Staff Paper

From Pilot Study to Commodity Subsector Economics Program: Institutionalizing a Market-Oriented Approach to Agricultural Research in Mali

by

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FROM PILOT STUDY TO COMMODITY SUBSECTOR ECONOMICS PROGRAM: INSTITUTIONALIZING A MARKET-ORIENTED APPROACH TO AGRICULTURAL RESEARCH IN MALI*

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ABSTRACT

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 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 and structural adjustment policies has changed these opportunity sets, sometimes radically. How can NARS take more account of market opportunities and constraints in the design of thematic and farming systems research (FSR)? The paper addresses this question on the basis of an 18 month collaborative research program with the Institut d'Economie Rurale (IER), Mali, one of the first African NARS to include both FSR and commodity subsector studies in its strategic plan in order to improve the economic impact of agricultural research programs. The paper applies a subsector perspective to analyzing the design of agricultural production and processing technologies for maize. The framework stresses how conditions at one level of a subsector influence constraints and opportunities for technical and institutional innovations at other levels. The final section of the paper describes the process of institutionalizing a Commodity Subsector Economics Program at IER, and the selection of priority commodities for the first phase.

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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 undertaken 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.

Figure 1. FOOD SYSTEMS MATRIX

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

Source: Adapted from Ndoye and Newman (1984).

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

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.

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.

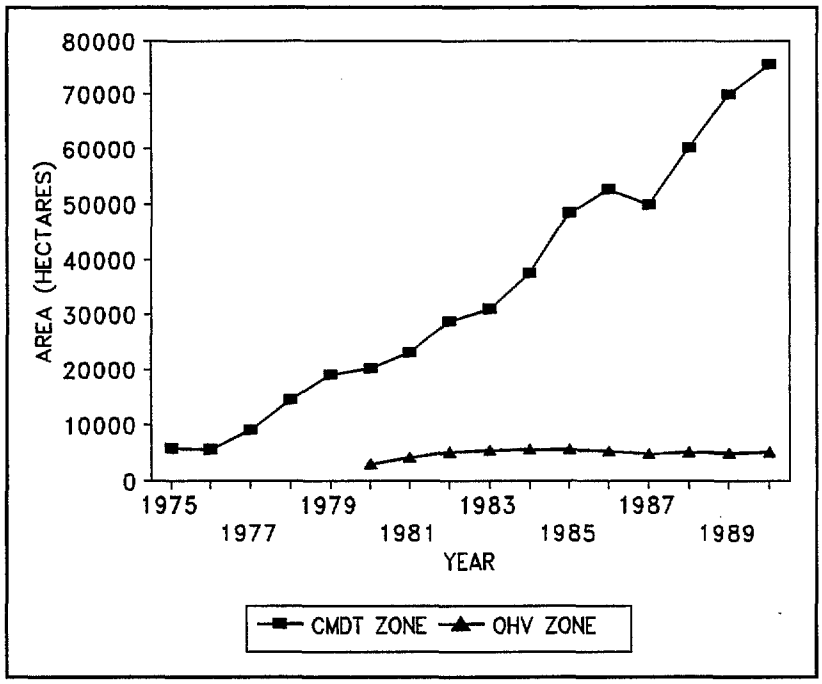
3. INTERACTIONS BETWEEN FARMING SYSTEM AND SUBSECTOR INTERVENTIONS: MAIZE PROMOTION IN SOUTHERN MALI

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 (Figure 2).

FIGURE 2: ADOPTION OF IMPROVED MAIZE IN THE CMDT AND OHV ZONES



Source: CMDT and OHV Annual Reports

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

[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.

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.

The joint impact on farm-level adoption of a coordinated subsector interacting with farming systems characterized by a high level of mechanization linked to a profitable cash crop can be clearly demonstrated by comparison of the CMDT and OHV zones. The OHV did not put an integrated maize technology development program in place, and farming systems have considerably lower levels of mechanization. Consequently, the adoption curve for intensive maize is almost flat (Figure 2).

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.

Despite the significant changes in production practices in recent years, the overall economic return to maize research and extension over the period 1969 - 1990 was very high at 135% (Boughton and Henry de Frahan, 1994). The main factors accounting for this high rate of return are the high value of maize in a food deficit situation, the low cost of maize research (germplasm and technical recommendations were borrowed from other countries or regional/international centers), and the rapid farm-level adoption rate. Sensitivity analysis indicates that this return is robust with respect to adverse changes in assumptions concerning overvaluation of the exchange rate, research costs, extension costs, and total area of improved maize. The estimated return is moderately sensitive to price and yield reductions.

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. OVERVIEW OF THE MAIZE SUBSECTOR IN MALI

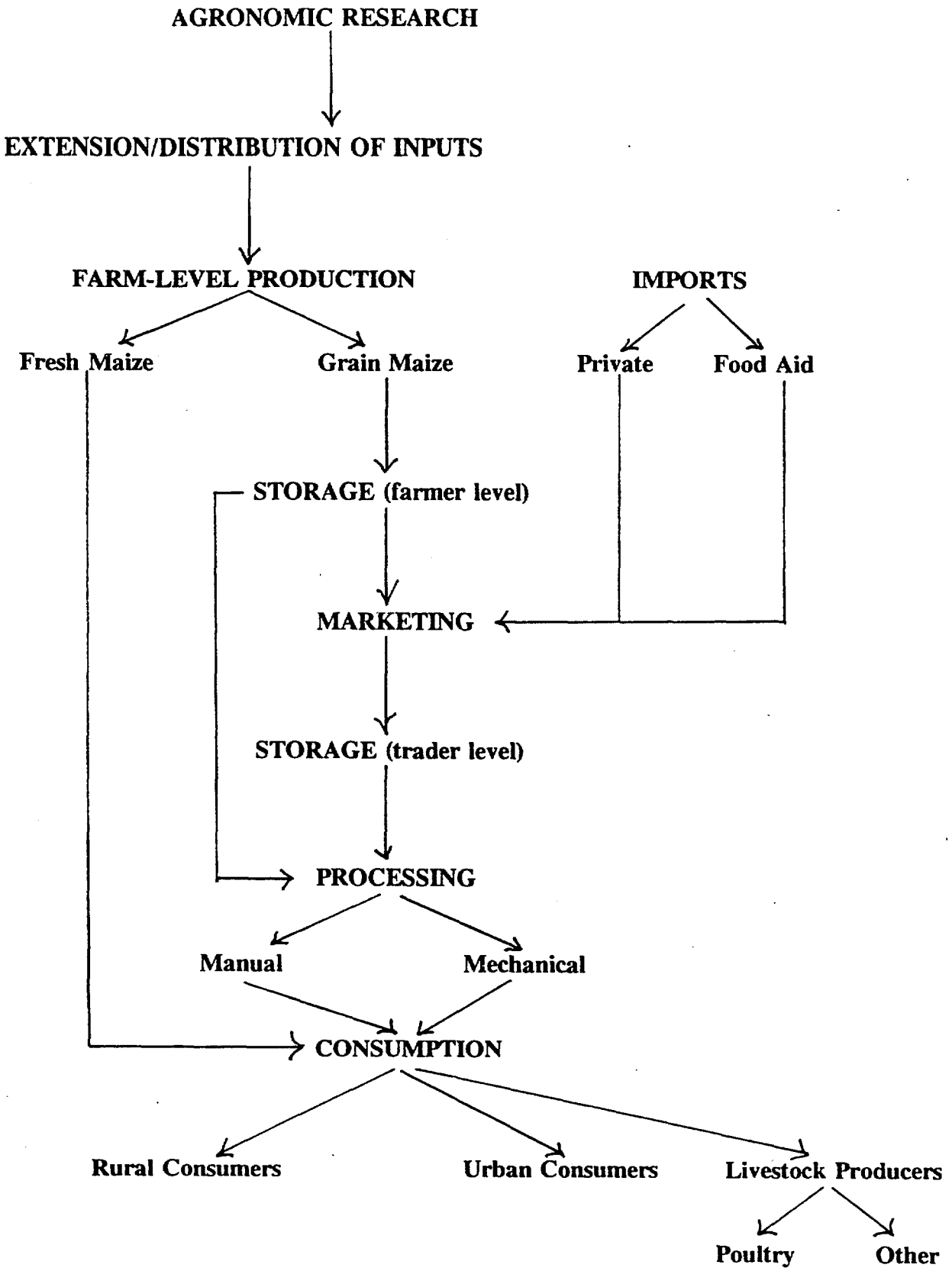
The previous section showed how, in the past, rapid farm-level adoption of intensive maize production practices was closely associated with the institutional innovation of a vertically integrated system for input delivery and output marketing. The purpose of this section is to provide a description of the maize subsector today, based on rapid reconnaissance, literature review and secondary data. The picture that emerges is one of a weakly coordinated subsector by contrast with the pre-market liberalization period. This descriptive analysis lays the foundation for a discussion of strategic issues related to the future development of the subsector in the next section, and an evaluation of opportunities for market expansion and improvements in vertical coordination consistent with the existing government policy of cereal market liberalization.

Maize research has historically been a very minor part of the total **agronomic research** effort (Figure 3)[3]. Since the early 1970s, the primary focus has been on varietal selection, initially based on linkages with French-operated research stations in West Africa, and more recently on linkages with regional and international centers/networks. By the end of the 1980s, several improved varieties had been released, but there is a dearth of quantitative information on adoption rates.

Extension services are provided by two parastatal organizations, the OHV and the CMDT. The supply of agricultural inputs has been liberalized, although the CMDT remains the main supplier of inputs because bulk purchasing and back haulage (lorries returning from cotton delivery to the Ivory Coast) permit lower input delivery costs than the private sector. Consequently, the CMDT's policy on what inputs to provide (varieties, fertilizer

[3] An activity or function that is boldfaced in the text refers to a stage in the maize subsector diagram (Figure 3). This descriptive analysis is based on a rapid reconnaissance of the maize subsector carried out during the period February to April 1992, with support from PRISAS/INSAH (IER, 1992).

FIGURE 3 : THE MAIZE SUBSECTOR IN MALI



compositions) largely determines what is available. Credit for the purchase of inputs is supplied by an agricultural bank, and the supervision of disbursement and recovery is increasingly being undertaken by village associations.

At the **farm-level production** stage, maize represents about 5 - 10% of the total cereal area in Mali, and about 10 - 15% of cereal production. At a 7% rate of growth of output it is the most rapidly growing cereal subsector, which could eventually have an effect on relative cereal prices (Holtzman et al., 1991). 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. For non-mechanized farmers, lack of equipment, high cost of fertilizer and drought risk are the major constraints cited. For mechanized farmers, the lack of a guaranteed price for maize is a key constraint. They are unwilling to lay out cash for fertilizer without a guaranteed price because of the risk of ending up in debt. Some farmers expressed that they were more concerned about the uncertainty of maize prices than rainfall. Quantitative information about costs of production and variability in returns is extremely scanty (Holtzman et al., 1991).

Fresh maize plays a vital role as a hungry season food source as early as mid-July, and is very popular in roasted form among urban dwellers. Consequently, it can be a valuable cash crop for farmers in peri-urban areas with good access to urban markets. In urban areas, fresh maize is marketed through the fresh vegetable subsector. Fresh maize wholesalers are exposed to high risks because of its perishability. **Grain maize**, available from the end of September, continues to be a key food source for rural consumers through to the arrival of the millet/sorghum harvest in November. Maize stover is generally left in the field and consumed by livestock during the dry season.

Farm-level **storage** is generally not a problem, partly because most of the crop is consumed in a relatively short period of time and partly because it is stored on the cob, making it more difficult for insects to penetrate the grain. A significant expansion of maize production might require changes in storage methods since the current practice is demanding in the amount of storage space required in relation to grain weight.

The **marketing** of grain maize takes place through the same network of rural collectors and wholesalers, transporters, and urban wholesalers and retailers as other coarse

grains.[4] The limited availability of quantitative information on cereal marketings permits only qualitative impressions. According to traders, the volume of maize is small relative to millet and sorghum, and relative to the total maize harvest since much is consumed by farm households themselves. According to farmers, the tendency to consume increasing amounts of maize on-farm is due to the fact that millet and sorghum commands a higher price than maize in local markets. Given the relatively low coarse grain prices in recent years, and the high costs farmers incur to bring their cereal to market because of poor roads, even a small difference in selling price such as 5 FCFA/kg represents a big difference in net margin. Traders report that most maize marketed beyond rural markets goes to the capital city of Bamako.

The quantities marketed also vary considerably from year to year according to the size of the maize and millet/sorghum harvest. Maize production is more variable than other cereals. Over the period 1971-72 to 1990-91 the coefficient of variation was 0.56 for maize production, compared to 0.34 for other coarse grains and 0.32 for paddy (Holtzman et al., 1991). Furthermore, if the millet/sorghum harvest is poor, then maize marketings will be low even if the maize harvest was good as rural producers replace millet or sorghum with maize in their diet.

Marketing margins between rural producers and urban consumers are substantial. The average marketing margin of 35 CFA/kg ($0.17/kg) represents approximately 50% of the average retail price in Bamako. However, the high correlation between prices in rural markets and Bamako retail prices indicates that this margin is not due to a lack of competition among traders. It is more likely due to high assembly and transportation costs that result from small, dispersed quantities of marketed produce, poor rural infrastructure, and the high cost of vehicles, fuel, and spare parts. Although the marketing margin is substantial, the lack of information concerning the components of this margin, and quantities traded, makes in-depth analysis difficult. From January 1993, the Market Information System began to collect

[4] The term coarse grains refers in this context to the following cereals: millet, sorghum, maize and findo.

cereal prices at different levels in the system, as well as quantities transacted, in order to carry out such analysis.

Only very limited quantities of maize appear to be stored off-farm. The majority of traders do not use formal credit, and cash constraints oblige them to seek earnings through turnover rather than speculative storage. Furthermore, storage of maize at merchant level presents more difficulties than farm-level storage because it is more vulnerable to insect infestation in grain form than it is on the ear. Finally, the possibility of imports from Ivory Coast (where the maize harvest is earlier) effectively places a price ceiling on maize, limiting potential profits to storage.

Processing represents a constraint to maize consumption. The processing of coarse grains involves four main stages: 1) threshing to remove grains form the ear or cob; 2) dehulling to separate the pericarp from the endosperm (involving significant loss of the thin layers of protein between them); 3) milling to reduce the endosperm to flour and/or grits and 4) sieving to grade the milled endosperm into particles of different sizes. Between each of these stages cleaning activities will be undertaken (e.g., winnowing after threshing, washing after dehulling). In rural areas, coarse grains are threshed, dehulled and milled using pestle and mortar, since mechanical processing is very costly relative to rural women's incomes (ATI, 1992). In urban areas coarse grains are usually purchased in grain form, dehulled manually and then taken to a custom plate mill for grinding into flour (Holtzman et al., 1991).

One disadvantage of maize compared to sorghum and millet is that it has to be soaked for several hours after dehulling in order to obtain the fine flour preferred by Bamako housewives. This means that dehulling for the mid-day meal would have to be done very early in the morning, and for the evening meal in the early afternoon. Neither time is particularly convenient since early in the morning women are preparing breakfast, and in the early afternoon they are cleaning utensils used to prepare the mid-day meal and/or taking a rare opportunity to rest.

The milling of maize also involves additional costs. Urban mill operators charge more for processing maize than millet or sorghum because it is harder. Although the additional financial costs of milling maize are small relative to the cost of grain (approximately 2.5 FCFA/kg), there are also transactions costs arising from the institutions that govern household

economic management. The household head is responsible for the provision of cereals and money for the purchase of condiments (meat, fish, cooking oil, spices etc.). Most commonly, household heads buy cereals in bulk and provide a daily sum of money ("nassongo") to cover the cost of condiments to the woman responsible for preparing food on a given day. Alternatively, the household head provides a sum intended to cover both cereal and condiment purchases.[5] Cereal processing costs are paid for out of the daily sum allotted for the purchase of condiments. Women resent the additional processing costs of maize because it reduces the amount available to purchase ingredients for, and therefore the quality of, the sauce. Frequently, they will argue for an increase in the "nassongo" if the household head purchases maize.

It is difficult for the household head to simply increase the nassongo by an amount equal to the additional processing cost for two reasons. First, the household head usually has only a vague notion of what it costs to mill the daily quantity of cereals. Second, it is difficult to increase the nassongo by a trivial amount. It usually increases by at least 100 FCFA per day.[6] Thus even if a household head could theoretically realize financial savings by purchasing maize (the difference between the price of maize and the price of sorghum or millet is greater than the additional processing costs), the costs of re-negotiating the nassongo may outweigh the benefits. Thus, the effect of transaction costs that arise from the prevailing institutions for household economic management is to reduce the cross-price elasticity of substitution between maize and other cereals.

The availability of pre-processed products such as flour that could avoid the additional time, cash and transactions costs associated with maize processing is very limited. The same is true for millet and sorghum. Small quantities of flour are offered for sale by women retailers in urban markets, but consumers are very wary of such products. Housewives expressed concern about hygiene, since the flour is sold from open containers and cannot be

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[5] This practice is more frequent among low income households without access to credit for the purchase of cereals from their employer.

[6] A frequency distribution of nassongo reveals that most households are grouped in increments of 500 FCFA per day.

washed like whole or dehulled grain prior to use. Furthermore, there is the always the possibility that flour has been mixed with the cleanings from custom mills. Finally, women cannot be certain how fresh the flour is. In short, housewives who might wish to purchase coarse grain flour believe they run a high risk of adverse selection.

The only other processed maize product available in urban markets is yellow maize grits. For the most part this product is manufactured artisanally and sold in clear plastic sachets as a high quality breakfast cereal or desert for relatively wealthy urban consumers. In contrast to flour, the grits can be washed prior to use, and their freshness can be judged by the color of the product. A donor-financed project to promote urban consumption of grits manufactured in rural areas using hammer mills has met with limited success. This is partly due to the high cost of the product. Only a small fraction of grits obtained from the hammer mill are of the desired size, leaving a high proportion of by-products that can be sold only at relatively low prices. Apart from the high cost of the product, a further constraint on demand is the long cooking time. Housewives report that maize grits take two to three times as long as rice to cook. Attempts to market white maize grits as a rice substitute were unsuccessful in Bamako, where consumers regarded the product as inferior ("poor man's rice") since the substitution of white maize grits for rice is a common practice in rural maize growing areas.

Human consumption of grain maize is mainly in the same form as millet and sorghum, i.e. tô (a thick porridge made from flour and usually consumed in the evening), bouillie (a thin porridge consumed at breakfast or supper), or couscous. Despite similarities with millet and sorghum, the consumption of maize in grain form rather than fresh is a relatively recent phenomenon. Many Malians first consumed maize as food aid during the famines of the early 1970s and early 1980s, and hence associate the cereal with very negative experiences. In contrast to urban consumers in other African countries, Bamako consumers prefer yellow maize.

Consumption of maize grain by livestock is mainly limited to the urban poultry subsector.[7] These enterprises are almost entirely confined to egg-laying units, since intensive broiler production cannot compete with free range birds from rural areas. Poultry rearers also

[7] Maize is also used in small quantities for the manufacture of pre-mixed feed for dairy cows.

have a strong preference for yellow maize since this affects the color of egg yolks. Discussions with poultry unit operators indicate that flock health management is the major constraint, followed by low egg prices associated with imports from Senegal and Ivory Coast. With the closure of the government-subsidized hatchery chicks have to be imported by air from France, adding further to costs. Until farmers can stabilize their flock numbers through effective health care, they are unlikely to enter into contracts for feedstock maize even if this institutional innovation permits them to secure supplies more cheaply.

In contrast to Bamako consumer preferences for yellow maize, whether for human consumption or for poultry, rural grain collectors were often observed not to make any special effort to separate maize by color. Urban consumer preferences were also irrelevant to farmers' choice of variety, which was exclusively based on agronomic characteristics. The one variety that seemed to be growing in popularity on the basis of its early maturity and lower fertilizer demand, TZESR-W, is a white variety. The failure to communicate consumer preferences to through the different stages of the subsector is also a reflection of the relatively small volumes moving through the market.

Potential quantities of maize required for industrial use are limited. These include flour as a source of starch in battery and glue manufacture, and grits for brewing. Although small in volume terms, industrial demand could nevertheless represent a relatively stable source of revenue for processing units. Unfortunately, all these products require maize to be de-germed prior to milling, for which no small-scale equipment exists.

5. AGRICULTURAL TECHNOLOGY DEVELOPMENT OPTIONS FOR THE MAIZE SUBSECTOR

Using the descriptive analysis in the previous section we first identify strategic research questions facing the development of the maize subsector in Mali. Of major concern is the recent 50 % devaluation of the CFA franc. We then summarize the results of an in-depth study of the potential for expanding urban consumption of maize through the introduction of processed products (flour). Opportunities for farm-level technological innovation in the light of market opportunities are also discussed.

5.1 Strategic issues for the future development of the maize subsector

The initial subsector appraisal revealed many characteristics associated with a thin market. Farmers appear to produce maize primarily in order to achieve food self-sufficiency, not for the market. Urban consumers tend to buy maize only when it is significantly cheaper than other cereals, due in part to the difficulty and/or higher cost of processing and in part to lack of familiarity with this cereal. Traders consequently have little incentive either to assure a regular year round supply of maize, or to meet urban consumer preferences for color or quality.

The development of the maize subsector therefore requires an increase in both demand and supply, as well as an increase in their predictability (i.e. improved coordination). For demand to increase, consumers need to perceive an improvement in the value of the product and/or a reduction in cost (taking account of additional processing activities necessary to get the grain into a useable form such as flour or grits). An increase in marketed supply requires a stable, profitable margin for producers. Improvements in net margins could be achieved through vertical integration by farmers organizations into the marketing of cereals, and/or by a reduction in unit costs of production. Stability in margins could be improved through contracts between maize producers and users. Such an innovation would require sufficiently strong effective demand for final products to induce the suppliers of those products to assure access to specific quantities and qualities of grain maize by planting time.

Development of the maize subsector, particularly through urban demand for processed maize products, could contribute to improved food security in both the short and the long run. In the short run, increased availability of maize will help ease late rainy season coarse grain prices, and thereby reduce costs for food deficit rural families, because it is harvested up to two months earlier than millet and sorghum. It will also provide a hedge against the risk of an early end to the rains causing poor millet and sorghum yields. The availability of processed maize products could improve food security by increasing the substitutability between rice and coarse grains in urban cereal consumption patterns. Greater substitutability between rice and coarse grains will result in smaller cereal price fluctuations in response to stochastic rice and coarse grain production levels (Boughton and Sanogo, 1994).

In the long run, demand-led expansion of the maize subsector will improve food security through soil conservation and more rapid agricultural sector transformation. Land degradation is a serious problem in the middle to high potential areas of Mali where maize is cultivated because extensification has been the primary source of increased rainfed cereal production over the last decade. Increasing the proportion of maize in total rainfed cereal production is one way to slow down degradation of the land resource base in Southern Mali because of the possibility to increase output per unit of land through fertilizer use.

In so far as demand-led expansion takes the form of processed products this will contribute to accelerated agricultural sector transformation and economic growth. The set of processed coarse grain products currently available to urban consumers is extremely limited in terms of product type, quality and price. The successful introduction of a processed maize product would expand the potential product demand space, through the possibility to market the same product type using a different cereal base or bases, or different price/quality versions of the product using the same cereal base.[8]

The question as to 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), or whether alternative market opportunities will develop that will entail an expansion of maize production and consumption via the marketplace over time, is also strategic for the purpose of defining an agricultural research agenda.

The question is strategic because different answers imply quite 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

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[8] Although apparently more severe for maize, processing costs are also a constraint on urban demand for coarse grains generally in West Africa (Reardon, 1993). Hence analysis of the possibilities for overcoming these constraints may be generalizable beyond the case of maize in Mali.

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.

The sequencing of research objectives over time may have important implications for the economic impact of investments in maize research. Investment in the selection and promotion of varieties with desirable processing characteristics will not generate an attractive economic return if low consumer incomes severely constrain effective demand for processed products in the short and medium term. It might be more rewarding to focus research resources on expanding the availability of maize during the hungry season in the short run, and shift priorities toward processing objectives when incomes have risen sufficiently. Finally, it is important to assess how the recent 50% devaluation of the CFA franc is likely to affect alternative development options for the maize subsector.

5.2 Opportunities for expanding urban demand for maize through the development of maize processing

In the light of weak 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 can be reduced. Since the cost of processed maize-based products will be sensitive to the cost of maize grain, it is also necessary to explore possibilities for reducing farm-level costs of maize production. 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.

In order to determine to what extent the availability of pre-processed maize products could overcome constraints to urban maize consumption, it was considered necessary to understand how maize fits into existing consumption patterns, how it is currently processed,

the costs involved, and the potential for pre-processed products to provide a satisfactory alternative at lower cost. The specific objectives of the consumption component of the maize subsector are therefore:

1. To understand how maize is currently integrated into urban food consumption patterns, and verify constraints to increased maize consumption. In order to achieve this it will be necessary to:
   a) describe seasonal variation in the consumption of different dishes and cereals used to prepare those dishes;
   b) document urban household cereal procurement strategies and determine the factors affecting choice of cereal and quantities purchased over time;
   c) document household processing strategies and determine the factors associated with choice of technique over time;
2. To ascertain the cost of preparing commonly consumed dishes from maize compared to other coarse grains and rice.
3. To estimate the potential demand for selected processed maize products among different types of consumers.
4. To examine the economics of alternative techniques and/or scales of processing equipment capable of manufacturing acceptable products, compared to existing manual and mechanical milling techniques.

These objectives were addressed by three types of research activity: 1) formal and informal surveys of cereal processing and consumption patterns of urban households; 2) consumer tests of existing and improved processed maize products, in collaboration with potential private sector maize processors and IER food technologists; and 3) determination of processing costs for existing and possible alternative processing equipment. Funding for IER's participation in the study was provided by the Programme de Restructuration du Marché Céréalier (PRMC), a joint government-multilateral donor group that monitors and facilitates the cereal market liberalization policy. This ensured a ready market for policy and/or technology innovations identified by the study.

A formal survey of 640 Bamako households revealed 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 dehulled grains and/or flour in order to make traditional coarse grain-based dishes more easily (Boughton and Témé, 1992). IER researchers therefore decided to focus on estimating the potential demand for pre-processed maize flour. Opportunities for improving the efficiency of dehulling services were also evaluated (Boughton et al., 1993).

Two potential private sector maize processors currently operate in or near Bamako: the Grands Moulins du Mali (GMM) and a groupement d'intérêt économique (GIE) operating under the trade name of SAMA. Both potential collaborators had limitations, due to technological scale and versatility respectively.

The principal activities of GMM are wheat milling and rice dehulling. GMM has the only wheat mill in Mali, and has historically benefitted from high import tariffs on imported wheat flour on the one hand and monopsony purchase of commodity aid wheat from the USA, Canada and France on the other.[9] GMM also has the technical capacity to produce dehulled and degermed grits of a range of sizes (including coarse and fine flour) from maize, millet and sorghum. An attempt to market maize flour in 1986 failed because of the use of poor quality maize (old imported food aid stock). Malian maize, which is considered to be of high quality by the Head Miller at GMM, has never been processed by this state-of-the-art plant. Neither has millet or sorghum.[10]

The principal drawback to market testing of GMM products is the minimum quantity of maize that must be processed. Due to the fact that the equipment has been idle for so long, it would be necessary to process at least ten tons in order to ensure a clean, uniform set of processed products. The team considered the financial and logistical hurdles too great and

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[9] GMM's margins on wheat flour milling have been squeezed in recent years through the reduction of external tariffs on wheat flour, illegal imports of wheat flour from Mauritania, and most recently by coordinated selling of commodity aid wheat by donors. When Canadian commodity aid wheat flour was auctioned by OPAM in late 1993, GMM shut down its wheat milling operations and laid off most of its employees for a week to bring pressure on the government (Le Républicain, December 1st, 1993). This continuing squeeze on historically fat milling margins, in excess of the average farm-gate price of maize, has made GMM management more receptive to new possibilities such as maize flour.

[10] GMM was obliged to install coarse grain milling equipment together with the wheat mill by the Malian government which has underwritten GMM's capital debt. GMM management had no interest in, or intention to use, this equipment at the time.

decided to "simulate" the GMM product range using food aid cornmeal. If consumer evaluation of this simulated product range suggested that processing by GMM could be profitable, then a market test using the necessary quantity of raw material could be proposed as a follow-on activity to the maize subsector study. Unfortunately, all stocks of food aid cornmeal were exhausted and the closest substitute that could be found was dehulled (but not degermed) flour manufactured by SAMA.

SAMA started out as a groupement d'intérêt économique (GIE) that marketed processed maize products in Bamako supplied by ten small-scale hammermills set up in rural areas by the CMDT through a project called CERECOM (short for "commercialisation des céréales"). The mills were set up with heavy subsidies to help provide farmers with a market outlet following the liberalization of maize prices in 1986. The products included medium and small grits, and flour obtained as a by-product of grit manufacture. SAMA began to process their own products in Bamako using equipment loaned by CERECOM after experiencing a number of shortages of stocks due to village mill liquidity and pricing problems.[11]

Only the medium-sized grits used to make "seri", a porridge eaten for breakfast or as a desert, found a ready market.[12] The flour obtained as a byproduct of grit manufacture proved very difficult to sell, and often became rancid in store (Holtzman et al., 1991). The scope for improving existing CERECOM products is limited due by the nature of processing equipment available. Due to the non-spherical shape of the maize grain, the abrasive disk dehuller cannot remove a high proportion of either pericarp or germ without also losing a high proportion of endosperm, resulting in a low yield of marketable product. The hammermill produces a range of grit sizes with little flexibility for increasing the proportion

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[11] Village mills provided SAMA with processed products at fixed prices. If local grain maize prices rose above a certain level, the mills had to stop processing in order to avoid financial losses. The mills had neither the liquidity nor the storage capacity to purchase an entire year's stock at harvest time when prices are generally lower (B.Goïta, personal communication). The reason for the fixed processed product price policy is not clear.

[12] Even in the relatively small market for medium-sized grits, SAMA faced stiff competition from artisanal manufacturers who produce a bright, clean product by selecting hard endosperm yellow maize kernels and repeatedly washing and sieving the product during processing.

of grits of the preferred size. Only a radical change in the type of equipment used could overcome these constraints (e.g. introduction of roller mill and degermer). This would involve investing in the same kind of equipment already available, but not utilized, at GMM. Such an investment seemed unwise given that if a market were successfully developed they would be unlikely to survive competition from GMM. Thus the focus of collaboration with SAMA was to assess whether there is a market niche for flour obtained from whole grains with their existing equipment.

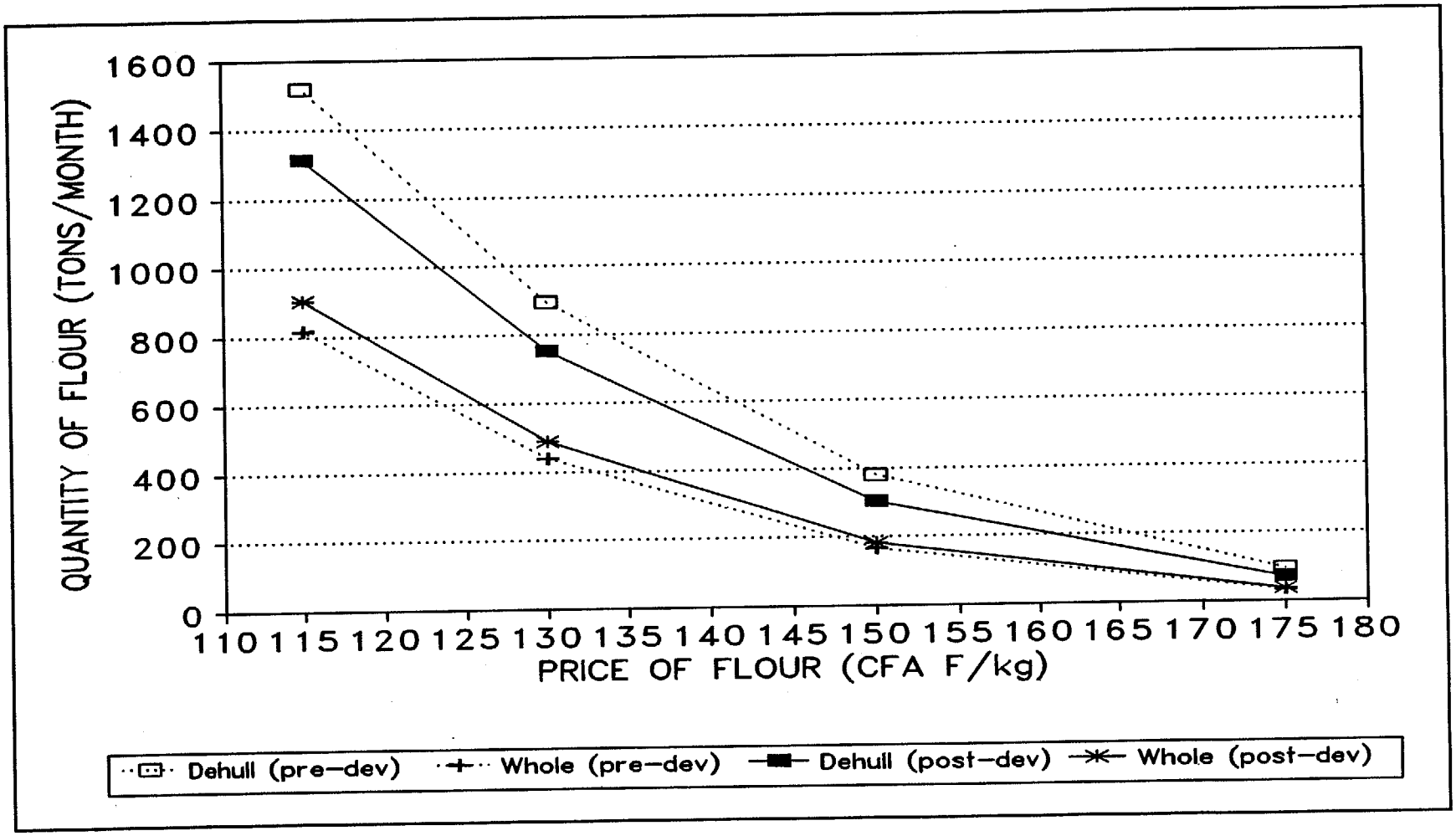
Figure 4 presents aggregate monthly demand for dehulled and whole-grain flour at different prices before and after devaluation, based on the results of consumer tests.[13] Devaluation affects quantity demanded in two ways. First, it reduces consumer real incomes. Second, it increases processing costs and therefore retail prices. Given relatively low income- and relatively high price-elasticity of demand for maize flour, the increase in processing costs has a more significant effect on aggregate demand than the reduction in real incomes. Analysis of the effect of devaluation assumes that the relative prices of other cereals remain unchanged or, equivalently, that the cross-price elastictity of demand is zero.

Prior to devaluation, assuming prices of 150 CFA F/kg for dehulled and 115 CFA F/kg for whole-grain flour, projected demand would be approximately 380 tons per month for dehulled and 815 tons per month for whole-grain flour.

Post-devaluation, assuming a price of 175 CFA F/kg for dehulled and 130 CFA F/kg for whole grain flour, projected demand falls sharply to 70 tons per month for whole grain and 490 tons per month for whole-grain flour. For whole-grain flour, this is approximately equal to current levels of maize grain consumption. However, these prices assume bulk (50 kg) packaging. During the promotional phase, with small (5 kg) packages, prices would be

[13] The demand curves are estimated using contingent valuation responses from men and women belonging to 110 households, a sub-sample of a representative sample of 640 houseolds surveyed for their cereal procurement, processing and consumption behavior (Boughton and Témé, 1992). Each participating household prepared the main coarse-grain based dishes from samples of the dehulled and whole-grain maize flours, and were then asked how frequently they would prepare these dishes at different prices for maize flour, holding the price of other cereals constant. A tobit maximum likelihood estimation procedure was used to generate demand curves from the household responses.

FIGURE 4: AGGREGATE DEMAND FOR MAIZE FLOUR FOR THE DISTRICT OF BAMAKO, MALI (TONS/MONTH)



Notes:

1. Dehull (pre-dev) refers to maize flour made from dehulled grain prior to devaluation of the CFA F.
2. Whole (pre-dev) refers to whole grain maize flour prior to devaluation of the CFA F.
3. Dehull (post-dev) refers to maize flour made from dehulled grain after devaluation of the CFA F.
4. Whole (post-dev) refers to whole grain maize flour after to devaluation of the CFA F.

approximately 10 CFA F/kg higher unless subsidized. This would reduce demand still further to 26 tons per month for dehulled and 260 tons per month for whole grain flour. Even for whole-grain flour, this is approximately half the present level of maize grain consumption in Bamako.

These estimates of the impact of devaluation may err on the pessimistic side. Estimated consumer response is contingent upon a reference price of 150 CFA F/kg for rice and 70 CFA F/kg for coarse grains. Rice prices are likely to rise significantly in the medium term, both absolutely and relative to coarse grains. Price rises for imported inputs such as fertilizer and fuel will inflate domestic costs of production, and the price of imported rice to meet any shortfall doubles in CIF terms. However, given the high sensitivity of maize flour demand to retail prices, and the lack of any obvious increase in substitutability with rice[14], it is difficult to conclude otherwise than that devaluation has likely had a major negative impact on potential demand for maize flour.

There are three main options open in terms of market development strategies. Option 1 is first to promote refined maize flour to build consumer confidence and then introduce whole grain flour as a low-cost competitor. Option 2 is to forget about refined flour and push whole meal flour, possibly with subsidies in connection with an urban food aid distribution program. Option 3 would be to push both flours simultaneously without direct subsidies.

The first option has three advantages and one major drawback. The first advantage is that Grands Moulins du Mali already has a state-of-the-art maize mill installed. Since the investment is a sunk cost, GMM is likely to be willing to price the product very competitively in the short run in order to obtain at least some return on the investment. This is especially true as milling margins on wheat are progressively squeezed by the removal of tariffs on flour imports and coordinated donor selling of commodity-aid wheat. Second, GMM would be

[14] Most consumption studies have found low cross-price elasticities of demand between rice and coarse grains (Reardon, 1993). Because the prices of other cereals were held constant for different prices of maize flour in the consumer tests, we cannot formally compute a cross-price elasticity of demand between maize flours and rice. However, analysis of the meals at which consumers intend to prepare maize flour reveals a heavy emphasis on breakfast and dinner, meals typically prepared from coarse grains. There was little demand for maize flour for meals at which rice is typically prepared, especially the noon meal.

willing to purchase maize from farmers on a forward contract basis if the PRMC would be willing to finance a maize flour promotion campaign. Farmers repeatedly stated that the lack of a guaranteed price was the principal reason for not investing in fertilizer for maize production. Since improved returns for cereal growers is a major objective of the PRMC, there would be solid justification for using PRMC funds to promote maize flour marketing if linked to maize procurement contracts from maize grower associations. Third, there are other industrial needs for maize products that are currently being met through imported products (e.g., starch for glue, batteries and conserves; grits for brewing) that could be supplied locally once GMM's maize production line was up and running.

The main disadvantage with this option is that the volume of demand at estimated post-devaluation retail prices may too small to make it worthwhile. One possible way to overcome this problem option would be to incorporate maize flour with wheat flour intended for baking bread. For example, a mix of 95% wheat and 5% maize flours would generate a requirement of 1500 tons of maize flour per year, based on pre-devaluation demand for wheat flour. If the technical and financial feasibility of maize flour incorporation with wheat flour can be confirmed, the next step would be to undertake a test of consumer acceptability.[15] In view of the acrimonious history of relations between GMM and the bakers, it would be useful to have some outside encouragement and supervision of such a test (e.g., by the PRMC) to ensure that it is undertaken and evaluated in good faith.

The second option has two key advantages. First, it would involve small-scale processors immediately rather than after a delay. Second, consumers need and are receptive to lower-cost products as a result of the fall in real incomes following devaluation. Even the lower post-devaluation level of demand of 490 tons per month is sufficient to keep up to 20 hammer mills in business. Nevertheless, this strategy also has disadvantages that must be overcome. First, there may be strong consumer resistance, at least initially, to purchasing flour from retailers unless it is in sealed packages. This would drive up the cost significantly, undermining the very basis on which the product could compete - cheapness. Second, whole

[15] According GMM's CEO, maize flour can be incorporated with wheat flour up to 5% without affecting bread quality. R.Achkar, personal communication, January 1994.

grain flour has a relatively short shelf life. It can become rancid in as little as three weeks. Unless a very rapid and effective distribution system is established, the product could quickly lose credibility with consumers. Third, owners and/or operators of coarse-grain processing equipment currently have very little experience in combining processing and product marketing operations (vertical integration).

The difficulties associated with the promotion of a whole grain flour processing and distribution could be overcome through innovative forms of organization. For example, rapid low-cost distribution could be achieved by networks of women retailers residing in the densely populated suburbs ("quartiers populaires"). Through their detailed knowledge of households in their locality, such retailers could establish a regular clientele. Knowing their clients personally, and being in a position to verify the quality of flour supplied to them and distribute it quickly, they could avoid the need for costly disposable packaging and deliver the product in re-usable containers instead. These retailers could be supplied on a regular basis either by an existing GIE such as SAMA, or purchase grain and have it milled at a hammer mill installed alongside an existing custom plate mill, or form their own GIE for processing the flour. Such an approach would create badly needed part-time informal sector employment opportunities for women, as well as providing households with a low-cost ready-to-use coarse grain product.

The third option is the most ambitious, seeking to capture the advantages of options 1 and 2. Option 3 has the advantage that the costs of a promotional campaign would not necessarily be significantly higher for two types of flour than for one, and could be designed to target the flours to different market segments. It would be difficult to promote whole grain flour using subsidies without undercutting GMM, however, since whole grain flour is only weakly self-targeting.

Whichever option is chosen, there will be a need to for strong technical backstopping. For both types of flour it will be necessary to monitor flour storage quality at different times of year. For potential hammer mill operators, there is a need to identify mills that can provide sufficiently fine flour without having to manually sieve the product as carried out for the second large-scale consumption test. Recommendations have been made by Mestres (1993), but consideration should also be given to machinery suppliers in Zimbabwe where

maize is milled primarily for human consumption rather than for animal feed. For option 2 or 3, organizational support from a specialized microenterprise development unit will also be necessary. In addition to facilitating the establishment of whole grain flour processing and distribution networks, assistance will also be needed to secure a year-round supply of maize grain of appropriate quality (floury endosperm) from urban wholesalers or farmer associations.

5.2 Opportunities for farm-level technological innovation

Analysis of processing costs indicates 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. There are two related technological themes for improving maize productivity and reducing unit costs of production: fertilizer use efficiency and varietal adoption.

As a result of devaluation of the CFA franc in January 1994, fertilizer prices in the CMDT zone will increase by 40% on average in the coming season.[16] Yet, because of aggregate cereal self-sufficiency last year, maize prices have not increased significantly. If farmers are to have an incentive to use fertilizer it is essential to improve fertilizer response and, if possible, find less expensive fertilizer sources. The current policy of not producing and distributing hybrid maize seed on the grounds that it is too costly, which has never been subject to a careful financial analysis, should be urgently reviewed (Boughton and Henry de Frahan, 1994). If hybrid varieties can produce a better return to the farmers' investment after including the higher cost of seed, they should be promoted. A careful evaluation of the costs and returns to hybrid varieties under farmers' management with different fertilizer regimes is an urgent agronomic research theme.

Farm-level surveys conducted by IER in collaboration with the CMDT suggest that adoption rates for existing improved varieties could be significantly increased by an extension

[16] CMDT Memorandum on agricultural input prices for the agricultural season 1994/95, May 26th, 1994.

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's farming systems program is studying ways of matching varietal recommendations to the needs of different groups of farmers.

6. INSTITUTIONALIZING THE APPROACH: ESTABLISHMENT OF A COMMODITY SUBSECTOR ECONOMICS PROGRAM WITHIN THE MALIAN NARS

Commodity subsector ("filière") studies were included as part of IER's 12-year strategic plan developed in collaboration with ISNAR during 1989 and 1990. The first six-year phase of the strategic plan is being implemented with support from USAID/Mali through the SPARC project and from the World Bank. In 1993, IER was re-organized into 16 research programs, 14 commodity programs and two cross-cutting programs (Commodity Subsector Economics and Farming Systems and Natural Resource Management). In order to launch the new Commodity Subsector Economics (CSE) Program IER management decided to hold a design workshop where the main participants would be the commodity research program heads and their counterparts from the agricultural extension services. The approach and methods used by the maize subsector study provided a concrete example for workshop participants.

6.1 Commodity Subsector Economics Program Design Workshop

The CSE program design workshop (December 6-11, 1993) had two major objectives. First, because the CSE program is entirely new, the workshop aimed to inform and build a consensus among technical scientists (commodity research program leaders) and their counterparts in the extension services about the nature and potential role of subsector studies.

Second, the workshop sought to engage the actors' expertise in identifying key constraints and research questions for specific commodity subsectors, and working out how the CSE program could work together with technical scientists to overcome those constraints.[17]

The workshop involved three phases. The first phase involved formal presentations and discussion of the subsector approach, using maize as a case study, and presentations on livestock and cereal marketing by OMBEVI and the SIM.

For the second phase, the workshop was broken up into commodity working groups in order to identify major subsector constraints and the role of research in addressing them. The groups used a matrix to guide their discussions (see Matrix A attached). The rows of the matrix represent the different stages of the subsector. The first four columns involve descriptive information, including the current situation and trends, interactions with other subsectors, current policies and effects, and actors involved at different stages of the subsector. The second four columns are more analytical in nature, involving the identification of constraints at national and regional level (if applicable), activities currently underway to address these constraints, and the areas where research has a contribution to make. The results of this activity were then presented by each group in plenary session and discussed. With the exception of the livestock working group, each of the other groups worked on a single commodity.

For the final phase of the workshop, the different working groups focussed on the task of specifying research objectives and questions to be addressed. The working groups again used a matrix as a guide (see Matrix B). Once detailed questions were adequately specified, the groups sought to determine what information was available and where, and what information needed to be generated by research. The respective roles of the CSE program and other research programs were also defined.

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[17] The workshop program was developed by a steering committee comprised of Bakary Coulibaly (head DPAER), Bino Témé (head DRSPR), Alpha Maïga (DRSPR), Ousmane Sanogo (Coordinator DPAER), and Duncan Boughton and Jim Shaffer (MSU). The committee was also assisted by Josué Dioné (INSAH/PRISAS) and Jim Tefft (Market Information System/OPAM), who have substantial experience in research design workshops and subsector studies. A list of workshop participants is attached.

The concepts and role of a subsector approach were clearly endorsed by the participants, and the constraint identification matrix was particularly successful in engaging the different disciplines in a constructive discussion.

6.2 Prioritization of subsectors and outline program for the first three years

Following the workshop, the steering committee allocated three days to the task of translating the wealth of diagnostic information and potentially researchable questions generated by the workshop into a manageable and realistic program. Two principles guided this task. First, personnel resources available to the program are limited in number and experience. Second, in view of the diagnostic role of subsector studies, and the limited amount of information available to a new program, it is important to keep the program flexible and responsive. The key task was to identify priority subsectors for study. For commodity subsectors identified as having highest priority, an outline program of work for the first three years was developed.

Given the very limited personnel resources available to the CSE program, it was essential to prioritize the different commodities that could potentially be studied. Each subsector was ranked according to the following criteria:

1. Importance to the economy (maximum 10 points)
   - share of GNP
   - share of export earnings
2. Severity of problems in the subsector (maximum 15 points)
   - supply and demand instability/imbalance
   - input delivery and credit
   - marketing and processing
3. Existing state of knowledge/potential contribution of research (maximum 5 points)
4. Development potential of the subsector (maximum 10 points)
   - potential for expansion of demand
   - potential for expanding supply

The top six ranking subsectors were:

1.	Cattle	4.	Sheep and goats
2.	Rice	5.	Fisheries
3.	Groundnuts (peanuts)	6.	Millet/Sorghum

Three subsector studies are proposed for the first phase: rice, livestock, and groundnuts.[18] The first two will have a team of three initially, composed of the following members:

Rice:	**Livestock:**
2 economists	1 economist
1 agronomist	1 livestock scientist
	1 sociologist

The first phase of the subsector studies will involve an initial subsector appraisal in order to prioritize and better define the constraints to be addressed in subsequent phases. Specific tasks will include a comprehensive literature review, informal surveys in order to better understand and incorporate the perspectives of different actors in the subsector (especially the private sector), and secondary data analysis (e.g., marketing margins). In the case of the livestock sector, careful attention will need to be given to defining the different subsectors and their interactions because of the relatively large number of products and by-products involved. The USAID funded APEX project will be a key collaborator in accomplishing this task. For the rice subsector, which is relatively simpler and better documented than the livestock subsector, more attention can be focussed on synthesizing existing information relevant to problems identified in the workshop. The Market Information System (SIM/OPAM) will be a key collaborator for the rice subsector study. The head of the SIM has been undertaking a study of the impact of small-scale rice dehullers on the organization of rice marketing in the Office du Niger zone for his Master's thesis at MSU. For both subsectors, the opportunities and problems posed by the recent devaluation of the FCFA will be a key concern.

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[18] Initially, two subsector studies were proposed. Groundnuts were added following the devaluation of the CFA franc on January 12th, 1994.

On the basis of this initial appraisal, a limited number of in-depth studies of constraints identified during the workshop (and/or raised in the course of the initial appraisal) will be formulated in cooperation with other IER programs, the private sector and development organizations. These programs will be submitted to the relevant regional and technical commissions in early 1995, and implemented over the following 12 - 15 months.

The need for a high degree of collaboration between the CSE program and the farming systems and commodity research programs is recognized. A key task of the initial subsector appraisal phase will be to develop productive working relationships with these programs, and with the private sector. This will be accomplished partly through interaction in the course of informal surveys and consultative meetings, and also through the establishment of an advisory committee for each team that will meet regularly during the first year to discuss the teams findings and workplans. Plans for the in-depth studies and activities to be undertaken in the second and third years will specify concrete responsibilities for all parties involved. These plans will likely include the placement of CSE team members at regional centers or stations for varying periods of time.

7. 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 by a combination of appropriately sequenced technological, institutional and policy innovations that better match the supply of agricultural technology to market demand over time. 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 contributes to both a methodological foundation for future studies and directly useable results to enhance the performance of Mali's cereal subsectors. 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 through organizations such as INSAH.

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