previous year's cotton fields. Maize is the most fertilizer-responsive rainfed cereal, and the presence of residuals permits lower cash outlays for farmers.

Although dramatically effective in terms of adoption rates, the integrated approach to maize production and marketing implemented by CMDT was not financially sustainable. Accumulated cereal trading losses on the part of the national grain board (of which only a small

proportion was maize) resulted in a default on payments due to the CMDT for maize procured from farmers. The CMDT in turn was obliged to cease purchases. With the removal of guaranteed prices for maize in 1986 (accompanied by the withdrawal of credit for maize inputs), farmers were exposed to lower and unstable market prices. Farmers' response to these changes also illustrates the importance of interactions between commodity subsector and farming systems.

While the combination of a highly coordinated subsector and mechanized farming systems had a dramatic effect on the increase in area under improved maize, the withdrawal of marketing services and guaranteed prices after 1986 primarily affected farmers' choice of production techniques. Although the area of improved maize quickly resumed its growth trajectory, farmers radically altered their choice of technology and degree of interaction with the market by the following measures:

(i) reduction in fertilization levels and substitution of manure for chemical fertilizer;

(ii) substitution of early maturing varieties tolerant of low soil fertility conditions for medium or long-duration varieties with high fertilization requirements;

(iii) rapid shift from sole cropping back to the traditional practice of maize-millet intercropping (a system more tolerant of lower soil fertility conditions, more drought tolerant, and with a higher gross margin due to the fact that under liberalized markets millet now sells at a higher price than maize);

(iv) changes in marketing strategy: if the early maize harvest is good, and if the prospects for the millet/sorghum also look good, farmers will off-load their old millet and sorghum stocks on the market while prices are still high and eat maize instead.

In the face of erratic maize prices, and without a line of credit to purchase fertilizer, farmers effectively chose those technology options that enabled them to insulate themselves from the uncertainties of the market.

The key lesson from this historical experience is that the possibility for both positive and negative interactions between changes in subsector organization and farm-level technology adoption need to be born in mind when designing future research and extension programs.

4. STRATEGIC RESEARCH QUESTIONS FOR THE MAIZE SUBSECTOR TODAY

A key question in defining the Malian agricultural research agenda is (1) whether maize will continue to be produced and consumed primarily as a rural food source (either for consumption during the hungry season or as a dry season staple), as appears to be the case at present; or (2) whether alternative market opportunities could develop that would entail an expansion of maize production and consumption via the marketplace over time.

The question is strategic in that different answers imply different research agendas and disciplinary mixes. In the case of maize for consumption during the hungry season, appropriate criteria for varietal selection will include marginal improvements in earliness and drought tolerance. If required for consumption during the dry season, yield, storage quality and ease of processing may also be important. In the case of maize required for commercial flour or grit manufacture, on the other hand, selection criteria could include factors such as the proportion of pericarp and grain hardness. Selection criteria that include manual or mechanical processing characteristics imply much greater involvement of food technologists than the former. While these technology development paths for maize are not mutually exclusive, differences in disciplinary mix and criteria in a context of limited research resources require that the objectives for maize research need to be prioritized over time.

In order to assess the potential for a broader, more stable grain maize market over time (strategic option 2), it is necessary to examine possibilities for increasing both supply and demand. Farmers are likely to be willing to increase production for the market in response to an increase in expected prices, a reduction in unit costs of production, or a reduction in uncertainty about prices and/or yields. Consumers are likely to be willing to increase consumption in response to a decrease in retail prices of maize, an increase in income (which might involve increased maize consumption in the form of eggs as well as grain), or an increase in the value of the product (by processing the grain into flour for example). Improvements in the prices received by farmers or paid by consumers need not necessarily be a zero-sum game if farm-level production costs, marketing costs, or processing costs can be reduced.

In the light of the limited industrial and livestock demand for maize feed, the principal market for potential maize surpluses in the medium term would appear to be the rapidly growing urban population, in particular Bamako, the capital city (population approx 1 million). The growth in urban demand for grain maize will depend in large part on the relative cost of preparing meals from maize compared to other cereals. This will depend in turn on relative prices of maize and other cereals, and the extent to which higher costs for processing maize into flour can be reduced.[3] The primary focus of the maize subsector study is therefore to estimate the potential demand for pre-processed maize flour. Since the cost of manufacturing maize flour is likely to be sensitive to the cost of maize grain, a secondary focus is to determine farm-level costs of maize production relative to other coarse grains, and explore possibilities for

[3] Although apparently more severe for maize, processing costs are also a constraint on urban demand for coarse grains generally in West Africa (Reardon et al. 1991). Hence analysis of the possibilities for overcoming these constraints may be generalizable beyond the case of maize in Mali.

reducing them. The potential for reducing marketing costs elsewhere in the subsector is being addressed by parallel studies by the Market Information System (SIM) of the national grain board.

Preliminary results indicate that considerable scope for increasing per capita consumption, estimated at 13 kg for 1988/89 (DNSI, 1990). The results illustrate, however, the interdependencies of constraints at various levels of the subsector. For example, the primary constraint to increased maize consumption identified during the first phase of the study is the difficulty and/or higher cost of processing maize. A key factor affecting the supply of processing services is the extent to which processors can develop strategies to adapt to instability in production between years. More in-depth consumer surveys indicated that in direct contrast to donor emphasis on the promotion of maize grits and parboiled sorghum as direct substitutes for rice, consumers want to buy decorticated grains and/or flour in order to make traditional coarse grain-based dishes more easily. In addition to low consumer incomes, important constraints to the development of the market for processed coarse grain products are 1) inefficient milling technology and organization of the supply of decorticated coarse grains; 2) lack of consumer confidence in the cleanliness of flour processing; and 3) gender division of household food procurement and preparation responsibilities.

Processing studies also indicated that the price of processed maize flour is sensitive to the raw material price by a factor of 2:1 (i.e., each 10 CFA/kg increase in the price of maize results in a 20 CFA/kg increase in the price of flour). Thus research into possibilities for reducing farm-level unit costs of production remains a valid concern despite the attainment of aggregate self-sufficiency in coarse grains in recent years.

Farm-level surveys suggest that adoption rates for improved varieties could be significantly increased by an extension policy that tailors varietal promotion to individual farmer

needs and circumstances. In trying to encourage intensification of rainfed cereal production, the CMDT promoted only long-duration varieties with high yield potential in the high-rainfall areas. Nevertheless, a significant proportion of farm families are food deficit due to low levels of mechanization and the absence of a cash crop. Their first need is for early maturing varieties, even if the yield is lower than could be obtained with long duration varieties. Improved early-maturing varieties of maize are available, but have not yet been made available to many farmers. In response to the study's findings, IER is now focusing on ways of matching varietal recommendations to the needs of different groups of farmers.

5. CONCLUSION

A commodity subsector approach can significantly improve the payoff to investments in agricultural research by identifying ways of driving down costs throughout the subsector through a combination of appropriately sequenced technological, institutional and policy innovations. The Institut d'Economie Rurale has included subsector studies in its strategic plan in order to ensure that its efforts are relevant to the needs, circumstances and opportunities of clients at all stages from farm-level production to final consumer. The maize subsector study is the first in this series, and seeks to provide both a methodological foundation for future studies, as well as directly useable results to enhance the performance of Mali's cereal subsector at large, and maize in particular. As experience in the implementation of subsector studies grows, the benefits could be multiplied further by diffusion of the lessons learned to other national agricultural research systems in the region.

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