Staff Paper

FARMING SYSTEMS AND MARKETS-COMBINING ANALYTICAL FRAMEWORKS FOR THE DEVELOPMENT OF COMMODITY SUBSECTORS THE CASE OF MAIZE IN SOUTHERN MALI

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Duncan Boughton Bino Témé

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Department of Agricultural Economics
MICHIGAN STATE UNIVERSITY
East Lansing , Michigan

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FARMING SYSTEMS AND MARKETS - COMBINING ANALYTICAL FRAMEWORKS FOR THE DEVELOPMENT OF COMMODITY SUBSECTORS THE CASE OF MAIZE IN SOUTHERN MALI[1]

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Duncan Boughton and Bino Témé[2]

1. INTRODUCTION

National Agricultural Research Systems (NARS) in both developed and developing countries are under pressure to demonstrate that agricultural research can achieve satisfactory economic returns to public investment. An important justification for the funding of farming systems research and extension (FSR/E) programs is that they speed up the process of technology adoption by farmers, thereby enhancing economic returns (Martinez and Sain 1983). However, the widespread adoption of improved technology can often be frustrated by constraints to the marketing of additional output. The move toward market liberalization in many countries, often accompanied by the withdrawal of guaranteed producer prices and state-funded marketing services, presents new challenges to technology development. Consequently, donors are urging that publicly funded agricultural research take more account of market circumstances in the design of research (USAID, 1992). Yet many FSR/E programs are ill-equipped to deal with marketing issues, and often consider them peripheral to the primary task of alleviating production constraints in an environmentally sustainable and gender-sensitive manner. This is unfortunate since the methods and analytical frameworks appropriate to marketing and FSR/E programs have much in common.

This paper has three objectives: (1) to identify the principal conceptual and methodological complementarities between FSR/E and the commodity subsector or "filière" approach to marketing; (2) to illustrate their significance for technology development by tracing the development of maize production and marketing in Southern Mali over the period 1975 - 1990; and (3) to consider constraints to, and possibilities for, the improvement of linkages between FSR/E and marketing research programs. The rest of our paper is organized according to this sequence of objectives. The next section briefly examines the relationship between farming and marketing systems in the context of a common conceptual

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[1] The case of maize in Southern Mali is one of seven studies of agricultural research impact in Africa financed by USAID (ARTS/FARA), and being implemented under the auspices of the Food Security in Africa Cooperative Agreement between Michigan State University and USAID. The views expressed in this paper are entirely those of the authors.

[2] Bino Témé is an agricultural economist and Program Coordinator in the Department of Rural Economy and Planning (DPER) of the Institute of Rural Economy (IER), Mali. Duncan Boughton is an agricultural economist and Visiting Specialist with the Department of Agricultural Economics, Michigan State University (MSU). The authors are particularly grateful to Drs. Josué Dioné (PRISAS/INSAH) and John Staatz (MSU) for their guidance and encouragement.

framework - a food system matrix. Section 3 describes key events in the evolution of the maize subsector in Mali and their effect on technology adoption. The final section examines possible avenues for collaboration between FSR/E and commodity subsector researchers in order to enhance the contribution of the maize subsector to Mali's food system.

2. COMPLEMENTARITIES BETWEEN FSR/E AND COMMODITY SUBSECTOR APPROACHES

In this section, we first examine the complementarity between FSR/E and commodity subsector analysis in the context of the overall development of food systems. Methodological complementarities are also considered. This provides the context for examining the experience of maize technology adoption in Southern Mali in the following section.

2.1 Linkages between farm-level production and marketing: the food system matrix as a tool for conceptualizing important interactions.

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 (1970), 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).[3] 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), for example, different crop enterprises compete for limited household labor, while livestock enterprises enhance crop productivity through increased soil fertility. Similarly, in the vertical dimension, transport availability may facilitate or constrain farmer access to urban horticultural markets.

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[3] Although some authors have advocated that the term "commodity subsystem" is more appropriate than "commodity subsector" in view of the interdependencies between different stages (e.g. Holtzman 1986), we use commodity subsector in order to avoid confusion with the frequent use of the terms crop or livestock subsystems in reference to components of farming systems. Fundamental to the concept of a commodity subsector is the recognition that productive activity occurs not only at the farm level, but at every stage as inputs are supplied and value added to a product as it moves from field to cooking pot.

Figure 1. FOOD SYSTEMS MATRIX

PRODUCTION/DISTRIBUTION FUNCTIONS	COMMODITY SUBSECTORS					
	Millet	Sorghum	Maize	Rice	Peanuts	Cotton
Input Distribution						
Extension						
Farm-level production						
Processing						
Storage						
Transport						
Exchange, transactions						
Finance						
Coordination functions						
- Prices						
- Quality control						
- Regulations						
- Property rights						
- Contracts						
- Risk management						
Consumption						

Source: Ndoye, Ousseynou and Mark Newman (1984) "Approche Méthodologiques pour l'Etude de la Commercialisation des Produits Agricoles et Alimentaires au Sénégal". Institut Sénégalais de Recherches Agricoles, Bureau d'Analyses Macro-économique, Document de Travail 84-2.

Historically, a common weakness in agricultural research has been 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. FSR/E researchers have consistently stressed the need for a holistic approach in order that the design of new technology take account of the full range of constraints and interactions confronting the farmer (Collinson). 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 (tools, fertilizers, labor, technical information) 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). One consequence of this process is that the farmer's demand for technology increasingly reflects the constraints, opportunities and preferences of her clients. If FSR/E researchers are to be able to respond to evolving farmer needs and concerns, they need information about the identity and circumstances of the farmer's clients (or potential clients) as well.

It is precisely this broadening of the clientele base with food system development that calls for active collaboration between FSR/E and commodity subsector researchers. Two key concerns will underpin this collaboration. One is to ensure that consumer preferences and market opportunities are effectively communicated to farmers through the various stages in the subsector (i.e. to improve vertical coordination within commodity subsectors). In the case of maize in Mali, for example, urban consumers in the capital prefer yellow maize while it is frequently a mixture of yellow and white grains that is predominantly available in rural markets. The second concern is to identify possibilities for driving down unit costs of production not only at the farm level but at all stages in the commodity subsector. In the case of food crops, many buyers are low income urban households or food deficit rural households. 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 as a 10% increase in crop yield. In the case of export crops, driving down unit costs at all stages is often necessary to maintain real incomes in the face of declining real world market prices.

Technological innovation is, by itself, unlikely to achieve all potential productivity gains within a given commodity subsector because of the need for coordination between different stages. In order to achieve this coordination, complementary institutional and policy innovations will also be necessary (Weber et al. 1988). Poultry producers in Bamako, for example need a year-round supply of yellow maize but often find it difficult to obtain during several months of the year. One possible solution is to develop contracting mechanisms (an institutional innovation) between poultry rearers and producers to ensure availability of maize with appropriate quality characteristics at prices which will give each party an adequate return. Poultry rearers will require access to credit in order to finance contracts, which may require modifications to existing credit policies. Close collaboration between researchers in FSR/E and commodity subsector programs will be necessary to exploit such complementarities between technical, institutional and policy innovations in the development of commodity subsectors.

2.2. Methodological similarities between FSR/E and commodity subsector research.

Collaboration between FSR/E and commodity subsector research requires compatibility in terms of organizational structures, concepts and research methods. The FSR/E and commodity subsector approaches are clearly compatible from a conceptual viewpoint. Even a very brief review will suffice to demonstrate that compatibility in methods is not likely to be a major barrier either.

Both FSR/E and commodity subsector research emphasize the use of rapid reconnaissance (RR) methods. RR has been widely demonstrated to be an effective means of promoting communication with client groups, and between team members from different disciplines. RR is an essential step in identifying priority constraints and research opportunities, in order to narrow down the scope of subsequent research and development activities (Holtzman 1986). Just as FSR/E researchers cannot conduct research on all farm-household activities, so commodity subsector researchers cannot undertake research at every stage. Researchers need to identify those stages or functions where there is the highest potential to achieve productivity gains (Staatz and Bernsten 1992).

The use of secondary data to orient the RR phase is also emphasized by both commodity subsector and FSR/E approaches. Just as analysis of historical rainfall data can provide important insights into drought risk, so the simple analysis of price series for markets in producing and consuming areas can indicate problems of competitiveness or market coordination (Staatz and Bernsten 1992).

FSR/E and commodity subsector analysis both emphasize the importance of client participation in the design, development and testing of interventions to relieve constraints. Gender and sustainability considerations are increasingly requiring FSR/E researchers to bring different groups together. In The Gambia, for example, researchers invited men to visit women's improved rainfed rice fields to discuss the advantages and feasibility of using male-controlled animal traction. Commodity subsector development will also often involve bringing different groups of clients together in order to work out satisfactory solutions (e.g. farmers and transporters, traders and policymakers, millers and consumers).

Having examined the conceptual and methodological complementarities between FSR/E and commodity subsector research, we next demonstrate the potential payoffs to collaboration between the two using a concrete example.

3. INTERACTIONS BETWEEN FARMING SYSTEMS AND MARKETS - THE CASE OF MAIZE IN SOUTHERN MALI

After a brief introduction to the case study, we provide an overview of the principal features of the maize subsector as it looks today, together with its constraints and opportunities. Much of the information presented is based on a rapid reconnaissance carried out during February and March 1992 (Témé and Boughton 1992). This overview provides the context for interpreting the historical experience of maize research and extension in Southern Mali. Together, the current situation and historical experience provide the basis for a set of collaborative research activities discussed in section 4.

3.1 Introduction

The case of maize in Southern Mali is one of seven agricultural research impact studies being undertaken in Africa for USAID (ARTS/FARA). At the design stage, the prevailing view among host-country research and extension staff was that the cultivation of intensive maize experienced a boom during the early 1980s when there was a guaranteed market that subsequently collapsed when prices were liberalized. It was therefore decided to link the impact assessment to a broader study of the maize subsector in order to:

1. better understand the constraints to the historical impact of maize research and extension in southern Mali;
2. to identify the kind of innovations, not only technological but also institutional and policy related, that could enhance the contribution of the maize subsector to agricultural and economic development in Mali.

The impact assessment study was initiated in July 1991 in collaboration with the Farming Systems Department (DRSP) of the national research program. The maize subsector study was initiated in January this year with the Planning and Rural Economics Department (DPER). This department has recently been entrusted with the mandate to undertake commodity subsector studies in order to help guide research priority setting and facilitate coordination of research

activities at different stages in the subsector. The maize subsector study is the first such study to be undertaken, and is regarded as a pilot study with a strong emphasis on developing cost effective and timely methods. The DPER will also have responsibility for establishing a baseline for monitoring and evaluation of research activities.

3.2 Overview of the maize subsector

Given our objective of combining commodity subsector and FSR/E perspectives in order to improve the effectiveness of agricultural research, it is appropriate that this be the starting point for a descriptive analysis of the maize subsector (Figure 2).[4]

Historically, maize research has been a very minor part of the total **agricultural research** effort. 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. During the 1980s, FSR/E teams made significant efforts to improve traditional maize-based intercropping technology (in particular maize-late millet) but without success. **Extension services** are provided by two parastatals, the Opération Haute Vallée (OHV) and the Compagnie Malienne pour le Développement des Textiles (Figure 3). 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. 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 also the most rapidly growing cereal subsector (Holtzman et al 1991). Approximately 80% of the total Malian maize crop is grown in the study area, where rainfall ranges from an average of 1200 mm in the south to 700 mm in the north. **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. **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 ear, making it more difficult for insects to penetrate the grains).

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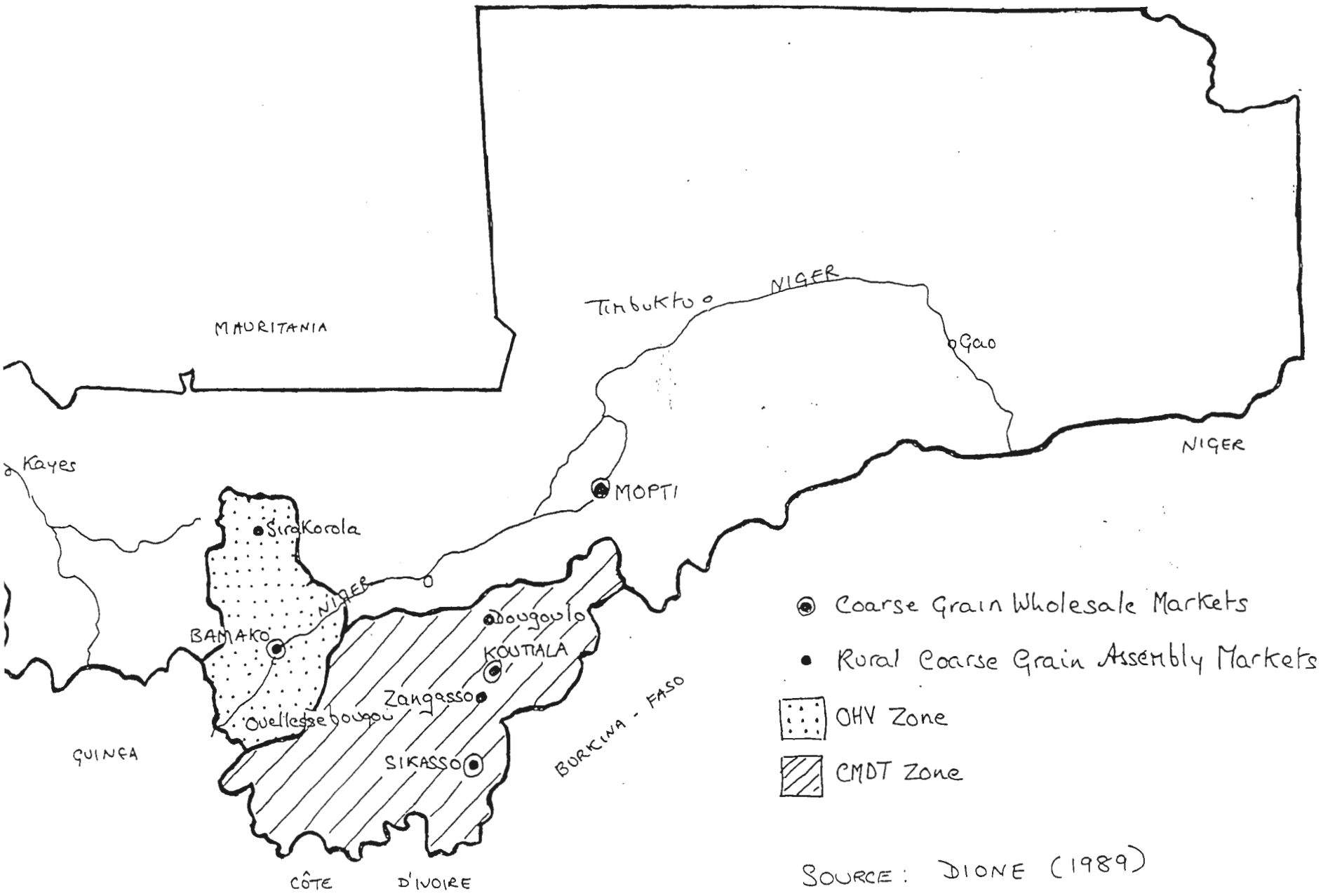
[4] An activity or function that is boldfaced in the text refers to a stage in the maize subsector diagram (Figure 2).

FIGURE 3 : THE CMDT AND OHV ZONES OF SOUTHERN MALI



SOURCE : DIONE (1989)

The marketing of maize takes place through the same network of rural collectors and wholesalers, transporters, and urban wholesalers and retailers as other coarse grains. Quantities marketed through these channels are small relative to millet and sorghum, and relative to the total maize harvest since much is eaten fresh. The quantities marketed also vary considerably from year to year according to the size of the maize and millet/sorghum harvest. If the millet/sorghum harvest is poor, then maize marketings will be low even if the maize harvest was good as rural producers substitute maize for millet and sorghum in their diet. Most maize marketed beyond rural markets goes to the capital, Bamako.

In general, the marketing system is competitive but costly. 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 (Figure 4). Rather it is indicative of the 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.

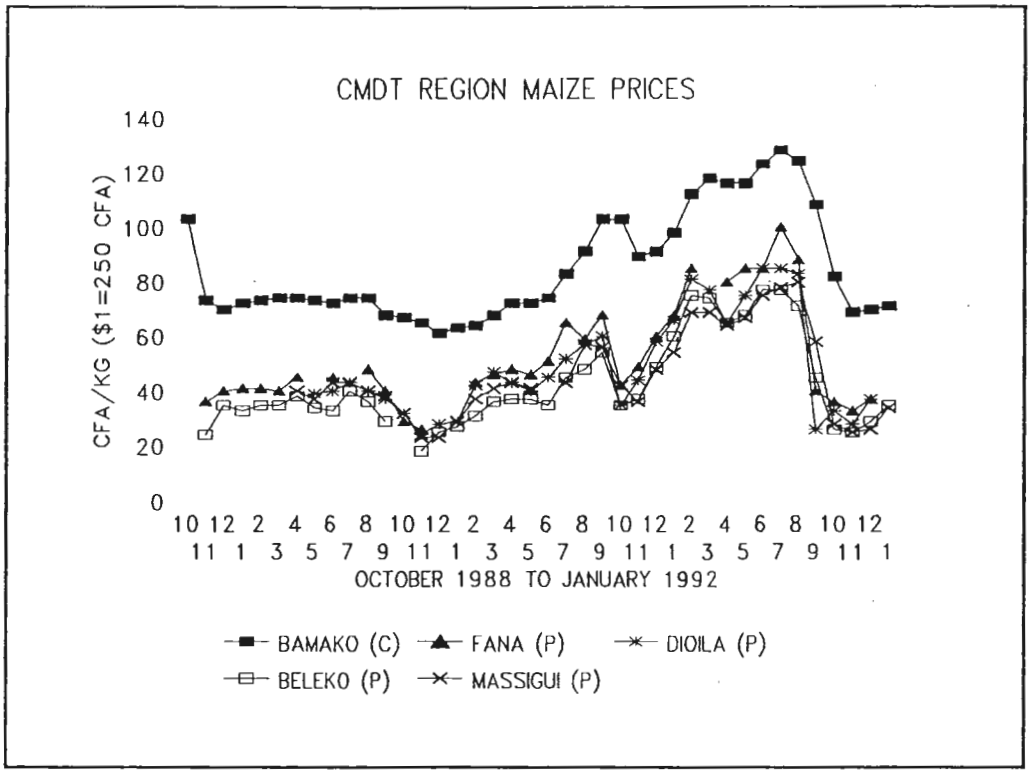
Only very limited quantities of maize are stored off-farm. The majority of traders are cash constrained and therefore seek profits from turnover rather than from speculative storage. Furthermore, storage at merchant level presents more difficulties than farm-level storage because it is in grain form and therefore more vulnerable to insect infestation. 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 major constraint to maize consumption. In rural areas, maize is both dehulled and milled using pestle and mortar, since mechanical processing is very costly relative to rural women's incomes (ATI 1992). In urban areas, maize is usually dehulled manually and then taken to a custom mill for grinding into flour (Holtzman et al 1991). Virtually no pre-processed products (e.g. flour) are available, with the exception of high quality maize grits manufactured artisanally as a breakfast cereal or desert for relatively wealthy urban consumers. Human consumption of grain maize is mainly in the form of tô (a thick porridge made from flour and consumed mainly in the evening), bouillie (a thin porridge consumed at breakfast or supper), or couscous. In contrast to urban consumers in other African countries, Bamako consumers prefer yellow maize.

Consumption of maize grain by livestock is mainly limited to a rapidly expanding urban poultry subsector. 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 have a strong preference for yellow maize since this affects the color of egg yolks. Maize is also used in small quantities for the manufacture of pre-mixed feed for dairy cows. Industrial uses of maize are extremely limited and are likely to remain so in the medium term. These include flour for battery and glue manufacture, and grits for brewing.

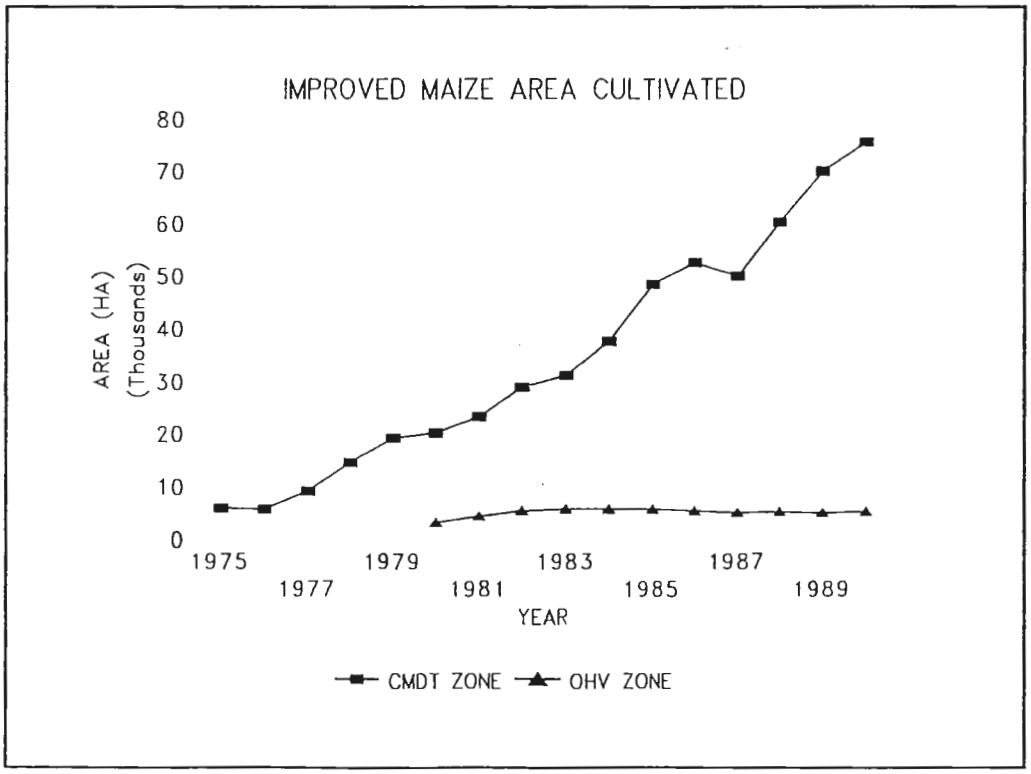
In the next section, we examine how changes in the organization of the maize subsector have interacted with farming systems to give rise to distinct patterns of technology adoption.

FIGURE 4: MAIZE MARKETING MARGINS BETWEEN RURAL MARKETS (P) IN THE CMDT ZONE AND RETAIL PRICES BAMAKO (C)



Source: Market Information System (SIM/OPAM)

FIGURE 5: ADOPTION OF IMPROVED MAIZE IN THE CMDT AND OHV ZONES



Source: CMDT and OHV Annual Reports

3.3 Historical perspective of maize research and extension impact

The decision by the CMDT to promote intensive maize production, in rotation with cotton, was taken against a background of chronic food deficits experienced during the early 1970s[5]. Initially promoted among farmers using small tractors, the program was quickly expanded to include farmers using animal traction. Adoption was rapid (Figure 5). The two factors underpinning this phenomena clearly demonstrate the significance of interactions between farming systems and markets for the rate of technology adoption at farm level.

The transfer of responsibility for the purchase of cereals at a guaranteed price from the national grain board (OPAM) to rural development agencies allowed the CMDT to apply to maize the same integrated approach to technology delivery that it was already using so successfully for cotton. This approach 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.

The stage of development of farming systems of Southern Mali also had an important bearing on the rate of technology adoption. Since the late 1950s, the CMDT's predecessor (the CFDT) had been introducing mechanization as part of its program to expand cotton production. By the mid-1970s there were an estimated 110,000 draft oxen, 37,500 plows, 1400 seeders, and 20,000 weeders in service. In 1990, the level of mechanization had increased to 305,000 draft oxen, 112,000 plows, 39,000 seeders and 74,000 weeders. Farmers were able to pay for this equipment out of their profits from cotton production. Mechanization is crucial to a farmers' capacity to adopt intensive maize because of need to plow and weed frequently in a timely manner. Not surprisingly, the area of improved maize is statistically highly correlated with level of mechanization over the period 1975-90.[6] A second factor encouraging the adoption of maize 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 implies a lower cash outlay for farmers.

The joint impact of a coordinated subsector interacting with farming systems characterized by a high level of mechanization and a profitable cash crop on farmer adoption 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 5).

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[5] The term "intensive" here refers to the use of improved varieties and husbandry practices together with chemical fertilizers.

[6] Multiple correlation between the area of improved maize and the number of draft animals and equipment in service over the period 1975-1990 gives the following results (all significant at the .01 level): number of draft oxen 0.98; number of plows 0.99; number of weeders 0.98; number of seeders 0.98.