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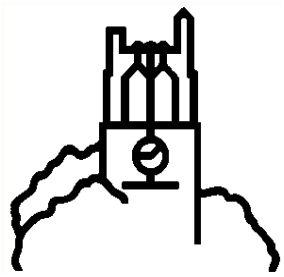
Cereal Market Dynamics: The Malian Experience from the 1990s to Present

by

Valerie Kelly, Abdoul Murekezi, Nathalie Me-nsope, Sonja Perakis. and David Mather



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FOREWORD

This report was prepared by the Food Security Group (FSG) in the Department of Agricultural, Resource, and Food Economics (AFRE) at Michigan State University with financial support from the Bill and Melinda Gates Foundation for the Guiding Investments in Sustainable Markets in Africa (GISAMA) project and the USAID-funded project *Projet de Mobilisation des Initiatives en Matière de Sécurité Alimentaire au Mali* (PROMISAM II) Associate Award to the USAID/MSU Food Security III Cooperative Agreement, (GDGA-00-000021-00) between Michigan State University and the United States Agency for International Development (USAID), Bureau for Food Security, Office of Agriculture, Research, and Technology.

The GISAMA study on the dynamics of staple food markets was to be based largely on secondary data at the national level, describing cereal production, demand, supply, and price trends during the past 20 years and changes in market structure, performance, and policies. Based on what we learned about past performance and the drivers of recent changes, we planned to discuss the extent to which improvements in cereal markets and complementary government policies and investments might contribute to future increases in incomes and poverty reduction for rural farmers throughout Mali. The joint funding permitted us to add a farm-level component to the cereal market dynamics topic so that we are able to describe in detail how different types of farms in different zones interact with cereal markets. This puts us in a better position to assess the extent to which improvements in cereal markets are likely to improve incomes and reduce rural poverty across the three principal cereal cropping systems in Mali, rather than only in the cotton zone.

Most of the research and analyses for the paper was completed prior to the March 22, 2012 military takeover of the Malian Government and the subsequent declaration of independence by the northern half of the country. While the political situation in Mali remains uncertain, we do know that it has had a negative impact on the ability of cereal markets to function in the northern half of the country.[1] Although the zones most directly concerned are north of our main study zones, the ongoing war, pillaging, and destruction of infrastructure has reduced the capacity of private sector actors, government services, and humanitarian organizations to supply the north with cereals. The disruption of trade patterns and the economic disruption in Mali due to all the political events will likely have a strong impact on the organization of the cereals value chains for the next few years. Donor support in the future will need to be mindful of the previous progress made in cereal market development via private sector actors and focus on rebuilding that capital and capacity rather than replacing it with an externally managed donor approach.

[1] For example, an October 18, 2012 report by IRIN described measures taken to fix cereal and bread prices by the new government in the North to lure back to the region Malians who fled when violence broke out. A sack of rice at 20,000 FCFA rather than the previous price of 40,000 was cited as an example by one interviewee—not a price that can be sustained by the government for very long but one that will force traditional rice traders out of the market.

ACKNOWLEDGMENTS

This paper is the result of work by a large number of international collaborators and MSU colleagues who researched and wrote many of the project working papers that are referenced and contributed to the collection and management of the farm survey data and market studies that are analyzed and reported in the paper.

Special thanks go to the farm survey team at *Programme d'économie de filières* (ECOFIL) in the *Institut d'Economie Rurale* (Bamako). The team was led by Amadou Samaké, with supervisory assistance from Moumouni Sidibé and Fassory Sangaré.

MSU's Bamako-based team (Niama Nango Dembélé, Boubacar Diallo, Abdramane Traoré, and Sidibé Thiam) played a major role in managing the farm survey data base, providing reference documents on the evolution of cereal markets in West Africa, fact-checking information on the recent evolution of cereal markets in Mali, and reviewing several draft versions of this paper. Duncan Boughton and Niama Nango Dembélé were also responsible for the design and conduct of the recent cereal market studies that provided critical information on the evolution of production and marketing basins in Mali and West Africa.

MSU's Margaret Beaver and Juha Sohlberg spent many long temporary duty assignments in Bamako helping the team set up the data base and training Bamako staff to manage it. CIRAD's Jean François Bélières was always available via the Internet to resolve any questions we had about the first year of the panel data that he had cleaned and analyzed so that we could ensure consistency in methods used across the three survey rounds.

Farm survey research and analysis support was provided by Brenda Lazarus and Mariam Sako, both MS graduate students based in East Lansing. MSU's Steve Longabaugh provided assistance with designing maps used in the report.

John Staatz and Duncan Boughton provided overall guidance throughout the farm survey, market studies, and literature review as well as reading through earlier drafts of this paper with a critical eye that substantially improved both the substance and the readability of the paper.

Patricia Johannes provided much needed assistance with final editing and formatting.

EXECUTIVE SUMMARY

This paper assesses the role that cereal markets have played in stimulating farm-level productivity growth and marketing of staple foods, in responding to changing demand patterns, in satisfying minimum food security needs, and in contributing to poverty reduction in both urban areas (through reductions in food prices) and rural areas (through increases in farm incomes). The paper uses a case study approach based on the Malian experience. Mali presents a particularly good case study of cereal market development because of (1) a unique approach to donor and government coordination during the early stages of market liberalization, (2) the contrasting development paths of the irrigated rice and the rainfed coarse grains subsectors, (3) Mali's growing role in West Africa's regional cereal trade, and (4) on-going policy debates that are relevant to the entire region. These policy debates include questions such as (1) how to balance consumer and producer interests via trade, tax, and safety net policies, (2) how to shape land policies that encourage a mix of family and commercial farms capable of meeting both national food production goals and poverty reduction objectives, and (3) how to provide incentives that reduce rural poverty by assisting resource poor farmers while also stimulating greater productivity among better-off farmers.

Although focused on cereal markets, the paper does not ignore other drivers of development such as the policy environment, technology, and agricultural infrastructure. A recurrent theme throughout the paper is the link between farm-level productivity, agricultural markets, and poverty reduction: what have been the contributions and what are the constraints to realizing the full potential of agricultural productivity growth and market development to reduce both urban and rural poverty?

The paper addresses the following specific research questions:

- How have national and regional cereal markets evolved over time in response to market liberalization, changing demand patterns, and the recent globalization of cereal markets?
    - What have been the structural changes in markets (market basins, numbers of actors, extent of cross-border trade, etc.)?
    - What do price and marketing margin analyses tell us about market performance?
    - Are there significant differences in how markets for different cereals function?
    - To what extent do agriculture and trade policies help or hinder markets from playing their role in the structural transformation process?
- Do the combined effects of market performance and policies encourage farm-level supply response?
    - If so, which types of farmers are most responsive and what is the impact on their production decisions and incomes?
    - Which types of farmers are least responsive and what are the factors that limit their response?
- What is the potential contribution of the cereal sector to rural poverty reduction in Mali; how does it differ by zone and farm type?

Answers to these questions are drawn from an extensive literature review and analysis of a 3-year panel data set covering roughly 450 farm families located in three different cereal production zones of Mali: traditional millet/sorghum, cotton/coarse grain, and irrigated rice.

In this executive summary, we present an overview of answers to the first two sets of questions listed above and then turn to a discussion of the implications of those findings for

increasing the cereal sector's contribution to rural poverty reduction to answer the third question.

a. How Have National and Regional Cereal Markets Evolved?

The three most striking changes in Malian cereal markets during the past 20 years include: (1) market liberalization, (2) changes in demand, and (3) increased exposure to regional and global markets.

Market liberalization transformed Malian cereal markets from ones that were constrained by heavy government regulation and intervention to ones that are now managed primarily by the private sector. Since the mid-1980s, government has focused on managing national security stocks and providing partial support (the rest covered by private sector contributions) for market information systems so that all actors have access to basic price information. At the same time, government has invested in irrigation infrastructure and crop research to increase agricultural productivity and reduce production risk.

In general, we found the private sector willing and able to perform the role of matching demand and supply once the Government of Mali (GOM) stepped down. This is illustrated by the aggregate production response that has not only kept abreast of growing demand but increased cereal availability from 183-185 kg/capita before 2005 to 201 kg/capita in 2007. Traders have managed to move increased production from surplus to deficit zones and to centers of urban demand as well as to neighboring cereal deficit countries. Nevertheless, there is some continued weakness in supplying cereal-deficit zones that have low purchasing power and high transactions costs, largely because effective demand is not adequate to make cereal supply profitable in these deficit, geographically remote areas. There also appear to be some shortcomings in terms of satisfying demand for better quality grains needed by processors. Although more research is needed to pinpoint the source of the problem, the weakness appears to be in transmitting the price premium for improved quality back to farmers and collectors. Private sector trade has been facilitated by government support of transparent price information systems and road investments; but it continues to be hindered by unofficial road taxes and administrative measures such as export bans designed to protect Malian consumers from higher prices.

Changes in cereal demand are largely a function of population growth and urbanization, also accompanied by income growth. These forces have significantly increased total cereal demand while reducing demand for traditional coarse grains (millet and sorghum) and increasing demand for urban cereals such as rice and, to a lesser extent, maize, which is now used for both human consumption and by the animal feed industry. Other changes in demand include a significant increase in the share of household cereals that are purchased (rather than home produced) and some changes (primarily for rice) in a willingness to pay for better quality.

Exposure to global markets is most evident in the phenomenal cereal price hikes experienced throughout West Africa in 2007 and 2008 as commodity prices world-wide skyrocketed. Mali is not only more exposed to world prices than it was several decades ago, but it is also affected by demand in neighboring countries (most of whose consumers have greater purchasing power than Malian consumers). Harvest short-falls elsewhere in the region often put pressure on Malian prices as traders attempt to fill the gaps with Malian cereals. Exchange rate fluctuations are also a factor influencing trade (since not all Mali's regional trading partners share the same currency).

Our review reveals important structural changes in markets since liberalization. Of most interest is the growth in numbers of traders, taken as a sign of increased competition, and the growth of cross-border trade, which signals progress toward the development of a regional market that should be better able to move cereals from surplus to deficit zones. There appears to be more use of contracts than previously, particularly covering sales to institutions (*Office des produits agricoles du Mali* (OPAM), World Food Programme of the United Nations (WFP), hospitals, and schools). There is also good evidence of trade channels becoming shorter: less distance traveled due to road improvements and fewer intermediate transactions due to improved communications and increased confidence among trading partners. Although there has been some progress in expanding the share of farmers actually participating in cereal markets, Lorenz Curve analyses of survey data for three production zones confirm that a large share of marketed production is still coming from a relatively small share of farmers (see below for details).

Price trends and margins analyses conducted to date do not provide many conclusive insights about changes in market performance. Nevertheless, the following points appear to be fairly well substantiated:

- A linear time line (1993-2010) shows that nominal prices increased at an average rate of 8.6 FCFA/kg/year for local rice and 5.8 FCFA/kg/year for millet (used as a proxy for all coarse grains); real prices increased at a slower rate of 1.4 FCFA/kg/year for local rice and 2.2 FCFA/kg/year for millet, despite the much stronger growth in demand for rice.
- Rapid productivity growth and declining unit costs of production for rice were important factors contributing to the lower rate of real price increases.
- Despite the popular belief that Mali's greater integration into regional and world markets has increased price volatility, an analysis of coefficients of variation for consumer prices shows lower variation since 2000 for every cereal crop, with considerably less variability for rice than for coarse grains.
- Margins remain extremely high along some marketing channels suggesting that investments in reducing marketing costs (including unofficial road taxes) might be more conducive to low consumer prices than improvements in agricultural technology.
- Evidence of margins rising or falling over time is very mixed and not accompanied by supplementary information on whether the quality of the product or the services covered by the margins have changed, making it difficult to draw any conclusions from margins about whether markets have become more or less efficient.

The study revealed important differences in the way the rice and coarse grain markets are organized, yet both seem to be performing the basic functions of collection, transfer, wholesaling, and retailing in a competitive manner that meets most of the demand for the different products.

It is difficult to draw any clear conclusions about how differences in the organization of rice and coarse grain marketing affect performance. Although some analysts suggest that one sector is more openly competitive than the other, this is difficult to assess with the data available. The potential for the coarse grain production zone wholesalers to exercise oligopolistic control over the market seems to have been diminished by the large number of smaller, independent operators and, more recently, by a sharp increase in foreign buyers from neighboring countries who are competing in the local collection and assembly markets. The potential for the oligopoly of rice importers to unduly influence domestic prices is diminished

by the relatively small share of the total rice market covered by imports in most years (<20%) and the Malian consumer's preference for domestic rice. Both sectors seem to be responding well to changes in consumer demand. The rice sector has been more responsive than the coarse grain sector to changes in demand for improved quality but hindered to some degree by a lack of credit needed to invest in better performing mills and by farmers' preference for milling rice themselves rather than selling paddy. While the licensed importers are well financed and have invested to some extent in processing of domestic rice, they seem to lack consistency in their efforts, withdrawing from local processing when the GOM authorizes large shipments of imported rice, which is apparently a more profitable activity. The coarse grain sector appears to be well financed from personal as well as bank sources, but the sector has been slow to adapt to demand from processors who are looking for more uniform and cleaner grain. This has been particularly constraining for the animal feed industry.

Agricultural and trade policies in place for most of the past 20 years have fostered increased production and marketing of cereals. Irrigation investments and crop research that resulted in major productivity improvements for rice and maize (but very limited improvements for millet and sorghum) have been a significant factor; however, the verdict is not yet in on the productivity results of the recent reintroduction of input subsidies. The subsidies do not appear to have significantly increased farm-level input use, but they did buffer farmers to some extent against the sharp increases in world fertilizer prices. A newly emergent agricultural policy issue concerns the appropriate mix of family and commercial farms—a topic being hotly debated as the government signs agreements transferring large tracts of land to foreign governments and commercial firms to speed up irrigation development while family farms in the *Office du Niger* are facing serious land shortages.

The regional trading channels of today are largely a continuation of channels that existed in the1970s (and earlier), but volumes are increasing and the directions of the flows can change, depending on harvests across the region. The impetus for increased regional trade flows since 2000 comes from a combination of improved transportation, improved information flow via information and communication technology (ICT), and trade agreements (e.g., West African Economic and Monetary Union (WAEMU), Economic Community of West African States (ECOWAS)), with the latter promoting investment in the two former. Population growth and urbanization are also contributing factors as well as income growth (particularly for some coastal countries), which is increasing demand beyond domestic supply. Although it is clear that regional trade has increased, numerous problems exist: weak enforcement of the rules, porous borders, inadequate efforts to control unofficial road taxes, and willingness on the part of member states to circumvent the rules through administrative measures such as export bans and unilaterally declared exemptions of cereals from import taxes and value added tax (VAT). All these unresolved issues tend to increase transactions costs and limit the ability of cereal markets to become more efficient and pass the savings on to farmers and consumers. Understanding the extent to which savings are passed through and what government can do to increase the pass-through remains a challenge. For example, consumer price monitoring after government suspension of taxes on imported rice in 2007 and 2008 suggest that this type of policy instrument did not result in much pass-through of benefits to consumers. Mali also has to deal with the threat of regional buyers from countries with higher purchasing power moving into Malian markets and pushing prices up beyond the reach of Malian consumers.

b. Does the Market and Policy Environment Encourage Farm-Level Supply Response?

Since 2000, Mali has demonstrated an ability to meet its domestic cereal demand and also export coarse grains to neighboring countries, particularly ones that have structural cereal

deficits (e.g., Senegal and Mauritania) or are heavily reliant on rainfed production that does not follow the same ups and downs as Malian rainfed production (e.g., Niger and Nigeria). Malian aggregate cereal supply from domestic production has increased over the past two decades at an average rate of about 4% (just 1% above the population growth rate). Increases have been primarily for rice and maize (roughly 7% annual growth). Millet grew at roughly 3% and sorghum at only 1%. This growth is an important accomplishment and, as noted above, it is largely the result of reforms in the irrigated rice sector that encouraged farmers to invest in yield enhancing practices, and of market liberalization in the rice and coarse grain sectors that provided both farmers and traders incentives to respond to changing demand. This increase in cereal production has been accompanied by an increase of 13.5% in the expenditure share of food purchased rather than home produced between 1989 and 2006; this illustrates the growing importance of markets in meeting food security needs. Growth in purchasing was evident even in the major cereal production regions (Segou, Sikasso, and Koulikoro).

Survey evidence suggests, however, that most of the marketed surplus of cereals continues to come from a small share of farmers. In the traditional coarse grain zone (Tominian), average cereal sales per capita were low (5 kg/capita) and 20% of households accounted for 92% of all sales, with 69% of households not selling at all. These results are not surprising for a zone with low rainfall and little government investment in agricultural research, extension, and infrastructure. Sales are less concentrated in the cotton/coarse grain zone (Koutiala) which had average sales of 44kg/capita; 20% of farms accounted for 60% of sales and just10% of farms made no sales. While not fully comparable, these results do suggest some improvement over the level of concentration found in the mid-1980s (Dioné 2000), when the top 28% of farms in the cotton zone accounted for 90% of sales (survey data shows that currently the top 28% account for only 78% of sales). In the irrigated rice zone (Macina), where rice is the main cash crop, average sales per capita were high (417 kg) and the concentration is even less: 20% of farms account for 52% of all sales and only 8% of farms have no sales at all. Although we see declining concentration across zones, even the best case scenario in the irrigated rice zone means that 20% of farms are earning roughly 50% of the revenue from rice sales, leaving the remaining 80% of farms to share the other 50% of revenue.

At the same time, a large share of rural farm households in the three production zones studied do not produce sufficient cereals to meet their basic needs (76% in Tominian, 30% in Koutiala, and 29% in Macina). The farm-level survey data show strikingly that even in the more favorable cotton/coarse grain and rice zones, some 30% of households are far (not a little, but far) below the per capita cereal requirement. Despite the aggregate increase in cereal available per capita reported in Food and Agriculture Organization of the United Nations (FAO) food balance sheets, many farmers in the more productive cereal systems have not achieved sustainable levels of productivity for their own families, let alone being in a position to feed a growing urban population at low cost. These findings do not bode well for the prospects of moving farm families out of poverty by getting them better integrated into the supply side of cereal markets. The findings suggest that a relatively important share of rural households must deal with their own food security before thinking about increasing their production for the market.

These production shortfalls, coupled with the relatively concentrated nature of cereal sales, suggest that many farms have not been able to reap the benefits of the market reforms and accompanying government investments. If marketing systems have become more competitive but supply response is still timid then more attention needs to be given to farm-level cereal production constraints. We think these constraints are of two types: structural constraints that keep a large share of rural households in perpetual poverty because they cannot access the

necessary productive assets and (2) technical constraints that prevent farmers who do have access to a minimum set of productive assets from mastering yield increasing technologies and practices capable of closing the yield gap.

Analysis of survey data suggests that access to land is the salient structural constraint to increased supply response. In all zones, net seller farms owned and cultivated a statistically significant greater amount of land than other farms. Other factors also differentiate net sellers from others, but the results are less robust across zones. For example, net sellers own more agricultural equipment than others in the higher productivity irrigated rice zone (Macina) and the cotton/coarse grain zone (Koutiala), but not in the traditional millet/sorghum zone (Tominian). Membership in producer associations and location in a village with easy access to markets differentiate net sellers from others in Tominian and Macina but not in Koutiala. Farms with younger household heads and a higher level of educational attainment are also more likely to be net sellers in Tominian and Macina but not in Koutiala. The net sellers across all zones produced more cereal per capita and were more likely to meet minimum cereal needs per capita. In general, inadequate access to land is exacerbated by generalized asset poverty (low levels of agricultural equipment, vehicles, and phones), poor access to inputs, and lower levels of education—all of which perpetuates poverty among roughly one-third of rural households that are unable to cover minimum cereal needs.

c. What Is the Potential Contribution of the Cereal Sector to Rural Poverty Reduction and How Can that Potential Be Realized?

There are a number of factors that make us pessimistic about the ability of the cereal sector to significantly reduce rural poverty in Mali by creating more net sellers of cereals. First of all, there is no easy path to alleviating the structural constraints that prevent at least 30% of farm families from producing enough cereal to feed themselves. The problem of access to land and equipment will be more difficult to solve as population continues to grow rapidly, land becomes more constraining, and access to irrigated land becomes ever more important because of climate change. Land policy may be the elephant in the room that policy makers have not yet focused on; but the prospect for land redistribution capable of pulling the poorest third of Malian farmers out of poverty is unlikely. As in other agrarian societies that have transitioned to more modern economies, it will be necessary to work on structural changes that can promote rural income diversification and employment. It will be important to do this in a way that is compatible with farming activities so that rural families can improve their food security through both income diversification and better cereal production while slowing the pace of permanent migration from rural to urban areas that is likely to put additional pressure on the cereal sector. The higher levels of education found among households in the agriculturally disadvantaged Tominian zone, suggest that perhaps the farmers have already seen the writing on the wall and are making the investments in education needed to move into other income generating activities. Government needs to accompany them in promoting the creation of jobs that are complementary to their farming activities.

While asset poverty seems to be an underlying cause of many farmers not producing marketable surpluses of cereals, there is also a question about the extent to which producing marketable surpluses of traditional coarse grains (millet and sorghum) will provide a road out of poverty given the weak prognosis for growth in demand for these two cereals.

Malian cereal demand has been increasing in response to a high population growth rate (about 3% annually), urbanization, and income growth, which has stimulated demand for feedgrains and more expensive cereals such as rice. This trend is expected to continue into

the future. Demand for coarse grains for animal feed is poorly documented but considered by most analysts to represent an important area of future growth as incomes rise and consumers demand more eggs, meat and dairy products. Another area of growth is better quality processed rice and coarse grains that meet the needs of food processors (more uniform grains and grains free of foreign matter). In short, the potential for increased cereal demand is strong, but the greatest growth area is likely to be rice (particularly better quality) and maize. Demand for other coarse grains is likely to grow at a slower pace and be more specific to particular processing needs, with increased rural demand due to population growth being the main driver. This does not bode well for farmers who have few options other than millet and sorghum production.

We are more optimistic about farms that are already meeting their minimum cereal requirements, as there appears to be scope for increasing production and incomes through alleviation of technical production constraints. Most of these farms are in Macina and Koutiala and are already producing some rice or maize—cereals for which demand is increasing rapidly. In our view, progress in this area calls for a better empirical understanding of the level of technology adoption by farmers and the causes of varying yield response. For example, new maize and sorghum varieties have been released but the level of adoption and effect of adoption are unknown. Malian research on soil and water management practices has shown remarkable growth in yields through the use of improved land preparation practices, but adoption of these practices is poorly documented and believed to be relatively limited. Rice yields in the *Office du Niger* (ON) appear to be declining after spectacular growth for more than a decade—research on the causes and cures is urgently needed.

Understanding of technology adoption needs to be accompanied by more aggressive on-farm experimentation integrating technical scientists, social scientists, and extension specialists to identify pathways to sustainable increases in productivity in all of Mali's cereal production environments. When making decisions about on-farm research and improvements in extension services, the zone's agroclimatic potential will need to be taken into account (including the potential effects of climate change) as well as the capacity of different types of farmers to adopt improved technologies. All zones that produce cereals will not be good candidates for cereal-centered production and income-generation programs, although even zones with relatively low cereal production potential (e.g., the Tominian study zone) could benefit from better extension of low-cost technologies or improved practices that do not require cash outlays but can reduce crop risk and improve food security. In zones of higher potential such as the irrigated rice zone and the cotton zone, programs will need to be designed differently for different types of farmers—taking into account the farm family's overall income strategy, its asset base (particularly land access, which is now inadequate for many farmers in the *Office du Niger*) and potential interest in using cereal production as a vehicle for increased income and food security.

A critical element for improving the well-being of coarse grain producers who are interested in generating marketable surpluses will be the development of risk management tools to protect them against loss when expenditures on inputs to increase production are lost following a poor rainy season or other negative cropping event. These risk management tools must be developed in tandem with the development and testing of improved cereal production technologies and practices to ensure broader adoption by farmers living with few resources to fall back on in case of crop failure. For the vast majority of Malian farmers in the rainfed production zones, improved cereal productivity for food security purposes will be important but other sources of complementary farm and/or nonfarm income will be needed by most to adopt improved practices capable of increasing cereal productivity up to just basic needs. For farmers in the *Office du Niger*, there is more potential for higher incomes through

rising demand, but access to land and to affordable inputs available in a timely manner is a major constraint. For the cotton zone, maize demand for animal feed should provide incentives for many to increase maize production, but access to credit and the costs of improved seeds and fertilizer are particularly constraining for farmers who do not also grow cotton as is the lack of understanding on the part of farmers on how to respond to the quality needs of animal feed processors.

In closing, we conclude that market reforms and agricultural policies promoted by the GOM during the past 20 years have made an important contribution to increasing cereal availability and food security nationally; but most of the farm-level income benefits of these policies have been concentrated among a relatively small share of farmers, with the majority of farmers not able to overcome structural constraints that prevent access to productive assets and/or inputs needed to producer regular marketable surpluses. More progress can be made in decreasing marketing costs and making markets more efficient; but changes in marketing efficiency are not likely to draw many poor farmers into cereal markets. Other more targeted measures will be needed to overcome the structural poverty that appears to keep at least one-third of farm families from becoming regular suppliers of Malian cereal markets.

As the GOM moves forward in designing programs and policies to ensure national food security while simultaneously reducing poverty and promoting market development, they must keep in mind the tradeoffs between different constituencies. For example, when price policy decisions favor urban consumers over rural producers, they are unlikely to provide farmers with adequate incentives to produce and market more cereals. Similarly, land policy decisions often pit the interests of family farms against those of commercial (often foreign owned) farms, exacerbating problems of land constraints that are already quite severe in the *Office du Niger*. A final example is the targeting of agricultural subsidies, which raises the question of how to balance assistance to the poorest farmers versus those most capable of significantly increasing aggregate cereal availability and national food security. There are no clear answers to what polices and balance of constituencies will be the best in the long-run for Mali, but informed decision making based on solid research by well-trained analysts working on good quality longitudinal data bases will improve the outcomes, so investments must be made in policy analysis capacity and market research to accompany direct investments in rural infrastructure and farmer capacity building.

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AFRE	Department of Agricultural, Food, and Resource Economics, Michigan State University
AGRA	Alliance for the Green Revolution in Africa
BMGF	Bill and Melinda Gates Foundation
CA	Comparative advantage
CAADP	Comprehensive Africa Development Plan implemented by NEPAD
CEDEAO	Economic Community of West African States (*Communaute Economique des Etats de l'Afrique de l'Ouest*); ECOWAS is the English acronym
CIRAD	A French research institute; CIRAD collaborated on the collection and analysis of the first year of the farm survey data (*Centre de coopération internationale en recherche agronomique pour le développement*)
CMDT	Mali's national cotton company (*Compagnie Malienne de Développement des Textiles*)
CNSA	*Conseil National de Sécurité Alimentaire*; it meets twice a year to review the food situation in the country and to set overall policy orientation for the CSA
CONOESAM	A Malian professional organization of agricultural produce traders (*La Coordination nationale des opérateurs économiques du secteur agro-alimentaire du Mali*)
CPS	*La Cellule de Planification et de Statistique du Ministère de l'Agriculture de l' Elevage et de la Pêche*
CSA	Mali's Food Security Commission (*Commissariat à la Sécurité Alimentaire)*
CSCRP	Mali's poverty reduction strategym (*Cadre Stratégique pour la Croissance et la Réduction de la Pauvreté*)
CV	Coefficient of variation (the standard deviation of a data series divided by its mean)
DADR	*Direction Aménagement Développement Rural* in the *Office du Niger*
DRC	Domestic resource cost, and indicator of the competitiveness of a product in domestic and international markets
ECOFIL	IER's agricultural subsector research division (*Programme d'économie de filières*)
ECOLOC	A program of assistance to communities wanting to analyze their local economy. The ECOLOC approach is based on principles derived from the findings of the West African Long Term Perspective Study (WALTPS) carried out by the Club du Sahel with support from a number of African states and donors.
ECOWAP	The Economic Community of West African States Agricultural Policy; it is the ECOWAS agricultural policy aimed at promoting economic integration of the agricultural sectors of the West African sub-region and synonymous with the regional CAADP program.
ECOWAS	Economic Community of West African States (CEDEAO is the French acronym); it is a 16 member economic community joining anglophone and francophone countries.
FAO	Food and Agriculture Organization of the United Nations
FBS	Food balance sheets (data assembled by the FAO)
FCFA	Currency managed by the *Banque Centrale des Etats de l'Afrique de l'Ouest* (BCEAO) for the WAEMU (UEMOA) monetary union to which Mali belongs

FSG	Food Security Group in the Department of Agricultural, Food, and Resource Economics at Michigan State University
GISAMA	Guiding Investments in Sustainable Markets in Africa—a project funded by the Bill and Melinda Gates Foundation and implemented by the FSG
GOM	Government of Mali
GREAT	The group involved in the ECOLOC study of the Koutiala zone (*Groupe de recherche en économie appliquée et théorique*)
IER	Mali's national agricultural research institute (Institut d'Economie Rurale)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (part of the system of international agricultural research institutes)
ICT	Information and communication technology
INSTAT	Mali's national statistical agency (*L'Institut National de la Statistique*)
INTSORMIL	A USAID-funded research program to promote millet and sorghum production and marketing (Sorghum, Millet, and Other Grains Collaborative Research Support Program or CRSP)
IPCC	International Panel on Climate Change
IR	Mali's input subsidy program; it started in 2008 (Initiative Riz)
LOA	Mali's long term vision for the agricultural sector (*Loi d'Orientation Agricole*)
M&E	Monitoring and evaluation
MSU	Michigan State University
NEPAD	New partnership for Africa's Development – a planning and coordinating technical body of the African Union, aiming to eradicate poverty and create sustainable growth
NGO	Non-governmental organization
NSD	No statistically significant difference
OHVN	Malian cotton production support program (*Office de la Haute Vallée du Niger*)
OMA	Mali's market information system (*Observatoire du Marché Agricole*)
ON	Mali's largest irrigation system located in the Ségou Region (*Office du Niger)*
OPAM	Mali's cereal marketing board (*Office des produits agricoles du Mali*)
PACCEM	Cereal Marketing Support Project (PACCEM), funded by Canadian Cooperation and implemented by the Québécoise agri-agency (development branch of a farmers' organization)
PDAM	Mali's Poultry Development Project (*Programme de Développement de l'Aviculture au Mali.*)
PNIP_SA	Mali's national plan for priority investments in agriculture (*Plan National d'Investissement Prioritaire dans le Secteur Agricole*)
PNISA	*Plan National d'Investissement du Secteur Agricole* (also known as the CAADP investment plan, which will be coming on-line to replace the PNIP_SA)
PRMC	Mali's cereal market restructuring program (*Programme de restructuration du marche céréalier*)
PROMISAM	FSG Food Security Project in Mali funded by USAID, (*Projet de Mobilisation des Initiatives en Matière de Sécurité Alimentaire au Mali*)
ReSAKSS	Regional Strategic Analysis and Knowledge and Support System; an Africa-wide network of regional nodes supporting implementation of the Comprehensive Africa Agriculture Development Programme (CAADP)

ROESAO	Regional organization of agricultural produce traders (*Reseau des opérateurs économique du secteur agro-alimentaire de l'Afrique de l'Ouest*)
RS	RuralStruc, a World Bank research program which provided the first year of our panel data set for Mali
SAP	Mali's Early Warning System (*Système d'Alerte Précoce*)
SIM	Système d'information sur les marchés (predecessor to OMA in Mali)
SNSA	Mali's national food security policy (*Stratégie Nationale de Sécurité Alimentaire*)
TDY	Temporary duty assignment
URDOC	*Unité de Recherche/Développement Observatoire du Changement*, a French funded research program in Mali
USAID	United States Agency for International Development
VAT	Value added tax
WAEMU	West African Economic and Monetary Union (WAEMU); UEMOA is the French acronym
WFP	World Food Programme of the United Nations

1. CONTEXT AND OBJECTIVES

Rural poverty has persisted in Mali since the turn of the 21st century, with the World Bank reporting that 50.4% of the population was living on less than $1.25 a day at 2005 purchasing power parity prices.[2] Recent changes in West African agricultural commodity prices (Staatz et al. 2008; Kelly, Dembélé, and Staatz 2008) and demand (ReSAKSS 2010 and 2011) have raised hopes about the potential to reduce rural poverty via increased cereal production and marketing by Malian farmers. To date, however, there is no consensus on the measures needed to improve the agricultural sector's capacity to take advantage of the new opportunities in a manner that contributes to the more general national goals of poverty reduction and food security. This paper focuses on just one of the many drivers of agricultural growth: cereal market development. More specifically, the paper assesses the role that cereal markets have played in stimulating farm-level productivity growth and marketing of staple foods, in responding to changing demand patterns, in satisfying minimum food security needs, and in contributing to poverty reduction in both urban areas (through reductions in food prices) and rural areas (through increases in farm incomes).

The paper uses a case study approach based on the Malian experience. Mali presents a particularly good case study of cereal market development because of (1) a unique approach to donor and government coordination during the early stages of market liberalization, (2) the contrasting development paths of the irrigated rice and the rainfed coarse grains subsectors, (3) Mali's growing role in W. Africa's regional cereal trade, and (4) on-going policy debates that are relevant to the entire region. These policy debates include questions such as (1) how to balance consumer and producer interests via trade, tax, and safety net policies, (2) how to shape land policies that encourage a mix of family and commercial farms capable of meeting both national food production goals and poverty reduction objectives, and (3) how to provide incentives that reduce rural poverty by assisting resource poor farmers while also stimulating greater productivity among better off farmers.

Although focused on cereal markets, the paper does not ignore other drivers of development such as the policy environment, technology, and agricultural infrastructure, but they are covered from the perspective of how they affect (1) farmers' incentives to produce for the market; (2) cereal traders incentives to purchase, stock, and transport cereals in Mali and the region; (3) cereal processors needs for reliable supplies; and (4) consumers' ability to satisfy their food security needs through the markets. A recurrent theme throughout the paper is the link between farm level productivity, agricultural markets and poverty reduction: what have been the contributions and what are the constraints to realizing the full potential of agricultural productivity growth and market development to reduce both urban and rural poverty?

[2] http://data.worldbank.org/indicator/SI.POV.DDAY, October 26, 2012.

2. RESEARCH QUESTIONS, METHODS AND ORGANIZATION OF THE REPORT

2.1. Research Questions

Specific research questions that are addressed in an effort to understand cereal market dynamics in Mali and their contribution to growth in incomes for farmers as well as for those employed in upstream (input supply) and downstream (crop processing and marketing) activities include:

- How have national and regional cereal markets evolved over time in response to market liberalization, changing demand patterns, and the recent globalization of cereal markets?
    - What have been the structural changes in markets (market basins, numbers of actors, extent of cross-border trade, etc.)?
    - What do price and marketing margin analyses tell us about market performance?
    - Are there significant differences in how markets for different cereals function?
        - If yes, why do the differences exist and
        - What are the consequences for market development?
    - To what extent do agriculture and trade policies help or hinder markets from playing their role in the structural transformation process?
- Do the combined effects of market performance and policies encourage farm-level supply response?
    - If so, which types of farmers are most responsive and what is the impact on their production decisions and incomes?
    - Which types of farmers are least responsive and what are the factors that limit their response?
- What is the potential contribution of the cereal sector to rural poverty reduction in Mali; how does it differ by zone and farm type?

2.2. Methods

The descriptive information and analyses in this report draw heavily on reports and data collected in the context of other studies as well as on focus group discussions and key informant interviews conducted specifically for this research activity. Our contribution is the pulling together of the diverse studies on the general topic of cereal market development in Mali and supplementary analyses of price data and farm-level survey data collected with a combination of USAID, the Bill and Melinda Gates Foundation (BMGF), and World Bank funding from 2007 – 2010 in three distinct production zones of Mali:

- irrigated rice and rainfed coarse grain production in the Macina sector of the *Office du Niger*;
- maize, millet, and sorghum production in the higher rainfall Koutiala sector of the cotton zone, and
- the largely subsistence coarse grain production in the low rainfall zone of Tominian.

Because of Mali's unique experience with market liberalization, there is an extensive literature on the reform process and its impacts covering the 1980s and 1990s for example, Egg 1999; Dembélé, Traoré, and Staatz 1999; Dembélé and Staatz 2000; Diarra et al. 2000;

Dembélé and Staatz 2002; Aw and Diemer 2005). Since 2000 there has been less systematic research and attention to the impact of cereal market reform, but we are able to draw on a variety of market studies to update the situation (for example, S. Diarra 2008; Samaké et al. 2008; Staatz et al. 2008).

As a result of investments made during the early reform process in the 1980s, Mali has a long time series of cereal market prices, which we examine in terms of producer and consumer price trends and trader margins, using the results as rough indicators of cereal market performance.

At the farm level, we present a comparative analysis of farmers' recent cereal production and marketing behavior in the three production zones described above. Descriptive statistics characterize the different types of farms in each zone and how they related to markets during the 2007 – 2010 period.

Because Mali does not have a longitudinal data set on farm production and marketing behavior (as found in many countries where the Michigan State University Food Security Group works in East and Southern Africa), we are constrained in our ability to use econometric techniques to look at changes in farm behavior over a long period of time (e.g., the mid 1980s to present); but we do draw on the results of a farm survey conducted in the Koutiala zone in the mid-1980s (Dioné 1989; D'Agostino, Dioné and Staatz 1990, Dioné 2000) to develop hypotheses about what changes took place in production and marketing behavior of cotton/coarse grain farmers between the two survey periods.

We also draw on market reconnaissance studies conducted during 2010 and 2011, which are not tied to the farm survey work, but provide information on the structure of Malian and regional cereal markets and how the trading channels have evolved in response to transportation and communications improvements.

2.3. Organization

The rest of the paper begins with an overview of the physical, policy, and price environment affecting cereal production and marketing in Mali. A discussion of the evolution of cereal demand and supply during the past 20 years follows, including a discussion of imports, exports, and national food balances. Section 5 is an analysis of farm-level survey data illustrating how farmers have responded to recent changes in prices and policies. Section 6 looks at how cereal markets have evolved in response to changes in demand, supply, and the policy environment. The paper closes with a summary of the key findings and implications, identifying policies and investments most likely to improve the contribution of cereal markets to economic development and poverty reduction in Mali.

3. OVERVIEW OF THE PHYSICAL, POLICY, AND PRICE ENVIRONMENT

3.1. Physical Environment

The key physical constraints to cereal production and marketing are climate and transportation infrastructure in this landlocked, Sahelian country that spans four agro-ecological zones.

3.1.1. Climate

Figure 1 presents the four climatic zones found in Mali (Sanders, Shapiro, and Ramaswamy 1996):

- Sudano Guinean (southern most parts of the regions of Kayes (Kenieba) and Sikasso (Yanfolila, Kolondieba, Kadiolo). Rainfall is 800-1000 mm/year. The crop mix is diversified and integrated with livestock; cotton predominates in many areas as well as maize.
- Sudanian (central sections of Kayes, Koulikoro, and Sikasso Regions). Rainfall of 600 – 800 mm/year. Some cotton is grown, but mostly sorghum, millet, maize, cowpeas, and some vegetables.

Figure 1. Administrative Regions and Climate Zones of Mali

Source: Map prepared by Steve Longabaugh.

- Sahelo Sudanian (northern parts of Kayes, Koulikoro, and Segou regions; southern part of Mopti region). Rainfall is 350-600 mm/year. Millet-cowpea intercrops and nomadic grazing predominate. Irrigated rice is grown where infrastructure has been developed in the Segou Region.
- Sahelian (north/northeast of Mopti). Rainfall is <350 mm/year. Subsistence millet/cowpeas predominate with irrigated rice when infrastructure is available; nomadic and transhumant livestock are present.

Figure 1 also shows the location of the three survey zones covered by the research presented in Section 5. Moving from south to north, we have first a cotton-producing survey zone located in the Koutiala *Cercle* (Sudanian climate), which is in the heart of Mali's cotton belt Next is a traditional millet/sorghum zone located in the Tominian *Cercle*, and then an irrigated rice zone located in the Macina *Cercle*. Both of these last two survey zones are located along the southern edge of Sahelo-Sudanian climate zone and the northern edge of the Sudanian zone.

Mali's cereal production comes largely from the regions of Segou (both coarse grains[3] and irrigated rice), Sikasso (primarily maize and sorghum), Koulikoro (millet and sorghum), and Kayes (millet and sorghum). The dependence of grain production on rainfall raises the issues of climate change and investments in irrigation infrastructure. The 21 General Circulation Models used by the International Panel on Climate Change (IPCC) to predict the climate changes that might occur by the end of the 21st century agree that it will become warmer in Mali, but the degree of warming predicted is variable and there is no consensus on whether rainfall will increase or decrease (Foltz 2010, citing Cooper et al. 2008).

Faced with a growing population[4] to feed and the uncertainty of climate change the Government of Mali (GOM) has been investing heavily in various types of irrigation systems and actively soliciting both public and private investment from domestic and foreign sources to speed up the process. Much of the increased cereal production of the past ten years has come through improvements in and expansion of irrigated production not only in the *Office du Niger* (Mali's largest irrigation system) but also in the Kayes, Koulikoro, Sikasso, and Mopti regions (PROMISAM 2011). Irrigation water provided by the Niger River system is not endless and must be shared with other countries in the region (Kuper, Olivry, and Hassane 2002). Consequently, future irrigation investments will need to be increasingly efficient in their use of this regional resource (Oakland Institute 2011; Foltz 2010) while technicians and farmers managing the system will need to improve their skills and coordination practices (Sidibé 2002).

Furthermore, much of rural Mali does not have irrigation potential. Government assistance to these zones is already coming in the form of cloud seeding to increase rains[5], but more work will be needed to develop diversified risk-reducing portfolios of crop production activities able to meet the challenges of climate change. This will likely involve more attention to technological change based on intercropping, multiple production processes, and soil and water conservation (SWC) technologies and less attention to mono-cultures and specialization (Foltz 2010).

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[3] In this report, the term *coarse grains* refers to millet, sorghum, and maize.
[4] Most reports provide preliminary population growth estimates of just under 3% annually using the most recent 2009 census data.
[5] See *West African Monsoon And Rainfall Enhancement Studies – Mali*. 1/27/2012 at http://www.ral.ucar.edu/projects/westafrica for more details on this approach to increase and improve the timing of rainfall.

In sum, the majority of Mali's farmers will likely be dealing with increased production risk in the future—a particularly difficult challenge for the many farmers already living in poverty.

3.1.2. Transportation Infrastructure: Improvements and Challenges

Figure 1 also reveals that Mali is a landlocked country and dependent on neighbors for access to ports. Abidjan in Côte d'Ivoire (connected by 926 km of paved highway) and Dakar in Senegal (previously connected by very poor train service but since 2008 also connected by 1045 km of paved road) were the ports commonly used, but political problems in the Côte d'Ivoire since the early 2000s have intermittently forced Mali to use more distant ports in Ghana (1160 km away), Benin (1340 km) and Togo (1240 km). Ports in Conakry and Nouakchott are also used occasionally. Mali has been improving road networks, with significant investments in paved roads connecting Mali's different production zones to both urban areas and neighboring countries and in feeder roads connecting farmers to markets.

Table 1. Official Details on Malian Road Improvements since 2000

Roads	**Length (km)**	**Years of major work**
Bamako-Kita	180.0	2007
Bamako- Kayes	621.0	2003 -2008
Kita-Kayes via Bafoulabé - Manantali	380.0	none performed
Kolokani-Nara (and to the Mauritanean border)	306.0	2003 - 2005
Diema – Nioro (and to the Mauritanean border)	161.0	2007
Bamako-Segou	236.0	2000
Segou- Monimpebougou	235.0	2005
Segou-San	199.0	2000
San-Mopti	189.0	2000
Mopti-Gao	571.0	1987/2010
Mopti-Bankass	152.0	2000
Bankass-Diallassagou	47.0	none performed
Gao- to the Niger border	310.0	2010
Bamako-Sikasso (and to the border heading toward Bobo Dialassou, Burkina Faso)	427.0	2005 - 2008 - 2011
Sikasso- Koutiala	131.0	2000
Koutiala-Bla	89.5	2000
Koutiala-Bamako	406.5	2000
Total	**4,641.0**	

Source: Service des Données Routières. Direction Nationale des Routes. Ministère de l'Equipement et des Transports.
Note : These road improvements include both paved and unpaved roads.

Box 1.
Road Improvements of Relevance to Cereal Production and Marketing Activities

Region of Kayes: Construction and repair of multiple roads across the entire region, such as one connecting the *cercles* of Kita and Bafoulablé (center of strong cereal demand associated with gold mining activities), a connector road from Kita to Kenieba (another center of mining operations) and Saraya (at the Senegalese frontier) and another section from Bafoulabé to Gangountéry, Diamou, and Kayes. The expansion of cotton production and gold mining in the Kayes Region has stimulated the demand for and supply of both cereals and improved roads.

Region of Koulikoro: Improvements in the road linking Dioila, Fana, Bamako; Dioila, Sikasso, Côte d'Ivoire (in place 2 years now); Kolokan, Didieni, Nara, and Mauritania; Kangaba, Bamako; Bamako, Koulikoro, Banamba; Didieni, Diema; and Kangaba, Bamako in addition to a number of rural feeder road improvements in the cotton producing areas of Koulikoro.

Region of Gao: A completely paved road now links Bamako to Gao, with easy connections to the road from many of the production zones in the Segou and Sikasso zones.

A study of the expansion of the cotton sector to the Kita area of Mali in the 1990s does a particularly good job of illustrating the contribution of feeder roads to economic development in general (Koenig 2003 and 2004). The most important improvements during the recent past are listed in Table 1, with a bit more detail about marketing channels affected summarized in Box 1.

Although not strictly a physical infrastructure issue, we must mention two characteristics of transport in West Africa that prevent transport users from realizing the full, cost-reducing benefit of infrastructure investments: unofficial taxes imposed on truckers and the oligopolistic structure of the transport sector. The West African Trade Hub (reports available at http://www.watradehub.com) has been monitoring the number of check points, the cost of bribes, and the amount of time lost per hundred kilometers since the first quarter of 2007 for several major transport routes and West African countries. Although there is an overall trend toward declining numbers in the region, Mali is consistently the country with the highest numbers for check points and the cost of bribes. Compounding the problem of administrative road blocks are the West African transport cartels that operate in an oligopolistic manner, thus contributing to higher than justified transport costs (West Africa Trade Hub 2009; Teravaninthorn and Raballand 2008). The combination of unofficial road taxes and the structure of the transport sector acts as a serious constraint to growth in agricultural production and trade by preventing the full realization of the benefits of infrastructure investments to improve roads. In the absence of alleviating policy changes, both farmers and traders will continue to face unnecessarily high transport costs that limit profits and the competitiveness of their production in regional markets.

3.2. Policy Environment

Before beginning the discussion of what Mali has done in terms of agricultural policies, it is useful to keep in mind three of the most challenging agricultural policy issues that Mali (as well as most other African nations) must address—all challenging because the issues pit the interests of one constituency against those of another. The challenge is to seek policies that

balance these diverse interests in a manner that moves the overall economy forward while not unduly penalizing any particular constituency. These three challenges were mentioned briefly in the introduction to this paper:

1. How to balance consumer demands for low food prices and producer demands for high crop prices;
2. How to balance poverty reduction and productivity growth objectives when designing production incentives such as subsidies;
3. How to design land policies that promote an efficient and equitable balance of family and commercial farms capable of meeting both national food production goals and poverty reduction objectives.

Although Mali has made a lot of progress toward improving the policy environment in which the cereal value chains operate, policy change has not been a smooth ride, with lots of bumps and backsliding encountered along the generally positive path forward. Section 3.2.1 rapidly summarizes the policy situation prior to full cereals market liberalization in the early 1990s and section 3.2.2 deals with the policy environment during the past two decades, with particular attention to the bumps in the road created by the commodity price spikes that occurred in 2007 and 2008. Appendix 1 provides supplementary information in the form of a timeline of policies having had the most impact on the performance of the cereal sector from 1986 to present.

3.2.1. Review of the Policy Environment prior to 1990

The Malian government's participation in cereal markets dates to 1964, when the state created the Office Malien des Produits Agricoles (OPAM) and granted it a legal monopoly on the grain trade. Through OPAM, the government fixed official producer and consumer prices for cereals, with three objectives: increasing rural incomes, providing cheap cereals to urban areas, and extracting a surplus from agriculture to finance other government investments.

Although the private cereals trade was illegal until 1981, OPAM handled only between 20% and 40% of total grain marketed in the country, which represented roughly 3-6% of total production (Humphreys 1986). OPAM's share of rice marketing was much higher than its share of coarse grains, as rice destined for the market was produced largely in government-run irrigation schemes, such as ON.

Up until the mid-1960s, Mali was a net exporter of cereals. During the drought years of the late 1960s and early 1970s, however, Mali had to import large amounts of grain on both commercial and concessional terms. OPAM was obliged to sell the commercial imports at low official consumer prices, which led to an increasing budget deficit. To stimulate cereal production after the drought, the government raised official producer prices without a proportional increase in consumer prices. OPAM was forced to absorb the implicit consumer subsidies, and its cumulative budget deficit reached CFAF 20 billion (US $80 million) by 1976/77, equivalent to three times its annual grain sales (Humphreys 1986).

In March 1981, the GOM agreed to a reform program aimed at increasing producer and consumer prices, liberalizing grain trade, and improving OPAM's operating efficiency. These reforms, embodied in the Cereals Market Restructuring Program (PRMC), used food aid to finance market liberalization. In exchange for a series of proposed reforms, ten major international agencies and donors pledged multi-year shipments of program food aid. The

food aid was sold, with the receipts going into a fund used to finance market restructuring actions agreed to by the donors and the Malian government.

The reforms were founded on the premise that (1) removal of official prices would allow producer prices to rise, creating incentives for farmers to increase production and shift their orientation from subsistence to commercial strategies; (2) opening the market to the private sector would reduce transactions costs and contribute to better balancing of demand and supply over time and space, and (3) lower transactions costs would lead to an increase in the scale and degree of specialization by traders, thereby reducing overall marketing costs and keeping consumer prices low. The full package of reforms was expected to result in more stable markets that served producers and consumers well (Dembélé and Staatz 2002). As we will see in the next several pages, the response to reforms was not always as strong as had been anticipated. Significant progress has been made, but the producer marketing response to the removal of price controls has generally been weaker than anticipated and the question of whether markets are more or less stable since reforms continues to be analyzed and debated.

3.2.2. Review of the Policy Environment after 1990

During the 1990s, Mali pursued the PRMC goals of market liberalization and a gradual withdrawal of government from commercial functions. By the end of the 1990s, OPAM's main roles were to manage the national security stock of cereals and provide facilitating services to the private sector, such as fumigation of grain stocks and market information (Egg 1999; Dembélé and Staatz 2002). The ON, which covers the largest irrigation area of the country, had moved out of rice marketing, input provision, and milling to focus on the provision of irrigation services (Bonneval, Kuper, and Tonneau 2002; Aw and Diemer 2005).

Starting in the late 1990s, reforms were undertaken in the politically sensitive cotton sector, which generates an important share of government revenues. The combination of internal inefficiencies and low world cotton prices had created a crisis situation by 2005. A public tender for the sale of the *Compagnie Malienne de Développement des Textiles* (CMDT) was conducted in 2010, but no final decisions have been made (see, for example, Pulaagu-studio.com 2011). This uncertainty has important implications for the cereal sector because the cotton zone produces the largest share of Mali's marketed coarse grains. Farmers' cereal decisions are intertwined with their cotton production decisions through a complex system of input credit, input supply, and output marketing that is managed by the CMDT (see Tschirley, Poulton, and Labaste 2009 and Kelly and Tschirley 2008 for details).

In 1994, the West African Economic and Monetary Union (WAEMU) devalued the CFA franc by 50%, boosting the competitiveness of Mali's agricultural commodities and further increasing the positive impacts of the PRMC reforms. Mali shares a common currency with eight other West African members of WAEMU. The currency has a fixed parity with the Euro, thus facilitating trade within the zone and with the Euro zone. In contrast, fluctuating exchange rates between the CFA franc and currencies of non-WAEMU countries (such as Ghana, Guinea, Nigeria, Mauritania, and Liberia) hinder trade and monetary transfers with others. Also, several of the commodities that Mali either purchases (e.g., fertilizer, Asian rice) or sells (e.g., cotton) are traded in US dollars, thereby subjecting farmers to price volatility related to exchange rate movements between the US$ and the Euro.

Since 2000, there has been increased attention to regional trade, particularly for cereals and livestock, stimulated by the introduction of common tariffs throughout the WAEMU zone and efforts to extend them to the entire Economic Community of West African States

(ECOWAS). Within this regional framework, Mali has developed what is generally viewed as a market-oriented agricultural development policy open to regional and world markets (with a few notable exceptions discussed in the next paragraph). The overall policy is shaped by four policy documents (see Appendix 2) that include (1) a poverty reduction strategy (*Cadre Stratégique pour la Croissance et la Réduction de la Pauvreté* – CSCRP) providing the overall framework for public investments to promote economic growth and poverty reduction; (2) a long-term vision for the agricultural sector (LOA), based on the promotion of a sustainable, modern and competitive agricultural sector comprised primarily of family farms; (3) a national food security policy (SNSA), which addresses food security through broad-based agriculture-led economic growth and the creation of market-compatible social safety nets; and (4) a national plan for priority investments in agriculture (PNIP_SA), focusing on four cereal value chains (rice, maize, millet and sorghum), inland fisheries and livestock products (meat and dairy). The PNIP_SA also calls for investments in improved land tenure, natural resource management, and irrigation/water management. National policies are coordinated through the ECOWAS regional agricultural policy known as the Economic Community of West African States Agricultural Policy (ECOWAP), which calls for a 6% annual increase in agricultural production and promotes joint actions to (1) improve key value chains (maize, rice, roots and tubers, and animal products), (2) improve the overall policy environment for growth and trade within the region, and (3) develop innovative tools to deal with food social safety nets and food crisis prevention.

In general, Mali has been pursuing the market-oriented goals outlined in these documents. One exception, however, has concerned rice imports. Because of the political sensitivity of rice prices for Malian consumers, the GOM has long maintained a policy of controlling imports by restricting import licenses to a limited number of traders and moderating prices by adjustments in import duties and value added taxes. Since 2007, however, the advent of rapidly rising world prices for food and inputs elicited some additional exceptions to the general pursuit of market-oriented policies:

- *Trade barriers:* Many of Mali's ECOWAS trading partners have per capita incomes higher than those in Mali, raising fears that Malian consumers could be hurt by cereals flowing to countries with greater purchasing power. This has led the GOM to strongly suggest, but not officially mandate, that traders refrain from exporting cereals when they see prices rising. Because an official trade ban would contravene ECOWAS agreements, more subtle tactics (e.g., the forms required for declaring exports not being available to traders) are used to effectively ban trade through official channels. These unofficial administrative barriers do not stop trade but they significantly increase transactions costs and opportunities for corruption at border crossing.
- *Input subsidies:* In 2008, Mali launched a rice initiative to stimulate domestic production of rice through input subsidies and government guaranteed credit; the program was expanded to maize, wheat, millet/sorghum 2009.
- *Leasing land to foreign developers:* Mali has been in the forefront of African nations offering long-term land leases to foreign entities (both government and private) so they can develop large-scale commercial farms, seemingly contravening the LOA commitment to support family farms. According to a recent study (Oakland Institute 2011), there are 545 thousand hectares in the *Office du Niger* that have been leased out or for which leases are being discussed; 22 investors/ leaseholders are involved (of which 16 are non-Malian). The investors are expected to develop the irrigation infrastructure in exchange for benefits such as long-term tax exemptions, with very imprecise contract terms concerning where the

production will be marketed (i.e., Mali or elsewhere) and compensation to those currently living on the land.

Thus, while the overall stated economic policies of Mali are market-oriented, there remain strong concerns among policy makers that unchecked market forces represent a potential danger or are insufficient to increase production and incomes as rapidly as needed. Poor urban consumers, in short, represent a serious political concern for the GOM and that concern often determines policies that affect cereal markets.

Given our focus on the potential for improvements in both rice and coarse grain markets to lift rural families out of poverty, the following lesson from the PRMC experience is informative. Despite the overall success, production of traditional coarse grains (millet and sorghum) – which are grown under rainfed conditions, with fewer improved technologies, and often in places where the basic transportation infrastructure is weak—grew at less than 3% per year from 1980-1997, compared to a 9% annual growth rate for rice and 12.5% growth for maize (Dembélé and Staatz 2002). The contrast between the large positive impact of policy reforms on rice and maize production and its less perceptible impact on millet/sorghum production illustrates the need to foster synergies to elicit strong agricultural productivity growth. Attention must simultaneously be directed at technology development, strengthening and reform of institutions governing production and marketing, and macro-economic policy reforms. The marketing reforms in the ON were effective largely because farmers in the zone had the technical capacity to respond quickly by intensifying production and the GOM was investing in both irrigation and roads. Similarly, extension services and input supply provided by the CMDT in the cotton zone encouraged the surge in maize production. The weak growth in millet/sorghum production was entirely through area expansion. Yields of both crops actually declined, reflecting Mali's lack of attention to extension and input supply for millet/sorghum producers.

Although trade agreements, market reforms, improved infrastructure, and other structural changes stimulated by government policies and investments have improved cereal supply in Mali during the past 20 years beyond the initial accomplishments of the PRMC, problems persist. Most of these problems are due to structural problems in coarse grain production and transportation in Mali that contributed to weaker growth in the coarse grain sector than in the rice sector. According to a 2002 Dembélé and Staatz analysis, these problems included:

- Instability of rainfed millet and sorghum production that contributes to instability in market supply and prices.
- Poor transport infrastructure and unofficial road taxes that persist throughout the West African region, limiting access to cereals and contributing to local market instability.
- Persistent poverty that limits access to cereals for an important share of Malian consumers.

More recently added to this list are the issues of private development of land in the *Office du Niger*, mentioned above, and the unpredictability of government policies regarding export restrictions. The latter discourages private traders from investing in market infrastructure and from holding long-term grain inventories. Recent long-run climate forecasts also suggest that higher temperatures could exacerbate a rainfed cereal production system that is already exhibiting a high level of production instability.

3.3. The Price Environment

The previous sections have alluded to the commodity price hikes that have had an important impact on GOM cereal marketing policies in the recent past. In this section, we describe cereal price trends from the early 1990s to present, looking at nominal and real price levels and price variability. Over time, price trends and performance indicators are often responding to policy and or climatic events, which were numerous during the period under study.

Highlights include:

1994 Devaluation of the FCFA;
2000 Implementation of new regional trade agreements; cotton boycott, and a generally poor agricultural season;
2002 Côte d'Ivoire political crisis, which cut Mali off from its principal port (Abidjan) and resulted in the repatriation of thousands of Malians from the Côte d'Ivoire;
2002 Poor agricultural production;
2004 Locust attacks and drought that significantly reduced harvests;
2007 Rapidly rising consumer food prices that continued through 2008;
2008 Cotton boycott (smaller scale than in 2000) and introduction of the fertilizer subsidy program called *Initiative Riz.*

Figure 2 graphs the average annual consumer price trends in both nominal and real terms for Mali's principal cereals from 1993 through 2010.[6]

Figure 2. Consumer Price Trends for Cereals: Bamako/Niarela Market

A. Nominal Prices B. Real Prices

Source: Compiled by authors using *Observatoire du marche agricole* (OMA) price data and the ILO general consumer price index for Mali (base year 2000).

[6] Unless otherwise noted, real prices throughout the report are deflated using the monthly general consumer price index reported by the International Labor Organization, Table B9, Consumer prices, general indices, 2000 =100; extracted on July 30, 2011.

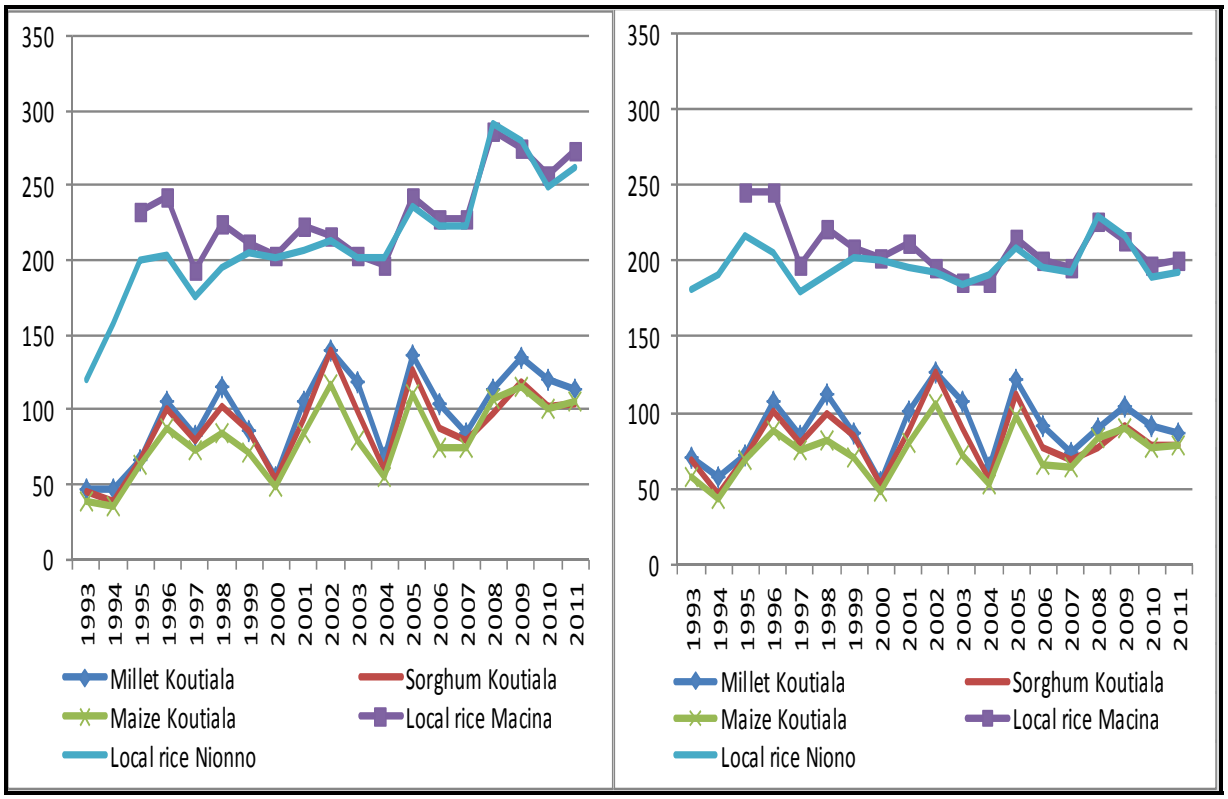
The graphs show that:

- Prices of all domestic cereals moved in tandem, exhibiting approximately the same peaks and valleys by year, but the size of the inter-annual changes were generally greater for coarse grains than for rice.
- Since 2000, millet prices have tended to be the highest prices among the coarse grains and maize the lowest prices.
- Before 2005, local rice prices were generally lower than imported rice of roughly equivalent quality; but since 2005, prices for local rice have been equal to or higher than the imported equivalent.

Over the 18 year period, a linear time line shows that nominal prices increased at an average rate of 8.6 FCFA/kg/year for local rice and 5.8 FCFA/kg/year for millet (used as a proxy for all coarse grains); real prices increased at a slower rate of 1.4 FCFA/kg/year for local rice and 2.2 FCFA/kg/year for millet, despite the much stronger growth in demand for rice. Rapid productivity growth and declining unit costs of production for rice were important factors contributing to the lower rate of price increases (Bonneval, Kuper, and Tonneau 2002; Aw and Diemer 2005).

Figure 3. Producer Price Trends for Cereals: Koutiala, Macina, and Niono

A. Nominal Prices B. Real Prices



Source: Compiled by authors using *Observatoire du marche agricole* (OMA) price data and the ILO general consumer price index for Mali (base year 2000).

Figure 3 shows the nominal and real trends for producer prices for coarse grains in the Koutiala market of the cotton zone and for local rice in both the Macina and Niono markets in the *Office du Niger*. Comparisons of millet prices in Koutiala with those of other major supply markets (e.g., Bankass and Monimpébougou) confirmed that the patterns and price levels are similar.

The overall producer price patterns are similar to consumer price patterns with the following differences:

- Estimated coefficients on the linear trends for both nominal and real producer prices are smaller than those for consumer prices;
- The coefficient on the real producer price for rice in Niono is very small (0.5) while that in Macina is negative (-1.6 FCFA/kg per year on average); continued increases in production and marketing of rice in the face of declining prices suggests that farmers have been able to reduce production costs per kg and maintain incomes despite lower real prices; but there is evidence that not all farmers are realizing these benefits (see Section 5);
- Rice prices between the two main markets in the *Office du Niger* are tracking each other more closely since the early 2000s, than previously; this suggests better market integration.

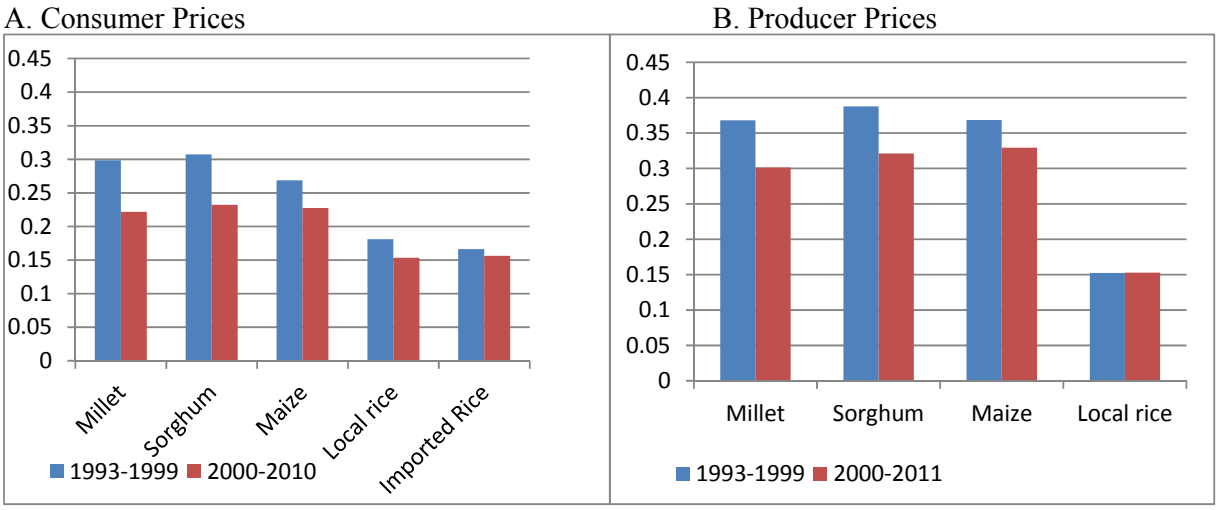
A major concern in recent years has been price volatility at both the consumer and producer levels. An analysis of the coefficients of variation (CV) within each year and for each cereal indicates that seasonal price variability peaked in 1995 (the year following the devaluation that increased cereal demand from neighboring countries and saw some substitution of coarse grains for rice) and again in 2005. The volatility in 2005 was likely a response to poor harvests in 2004 that depleted stocks, making the markets thinner; changing purchasing power may also have had an influence. Nigerian production was particularly hard hit in 2004/05, putting regional demand pressures on the Malian market. Prior to 2000, sorghum had the highest variability in five of the seven years; since 2000 the seasonal variability for maize and millet has exceeded that of sorghum in most years.

A second way of looking at price variability is across years. Figure 4 compares the CV calculated using the underlying monthly observations for consumer and producer prices for two periods: 1990-1999 and 2000-2010. Despite the popular belief that Mali's greater integration into regional and world markets has increased volatility, these CV suggest lower variability since 2000 for every crop, with considerably less variability for rice than for coarse grains. The reasons for the reduced variability require analyses of different market interventions (e.g., OPAM and other institutional purchases, import tax policies); but proponents of regional integration of West African cereal markets have argued that because regional production levels are less volatile than country-specific levels, regional integration should reduce price volatility at the national level through spatial and temporal arbitrage (Badiane 1998, for example). Although the comparison of CVs for these different time periods suggests declining volatility, it is unlikely that the average consumer looks at price changes from such a long-term perspective and may therefore be inclined to perceive greater variability than that suggested by these analyses.

The producer-price CVs are uniformly higher than the consumer CVs—a commonly observed relationship in agricultural markets throughout the world. Some observers, however, have suggested that government policy may contribute to part of the difference given that GOM policies have historically been aimed more at stabilizing consumer prices when they start to rise rapidly than toward stabilizing producer prices when they drop due to

an abundant harvest (Diarra and Diallo 2011). Although OPAM is expected to play a role in stabilizing prices after harvest, it frequently does not get the funding in time to effectively perform this role when harvests are abundant.

Figure 4. Coefficients of Variation for Consumer and Producer Prices



Source: Compiled by authors using *Observatoire du marche agricole* (OMA) price data.

4. NATIONAL TRENDS IN CEREAL DEMAND AND SUPPLY: 1990 TO PRESENT

4.1. Changing Consumption Patterns and Cereal Demand

Rapid demographic growth and the rural-urban transition are the most important factors driving cereal demand in Mali. Preliminary results from the 2009 national census showed that Mali was growing at 3.6% per year. Estimated to have a total population of 14.5 million in 2009, one in three who lived in urban areas, Mali's projections of total population growth range from more than doubling by 2035 to as much as trebling (to 33.9 million) depending on assumptions about the fertility rate (World Bank 2010). By 2035 the rural and urban shares of the population will be approximately equal. This rural-urban transition has important implications for the composition of cereal demand.

A recent analysis by ReSAKSS (2010) of data from two nationally representative budget/consumption surveys (1989 and 2006) illustrates changes in consumption patterns in terms of expenditure shares. Although expenditures do not provide precise information about changes in quantities of products consumed, the Regional Strategic Analysis and Knowledge and Support System (ReSAKSS) analysis reveals the general direction in which demand is moving for different cereals and cereals versus other food products.[7]

As populations become financially better off, we anticipate a decline in the share of income spent on food: this decline is strongly evident at the national level, with food expenditures declining from 50% to 42% over the 17 year period. The decline was much sharper, however, for urban households (45% to 34%) than for rural households (53% to 50%). Looking at the food expenditure shares by income group, we find the lowest income quintile using 57% of their expenditures for food in 2006 while the wealthiest quintile now spends 32% on food.

The overall share of cereals in total food expenditure barely changed, increasing from 39% in 1989 to 40% in 2006. A closer look at Table 2 suggests that the relatively stable expenditure shares for cereals may be the result of sharp increases in rice consumption (a more expensive cereal) by both urban and rural populations.

Table 2. Food Expenditure Shares for Cereals

Product	1989			2006		
	Urban	Rural	National	Urban	Rural	National
Sorghum	5.4	11.4	9.3	3.2	7.6	5.7
Rice	16.0	9.2	11.5	20.3	17.3	18.6
Millet	6.4	17.8	13.9	6.7	15.6	11.8
Maize	1.6	4.2	3.3	2.6	4.9	3.9
Wheat	1.9	0.5	1.0	0.3	0.2	0.2
All cereals	31.3	43.1	39.0	33.1	45.6	40.2

Source: Compiled from data in ReSAKSS 2010.

[7] The ReSAKSS report rarely mentions the level of statistical significance for the various differences described across years and food groups. When queried on the issue, the authors stated that most, if not all, differences were statistically significant given the sample design and size.

A 2004 study of Malian rice demand and supply (past patterns and future projections) also highlighted the strong growth in demand for rice (Baris and Zaslavsky 2004). Aggregate per capita consumption data from the FAO Food Balance Sheets (FBS) reveals moderate increases over time in per capita consumption of cereals. Compared to the late 80s and early 90s, per capita rice availability increased while that of millet and sorghum declined.

National supply of consumable rice doubled from 27 kg per person in 1989 to 54 kg per person in 2007, while maize available for food consumption increased by 39% from 17 kg in 1989 to 24 kg in 2007. Although the overall supply of maize has been increasing, FAO reports that maize available for food has been declining steadily since 2004 when it reached 30 kg per person (FAO FBS data). The downward trend in maize consumed as food is consistent with the general trend of increased demand for rice versus coarse grains, which are more difficult and time-consuming to prepare. Recent estimates of the maize demand for animal feed are roughly 70,000 MT/year (50,000 MT for poultry and 20,000 MT for other animals) (Temé et al. 2010; Diallo 2011). This estimated growth is not sufficient to account for the difference between increasing production levels and FAO's estimate of decreasing human consumption, so better production, consumption, and trade statistics may be needed to fully understand what is happening with maize. Nevertheless, estimates for continued growth in total maize demand are robust at 10-15% annually, with demand expected to reach one million tons in the next 5-10 years, putting significant pressure on maize markets, which are not as well organized as they need to be to deal with such an increase (Temé et al. 2010; Diallo 2011).

As income increases, we would expect a shift away from staples like cereals to meats, vegetables, and dairy products. This shift is not yet apparent in Mali's expenditure data (Table 3). The major increases in expenditure shares for non-cereal products were for sugar and other sweets (shares almost doubling from 3.2 to 6.3%) and for dairy and fats/oils (both increasing shares by 1%). Despite significant increases in fruit and vegetable production since the mid-1990s, there is a sharp decline in the expenditure share going to fruits and vegetables (from 12% to only 7.2%). This reduction may be the result of increased supply

Table 3. Food Expenditure Shares for Non-cereal Products

Product	1989			2006		
	Urban	Rural	National	Urban	Rural	National
Tubers	1.7	0.9	1.2	3.0	1.0	1.9
Fruits/Vegetables	12.8	11.6	12.0	5.8	8.2	7.2
Pulses	4.7	8.5	7.2	8.4	4.4	6.2
Fats/Oils	4.4	2.7	3.3	4.9	3.8	4.3
Meat/Poultry	15.1	6.9	9.8	13.0	7.5	9.8
Fish	6.0	5.6	5.8	5.3	5.5	5.4
Dairy/Eggs	3.1	3.3	3.2	4.5	4.0	4.2
Sugar/Sweets	5/0	2.3	3.2	6.4	6.3	6.3
Other Foods	15.9	15.0	15.4	15.6	13.7	14.5

Source: Compiled from data in ReSAKSS 2010.

Table 4. Change in Cereal Shares 1986 to 2006, by Expenditure Quintile

	Expenditure Quintile					
Product	1(poorest)	2	3	4	5	Total
	(% change)					
Coarse Grains	-17.7	-17.2	-13.9	-16.7	-25.5	-19.2
Rice	70.8	56.6	81.4	53.1	56.7	61.7
Total Cereals	-4.6	-0.9	7.6	4.5	5.6	3.1

Source: Compiled from data in ReSAKSS 2010.

and lower costs rather than reduced consumption.[8] Or, as hypothesized by ReSAKSS (2010), much of the increased supply may go to regional rather than national markets—a result of the free trade zones established in the region—forcing domestic prices up and consumer demand down.

A comparison of the percent changes in cereal shares by expenditure quintile illustrates that the pattern of declining coarse grain and rising rice consumption is constant across income groups but of very different magnitudes for some quintiles (Table 4).

The share of expenditures on purchased food products has increased (from 71 to 81% nationally, and from 58 to 71% in rural areas), confirming the growing importance of markets in ensuring food security. The increased reliance on markets was fairly consistent across expenditure quintiles, with the exception of the 3rd quintile, whose share of purchases increased by only 8%, while those of the other quintiles increased by 14-15% (Table 5).

Table 5. Shares of Purchased Food Products by Region

	1989			2006			% increase in purchases 1989 to 2006
Region	% of food purchased	% of food home produced	% other sources	% of food purchased	% of food home produced	% other sources	
Kayes	71.2	26.0	2.8	77.4	21.8	0.8	8.7
Koulikoro	65.5	25.8	8.7	75.8	23.9	0.3	15.7
Sikasso	58.9	39.1	2.1	65.8	33.4	0.8	11.7
Segou	67.7	30.0	2.3	78.8	20.5	0.6	16.4
Mopti	61.6	35.5	3.0	85.4	14.1	0.5	38.6
Tombouctou	76.4	20.8	2.8	82.7	16.1	1.3	8.2
Gao	78.0	19.0	3.0	87.6	12.3	0.1	12.3
Kidal				93.0	6.5	0.5	Not Av.
Bamako	98.7	0.8	0.6	98.8	0.8	0.4	0.1
Total	71.7	24.9	3.4	81.4	18.0	0.6	13.5

Source: Compiled from data in ReSAKSS 2010.

[8] The problem with expenditure data is one cannot say with certainty whether the physical quantities of particular products consumed increased or decreased.

The geographic distribution of purchasing patterns has not changed over time, with the lowest share of food purchases recorded in the regions where most of Mali's cereal supply originates (Segou, Sikasso, and Koulikoro). Nevertheless, even these regions increased their share of purchases (by 11 to 16%), reflecting a growing tendency for farm families to purchase foods that diversify their diet beyond home grown crops.

Estimates of marginal propensities to consume cereals using the 2006 expenditure data (Table 6) confirm that Malian consumers follow anticipated patterns, with wealthier households exhibiting negative propensities for coarse grains and very low positive propensities for rice (0.25%) and wheat (0.13%). The 4th income quartile (the next to the richest group) still exhibits a relatively strong propensity to consume rice (9.25%), but the propensities for other cereals are very low or negative. This means that about 40% of the population is not likely to increase consumption of coarse grains in the future, so demand for these products will need to come primarily through population growth from the lower income quartiles and perhaps increased urban demand for processed coarse grain products that require less preparation time. The most important demand for coarse grains, however, will probably be growth in demand (particularly maize and sorghum) for animal feeds that is stimulated by growth in consumer demand for poultry, eggs, and dairy products. These consumption patterns also suggest that for the high-income group, there may be some cereals that are inferior goods; if so, this could permit self-targeting some staples to the poor in future safety-net programs.

As noted earlier, our understanding of the indirect maize demand is currently weak, with no systematic statistics collected on the use of coarse grains in animal feed for dairy cattle in peri-urban areas and for poultry/egg production. The Temé et al. (2010) estimates of maize demand for animal feed (70,000 MT/year) represent 9 % of total maize production while FAO food balance data (see Figure11 below) suggest that up to 150,000 tons of maize and 350,000 tons of coarse grains are going to animal feed (roughly 10-12% of coarse grain production). The Mali Poultry Development Project (PDAM) reports that the production of day-old chicks for meat and egg production more than doubled from 2001 to 2009 (522,200 to 1,356,900 chicks); this may be the best available indicator of growth for the poultry sector.

For the vast majority of rural and urban households, cereal consumption expenses remain high as a proportion of total food expenditure, particularly for low-income households and the many rural households who are net buyers of cereals (estimated to be roughly 30% of farm households in recent survey data; see Section 5). There is also evidence of increased consumer reliance on markets for cereals, with a larger share of cereals consumed in 2006 being purchased rather than home produced. Reductions in the market prices of cereals can therefore be expected to have a strong, positive poverty reduction effect for consumers.

Table 6. Marginal Propensities to Consume Cereals by Expenditure Quintile: 2006

	Expenditure quintiles				
Product	1	2	3	4	5
Sorghum	5.12	4.15	1.77	-0.66	-0.13
Rice	14.22	10.52	12.2	9.25	0.25
Millet	8.8	1.96	9.18	2.07	-0.08
Maize	1.21	2.94	1.37	0	-0.03
Wheat	-0.2	-0.02	0.17	0.14	0.13

Source: Compiled from data in ReSAKSS 2010.

Given the relatively concentrated nature of cereal sales (roughly 60% of net marketed volumes are sold by just 20% of farmers), those who will support the negative consequences of lower prices will generally be those with the greatest production, sales, and productive assets who are better able to maintain incomes through expansion of production (see Section 5 for recent survey results on the characteristics of farms that are net sellers of cereals).

4.2. Changing Production Patterns and Cereal Supply

Since the beginning of the 1990s, cereal production has grown from 1.9 million tons (three-year average 1990/1 to 1992/3) to 4.1 million tons (three-year average 2006/7 to 2008/9). This is equivalent to an average annual growth rate of 4.4%. Table 7 summarizes changes in area, yield, and production for each of the cereal crops tracked by official government statistics in Mali.

Table 7. Trends in Area, Yields and Production of Major Food Crops: 1990/91 - 2008/09

Part A. Area Cultivated

	Mean Area (ha)		% change in 3-yr average	% Annual Growth
Crop	1990/91- 92/93	2006/07- 08/09		
Millet	1,116,202	1,552,782	39.10%	2.02%
Sorghum	816,379	999,430	22.40%	0.45%
Maize	182,423	391,554	114.60%	4.32%
Rice	230,948	427,639	85.20%	3.75%
Fonio	44,950	43,177	-3.90%	-0.31%
Total cereals	2,392,134	3,418,746	42.90%	1.91%

Part B. Yields

	Mean Yields (kg/ha)		% change in 3-yr average	% Annual Growth
Crop	1990/91- 2/93	2006/07- 08/09		
Millet	662	797	20.60%	1.34%
Sorghum	797	901	13.00%	0.86%
Maize	1,181	1,790	51.50%	2.27%
Rice	1,641	2,902	76.90%	3.43%
Fonio	617	766	24.20%	1.26%
Total cereals	840	1,208	43.80%	2.45%

Part C. Production

	Mean Production (tons)		% change in 3-yr average	% Annual Growth
Crop	1990/91- 2/93	2006/07- 08/09		
Millet	736,400	1,239,263	68.30%	3.38%
Sorghum	634,577	899,224	41.70%	1.31%
Maize	215,295	697,243	223.90%	6.69%
Rice	382,244	1,253,289	227.90%	7.31%
Fonio	27,724	32,071	15.70%	0.94%
Total cereals	1,945,811	4,131,173	106.70%	4.41%

Source: *La Cellule de Planification et de Statistique du Ministère de l'Agriculture de l' Elevage et de la Pêche* (CPS) data.

Notes: Fonio (*Digitaria exilis*) is an annual herbaceous plant from the Poaceae family (Graminées) grown for its seeds; it is also known as « hungry rice » in English.

The % annual growth was estimated using a linear trend on the natural logs of the annual values and converting the estimated "b" using (EXP(b)-1)*100.

The series stops at 2008/09 because complete data for 2009/10 is available for only millet and rice. Preliminary data for 2009/10 show a slight decline in millet area and production but a rise in yield; rice area and production increased but yield growth declined.

Data for rice production combine irrigated and lowland production. Rice and maize have shown the most dynamic growth. This rapid growth reflects both area expansion and substantial yield growth. By contrast, production growth for millet and sorghum has been modest, with increased millet production coming primarily from increases in area cultivated, while the area planted to sorghum has declined. While millet and sorghum remain very important staples, particularly in rural areas, paddy production now equals, in total tonnage, that of millet; maize production is 78% that of sorghum. These production trends mirror the changes in demand described above (increasing expenditure shares for rice and declining shares for coarse grains).

Malian rice production has experienced the most spectacular growth among the cereal crops, mainly due to its politically sensitive status. Table 3 shows 7.3% average annual growth in production since 1990, associated with 3.8% average annual area expansion and 3.4% average annual yield increases, fueled mainly by public-led investments in large-scale gravity-fed irrigation infrastructure in the ON and related improvements in the production environment (see Aw and Diemer 2005 for a discussion of productivity growth in the ON and Kébé et al. 2005, Bélières et al. 2002, or Bélières et al. 2011, which questions the sustainability of that growth).

For two decades, maize has experienced the fastest growth of the rainfed coarse grain cereals, with production increasing from about 200,000 tons in 1991 to close to 700,000 in 2009. Pressure on the CMDT to refocus its mission on cotton has made it more difficult for farmers to obtain maize inputs on credit since the early 2000s (Kelly and Staatz 2006). This has not seriously reduced production, however, which is growing in response to domestic and export demand. Supply has increased due to improved varieties that have increased yields. Fertilizer subsidies in 2009/10 were intended to stimulate increased maize production, but there has been no evaluation of the production impacts of the subsidy program.

From the 1990/91 cropping season through 2008/09, production increased by 68% for millet and 42% for sorghum, compared to 224% for maize and 228% for rice. Annual growth rates for yields were 1.2% for millet and only 0.9% for sorghum, while area expansion averaged 2% for millet and 0.5% for sorghum. Expansion of production of both grains was primarily through increases in the area cultivated rather than intensification—a pattern that will likely be unsustainable in the future as soil quality declines. While some fertilizer-responsive, higher yielding sorghum varieties have been developed (notably by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and collaborative efforts by the USAID-funded INTSORMIL program), their adoption remains limited. Based on past experience, the scope for widespread intensification of the production of millet and sorghum and their conversion into major cash crops seems much more limited than for maize or rice. Millet generally shows low fertilizer response, and while there are more productive new sorghum cultivars, less-than-vibrant market opportunities (as indicated by decreasing per capita consumption of sorghum) may constrain their widespread adoption.

Although fonio shows little positive change in production, area, and yield it is a crop that seems to be evolving from a hungry season crop grown for home production to a cash crop for a small number of farmers in traditional millet/sorghum production zones with relatively unfavorable cereal production climates (see Section 5 for recent survey results on fonio production and sales).

4.3. Imports, Exports, and Food Balances

A major concern of the Malian Government is ensuring that net imports resulting from cereal trade and domestic production provide adequately for domestic consumption needs. In recent years, there has been considerable debate about appropriate government policies to address price spikes that lead consumers to voice their dissatisfaction through mass demonstrations, as happened in Burkina Faso and Senegal in 2007 and 2008. While one needs to be cautious in using official trade statistics for cereals given Mali's multiple and porous borders, Table 8 suggests that there is no clear trend in imports or exports since 2000 but rather a series of ups and downs in response to production and trade policies.

The salient characteristics of Mali's cereal trade since 2000 include:

- High levels of imported broken rice from Asia (peaking in 2005 and 2009) to satisfy the demand of cash-constrained consumers who cannot afford Malian rice.
- High levels of imported wheat ('other' category in the Table), peaking in 2006, and declining thereafter.
- Exhibited potential to export coarse grains to regional partners from 2000-2001 and 2004-2006; since 2007, GOM concerns about perceived shortages have made exporting politically difficult for private traders.

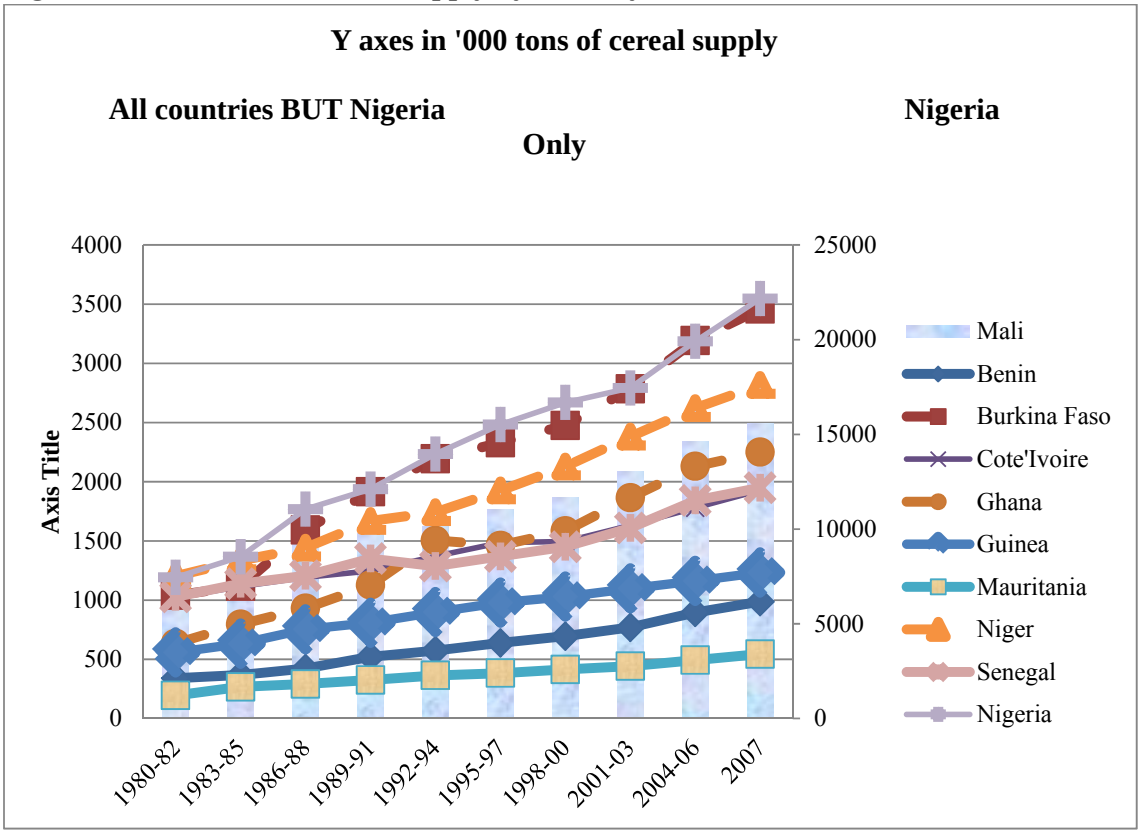
Table 8. Cereal Trade: 2000 - 2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Imports	(Import & Export quantities in '000 tons)									
Total Rice	**51.970**	**82.763**	**202.815**	**186.675**	**105.390**	**272.372**	**180.208**	**137.143**	**165.716**	**278.166**
Share broken rice	70%	57%	47%	55%	56%	51%	61%	55%	55%	42%
Total Coarse Grains	**0.077**	**1.124**	**8.679**	**3.040**	**6.694**	**14.684**	**4.254**	**0.554**	**2.132**	**0.772**
Share maize	100%	100%	100%	99%	53%	100%	50%	95%	100%	100%
Share millet	0%	0%	0%	0%	13%	0%	49%	4%	0%	0%
Share sorghum	0%	0%	0%	1%	34%	0%	1%	1%	0%	0%
Total Other Cereals	**26.878**	**36.513**	**29.813**	**39.582**	**21.114**	**84.299**	**115.329**	**61.299**	**41.884**	**49.134**
Share wheat	100%	100%	100%	100%	100%	100%	99%	68%	100%	100%
Total Cereals	**78.925**	**120.399**	**241.306**	**229.297**	**133.197**	**371.354**	**299.791**	**198.995**	**209.732**	**328.071**
Exports	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Rice	0.159	0.000	0.203	0.411	0.000	0.223	0.000	0.000	0.000	0.001
Coarse Grains	38.916	57.306	8.462	0.195	33.935	14.243	32.990	3.410	1.033	10.556
Other cereals	0.002	0.033	0.012	0.012	3.144	0.101	11.534	0.038	3.239	0.052
Total unprocessed cereals	39.077	57.339	8.677	0.618	37.079	14.566	44.524	3.448	4.272	10.609
Processed cereals (e.g., flour)	0.375	0.863	2.586	7.947	2.686	0.139	0.102	2.014	0.000	0.086
Grand total	39.452	58.202	11.263	8.565	39.766	14.705	44.627	5.462	4.272	10.695
Net Imports (unprocessed)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Rice	51.811	82.763	202.612	186.264	105.390	272.149	180.208	137.143	165.716	278.165
Coarse Grains	-38.839	-56.182	0.217	2.844	-27.242	0.441	-28.736	-2.856	1.099	-9.785
Other	26.877	36.480	29.801	39.570	17.970	84.198	103.795	61.261	38.645	49.082
Total unprocessed	39.848	63.060	232.630	228.678	96.118	356.788	255.267	195.548	205.460	317.462
Notes: the processed exports are generally some type of flour; there was no flour reported in the import data available.										

Source: Official trade data from INSTAT, Mali's national statistics service.

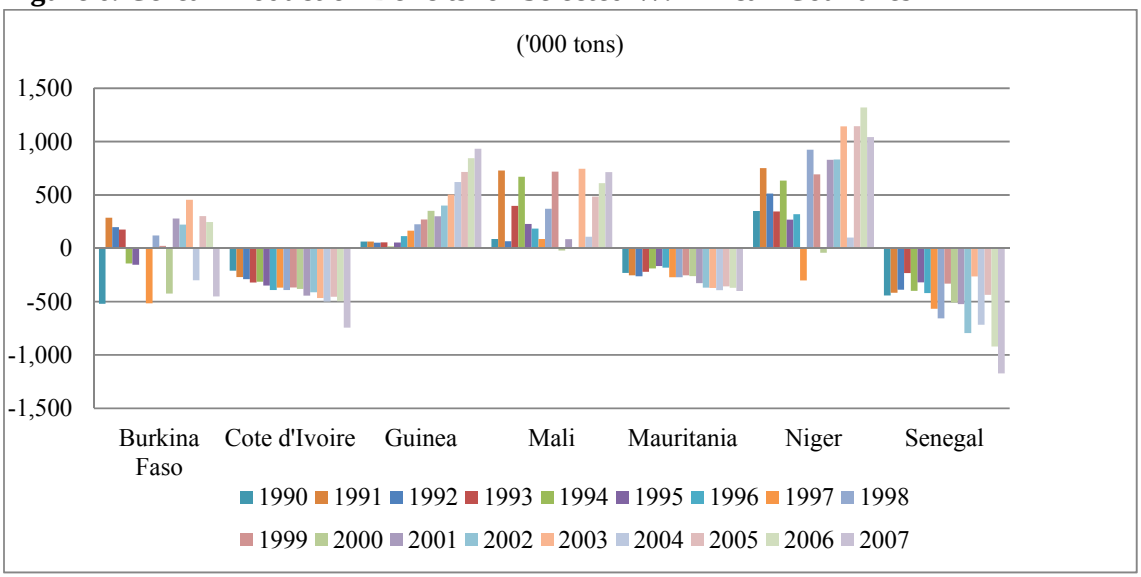
Mali is far from the largest cereal producer in West Africa. Figure 5 shows that Nigeria, (the highest line on Figure 5, with y axis values on the right side of the graph), far surpasses all other countries in volume of total cereal supply. Nigeria accounts for 47% of cultivated land in ECOWAS countries (Blein et al. 2008) and roughly 53% of total ECOWAS cereal production (43% of rice, 68% of sorghum, 40% of millet and 54% of maize) (Konandreas 2011). As a result, Nigerian production surpluses and deficits tend to affect aggregate cereal availability and prices throughout the region. Burkina Faso and Niger (despite recent publicity about recurrent food deficits for Niger) also tend to produce more cereals than Mali. Ghana, Côte d'Ivoire, and Senegal produce less than Mali, but have been at the same general level of production since the 1980s, advancing from levels between 500 thousand and a million tons in the early 1980s to a level of 2 to 2.5 million tons since then. All other countries in the region are considerably below this level. Some of the countries with lower cereal production levels (e.g., Ghana and Côte d'Ivoire) rely heavily on tubers (yams and cassava) for basic food staples. Mali's relatively high cereal production levels plus its proximity to several countries with growing structural or intermittent deficits (Figure 6) provides an opportunity for Malian farmers to significantly increase coarse grain exports.

Figure 5. West African Cereal Supply by Country



Source: Me-nsope forthcoming.

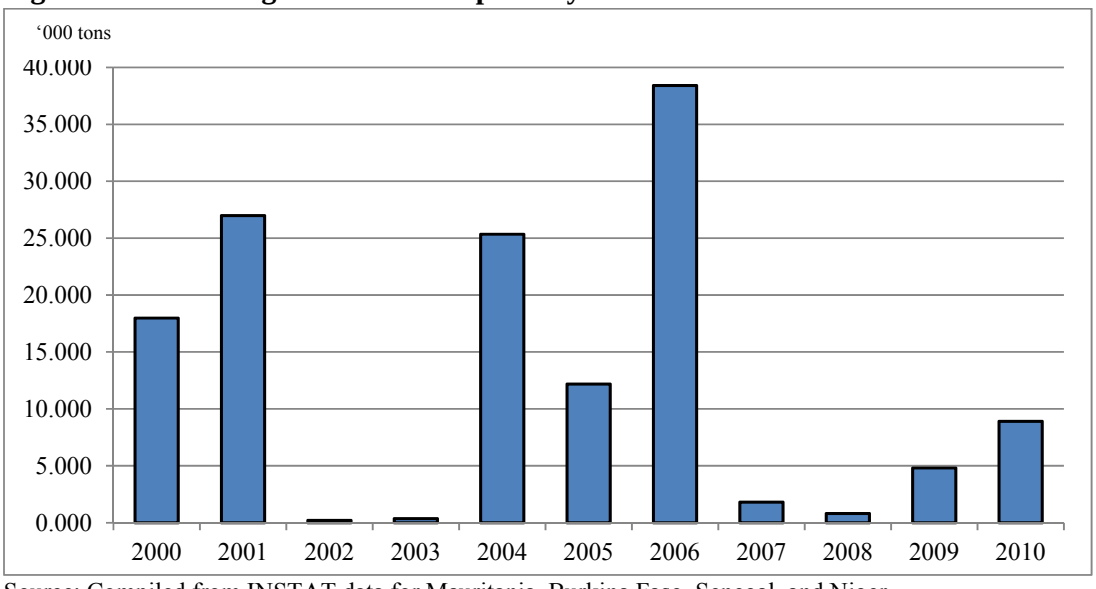
Figure 6. Cereal Production Deficits for Selected W. African Countries



Source: Me-nsope forthcoming.

Figure 7 illustrates some of the recent trends in regional cereal trade with four regional trading partners, while Figures 8A and 8B show the shares by product and by importing country. The relatively large share of exports to Niger is unexpected given that Niger shows only one year of deficit in Figure 6; our hypothesis is that the exports to Niger include cereals that are subsequently exported to other countries (particularly Nigeria) or that are substituting for Nigerien production that is exported to Nigeria. There has been some suppression of this trade since 2006 as Mali tries to maintain low cereal prices through unofficial trade barriers that discourage exports and push traders to pay bribes to get cereals out of the country.

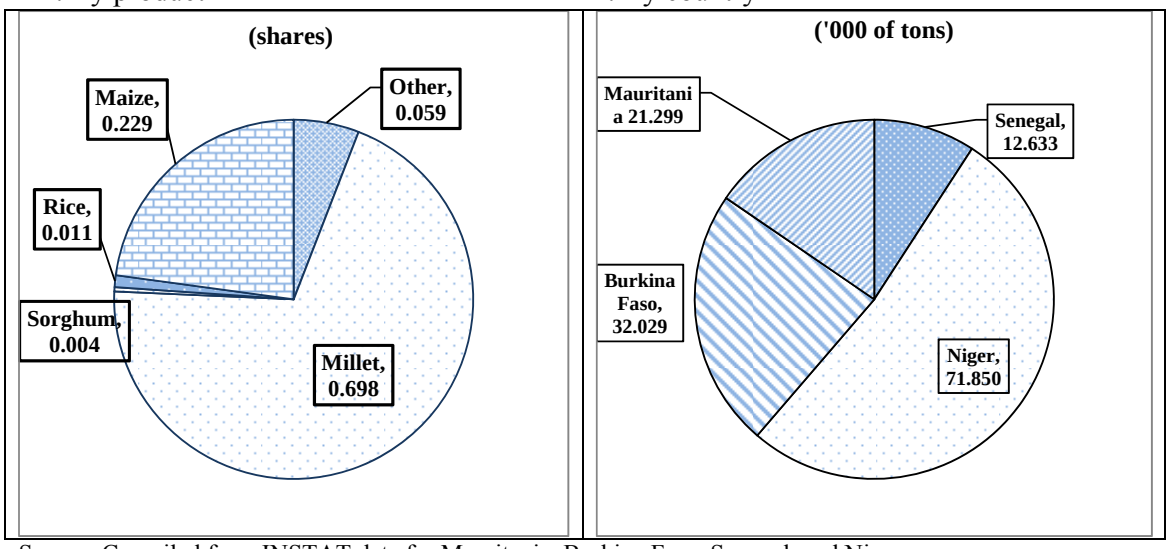
Figure 7. Malian Regional Cereal Exports by Volume: 2000 - 2010



Source: Compiled from INSTAT data for Mauritania, Burkina Faso, Senegal, and Niger.

Figure 8. Regional Cereal Exports by Product and Country

A. By product B. By country



Source: Compiled from INSTAT data for Mauritania, Burkina Faso, Senegal, and Niger.

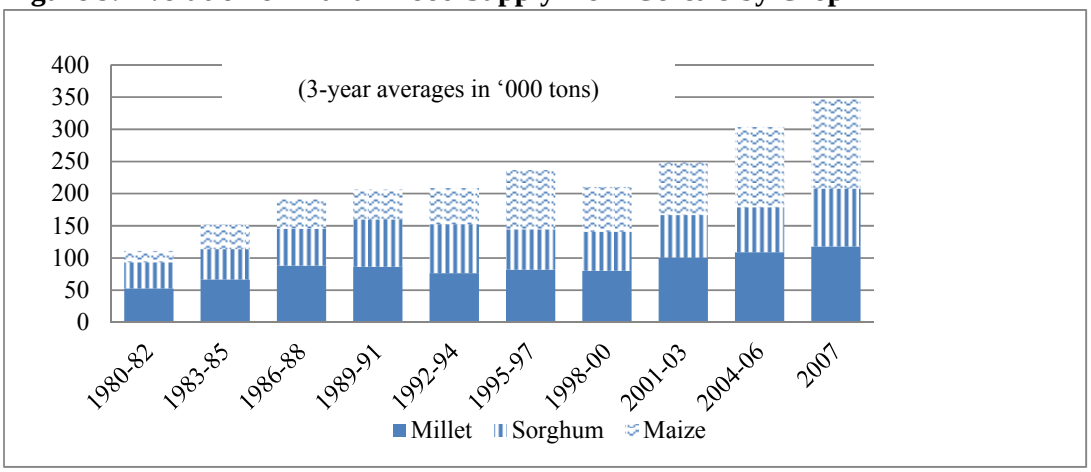
There are documented cases of these trade bans hindering traders from serving deficit areas in neighboring countries such as Senegal and Mauritainia when supplies were more than adequate at Malian export assembly points such as Kayes (Kelly, Dembélé, and Staatz 2008). Senegal and Mauritania are countries that are now and likely to continue being structurally deficit in cereals (producing less than 30% of current needs). As Malian neighbors connected by recently improved road links, they offer important opportunities for cereal exports that could improve incomes of Malian cereal producers who are net sellers. While the GOM decision to prioritize the needs of Malian consumers over those of neighboring countries is politically understandable, the government's ability to accurately assess cereal demand and supply at various points throughout the country and enforce the bans is limited, suggesting that alternatives to trade bans need to be developed (e.g., better safety net programs for domestic consumers and/or more coordination with traders on stock assessments).

Mali is not yet self-sufficient in rice, with net rice imports representing from 60 to 80% of total cereal imports. However, the country has been largely self-sufficient in coarse grains, with exports exceeding imports in six of the ten years covered in Table 4 and imports representing less than 0.05% of total cereal imports each year. Fifty percent or more of the coarse grain imports have been maize. Some of these are seasonal imports for human consumption as maize is harvested earlier in Côte d'Ivoire than in Mali; some are assumed to be inputs for the animal feed processing industry where demand for quality grain exceeds local production. Trade flows tend to reverse later in the year after Mali's maize harvest.

Aggregate cereal supply available for human consumption (referred to as food supply) is a key indicator of national food security. It has been growing regularly over time as illustrated by Figure 9, with one small decline for the 1998-2000 period. Rapid population growth, however, meant that availability per capita remained stable at 183-185 kg/person until 2005, when it increased to 197 kg/person. There was a small additional increase up to 201 kg/person in 2007, the last year for which data are available. Since the mid-1990s, Mali has had higher kcal/capita availability than Senegal and Niger, but lower than Burkina Faso and Mauritania, all of which are cereal trading partners (Figure 10). The high consumption/capita in Mauritania is surprising given the structural deficit suggested by Figure 6; if correct, the

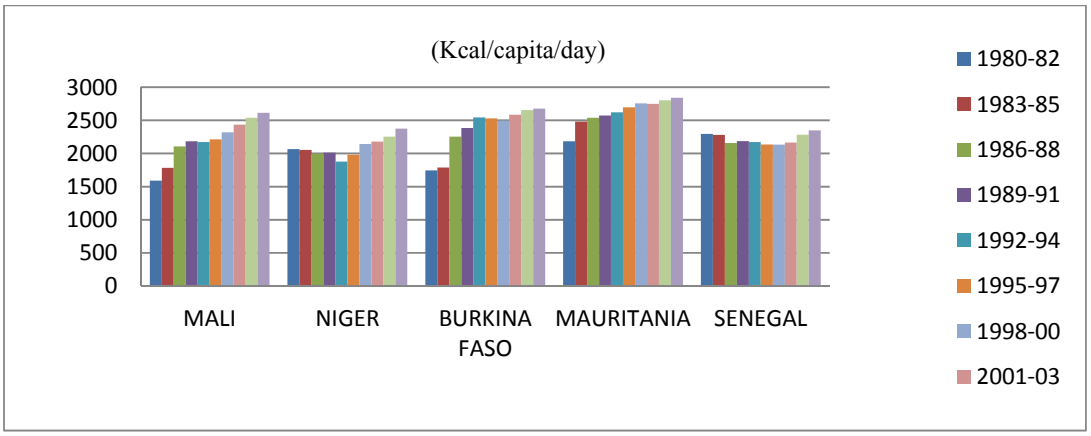
data suggest that Mauritania is doing a relatively good job of managing national food availability through imports. In general, FAO data suggest that cereals available for human consumption represent 80% of total domestic supply (production + imports – exports +/- changes in stocks), with roughly 10-12% going to animal feed, a sector that has been growing rapidly since 2005, as illustrated by Figure 11.[9] Food aid has accounted for less than one percent of Mali's cereal consumption during the past decade with total quantities ranging from 7,000 tons in 2001 to 21,000 tons in 2006 (more recent data not available). Coarse grains account for the bulk of the aid, with rice generally in second place and wheat in third.

Figure 9. Evolution of Malian Food Supply from Cereals by Crop



Source: Me-nsope, forthcoming.

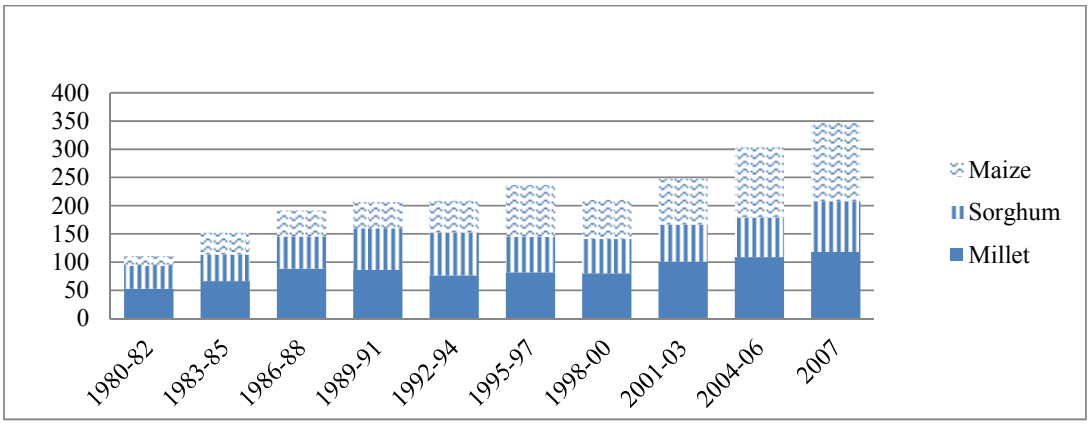
Figure 10. Dietary Energy Availability in Sahelian W. Africa: 1980-2007



Source: Me-nsope, forthcoming.

[9] Note that different data sources estimate different shares of cereals going to animal feed. We have been unable to determine which sources are most accurate so report the various estimates here and in the last two paragraphs of section 4.1.

Figure 11. Evolution of Cereals Used for Animal Feed in Mali



Source: Graphed by authors from FAO food balance data.

5. FARMER'S RESPONSE TO THE CLIMATE, POLICY, AND PRICE ENVIRONMENT: 2006/07 – 2009/10

5.1. Salient Characteristics of the Production and Marketing Environment during the Survey Period

The discussion in the previous two sections shows that both Malian and West African cereal demand has been steadily increasing. Fortunately, the domestic coarse grain supply in Mali has generally kept pace with domestic demand and permitted some limited regional exports. Although rice supply has increased significantly, there continue to be fairly regular imports, which accounted for roughly 15 % of Malian rice consumption from 2007-2009.

Policy measures affecting cereals differ depending on the category of cereal. For rice, the GOM does not intervene directly in markets; but it does use a variety of policies (e.g., adjustments in import licenses and duties or value added taxes) to maintain prices deemed affordable by consumers yet profitable for producers. For coarse grains, the GOM had a relatively hands-off policy from the introduction of market liberalization in the 1980s until 2005, dealing primarily with ensuring adequate national emergency stocks. The poor harvests of 2005 moved the GOM to create and stock a network of locally managed but centrally stocked cereal banks to ensure a minimum level of cereal availability during the hungry season, particularly in deficit zones. When commodity prices began to spike in late 2007, however, the GOM became more interventionist with policies that seriously impeded regional cereal trade, particularly exports from Mali to neighboring countries (Staatz et al. 2008). The export restrictions were coupled with subsidy programs to stimulate increased cereal production, first of rice (2008/09) and then of all cereals (2009/10 and after).

In this section we use recent farm-level survey data to assess how producers in three distinct cereal production zones of Mali responded to these changing policies and prices as well as to a few additional factors (described below) that were more zone-specific in nature.

5.2. Background on the Survey Data

This analysis uses household survey data that was collected by a consortium of three institutions: IER (*Institut d'Economie Rurale du Mali*), CIRAD (*Centre de coopération internationale en recherche agronomique pour le développement*) and Michigan State University. The panel data covers three distinct production zones (millet/sorghum, irrigated rice, and cotton/coarse grains) and three cropping seasons (2006/07, 2008/09 and 2009/10), with a gap between the first and second year. The first year of data was collected as part of the World Bank RuralStruc (RS) research program on the structural transformation of seven economies at different stages of development (Mali, Kenya, Senegal, Madagascar, Morocco, Nicaragua, and Mexico).[10] Consequently, the survey design and approach to data analysis is influenced by rules initially set up to ensure cross-country comparability for RS.

The sample covers six villages selected purposively for each zone for a total of eighteen villages (details below in zone-level discussion). The overall sample included 451 family farm enterprises in 2006/07. Due to attrition and other problems, there were 443 in 2008/09 and 446 in 2009/10. The number of farms in each of the three production zones ranges from

[10] http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:21079721~pagePK:146736~piPK:146830~theSitePK:258644,00.html

143 to 151 (roughly 25 farms per village), depending on the year and the zone. An earlier study using the first year of data from this 3-year panel (Samaké 2008) showed that there is a great deal of heterogeneity among Malian farmers, even those living in the same production zones and the same villages. Although we have captured a large share of this heterogeneity, the findings presented for each zone should be taken more as results of case studies than representative samples of the entire zone.

Despite the limitations of the survey in terms of national representativeness, it provides a particularly good source of information on the role of cereal production and marketing in three of the most important production systems in Mali and across a range of farm types. Consequently, the research offers insights into the opportunities and challenges Mali faces in ensuring food security for its entire population and the contribution that cereal production and marketing can make to poverty reduction in particular farming systems.

The primary sampling unit is the family farm enterprise, which is defined as a group of individuals who are engaged in joint production and consumption activities implemented under the direction of a single patriarch who makes the major production and consumption decisions for the entire group and manages the group's assets (primarily land and agricultural equipment), labor supply, and finances. A family farm enterprise can be a single nuclear family unit or it can be multiple nuclear families (e.g., a father plus all of his unmarried children, all of his married sons and their families, and, perhaps, one or more brothers and their families). The word *household* in this report should be understood as shorthand for the concept of the family farm enterprise just defined.

Households were interviewed once during the first two survey years and twice during the last year. Because using a yearlong recall for the first two years resulted in very long interviews and respondent fatigue, the questionnaire was divided into two sections for the last year with most of the questions about agricultural production for the rainy season covered in the first interview and questions about dry season agriculture, livestock, and non-farm income covered in the second interview. The data set contains the following categories of information:

- Household demographics: age, gender, education, marital status, and whether the person was economically active or not; economically active was defined as participation in productive activities such as crop production, animal husbandry, and nonfarm activities, but excluding housekeeping tasks conducted for one's own family.
- Household assets: ownership of or ensured access to farm land and other real estate; ownership of agricultural equipment, livestock, vehicles, selected household durable goods and indicators of the quality of housing.
- Crop production (cultivated area and production by plot, input use by crop for 2008/09 and 2009/10 (combining all plots of the same crop) and input use by household (combining all plots regardless of crop) for 2006/07; farmers' qualitative assessments of their yields and reasons for good/bad yields;
- Tree crop ownership, production costs, and sales;
- Crop sales (quantities and receipts from all sales by crop);
- Livestock sales, purchases, deaths/losses, births;
- Qualitative questions about the household's food security and well-being asked independently of both the household head and his wife (2006/07 only) and some indicators of levels and adequacy of household cereal consumption (all years);

- Non-farm income (enumeration of net incomes from different activities; some reported at the household level (e.g., agricultural labor and migration remittances) and others attributed to individual members of the household.

We also draw on results from focus group interviews as well as market price data from Mali's national market information service (OMA).

5.3. Research Questions Addressed with Survey Data

Using this data base, we address the following research questions:

- What evidence is there of farm-level supply response to government policies and the changing demand for cereals?
    - Which types of farmers are most responsive and what is the impact on their production decisions and incomes?
    - Which types of farmers are least responsive and what are the factors that limit their response?
- What is the potential contribution of the cereal sector to rural poverty reduction in Mali; how does it differ by zone and farm type?

These questions are asked individually for each of the three production zones covered:

- A zone of rainfed millet and sorghum production supplemented with peanuts, cowpeas, sesame, and fonio[11] located in the *Cercle*[12] of Tominian in the Ségou Region.
- A zone of cotton and coarse grain production located in the *Cercle* of Koutiala in the Sikasso Region where rainfed cotton is grown in rotation with coarse grains and complemented by some rice and horticultural production in *bas fonds* (seasonally flooded lowland areas) for farms having access to this type of land.
- A zone of irrigated rice production in the *Office du Niger* (ON) irrigation scheme located in the *Cercle* of Macina in the Ségou Region; most farmers in the study zone cultivate rainy season rice on land benefiting from gravity-fed irrigation and some are able to supplement that production with rainfed coarse grains and limited amounts of dry-season irrigated production (some rice, but mostly onions and other vegetables).

The discussion that follows presents results reported in a number of more detailed working papers (listed in Appendix 3), where a full discussion of the data and analytical methods is presented. Here, we summarize the key findings of the different working papers as they pertain to each zone. Each zone subsection begins with a general description of the zone based on official documents and other published sources and then uses survey data to describe cereal production, sales, purchases, net cereal marketing positions, and the relationship between selected farm characteristics and the different cereal production and marketing variables. The focus is on understanding the different production and marketing responses to the climate, price, and policy environment faced by farmers during the three survey years. We pay particular attention to identifying the factors that differentiate farmers

[11] Fonio (Digitaria exilis) is an annual herbaceous plant from the Poaceae family (Graminées) grown for its seeds; it is also known as « hungry rice » in English.
[12] Administratively, Mali is organized into Regions, *Cercles, Communes Rurales*, and Villages.

who market cereals from others and households that appear to meet minimum per capita cereal needs from others. Supplementary information is also provided on non-farm and livestock income.

5.4. Traditional Millet/Sorghum Zone: Tominian

5.4.1. General Background on the Zone and Sample Selection

The Cercle of Tominian is located on the northeastern edge of the Region of Segou, with the eastern border of the Cercle running along Mali's border with Burkina Faso. The Cercle covers 6,573 square kilometers comprised of relatively flat land interspersed with cliffs in the north, hills in the south, and a plateau in the center. The climate is soudano-sahelian, with average rainfall about 700 mm/year. Vegetation consists of savannah trees and shrubs, with noticeable degradation. Soils are predominantly sandy loams and easily degraded by wind and water erosion. The Cercle has no permanent water resources (e.g. rivers, lakes) but multiple temporary streams and ponds dependent on runoff from rains.

The villages selected in the *Cercle* of Tominian are located in the central plateau area and represent a high-risk production zone that has not benefited from many investments in infrastructure, market development, or major agricultural development programs.[13] Production in the study zone is largely used for subsistence purposes. Principal cereal crops are millet, sorghum, and fonio with small amounts of maize and rice; cash crops include peanuts, sesame, and cowpeas. Animal husbandry is the second most important economic activity with ownership of beef cattle dominating (roughly one animal for every 2.6 people), followed by goats, then sheep and hogs (*Commissariat à la Sécurité Alimentaire* (CSA) and PROMISAM 2008). The estimated 2009 population of the Cercle was 219,853 and the average annual population growth rate from 1998 to 2009 was 2.9% (official Segou Region population statistics). Ethnically, the Cercle is dominated by Bobo (also known as Bwa) but also includes other groups such as Dafing, Dogon and Fulani. Unlike other survey areas, the Cercle of Tominian lists Christianity as the dominant religion, followed by animism and Islam (CSA and PROMISAM 2008). Among the principal constraints listed in the Cercle's 2008-2012 food security plan (CSA and PROMISAM 2008) were:

- Low rainfall
- Poor distribution of rains over time and space
- Poor soils
- Lack of irrigation infrastructure permitting rice production
- Low levels of purchasing power
- Seasonally impassible roads

The sample comprises six villages located in four of Tominian's twelve communes (see Figure 12 and Table 9). Roughly 33% of the *Cercle* population lives in the four communes covered by the survey. Population growth was much slower than the average in the communes selected for the survey (ranging from 1.1 to 1.9%), with the exception of the commune of Tominian where growth was 2.7%. We believe the slower population growth rates reflect the limited economic opportunities in the study zones and higher levels of outmigration than found in other communes. Three of the six villages were purposively

[13] Part of the Cercle of Tominian benefitted in the 1970s and 1980s from participation in the irrigated rice perimeters associated with Operation Riz Segou; the sample villages selected are not in those areas.

selected to have easy access to markets and three to have difficult access. Ethnically, the sample is fairly homogeneous, with 81% belonging to the Bobo (Bwa) group and the rest a mix of six different ethnic groups. Only 2% of the sample belongs to a caste such as blacksmith or griot; a characteristic that might influence the relative importance of cropping activities and income.[14]

Figure 12. Tominian Cercle and Sample Village Map

Table 9. Millet/Sorghum Sample Villages in Tominian

Village	Commune	Access	Roads	Markets (1st & 2nd)	Distance to 1st Market (km)
Kombori Kouna	Koula	Difficult	Roads cut by water during rains	Bambara/Kouna	12
Bonakuy	Koula	Difficult	Roads cut by water during rains	Sokoura/Fangasso	20
Kouara	Yasso	Easy	Laterite road	Yasso/Sanké	8
Manina	Bènèna	Difficult	Roads cut by water during rains	Bènèna/Mandjakoui	10
Dobwo	Bènèna	Easy	Laterite road	Bènèna/Mandjakoui	18
Séoulasso	Tominian	Easy	Paved road	Yasso/Tominian	12

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

[14] Praise singers (griots) and blacksmiths in rural Mali often rely heavily on these activities for income and pursue farming as a secondary activity. In general, there were too few observations for us to do any analysis of the role played by membership in these castes.

Table 10. Factors Expected to Influence Livelihood and Income Strategies: Tominian

Factor	Factor details	2006/07	2007/08	2008/09	2009/10
Rainfall	mm/days	557/44	732/40	641/41	452/35
			FCFA		
Prices *	Millet	82	111	126	116
	Sorghum	77	97	115	104
	Urea/NPK				12,500/12,500
Policies	(1) Since the mid-1960s, farmers in the zone are on their own for input acquisition. (2) Skyrocketing commodity prices in late 2007 and continuing to 2008 increase need for income to purchase cereals in this cereal deficit zone. (3) Not clear if subsidized fertilizer available in the zone, but little reported use among survey participants.				

* Cereal prices are producer prices in FCFA/kg; fertilizer prices are FCFA/50 kg bag.
Source: Rainfall data from Malian meteorological service via *Système d'Alerte Précoce* (SAP). Cereal prices from OMA market data for San. Fertilizer prices from official documents and/or survey data. Policies from various government documents.

Table 10 summarizes zone-specific information on climate, prices, and policies thought to have influenced farmer livelihood and income strategies during the survey period. Poor access to subsidized fertilizer and poor rains in 2009/10 are expected to be important factors affecting farmer behavior.

5.4.2. Farm Characteristics and Cereal Production and Marketing Behavior: Tominian

Millet and sorghum each represented about 42% of cereal production in Tominian but with inter-annual variations (Table 11).

The only other cereal of note is fonio[15], which represented 12-15% of production. In terms of cereal production per capita, Tominian is the lowest of the three zones with an average of 191 kg/capita, roughly 90% of the 214 kg/capita recommended for food security. This shortfall suggests that the zone was in a deficit position, needing to import some cereals from other zones each of the survey years.

Table 11. Tominian Cereal Production

	Cereal Production			
	2006/07 (n=151)	2008/09 (n=149)	2009/10 (n=151)	Average
Crops			(% of total cereals)	
Rice	0	1	1	1
Maize	1	1	1	1
Sorghum	37	43	47	42
Millet	50	41	36	42
Fonio	12	14	15	14
		(kg/capita)		
Total coarse grains	186	171	141	166
Total Cereals	208	199	167	191

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

[15] Fonio (Digitaria exilis) is an annual herbaceous plant from the Poaceae family (Graminées) grown for its seeds; it is also known as « hungry rice » in English.

Cereal sales are only 5 kg/capita and represent roughly 2% of the total production during the survey period (Table 12). This result reinforces our initial description of the zone as one of semi-subsistence cereal production. On average 14% of farms sold cereals each year, but this ranged from a high of 18% in 2008/09 to a low of 7 % in 2009/10 (the year with the lowest total cereal production). Sales represented 8 to 22% of cereal production among farmers who sold, averaging 13% across years. A Lorentz curve analysis of average household cereal sales per year over the three survey years shows a very concentrated sales structure for Tominian. Sixty-nine percent of households had no sales during the entire survey. Eighty percent of households account for only 8% of all sales, leaving 20% of households to account for 92% of all sales (Figure 13).

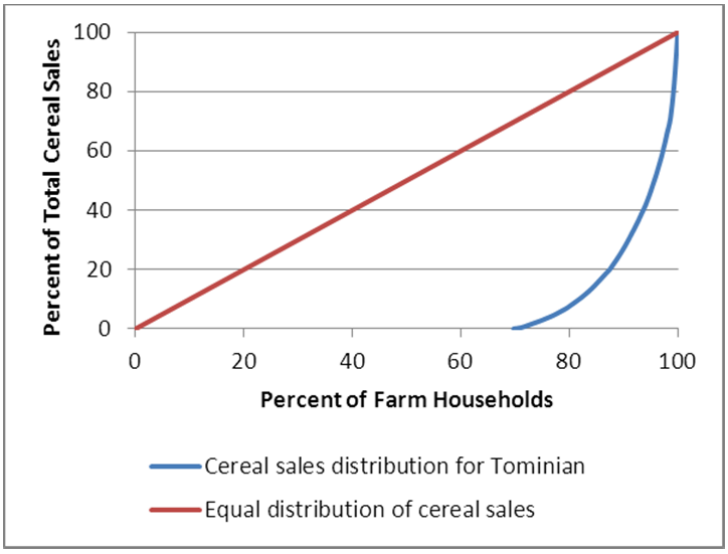
Table 12. Tominian Cereal Sales

	Cereal Sales			
	2006/07 (n=24)*	**2008/09 (n=27)***	**2009/10 (n=11)***	**Average**
			Kg/capita	
Mean (sample)	10	5	1	5
Mean (sellers only)	64	25	18	36
			%	
% production sold for the sample	4	2	1	2
% sellers	16	18	7	14
% production sold by sellers	22	10	8	13

*Number of sellers from total sample of 151, 149, 151.

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Figure 13. Lorentz Curve of Average Annual Cereal Sales by Tominian Farm Households



Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Table 13. Tominian Cereal Purchases

	Cereal Purchases			
	2006/07 (n=89) *	2008/09 (n=78)	2009/10 (n=115)	Average
	Kg/capita			
Mean (sample)	34	16	33	28
Mean (buyers only)	57	31	44	44
	%			
% cereal buyers	59	52	76	62

*Number of buyers; total sample 151, 149, 151.

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Because of their low production per capita, Tominian farmers have a high rate of cereal purchases, involving from 52 to 76% of farm households depending on the year (Table 13). Average annual purchases were 28 kg/capita for the entire sample but increased to 44 kg/capita if only those purchasing were considered.

The first section of Table 14 classifies households in terms of their net marketing position (sales minus purchases), illustrating that the majority of households (61%) are net buyers. In sharp contradiction to the conventional wisdom about farmers selling at harvest and having to buy back later in the year, the data show that only 6% of the sample sold and purchased in the same year.

Table 14. Tominian Cereal Market Position and Consumption Adequacy

	Marketing Position			
	2007 n=151	2009 n=149	2010 n=151	Average
	% of farm enterprises			
a. Autarkic (no buy or sell)	**30**	**36**	**22**	**29**
b. Buy only	54	46	71	57
c. Buy and Sell (Purchases>Sales)	3	4	4	4
d. Net buyer (sum of b + c)	**57**	**50**	**75**	**61**
e. Sell only	11	12	2	8
f. Sell and Buy (Sales>Purchases)	2	2	1	2
g. Net seller (sum of e + f)	**13**	**14**	**3**	**10**
Total (a+d+e+g)	100	100	100	100
	Consumption Adequacy			
% of farms under 214 kg/capita	73	78	77	76
Avg kg/capita for farms under 214	144	127	116	129

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

This suggests that most farmers are finding other sources of income to cover day-to-day expenditures and saving their cereals for home consumption. The bottom line of Table 14 shows, however, that on average 76% of the households did not meet Mali's benchmark of 214 kg/capita of consumable cereals. This calculation takes into account production – sales + purchases and converts grain to its consumable equivalent using the standard ratio of 85% consumable for coarse grains after hulling and removal of the bran, which is generally used as animal feed in Mali. For the households in Tominian that are under the recommended level of cereals per capita, the average gap ranged from 70 kg/person in 2006/07 to 98 kg/person in 2009/10, the latter gap representing 46% of recommended levels. Although only 62% of households buy cereals on average, 76% appear to have net cereal availability at levels below minimum needs, suggesting that more production and/or more purchasing is needed.

One hypothesis about what is preventing farmers from increasing cereal production and marketing and improving food security is that as population grows, land becomes more of a constraint. We found a statistically significant and relatively strong correlation between land assets per capita and consumption adequacy (0.40 correlation at 0.01 level of significance). We also found a statistically significant negative coefficient (-0.24) between land ownership and cereal purchases, showing that farms with less land are more reliant on cereal purchases. On the sales side, there is also a significant but positive and smaller correlation coefficient (0.15), indicating that the larger the amount of land per capita, the more likely the farm is to sell cereals. These results suggest that land assets play a small role in sales behavior, a slightly larger role in purchasing behavior, and a much stronger role in shaping levels of consumable cereals available after sales and purchases.

We had hoped to be able to develop a multivariate model of determinants of cereal sales (i.e., what differentiates farmers who are net cereal sellers from those who are not). Because the number of net cereal sellers is so small in this zone, we have not been able to develop a satisfactory model. Of the 151 farms in the Tominian sample only 37 were net cereal sellers at some point during the survey period; 9 of these 37 were net sellers only two years and none was a net seller in all three years, Table 15 summarizes the results of comparisons between net sellers and all other farmers during the survey period. Across all years there were 46 net seller observations (20 in 2007, 21 in 2009, and only 5 in 2010) and 448 total observations for most analyses (150 in 2007, 148 in 2009, and 150 in 2010). Net seller households tended to have younger household heads, more land, smaller household sizes, a higher maximum level of schooling among all members, and a disproportionately larger share of household heads with some primary school education than was the case for those who were not net sellers. Net seller households were also more likely to belong to associations and more likely to be living in villages with easier access to markets. Net sellers are also more likely to be of the Bobo (Bwa) ethnic group. Because the Bobo tend to be more dominant in the villages with easy access it is difficult to know if it is access or ethnicity or both that make Bobo farms are more likely than others to be net sellers (the sample is 81% Bobo and 19% a mix of six other ethnic groups with Bobo comprising 96% of the farms located in easy access villages—15% higher than the anticipated level).

A number of family farm characteristics expected to differentiate net sellers from others did not prove to be statistically significant such as dependency ratios, gender of the household head (only four of the 150 farms had female heads), and various indicators of household wealth such as livestock holdings, durable goods, and ownership of agricultural equipment (Table 16). Also average non-farm income per capita was not statistically different for the net sellers; however, there was a significant difference (P=.005) in average levels of non-farm income per capita between households meeting and not meeting minimum cereal consumption requirements of 214 kg/capita. Those meeting the requirements (through a

combination of production and purchases) had average non-farm incomes of 35,900 FCFA/capita while those not meeting the requirement earned only 16,200 FCFA per capita, suggesting that non-farm income opportunities are an important determinant of food security for households in this zone.

We ran a series of statistical tests similar to the ones reported above using the binary variable for households who met or did not meet the minimum 214 kg/capital cereal availability benchmark. We do not show results here, but the tendencies were similar to those for the net seller variable—those meeting the minimum cereal requirements have the same general characteristics as those who are net sellers.

Table 15. Characteristics that Differentiate Tominian Net Sellers from All Other Farmers

Statistically significant variables	**Net sellers**	**All Others**
**probability of no difference <0.05% *probability of no difference <0.10%	(mean values by group)	
Household Characteristics		
Age of household head**……	51.00	57.00
Land owned total (ha.) **..…….	9.01	7.23
Land owned per capita (ha.)**……	.88	.64
Land in fallow (ha.)**…….	2.09	1.04
Land owned but not cleared (ha.)**……...	1.12	0 .20
HH Members present**……..	10.00	12.00
HH Adult equivalents present**…….	8.08	9.88
Maximum years of schooling attained by any member of the HH**……...	8.00	5.00
Percent of households …	(% of each group by category)	
-belonging to an association (sample average of 12%)**……..	26%	10%
-living in village with easy market access (sample average – 45%)**……..	74%	42%
-having a HH head of the Bobo (Bwa) ethnic group (sample average =81%)**	98%	79%
-having a HH head who achieved one of the following education levels:		
None (sample avg = 75%) *…….	66%	77%
Some primary (sample avg = 17%) *……	32%	15%
Finished primary (smp. avg = 2%) ……..	0%	2%
Some secondary (smp. avg = 5%) ……..	2%	5%
Finished secondary (smp. avg = 1%)……	0%	1%
Total	100%	100%
Performance indicators		
Avg. area cultivated (total hectares)**……	6.64 ha	5.08 ha
Avg. coarse grain production (kg/capita))**……	262 kg	156 kg
Avg. fonio production (kg/capita)**……	49 kg	21 kg
% of households meeting 214 kg/capita cereal needs (avg = 24%)**…….	35%	23%

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Table 16. Factors NOT Differentiating Tominian Net Sellers from All Other Farmers

Variables with non-significant results	Net Sellers	All Others
	(mean values by group)	
Assets/income		
Index of equipment assets (1 = best)	0.31	0.27
Durable goods index (1 = best)	0.39	0.39
Tropical livestock units owned	7.10	6.20
Non-farm income/capita ('000 FCFA)	21.00	24.00
Livestock income/capita ('000 FCFA)	3.68	1.46
Demography		
Gender of household head (females in each group)	1.00	3.00
Dependency ratio	0.97	1.00

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Farming communities like the one found in Tominian represent a large share of the rural population of Mali. The prospects for increasing incomes through cereal marketing do not seem strong given the unfavorable and risky production environment. Incentives for increased use of productivity-enhancing inputs are few, as evidenced by the relatively limited recourse to purchases of subsidized fertilizers in 2009/10. Some farmers have been able to take advantage of fonio as a cash crop, but fonio alone is not likely to provide a route out of poverty for the entire zone. While access to land does influence the food security situation, the relatively small correlation coefficients between land assets and sales do not suggest that increasing access to land will help most farmers market more cereals. Income diversification and migration seem to be the primary short-run solutions, with those who cannot find employment staying at home to create as large a stock of cereal as possible for home consumption.

5.5. Cotton/Coarse Grain Zone: Koutiala

5.5.1. General Background on the Zone and Sample Selection

The Cercle of Koutiala is located in the northeastern part of the Sikasso Region and shares part of its eastern border with Burkina Faso. The Cercle is the principal cotton production zone in the Sikasso region and a major producer of coarse grains. Livestock is also important with beef cattle dominating (roughly one animal per 1.6 people); small ruminants and poultry are also important with some hog production.[16]

The *Cercle* covers an area of 8,740 square kilometers representing 12% of the Sikasso region. It consists of 35 rural communes, one urban commune and 242 villages. The *Cercle* of Koutiala is not only a center for cotton production but also an important commercial crossroads (cereal trade in particular) and industrial center (processing industries for cotton and other agricultural products). From 2004-2007, the town of Koutiala participated in an ECOLOC study of the town's economy and its relationship to the surrounding rural economy.

[16] Unless otherwise noted, information is drawn from the CSA and PROMISAM (2007) Koutiala *Cercle* synthesis of commune level food security plans.
http://www.aec.msu.edu/fs2/mali_fd_strtgy/plans/sikasso/koutiala/psa_cercle_koutiala.pdf

The study summary (GREAT 2005), provides information about the history of the region and various aspects of the local economy (infrastructure, employment, major agricultural sectors, social services, etc.). Data collected were used to create a social accounting matrix that was used to develop a plan for future economic growth. A key discussion point of the study was the contribution of the agricultural sector, but more specifically the cotton sector. Cotton was credited with a non-negligible contribution to the overall economy of the town and its surrounding area, with cotton incomes used to finance livestock, agricultural equipment, cereal production, increased fertilizer and pesticide use, the creation of jobs through industrial processing of cotton and through artisanal manufacturing of animal traction equipment. Growth in local banks and micro credit institutions was also linked to the cotton sector. On the other hand, cotton-dependence was charged with depleting the soils, creating air pollution from industrial processing, and contributing to the growth of poverty. The study called for the cotton sector to pay more attention to job creation through the promotion of cotton value added activities that would permit the population of the entire zone to benefit from the sector.

The 2009 population of the Koutiala *Cercle* was estimated at 575,253 giving an average density of 66 persons per square kilometer. Since 1998, the population has grown from 382,350 people; this gives an average annual growth rate of 4.5% (http://www.webcitation.org/ 6AnYveESp, provisional 2009 census results). As a result of population growth, cultivable land declined from 1.15 to 0.87 ha/person from 1988 to 2002, but actual cultivated area per person has increased during the same period (from 0.61 to 0.72 ha) (Bodnar 2005 cited by Samaké et al. 2008). Minianka, Bambara, Fulani, Dafing and Dogon are the principal ethnic groups.

The climate is Soudanian with annual rainfall averaging 750 to 1100 mm. Vegetation consists of savannah trees and shrubs and the ecology is considered fragile. Area devoted to national forests is estimated to be 14,296 ha, and that to village forests 816 ha. The *Cercle* has no important rivers or lakes, but there are some lowlands that accumulate rain water on a temporary basis and can be used for rice and vegetable cultivation.

This zone has benefited from significant investments in infrastructure (roads and markets), agricultural research, and farmer extension and literacy training programs provided by the CMDT, Mali's cotton parastatal. In addition, all cotton farmers have had access to input credit, which is linked to guaranteed markets for their cotton production (the cotton serves as the credit guarantee). Despite declining producer prices and cotton production in recent years, cotton remains the principal cash crop.

The sample comprises six villages located in five of the thirty-six communes that comprise the *Cercle* of Koutiala (Figure 14 and Table 17).

Among the six sample villages, there were three with relatively good access to roads and markets and three with relatively poor access, permitting us to look at the effect of access on production and marketing behavior.[17] Ethnically, the sample is 64% Minianka, 15% Bambara, 10% Senoufo, with six other ethnic groups accounting for the remaining 11%.

[17] The survey design also called for selecting half the villages to represent zones where land constraints were thought to be relatively severe and the other half to represent zones where land was not yet a problem. This distinction was not borne out by analyses of the first year of the data (Samake et al. 2008) so we do not use this distinction in our analyses.

Figure 14. Koutiala Cercle and Sample Village Map

Source: Map designed by Steve Longabaugh, MSU.

Table 17. Cotton/Coarse Grain Sample Villages in Koutiala

Village	Commune	Access	Roads	Markets (1st, 2nd, 3rd)	Km. to Markets
Nampala II	Fagui	Difficult	Dirt road	Zangasso/Koro Barrage	30; 27
Tonon	Sinkolo	Difficult	Dirt road	Zangasso/Sadiola/Koro Barrage	22; 12; 17
Kaniko	Sincina	Easy	Dirt road	Koutiala/Molobala/Karangasso	15; 20; 17
Try I	Sincina	Easy	Dirt road	Koutiala/Molobala	13; 15
Signe	Koutiala	Easy	Paved road (RN 6)	Koutiala/Mpessoba/Zankorola	15; 29; 7
Gantiesso	Mpessoba	Difficult	Dirt road	Mpessoba/Zansoni/Toton, BF+	22; 15; 15

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Seven percent of the sample belong to the blacksmith caste, a factor that might influence the relative importance of crop income in total income. Table 18 summarizes some of the exogenous factors expected to influence livelihood strategies and incomes of sample farmers during the survey period. Delayed payment of farmers for their cotton in 2007 had a significant impact on planting decisions and cash flow for the 2008/09 production season as did cereal export bans.

5.5.2. Farm Characteristics, Production and Marketing Behavior

Sorghum and millet together represent 75% of cereal production in the Koutiala sample, maize about 23% and lowland rice production done largely by women for home consumption only 1% (Table 19).

Table 18. Potential Influences on Livelihood Strategies and Incomes: Cotton/Coarse Grain Zone (Koutiala)

Factor	Factor details	2006/07	2007/08	2008/09	2009/10
Rainfall	mm/days	782/65	948/73	713/66	899/78
Prices*	Maize	71	101	110	n.avail.
	Sorghum	78	95	116	n.avail.
	Cotton	165	160	200	170
	Urea/NPK		12,000/10,275	17,210/17,500	12,500/12,500
Policies	• Entire period characterized by great uncertainty concerning the privatization of the national cotton company; plans in place but no official movement. • Payment for the 2007 cotton production, which was harvested Nov. 2007 – Jan. 2008 and collected Jan. – Mar. 2008, was not received prior to 2008 planting season (June 2008), resulting in a significant boycott of cotton production. • Export ban imposed on all cereals during the last quarter of 2007 to curb rapidly rising domestic cereal prices; makes it more difficult for farmers to recoup cotton losses through cereal sales. • Payment for 2007 cotton production received Nov 2008, reducing the liquidity constraints facing farmers to that point, but too late for investment in 2008/09 cotton production. • Export ban on cereals continues through 2008. • Subsidized fertilizer available with credit for cotton producers for 2009/10 production season. • Subsidized fertilizer available to maize producers not in cotton program in 2009 (but without credit).				

* Cereal prices are producer prices in FCFA/kg; fertilizer prices are FCFA/50 kg bag.
Source: Rainfall data from Malian meteorological service via SAP. Cereal prices from OMA market data for MPessoba. Cotton and fertilizer prices from official documents and/or survey data. Policies from various government and cotton company documents.
Source: Compiled by authors from official GOM documents.

Table 19. Koutiala Cereal Production

	Cereal Production			
	2006/07 (n=153)	2008/09 (n=150)	2009/10 (n=150)	Average
Crops	(% of total cereals)			
Rice	1	1	2	1
Maize	25	21	23	23
Sorghum	40	46	44	43
Millet	34	32	31	32
Fonio	0	0	0	0
	(kg/capita)			
Total coarse grains	476	402	370	416
Total Cereals	482	407	375	421

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Average cereal production per capita far exceeds the 214 kg/capita benchmark, averaging 421 kg/capita, but falling as low as 375 kg/capita in the relatively poor production year of 2009/10. Koutiala exhibits the highest coarse grain production per capita of the three zones covered, but not the highest total cereal production per capita (found in the irrigated rice zone of Macina).

Table 20 summarizes key statistics on Koutiala cereal sales.

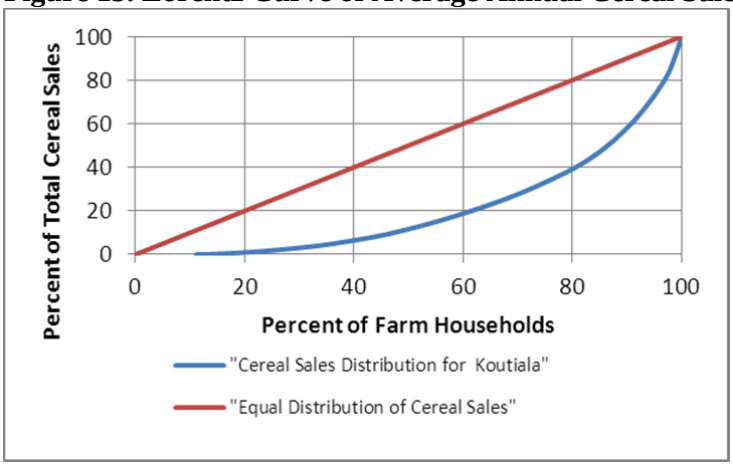
Table 20. Koutiala Cereal Sales

	Cereal Sales			
	2006/07 (n=115)	2008/09 (n=95)	2009/10 (n=99)	Average
	Kg/capita			
Mean (sample)	62	33	37	44
Mean (sellers only)	83	52	56	64
	%			
% production sold for the sample	13	8	9	10
% sellers	75	63	66	68
% production sold by sellers	15	12	12	13

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

For the entire sample, sales averaged 44 kg/capita (far above the 5 kg/capita for Tominian). Sales represented roughly 10% of total production (2% for Tominian) and were made by 68% of the farms (compared to only 14% selling in Tominian). Among selling households only, sales were 66 kg/capita and represented 13% of their production (slightly more than the sample average of 10%). Even though sales are significantly higher in Koutiala than in Tominian, 90% of cereal production is being used for home consumption and not passing through markets. A Lorentz curve analysis of average cereal sales during the three survey years shows that although the sales structure in Koutiala is less concentrated than that observed in Tominian, it is still dominated by a relatively small group of farms. Twenty percent of farms selling cereals account for 60% of all sales in Koutiala (the Tominian equivalent was 92%) while 80% account for 40% of sales (the Tominian equivalent was only 8%). Only 10% of households had no sales (compared to 69% in Tominian). Figure 15 illustrates the more egalitarian sales structure for Koutiala; but the distance of the Koutiala Lorentz curve from the line of equal distribution is still substantial. Because of the relatively abundant production, the share of farm households making cereal purchases is substantially less than the share selling (44% buyers compared to 68% sellers, shown in Table 21). Quantities purchased are also low: 11 kg/capita for the overall sample and 26 kg/capita among those making purchases.

Figure 15. Lorentz Curve of Average Annual Cereal Sales by Koutiala Farm Households



Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Table 21. Koutiala Cereal Purchases

	Cereal Purchases			
	2006/07 (n=88)	**2008/09 (n=46)**	**2009/10 (n=69)**	**Average**
	Kg/capita			
Mean (sample)	13	8	13	11
Mean (buyers only)	24	24	29	26
	%			
% cereal buyers	56	31	46	44

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Despite the relatively abundant aggregate production and sales, 30% of farmers in the Koutiala sample did not meet the 214 kg/capita requirement for consumable cereal availability, with the average gap between availability and the recommended norm being 60kgs/capita (Table 22). This result is worrisome given that cereal production was relatively favorable during the three years; but it illustrates a better situation than that in Tominian where 76% did not meet the norm and the average gap was 85 kg/capita. During the survey period an average of 61% of all farms were net sellers (sales > purchases), with the lowest net sales in 2009, a year when cotton production was unusually low and farmers were probably being more cautious about selling cereals because of the reduced availability of cotton revenues, often used to buy rice to improve on dietary diversity. The lower sales in 2009 do suggest that rather than using coarse grains as a substitute cash crop to replace cotton income, many farmers were reverting to a strategy of self-sufficiency with respect to cereals. This hypothesis is supported by the marked increase in farmers with autarkic marketing positions.

Table 22. Koutiala Marketing Positions

	Marketing Position			
	2007 (n=153)	**2009 (n=150)**	**2010 (n=150)**	**Average**
	% of farm enterprises			
a. Autarkic (no buy or sell)	**12**	**24**	**16**	**17**
b. Buy only	13	13	19	15
c. Buy and Sell (Purchases>Sales)	7	3	11	7
d. Net buyer (sum of b + c)	**20**	**16**	**30**	**22**
e. Sell only	31	45	39	38
f. Sell and Buy (Sales>Purchases)	37	15	15	22
g. Net seller (sum of e + f)	**68**	**60**	**54**	**61**
Total (a+d+e+g)	100	100	100	100
	Consumption Adequacy			
% of farms under 214 kg/capita	25	35	29	30
Kg/capita for farms under 214 kg	154	150	159	154

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

The marked increase in farmers selling only is more difficult to interpret, but may reflect a choice to sell but not use the receipts to purchase other cereals such as rice, which continued to have a higher than usual prices. There seems to be a variety of strategies in use for dealing with reduced cotton incomes that requires multivariate analyses to better understand the different approaches (see Murekezi and Mather forthcoming).

The cotton zone is the only one for which we have some historical data on marketing behavior. Dioné (2000) reported that following the two relatively abundant harvests of 1985 and 1986, up to 43% of the farm households in two of the best agricultural zones of Mali (CMDT[18] and *Office de la Haute Vallée du Niger* (OHVN) were net grain buyers. The more recent survey data shows only 22% of farms having been net buyers, and the harvests for the three years covered were not particularly abundant. Dioné also reported that 53% of the farms were net grain sellers in the mid-1980s; the more recent data show improvements in that 61% of farmers are now making net cereal sales. The final point of comparison concerns the concentration of cereal sales. In the mid-1980s, 90% of the total quantity of net sales came from only 28% of the farms. Comparable results for the Koutiala zone based on the three years of more recent survey data show that the top 28% of net sellers account for only 78% of total net sales. These numbers still imply substantial inequality in market participation across households (as illustrated by Figure 15 above), however, they do indicate an improvement since the mid-1980s.

In discussing the factors that differentiated net sellers from other producers in the mid-1980s, Dioné noted that most of the net cereal-buying households had poor access to extension services, input markets and formal credit and many were located in the less humid OHVN zone. As a result of their low investment capacity, these farmers used low-productivity technologies. The net sellers of cereals, in contrast, were essentially farm households located in the more humid southern part of the CMDT zone (where Koutiala is located), with good access to improved farming techniques through relatively efficient systems of agricultural research, extension, input supply and credit, and heavily engaged in cotton production.

At present, one hypothesis about what is constraining cereal production and marketing in the zone is limited access to land due to significant population growth since the mid-1980s. For Koutiala, we found no statistically significant correlation between land assets per capita and cereal purchases, but other results were similar to those in Tominian. Land assets were correlated with quantities of consumable cereals available (0.49 correlation at 0.01 level of significance) and with sales per capita (coefficient of 0.12 at $P<0.01$). As in Tominian, land assets appear to play a small role in sales behavior but a much larger role in food security.

Table 23 presents statistics on variables that differentiate between net sellers and all other farm households in the Koutiala zone. Although we used the same set of variables for the tests as in Tominian, the variables showing statistically significant differences are fewer for Koutiala and non-significant differences more frequent.

Net sellers own more land and more land per capita than other farmers, as in Tominian, but the amount of land in fallow or not yet cleared are not significantly different from that held by households that are not net sellers. While asset variables did not differentiate net sellers in Tominian, they are highly significant in Koutiala—both the equipment asset index and the durable goods index. The village and ethnic tests give ambiguous results.

[18] The Koutiala zone covered by the present survey was one of the zones included in the Dioné work.

Table 23. Characteristics Differentiating Net Sellers from All Other Farmers: Koutiala

Statistically significant variables	Net sellers	All Others
**probability of no difference <0.05% *probability of no difference <0.10%	(mean values by group)	
HH Characteristics		
Land owned total (ha.)**	9.01	7.23
Land owned per capita (ha.)**	0.95	0.82
Index of equipment assets (1 = best)**	0.21	0.20
Durable goods index (1 = best)**	0.24	0.23
Percent of households …	(% with characteristic)	
- having a head of the Senoufo ethnic group (average = 10%)*	12%	7%
-located in Nampala or Try 1 (32% of sample is in these villages)**	38%	23%
Performance indicators	(mean values)	
Avg. area cultivated (total ha.)**	10.9	8.8
Avg. coarse grain production (kg/capita)**	477	321
Avg. maize production (kg/capita)**	122	84
% households meeting 214 kg/capita needs (sample average =71%)**	76%	61%

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

The sample included three villages with easy market access and three with difficult access, but the villages that had a larger number of net sellers than would have been predicted by their share of the overall sample were Nampala (a village with difficult access) and Try 1 (a village with easy access). Signe, a village with easy access to a paved road, surprisingly had fewer net sellers than would have been expected given the village's share of the sample population. The Koutiala sample includes nine ethnic groups, with four that dominate: Minianka (64%), Bambara (15%), Senoufo (10%) and Fulani (7%). The Senoufo represented a significantly larger share of the net seller group than their share of the sample population warranted.

The Senoufou are also the dominant ethnic group in the village of Nampala, which we would not normally expect to be home to a large share of the net sellers because of the poor road and market access. It appears that being Senoufo contributes to being a net seller in a manner that is able to overcome living in a village with poor access, but more sophisticated multivariate analyses are needed to understand the underlying relationships.

The performance indicators all show sharp differences between net sellers and other farmers: more area cultivated, more per capita coarse grain production in general and more maize production in particular. Maize tends to be marketed more in the zone than millet and sorghum—an anticipated result. Finally, a larger share of net sellers met minimum cereal availability needs than would be expected (76%) given the overall sample average of only 71%.

Table 24. Characteristics NOT Differentiating Net Sellers from Other Farmers in Koutiala

Variables with non-significant results	Net Sellers (mean values by group)	All Others
Assets/income		
Land in fallow (ha.)	1.80	2.30
Land owned by not cleared (ha.)	1.09	1.08
Tropical livestock units owned	14.00	13.00
Non-farm income/capita (‘000 FCFA)	36.00	15.00
Livestock sales income/capita ('000 FCFA)	4.28	5.70
Demography		
Age of the household head (years)	54.00	55.00
Gender of household head (no. of females by group)	2.00	1.00
Dependency ratio	1.16	1.24
Household members present during survey	15.30	15.50
Household adult equivalents present during survey	12.40	12.60
Maximum years of schooling attained by any member of the HH	4.00	4.00
	(% with characteristic)	
Percent of households…		
-belonging to an association (sample average of 82%)	83%	81%
-living in village with easy market access (sample average = 49%)	49%	50%
-having a head who achieved the following education levels:		
None (sample avg = 85%)	84%	86%
Some primary (sample avg = 11%)	11%	9%
Finished primary (smp. avg = 2%)	2%	3%
Some secondary (smp. avg = 3%)	3%	2%
Finished secondary (smp. avg = 0%)	0%	0%
Total	100%	100%

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

The list of variables that do not differentiate net sellers from others in Koutiala is long (Table 24) and in some cases surprising. For example, we find no significant difference in the share of net sellers by village when they are classified by the difficulty of access to markets and roads. There are also no statistically significant differences in any of the education variables or household size variables and no significant differences for several of the complementary sources of income that might substitute if a farmer is not selling coarse grains (e.g., non-farm income, livestock income, remittances, etc.). Association membership is much higher in the Koutiala zone than in Tominian, so this may explain why it does not differentiate net sellers from others, as 82% of farmers do belong to associations.

One of the questions raised about the cotton zone is whether farmers could eventually turn coarse grain production into a cash crop alternative to cotton. To take a preliminary look at this question we examined the extent to which net cereal sellers were involved in the production and sale of other crops such as peanuts, cowpeas, and sesame during 2009—a year when there was a large decline in the number of farms producing cotton. In all the comparisons of area cultivated, production, and sales we found that the mean values for these variables for net cereal sellers were equal to or greater than those of other farmers. Our

interpretation of this result is that net cereal sellers are not specializing in cereals but pursuing a strategy of diversified crop production to reduce risks and increase incomes. They are no doubt aided in this pursuit by better access to land and to agricultural equipment documented above.

Another important question in the zone is the extent to which cotton production contributes to more cereal production, better food security, and cereal sales. Various statistical tests suggest a positive relationship between cotton and cereal variables in general but for maize in particular. Cotton farmers were more likely than non-cotton farmers to meet the 214 kg/capita benchmark for cereal availability (76% of cotton farmers versus only 61% of others met the benchmark). They also realized significantly higher total cereal production for millet, maize, and all coarse grains combined during the three-year survey period; yet at a per capita level these differences disappeared except for maize production, which was 32 kg/capita higher for cotton producers. This supports the conventional wisdom that cotton farmers are better able to cultivate maize because they have better access to fertilizers through the cotton program – fertilizers are required for maize production but not for the production of other coarse grains. There are also highly significant but relatively small correlations between levels of cotton production and levels of total maize production (coefficient of 0.38), per capita maize production (0.14), maize sales (0.16) and coarse grain sales (0.13). The correlation between cotton production and consumable cereal availability is also significant and the coefficient much higher (0.42). Looking at the link in reverse from the position of net cereal sellers, we also found that they produce more cotton than other farmers (1651 versus 1330 kg per farm).

Preliminary results from econometric modeling of the survey data for 2008/09 and 2009/10 (Murekezi and Mather forthcoming) provide the following insights concerning area planted to cotton by the subset of farmers who also cultivated maize:

- Membership in a co-op and working with an non-governmental organization (NGO) are both associated with more cotton area; membership in a non-cooperative producer association was positively related to cotton area, but the coefficient was not statistically significant at 10% or better.
- Cereal price expectations[19] were significant at 5% or better but of opposite signs; higher price expectations for millet were associated with less cotton area while higher price expectations for sorghum were associated with more cotton area.
- Farmers located farther from weekly markets are likely to plant more area to cotton than farmers closer to weekly markets.

The first result is consistent with prior research on the cotton zone as farmers must be members of producer organizations to participate in the cotton program. Cooperatives (as opposed to less structured Village Associations) tend to have a higher level of organization and management that facilitate farmers' access to inputs and credit. The second finding is difficult to interpret; the expectation was that higher prices would lead to more production of cotton to reinforce the farm's cash flow, enabling it to purchase cereals when needed. The third finding was not anticipated, but can be explained by the fact that regardless of a farmer's proximity to markets, the CMDT guarantees collection of cotton at designated pick up points, which are generally attached to cotton producer associations and therefore easily accessible by farmers. Thus, farmers who have more difficulty accessing the public markets where non-cotton crops are sold appear to be taking advantage of the cotton sector purchase and collection guarantees to ensure a minimum level of cash incomes.

[19] Price expectations were represented by the prevailing village price at planting time.

Results concerning the link between cotton production and use of fertilizer on maize confirm the longstanding belief that cotton production facilitates access to fertilizers, which subsequently encourages greater fertilizer use on maize. For example, an additional hectare of cotton increases the amount of nitrogen applied to maize by 5 kg (roughly the equivalent of 10 kg of urea). The results also identify a number of other factors related to fertilizer use:

- Ownership of more agricultural equipment is associated with more nitrogen use/hectare;
- Ownership of more small ruminants is negatively associated with nitrogen use;
- Education of the household head is also relevant as those with one year of primary school education or more used 9.5 kg of N per hectare more than other farmers;
- Younger household heads use more nitrogen than older heads;
- The prices of fertilizer and individual coarse grains did not have a statistically significant effect on fertilizer use.

The non-significant effects of input and output prices were surprising given that a subsidy was introduced for maize farmers in 2009/10. One hypothesis is that access to credit – which is not included in the regression explaining fertilizer use, but whose effect is likely captured by the cotton area variable – is a more important determinant of fertilizer use than the fertilizer price itself.

Results concerning the link between yields and nitrogen applications confirmed that fertilizer does increase maize yields, but that the amount of the yield increase can be highly variable from year to year.

- For 2008/09 a kilogram of N applied to maize increased yield by 22.6 kg
- For 2009/10 (the year of the subsidy) the yield increase was only 7.8 kg

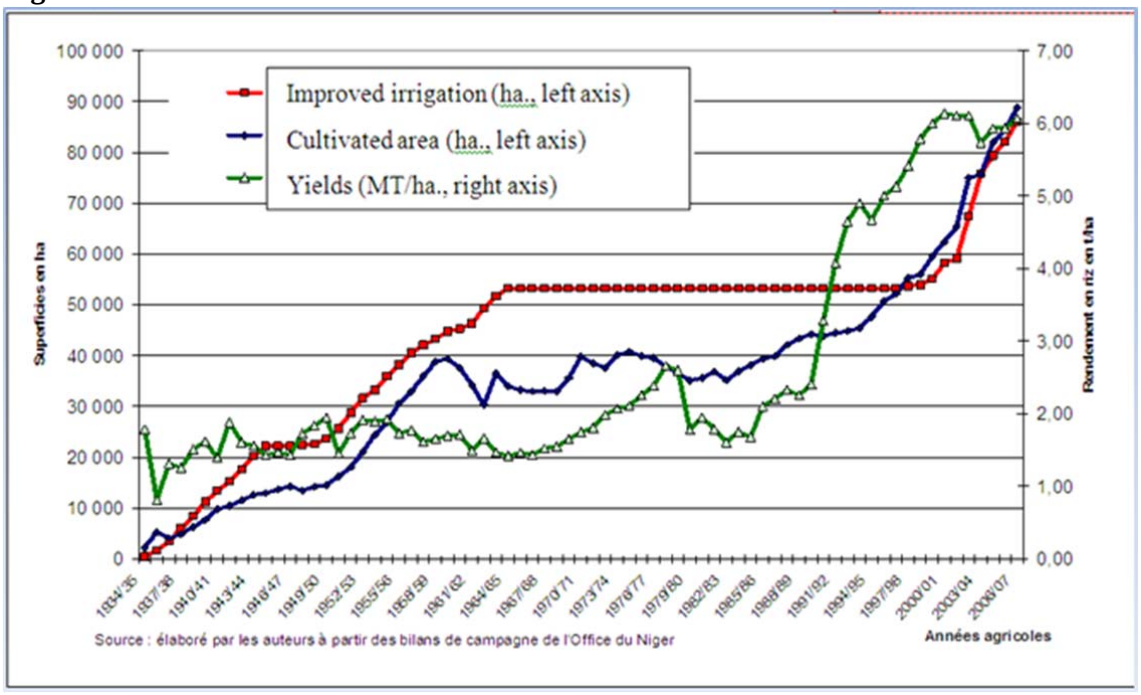
It is possible that late deliveries of subsidized fertilizer in 2009/10 may have contributed to lower yields, but climate factors may also have been at play. More work is needed to understand the causes of these differences.

5.6. Irrigated Rice Zone: Macina, Office du Niger

5.6.1. General Characteristics of the Zone and Sample Selection

The third study zone is located in the Macina *Cercle* of the Segou Region of Mali. The *Cercle* covers 11,750 square kilometers in the Sahelo Sudanian agroecological zone where rainfall is low (350-600 mm/year) and livelihoods based on millet-cowpea intercrops and/or nomadic grazing predominate. Given the study objective of understanding production and marketing behavior among producers of irrigated rice, the survey sample is limited to a small part of the Macina *Cercle* that is located along the left bank of the Niger River in the ON. The ON is a government authority created shortly after independence to manage Mali's most important irrigation scheme, which was built by the French during the colonial period. The ON has evolved from a structure that controlled all aspects of irrigation management, rice production, and rice marketing to a more streamlined operation that now focuses on irrigation and land management. Reforms during the 1990s and 2000s coupled with substantial investments in farmer capacity building and technological innovations led to significant improvements in

Figure 16. Area and Yield Trends in the ON: 1934/35 - 2002/03

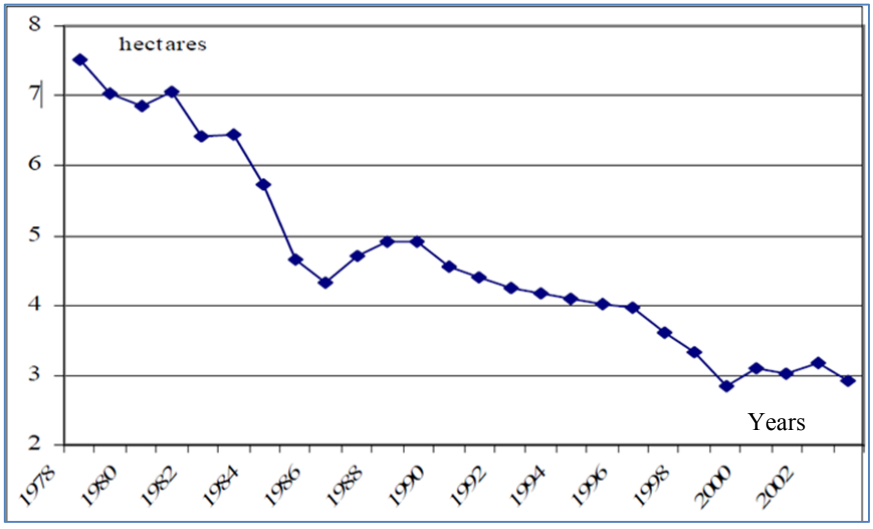


Source: Adapted from Kébé et al. (2005) which used official ON data.
Notes: The data cover only the central (*casiers*) sections of the ON and rainy season area and yields.

productivity that boosted average yields from roughly two tons to six tons/ha between the mid-1990s and the early 2000s (Figure 16) (Bonneval, Kuper, and Tonneau 2002; Aw and Diemer 2005).

As a result of these successes Mali's overall agricultural development strategy relies heavily on the expansion of irrigated perimeters, particularly in the general area of the ON, which is estimated to have a capacity for more than 1,000,000 hectares of irrigated land with full water control (area currently developed is under 100,000 hectares). While the past contributions of the ON to Malian cereal production and food security are undeniable, the plans for expansion are not without their critics. Access to irrigated land throughout the ON is a growing problem (Figure 17). There is strong evidence (including the current survey data) that many ON farm families are falling below the poverty line due to declining availability of irrigated land per capita and intermittent, but increasingly frequent problems with water control (Kébé et al. 2005; Bélières et al. 2002; Bélières et al. 2011. Family farms that are not getting the irrigated land they feel they need, are increasingly vocal in speaking out against the GOM's recent decision to sign long-term land leases, primarily with foreign developers, for large swaths of potentially irrigable land that will be dedicated to commercial rather than family-based agriculture (Oakland Institute 2011). This approach to irrigation development raises questions about the appropriate mix of family and commercial farms and whether the expansion of commercial farms will create a class of landless laborers, which, to date, is more common in Asia and Latin American than in Africa.

Figure 17. Cultivated Rice Area per Farm in the *Office du Niger*



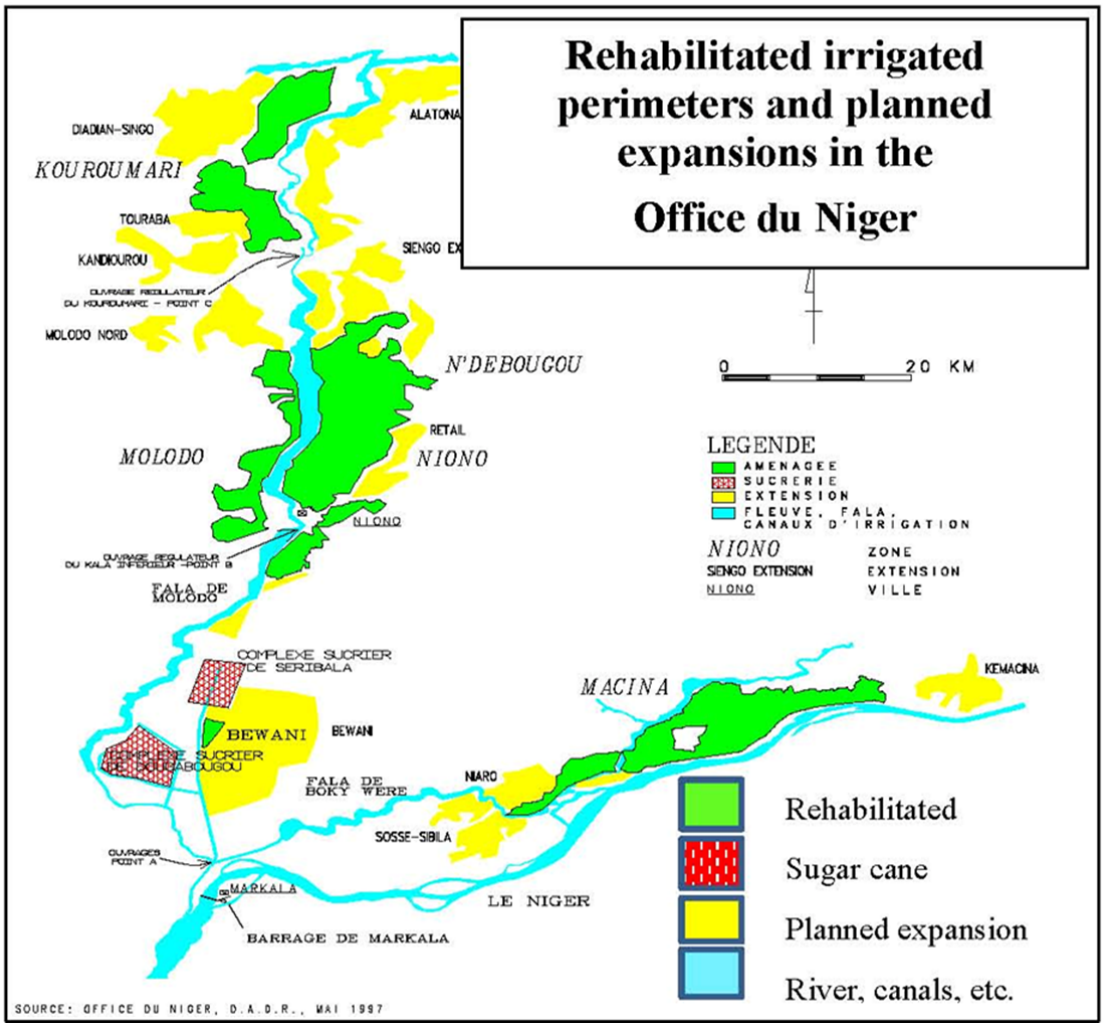
Source: Adapted from Kébé et al. 2005; based on official ON data.

The ON portion of the *Cercle* of Macina represented by the study sample comprises 17,500 irrigated hectares, representing only 1.5% of the *Cercle*'s total land area. Most of the irrigation infrastructure (13,000 ha) was developed prior to the 1980s (primarily during the colonial period); the remaining 4,500 ha have been developed since 2000 (see Figure 18). Households officially listed as having rights to cultivate land in the entire ON in 1999 numbered 19,470 with a total population of 236,116 (more recent numbers unavailable). At that time, the Macina sector represented 25% of the households, 25% of the irrigated land, and 24% of the population (Bélières et al. 2003).

Farmers in the ON grow primarily irrigated rice during the rainy season and horticultural crops (mostly onions) along with some rice (water permitting) during the dry season. Dry season cropping became possible after 1982, when the Sélingué reservoir was built on an upstream tributary. The rainy season runs from May to October, with more than 90% of the rainfall concentrated in June and September. Farmers planting a second (dry season) crop of rice usually aim to plant in December and harvest in late March or April. Average annual rainfall is 550 mm (ranging from 300 to 850 mm). Horticultural crops can be grown year-round, but are concentrated in the dry season. Temperatures are generally suitable for rice, but during the dry season the temperature frequently drops below 15 degrees Celsius, which is low for some varieties of rice. Low temperatures, water scarcity, and relative crop values often make vegetables more profitable than rice as a dry season crop. All of the rainfed land and much of the irrigated land is not used during the dry season.

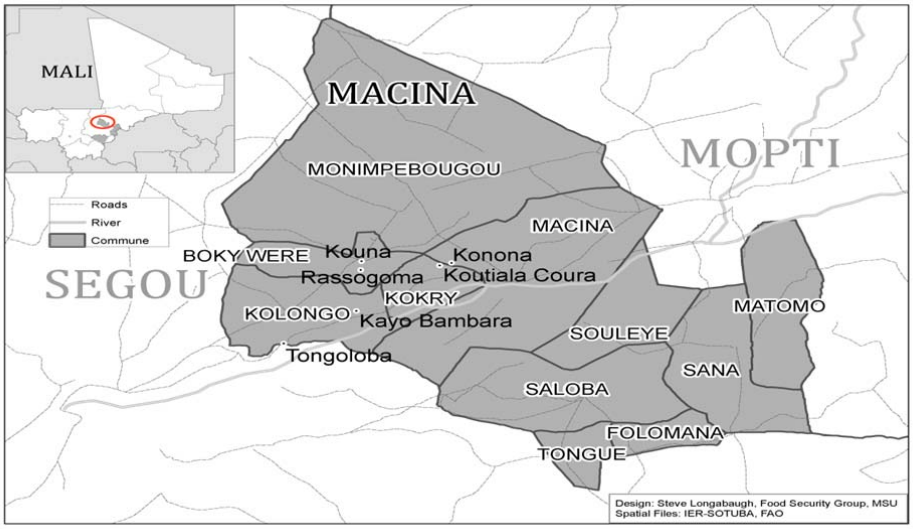
The study sample comprises six villages (Figure 19). Three were purposively selected in the heart of the Macina sector's irrigated perimeters (*casiers*); they represent villages with easy access to markets and to *casiers* fields that have fully controlled irrigation but limited access to rainfed crop land. The other three were purposively selected to represent villages on the edges of the irrigated zone (*bord du casier*) where *hors casier* fields (ones with less certain water control) dominate and access to markets is more limited but land for rainfed production and pasture is more available. A 1999 ON report listed officially registered *hors casier* fields as roughly 7% of total registered land, but this number underestimates the current levels and does not take into account large areas that are in use but not officially registered. Although ON does not have official statistics on the share of farmers living in the center of the irrigated

Figure 18. Map of the *Office du Niger* Irrigated Zones: 1997



Source: Official *Office du Niger* map, May 1997.

Figure 19. Map of Macina Cercle with Communes and Sample Villages



Source: Map designed by Steve Longabaugh, MSU.

zone versus the edges, a 2000 survey (Bélières et al. 2003) would suggest that the 50-50 sampling split over-represents the farmers living on the edges of the ON. For this reason, we often break out the descriptive statistics for the Macina zone by the type of village so one can assess the differences between the *casiers* and *bord du casier* villages.

Table 25 lists the sample villages and summarizes their key characteristics.

Ethnically, the sample is 47% Bambara (Mali's dominant ethnic group), 13% Bozo (a group active in fishing), 8% Soniké (a group active in commerce), and 10 other ethnic groups, each with relatively small numbers in the sample. Six percent of the sample belong to castes (blacksmiths 5%; griot 1%) that might influence the importance of crop income in total income.

Table 26 lists exogenous factors expected to influence farmer livelihood strategies and incomes during the survey period. High producer and consumer prices for rice and the *Initiative Riz* fertilizer subsidies are among the most important.

Table 25. Sample Villages in the Macina Sector of the *Office du Niger*

				Markets (1st; 2nd; 3rd)	
Village	**Commune**	**Location**	**Access**	**Names**	**Km**
Tongoloba	Kolongo	*Bord du casier**	Difficult	Kolongo; Sibla	??
Rassogoma	Boky Wéré	*Casier***	Easy	Kouna; Kolongo(Bolibana)	4; 20
Kouna	Boky Wéré	*Bord du casier*	Difficult	Kolongo; Monimpé	18; 20
Konona	Macina	*Bord du casier*	Difficult	Macina; Kokry; Monimpé	14; 6; 18
Koutiala Coura (K07)	Kokry	*Casier*	Easy	Macina; Kokry	11; 5
Kayo Bambara	Kolongo	*Casier*	Easy	Bolibana; Kouna	8; 20

*Edges of the irrigated perimeters

** Center of the irrigated perimeters

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Table 26. Potential Influences on Livelihood Strategies and Incomes: Irrigated Rice Zone in the *Office du Niger*

Factor	**Factor details**	**2006/07**	**2007/08**	**2008/09**	**2009/10**
Rainfall	mm/days	574/39	680/37	656/38	660/40
Prices*	Millet	88	128	143	111
	Rice	228/227	227/286	286/274	274/257
	Urea/NPK			12,500/12,500	12,500/12,500
Policies	• Rapidly rising prices of cereals (particularly rice) in late 2007 led the government to introduce the *Initiative Riz (IR)*, a program to stimulate large increases in rice production for the local market. The IR included: o In 2008/09: fertilizer subsidy and a credit guarantee for rice producers (the GOM backed the loans made by the banks enabling farmers with outstanding debts to get credit). o In 2009/10: the subsidy continues but the credit guarantee stops. • Cereal prices did not begin to fall until late in 2009. • Increasing farmer complaints about irrigation infrastructure and poor water control, most strongly noted by sample farmers in 2009/10.				

* Cereal prices are average annual producer prices in FCFA/kg; fertilizer prices are FCFA/50 kg bag.
Source: Rainfall data from Malian meteorological service via SAP. Cereal prices from OMA market data for Macina. Fertilizer prices from official documents and/or survey data. Policies from various government and ON documents.

Source: Compiled by authors from official GOM documents

5.6.2. Description of Farm Characteristics and Cereal Production and Marketing Behavior

The zone of Macina has a different set of cereal issues than the zones of Tominian and Koutiala. First, the primary cereal produced—rice—is also the primary cash crop; much of it must be marketed to pay for the production costs (irrigation fees, fertilizer, hired labor for transplanting, threshing and milling fees, etc.). The issue is not simply differentiating net sellers from others (88% are net sellers) but understanding what determines total production and the share of total production that a farmer sells. When cereal prices began spiraling out of control in late 2007, the GOM opted to focus on increasing rice production as a means of increasing national cereal supply and bringing prices down.

The primary stimulus for the *Office du Niger* was the *Initiative Riz* (IR), which began in 2008/09 by providing subsidized fertilizer and government-guaranteed input credit for farmers who did not have access to credit through their producer associations (often due to unpaid past credit). In 2009/10, the subsidy continued but the government-backed credit did not (because of relatively low repayment rates for the entire program, which included many low-land rice producers outside the ON). The impact of the IR on production and marketing has been a topic of much controversy because there was no systematic monitoring and evaluation program. Compounding the lack of monitoring and evaluation (M&E) were conflicting rice production estimates for 2008 and a variety of complaints about late fertilizer delivery (Bureau du Vérificateur Général 2009).

Although the Macina sample is not strictly representative of the entire ON because 50% of the farms are located on the edges of the irrigated perimeters where access to irrigated land is limited, a comparison of the production, sales, and input use data across the three years of the survey provides insights into the challenges that need to be addressed if Mali is to significantly increase rice production in the many parts of the ON that resemble this survey zone. The GOM has long recognized the importance of expanding investments in irrigation, with a number of large public/private partnerships in the works, but the survey data suggest that neither the IR nor the large scale investments are adequately addressing the constraints faced by farmers already growing rice in the Macina zone.

Table 27. Macina Cereal Production

	Cereal Production			
	2006/07 (n=147)	**2008/09 (n=144)**	**2009/10 (n=145)**	**Average**
Crops	(% of total cereals)			
Rice	85	88	84	86
Maize	1	2	2	2
Sorghum	1	1	1	1
Millet	13	9	13	12
Fonio	0	0	0	0
	(kg/capita)			
Total coarse grains	76	65	78	73
Total Cereals	1013	1027	872	971

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Table 27 shows that rice averaged 86% of total cereal production during the survey period, but sample farmers on the edge of the irrigated perimeters also grew millet, which accounted for 12% of total production.[20] Macina stands out among the three survey zones in terms of total cereal production per capita (971 kg on average). There was a significant dip in rice production in 2009, attributed by farmers to poor water control on many rice fields, late planting, and other production problems.

Table 28 summarizes data on cereal sales in the zone, showing a sample average of 417 kg/capita and a slightly higher level (456 kg) if only those selling are included in the average; this means that on average each ON farm is marketing enough per capita to meet the minimum cereal requirements (214 kg/capita) for two other people. Because rice is a cash crop, most farmers (92%) do sell cereals; their sales represent roughly 45% of their production during the entire survey period, but ranged from a high of 54% in 2006/07 to a low of 38% in 2009/10.[21]

A Lorentz curve analysis of average sales for the three survey years shows that Macina has the least concentrated sales structure of the three zones studied (Figure 20).

Table 28. Macina Cereal Sales

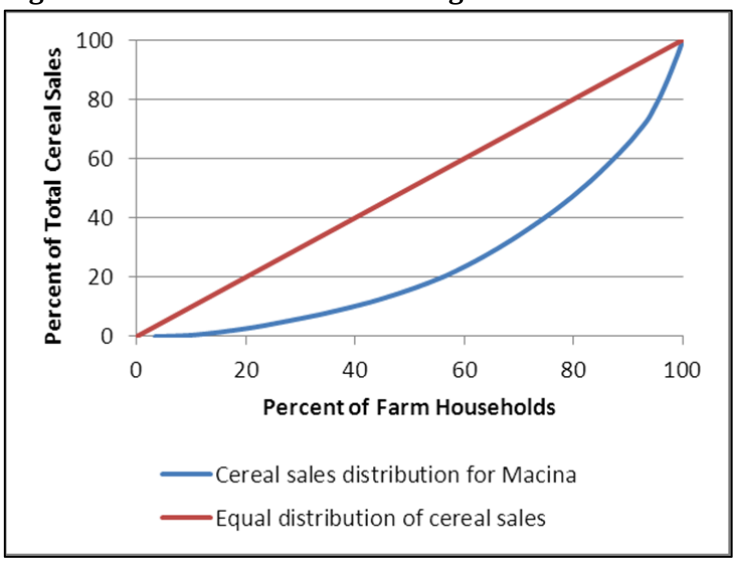
	Cereal Sales			
	2006/07 (n=132)	**2008/09 (n=134)**	**2009/10 (n=148)**	**Average**
	Kg/capita			
Mean (sample)	527	406	317	417
Mean (sellers only)	587	436	346	456
	%			
% production sold for the sample	53	41	38	44
% sellers	90	93	92	92
% production sold by sellers	54	43	38	45

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

[20] Unless otherwise noted, rice production and sales is reported as kilograms of processed, white rice rather than paddy, taking into account the fact that most farmers sell processed rice. As for the other zones, coarse grains are reported as unprocessed grains. Total cereals is the sum of processed rice and unprocessed coarse grains.

[21] The difference between 2006/07 and other years may be overstated due to differences in the survey timing and questionnaire design. The enumeration of sales for the 2006/07 questionnaire did not specify that only sales of the 2006/07 production season were to be reported, so it is possible that we have some sales of 2005/06 carry-over stocks included in the 2006/07 data. Interview dates for the 2008/09 and 2009/10 surveys were in July 2009 and 2010, so any sales made after the interview dates were not captured. Based on supplementary questions concerning sales of carry-over stocks from the 2007/2008 production that were made during the 2008/09 cropping season, we believe that sales beyond July are unusual. While we cannot be sure that marketing behavior with regard to stocks carried into the subsequent production year did not change from year to year, we believe that the marketed shares shown above reflect fairly closely the total marketed production from each year, with the possibility of a small upward bias for 2006/07 and a small downward bias for subsequent years sales.

Figure 20. Lorentz Curve of Average Annual Cereal Sales by Macina Farm Households



Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Only 3% of farms had no cereal sales. Eighty percent of farm households account for 48% of all sales, leaving 20% of farms to account for 52% of sales. Even though sales are more evenly distributed among Macina farm households than in the other zones, the results imply that a relatively small group of farms (20%) are earning roughly 50% of the sales revenues generated by rice marketing with the remaining 80% sharing the other half of the sales revenues. This type of sales distribution suggests that rice sales as currently practiced are not likely to lift the majority of ON farmers out of poverty. We believe these results reflect, in part, the land constraint and declining farm size mentioned in previous studies (e.g. Bélières et al. 2003; Coulibaly, Bélières, and Koné 2006; Bélières et al. 2011; Kébé et al. 2005) that is making it increasingly difficult for ON farms to produce marketable surpluses.

Because fertilizer acquired on credit through producer organizations significantly increased between 2006/07 and 2008/09, it is possible that the drop in sales reported is due to an increase in the number of farmers paying for their fertilizer in-kind by turning rice over to their cooperatives and associations at harvest. Households purchasing fertilizer on credit from associations increased from 84% in 2006/07 to 93% in 2008/09 and to 98% the following year. In-kind payment for fertilizer credit was reported in focus group discussions but unfortunately not captured in the survey data, which simply reports the cost or farmer's estimated value of the different inputs used.

Although Macina farmers have the highest cereal production per capita, they do not have the lowest cereal purchases per capita (Table 29). In the zone, 71% of households purchased cereals while only 44% did in Koutiala and 62% in Tominian. The sample average purchase in Macina was 44 kg/capita (equal to purchases in Tominian but higher than those in Koutiala). The explanation is that rice is the highest priced cereal in Mali; for rice producers who are not wealthy enough to be eating the highest priced cereal on a regular basis, the strategy is to sell rice and use the receipts to purchase less expensive cereals such as maize, millet and sorghum. Farmers who live on the edges of the irrigated zones often produce enough coarse grains to provide for home consumption, but most farmers living in the middle of the irrigated zone have limited access to rainfed crop land and therefore must purchase coarse grains if they want to diversify their cereal consumption.

Table 29. Macina Cereal Purchases

	Cereal Purchases			
	2006/07 (n=102)	2008/09 (n=99)	2009/10 (n=111)	Average
	Kg/capita			
Mean (sample)	45	38	48	44
Mean (buyers only)	66	56	64	62
	%			
% cereal buyers	69	67	77	71

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

The percent of cereal buyers in 2009/10 was roughly 10% higher than in the earlier years, reflecting the lower production reported by sample farmers.

Table 30 classifies farmers by their cereal marketing position as was done for the other two zones. On average, 88% of farmers were net sellers (kg of sales > kg of purchases) compared to only 61% in Koutiala and 10% in Tominian. Twenty-six percent of sample farmers reported only cereal sales (no purchases), while 62% sold and bought with sales exceeding purchases. Only 3% were autarkic, and 9% were net purchasers. Despite the very high average cereal production per capita for the Macina sample, 29% of households did not meet the minimum of 214 kg/capita of consumable cereal availability, with the average gap being 73 kg/capita. While this situation is better than that found in Tominian (76% deficit by 85 kg/capita), it is similar to the results for Koutiala (30% deficit by 60kg/capita). We have factored into the consumption adequacy estimates in Table 29 the assumption that 10% of paddy production is used to pay for threshing services, as this is almost universal throughout the ON. If, as mentioned above, fertilizer costs are also paid for in-kind, the net cereal availability will be lower.

Table 30. Macina Cereal Marketing Positions

Cereal market position and consumption adequacy	Marketing Position			
	2007 (n=147)	2009 (n=144)	2010 (n=145)	Average
	% of farm enterprises			
a. Autarkic (no buy or sell)	3	3	2	3
b. Buy only	7	4	7	6
c. Buy and Sell (Purchases>Sales)	1	3	6	3
d. Net buyer (sum of b + c)	**8**	**7**	**13**	**9**
e. Sell only	27	28	22	26
f. Sell and Buy (Sales>Purchases)	62	62	63	62
g. Net seller (sum of e + f)	**89**	**90**	**85**	**88**
Total (a+d+e+g)	100	100	100	100
	Consumption adequacy			
% of farms under 214 kg/capita	30	30	28	29
Avg kg/capita for farms under 214 kg	147	132	144	141
Observations for adequacy	146	142	144	

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

It would not be surprising to have a higher share of farms not meeting minimum cereal needs, as a number of earlier surveys in the ON have signaled the problems of declining farm sizes per capita and per active worker and the correlation between farm size and various poverty indicators (Bélières et al. 2003; Coulibaly, Bélières, and Koné 2006; Bélières et al. 2011; Kébé et al. 2005). Recommended norms in the ON are 1 hectare of irrigated land per active worker, yet recent surveys suggest that the average is now only 0.6 ha/active worker. It is increasingly difficult for farm families with less than 5 ha of irrigated land to provide enough production to adequately pay for crop inputs and basic necessities (food, health care) for the average household of roughly 10 people, yet only 10% of the farm households in the ON had access to more than 5 ha of irrigated land in the mid-2000s.

Tables 31 through 34 compare the mean values of a number of asset, demographic, and performance indicators for farmers grouped by location, food security situation, and marketing position. The analysis of location reflects the sample's stratification into farms located (1) in the center of the irrigated zone (*casiers*) where improved (*réamenagé*) plots dominate and market access is relatively easy and (2) on the edges of the irrigated zone (*bord du casier*), where access to irrigated plots is more limited, rainfed production complements irrigated production, and access to markets is more difficult (bad roads and longer distances). Food security is measured by whether a farm was able to provide 214 kg/capita of consumable cereals taking into account production, sales, and purchases. The marketing position analysis compares farmers who are net sellers (kg sales > kg purchases) to all other farmers.

Table 31 presents several indicators of land assets. Land is not actually *owned* by farmers in the *Office du Niger*, but farmers who have cultivated the same land year after year and have their use of it officially registered by the ON are considered owners in the following discussion. For land outside the ON, ownership is generally a function of having been authorized use rights by the village chief and/or having cleared the land.

Table 31. Macina Land Assets by Location, Food Security and Market Position

Land asset indicators examined	Village Location			Cereal Adequacy			Marketing Position		
	Casier and Easy Access	*Bord Casier* and Difficult Access	Statitical Signif.	<214 kg per capita	≥214 kg per capita	Statitical Signif.	Not net seller	Net Sellers	Statitical Signif.
	(mean values)			(mean values)			(mean values)		
Hectares currently owned	4.2	8.6	**	5.4	6.9	**	4.8	6.6	**
Hectares owned per capita	0.33	0.71	**	0.42	0.57	**	0.54	0.53	nsd
Hectares of improved irrigated land owned	4.00	2.2	**	2.4	3.3	**	0.9	3.4	**
Hectares of *hors casier* irrigated land owned	0.07	1.2	**	0.45	0.75	*	0.43	0.70	nsd

**probability of no difference <0.05%; *probability of no difference <0.10%; nsd = no significant difference at <0.10%
Means of 432 observations (roughly 3 annual observations for each household); some variation in observations by year and by variable due to missing values.

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Farmers in the *bord du casier* have much more total land and land per capita than farmers in the *casiers* because they are more reliant on extensive rainfed production of coarse grains. *Bord du casier* farmers have significantly less high quality irrigation land with fully controlled water and more of the lower quality parcels with partial control. The average *casiers* farm in the sample *owns* a total of only 4.2 hectares, which are predominantly irrigated parcels; this is less than the recommended minimum size of 5 hectares needed to ensure food security and access to basic necessities, but includes substantially more good quality irrigation land than farmers in the *bord du casier* villages (4 versus 2.2 ha). While location does not differentiate households by food security status (roughly 71% of *casiers* and *bord du casier* farms meet minimum needs), land ownership patterns differentiate farms in terms of cereal availability, with households meeting the 214 kg benchmark having more total land, more land per capita, and more irrigated land—both improved and unimproved. The same pattern differentiates net sellers from all other farms, with the exception that there is no significant difference in terms of land per capita. Net sellers have access to 3.4 hectares of improved irrigation land and 0.70 hectares of the less productive *hors casiers* land while other farmers have access to only 0.9 hectares of improved irrigation and 0.43 ha of *hors casiers* land, suggesting that access to irrigated land may be an important determinant of whether one becomes a net seller. As in other zones, land owned per capita is significantly ($P<0.05$) and positively correlated with coarse grain sales (0.18 coefficient), and with the quantity of cereals/capita available for consumption (0.33). It is negatively correlated (-0.26) with cereal purchases (i.e., farms with more land make fewer purchases), primarily because the larger farms are those on the edges of the irrigated area where in addition to their small irrigated plots they cultivate millet on relatively large plots.

While land access—both quantity and quality—seems to be an important determinant of food security and marketing position, there are a number of other farm characteristics that differ across location, food security situation and marketing position. Asset indices reported in Table 32 suggest that households in the *casiers* possess more durable goods and more livestock but less agricultural equipment. Lower levels of equipment are consistent with the generally lower farm sizes because there is little rainfed production in the *casiers*.

Table 32. Non-land Assets of Farms Differentiated by Location, Food Security, and Market Position

Non-land asset indicators examined	Village Location			Cereal Adequacy			Marketing Position		
	Casier and Easy Access	*Bord Casier* and Difficult Access	Statitical Signif.	<214 kg per capita	≥214 kg per capita	Statitical Signif.	Not net seller	Net Sellers	Statitical Signif.
	(mean values)			(mean values)			(mean values)		
Index of equipment assets (0 = none; 1 = best)	0.18	0.24	**	0.17	0.23	**	0.16	0.22	**
Durable goods index (0 = none; 1 = best)	0.53	0.44	**	0.42	0.51	**	0.33	0.51	**
Tropical livestock units owned	14	9	*	9.5	12.3	*	3.9	12.6	**

**probability of no difference <0.05%; *probability of no difference <0.10%; nsd = no significant difference at <0.10%
Means of 432 observations (roughly 3 annual observations for each household); some variation in observations by year and by variable due to missing values.

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

The higher level of livestock ownership is surprising given that pasture land is more limited in the *casiers*; these households may be sending some of their animals on migration for part of the year. As expected, these indices, which serve as proxies for relative wealth, tend to be higher for households meeting the minimum cereal requirements and for net sellers.

Table 33 compares mean values of household demographic variables by location, food security, and marketing position. There is only one female headed household in the sample with three annual observations so it is not possible to say anything statistically relevant about female headed households; we note however, that this household was food secure in two of three years and a net seller one year. In general, demographic factors such as age, household size, and dependency ratio did not differ with the following exceptions:

- Dependency ratio was lower (one adult feeding him/herself plus one other individual) for households meeting the 214 kg/capita benchmark than for those not meeting it (one adult feeding him/herself plus 1.22 other people);
- Dependency ratio was lower for net sellers (one adult producing for him/herself and one dependent) versus all other farms (one adult producing for him/herself and 1.5 others)
- Membership in farmer associations was more common in the *casiers* villages and among net sellers;
- The average age of the household head for net sellers was 5 years lower than that of other farms;
- The maximum level of education attained by any household member was 1 to 2 years higher in the *casiers*, for those meeting food security requirements, and for net seller households.

Table 33. Demographic Characteristics by Location, Food Security, and Market Position

Demography variables examined	Village Location			Cereal Adequacy			Marketing Position		
	Casier and Easy Access	*Bord Casier* and Difficult Access	Statitical Signif.	<214 kg per capita	≥214 kg per capita	Statitical Signif.	Not net seller	Net Sellers	Statitical Signif.
HH=household	(mean values)			(mean values)			(mean values)		
Age of the HH head	52	54	*	54	52	nsd	57	52	**
Gender of HH head (females in each group)	0	3	nsd	1	2	nsd	2	1	nsd
HH Members present	14	13	nsd	14.3	13.5	nsd	9.5	14.3	**
HH Adult equivalents present	11	11	nsd	11.6	11	nsd	7.9	11.6	**
Dependency ratio	1.06	1.08	nsd	1.22	1	**	1.5	1	**
Avg. of maximum years of schooling attained by members of the HH >14 years	4.6	2.81	**	3.09	3.90	**	1.44	3.96	**
-HH belongs to an association (sample average = 66%)	72%	60%	**	62%	67%	nsd	41%	69%	**

**probability of no difference <0.05%; *probability of no difference <0.10%; nsd = no significant difference at <0.10%
Means of 432 observations (roughly 3 annual observations for each household); some variation in observations by year and by variable due to missing values.
Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Table 34. Farm Performance Indicators by Location, Food Security, and Market Position

Performance indicators examined	Village Location			Cereal Adequacy			Marketing Position		
	Casier & Easy Access	*Bord Casier* & Difficult Access	Statitical Signif.	<214 kg per capita	≥214 kg per capita	Statitical Signif.	Not net seller	Net Sellers	Statitical Signif.
	(mean values)			(mean values)			(mean values)		
Avg. hectares cultivated**	4.2	7.3	**	4.7	6.3	**	3.8	6.1	**
Avg. hectares cultivated/capita (ha)	0.34	0.61	**	0.33	0.54	**	0.4	0.49	*
Avg. kg coarse grain production/capita**	15	131	**	40	89	**	96	72	**
Avg. kg coarse grain purchases/capita**	50	25	**	27	41	**	56	34	**
Avg. yield/ha (kg)	3161	2543	**	2476	2989	**	1946	2921	**
Avg. kg rice production/capita**	1092	699	**	502	1048	**	214	981	**
Avg. rice purchases/capita	7	7	nsd	7	7	nsd	32	4	**
% Net sellers (sample avg =88%)**	94%	83%	**	82%	91%	**	xxx	xxx	xx
% HH meeting 214 kg (sample avg 71%)	71%	72%	nsd	xxx	xxx	xx	57%	73%	**
Avg. kg cereal availability/capita	407	364	nsd	141	484	**	287	398	**
Livestock income/capita (FCFA)	48	693	nsd	727	238	nsd	-345	474	nsd
Non-farm income/capita (FCFA)	34,000	30,000	nsd	19,000	38,000	**	33,000	32,000	nsd

**probability of no difference <0.05%; *probability of no difference <0.10%; nsd = no significant difference at <0.10%
Means of 432 observations (roughly 3 annual observations for each household); some variation in observations by year and by variable due to missing values.

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.

Performance indicators reported in Table 34 include various measures of crop production and non-cropping sources of income as well as cereal purchasing behavior. Observations of note include:

- While location is associated with differences in the composition of cereal production (*bord de casier* farmers produced almost nine times more coarse grains per capita but only 2/3rds of the rice produced by farmers in the *casiers*), the differences in average kg of cereal available for consumption for the two groups were not statistically significant nor the percent of households falling below the 214 kg/capita cereal adequacy benchmark (roughly 30% for each location).
- Farmers located in the *casiers* are more likely to be net sellers of cereals than those on the edges; this result reflects the more difficult market access for the *bords casier*s farmers (poor roads and longer distances), in addition to the more constrained access to high quality irrigated land and lower yields for households in the *bord du casier.*
- Survey yields for both *casiers* (3161 kg/ha) and *bord du casier* (2543 kg/ha) farmers are lower than average Macina yield statistics (5570 kg/ha for *casiers* and 3160 kg/ha for *hors casiers* fields) reported in earlier studies (Diarra 2004, for example) but similar to other studies (3137 kg/ha for 2003 reported by Kébé et al. 2005).
- Per capita income from livestock and poultry sales and by-products is very low and does not differ by location, food security or marketing position.
- Non-farm income appears to be a decisive factor for insuring food security for some households, with average non-farm incomes per capita for those attaining food

security double that of those not attaining it (38,000 FCFA/capita versus 19,000 FCFA).

- Net sellers are more likely to meet food security needs than those who are not net sellers, providing some evidence that sales are not being made at the expense of food security.
- Coarse grain purchases per capita in the *casiers* (where coarse grain production opportunities are limited) are twice as high as in the *bord du casier* (50 kg/capita versus 25 kg).
- Rice purchases are inconsequential at 7 kg/capita and do not differ by location and food security situation; in comparing net sellers to others there is a difference with net sellers purchasing only 4 kg/capita and others purchasing 32 kg/capita

The statistics in Tables 27 - 34 combined the three years of observations to provide an overall picture of sample farmers during the entire survey period. The salient findings are that (1) access to land, particularly improved irrigation plots, may be constraining farmers' ability to respond to the incentives offered by the Initiative Riz program, (2) food secure and net seller households have lower dependency ratios, (3) food secure households have higher levels of non-farm income, (4) households located in the *bord du casier* are not at greater risk of food insecurity than those in the *casiers* and net seller households produce more than four times more rice/capita than other households.

Multivariate analyses of the Macina data base to identify the factors influencing rice yields and rice marketing decisions are presented in Mather and Kelly forthcoming. The principal observable determinants of rice yield in Macina include nitrogen, the amount of hired transplanting labor per hectare, and reported household-level production problems such as poor water control. As expected, nitrogen has a strong, significant, and positive effect on rice yield. At the mean level of nitrogen use in the sample (79.6 kg of Nitrogen/ha), an additional kg of nitrogen/ha increases rice yield by 11.3 kg/ha. Given prevailing price relationships, the value cost ratio for this response would have been 2.3 in 2008 and 2.2 in 2009.[22]

While the mean/median quantity of nitrogen applied to rice increased slightly from 2008 to 2009, the yield benefits from nitrogen appear to have been more than offset by various reported household-specific production problems, which have large and significant negative effects on rice yields. For example, problems with water control reduced yield by 477 kg/ha, late planting reduced yield by 356 kg/ha, and 'other' undefined problems reduced yield by 610 kg/ha. These findings help explain the decline in rainy season rice yields from 2008 to 2009, as we found a larger percentage of households reported problems with water control and 'other' problems in the latter year.

The marketing models revealed that the principal observable factors affecting the household quantity of rice sold were household rice production and the level and source of input credit that season. Because a principal factor explaining rice sales is rice production, it's not surprising that quantities of rice sold fell over time as production and yields fell. What is

[22] Calculated using 4.34 kg of urea, which is 46% nitrogen, to obtain 1 kg of nitrogen: 4.34 * 306 as an average price for fertilizer puts the cost at 1316 FCFA; 11.3 kg of paddy that sells for a typical 2008/09 price of 262 FCFA/kg = 2961 FCFA for a value/cost ratio of 2.3 and a net benefit of 1645 FCFA/kg of N or per 4.3 kg of urea. With the lower fertilizer and rice prices prevailing in 2009, the v/c ratio would have been 2.2 and the net benefit 1472 FCFA.

perhaps surprising from this analysis is that even after controlling for the amount of rice and coarse grains produced, the level of input credit, and demographic and wealth measures, variation in the household's rice sale price does not have a significant effect on the quantity sold. This suggests that either there is considerable heterogeneity of price responsiveness across different kinds of households or that household rice sales are simply not very responsive to changes in the rice price. Another hypothesis might be that the price responsiveness is linked to the production decision based on price expectations. The model eliminates quantifying this effect by using production as an explanatory variable. Because the ability of a farmer in the ON to change land area is limited, the main production response would probably be through more fertilizer to increase yields. Such a response was facilitated by the fertilizer subsidy that began in 2008/09, but there was little evidence of a substantial increase in fertilizer use and/or yields for sample households as a result of the fertilizer subsidy despite rising output prices (Mather and Kelly forthcoming). Analyses by cereal production groups also returned non-significant price coefficients for both the lower 1/3 and the upper 2/3rds of cereal producers, suggesting that the problem is not heterogeneity based on levels of cereal production.

5.7. Cross-zone Synthesis

This review of survey data for three different production zones in Mali highlights the important differences due not only to geographic and climatic factors but also due to different approaches to government investment and support to agriculture. Given our interest in understanding how farmers who participate actively in cereal markets differ from others, Table 35 summarizes the statistically significant differences between net seller farms and others for all three zones. The most important finding is that net seller households own and cultivate more land regardless of zone. They also surpass other farms in terms of cereal production per capita and ability to meet the 214 kg/capita minimum cereal requirement.

Table 35. Characteristics that Differentiate Net Sellers from Other Farmers, by Zone

Characteristics	Tominian	Koutiala	Macina
Asset variables	**Net seller households own statistically more of indicated asset**		
Land owned by household	yes	yes	yes
Land owned per capita	yes	yes	NSD*
Agricultural equipment owned	NSD	yes	yes
Durable goods owned	NSD	yes	yes
Tropical livestock units owned	NSD	NSD	yes
Demographic and locational variables	**Net seller households are more likely to have these traits than others**		
Someone in household is a member of a producer association	yes	NSD	yes
Located in a village with easy market access	yes	NSD	yes
A lower dependency ratio	NSD	NSD	yes
A younger household head	yes	NSD	yes
Higher level of educational attainment	yes	NSD	yes
Performance indicators	**Net sellers are more likely to have better performance than others**		
In meeting 214 kg/capita cereal needs	yes	yes	yes
In total cereal production /capita	yes	yes	yes
In coarse grain production/capita	yes	yes	No
In area cultivated	yes	yes	yes

Source: Authors' calculations based on IER-CIRAD-MSU household survey data.
* NSD means not statistically significant difference.

None of the other variables examined are significant across all three zones; however, ownership of agricultural equipment and other durable goods plays an important role in differentiating net sellers from others in the two more productive cereal zones of Koutiala and Macina. Demographic characteristics are surprisingly unimportant in Koutiala, but younger household heads and households with higher educational attainment are more likely to be net sellers in Tominian and Macina. Net sellers are also more likely to be members of producer associations in Tominian and Macina, but this variable was not significant in Koutiala, where a much larger share of the sample were members of associations, diminishing the opportunity to find differences. Similarly, net sellers were more likely to live in villages with easy access to markets in Tominian and Macina, but this relationship was not supported in Koutiala.

These cross-zone comparisons lead us to conclude that the greatest constraints to moving rural households out of poverty through cereal production and marketing are structural and related to poor access to productive assets—first land, and then agricultural equipment and durable goods (particularly vehicles and phones). Better physical access to markets can complement access to productive assets in two of the three zones. Attention to the asset constraints in the irrigated rice and cotton/coarse grain zones should be able to increase the share of farmers becoming net sellers. The extent to which this would be possible in the traditional coarse grain zone of Tominian is not clear given the additional constraints associated with soil quality, climate, and a farming system dependent on relatively unproductive cereals (millet and sorghum) for which demand is declining.

6. CEREAL MARKET RESPONSE TO CHANGING PRICE AND POLICY ENVIRONMENT

Having analyzed farmers' cereal production and marketing responses to recent changes in the policy and price environment, we now turn to a review of how cereal markets have evolved since the beginning of market liberalization in Mali. In the first part of this section we present a description of changes in the coarse grain market structure and coordinating practices and then describe how they differ from rice markets, ending with a brief overview of current domestic and regional marketing channels. The second part of this section is a descriptive analysis of marketing margins and what available analyses can tell us about market performance across time and space.

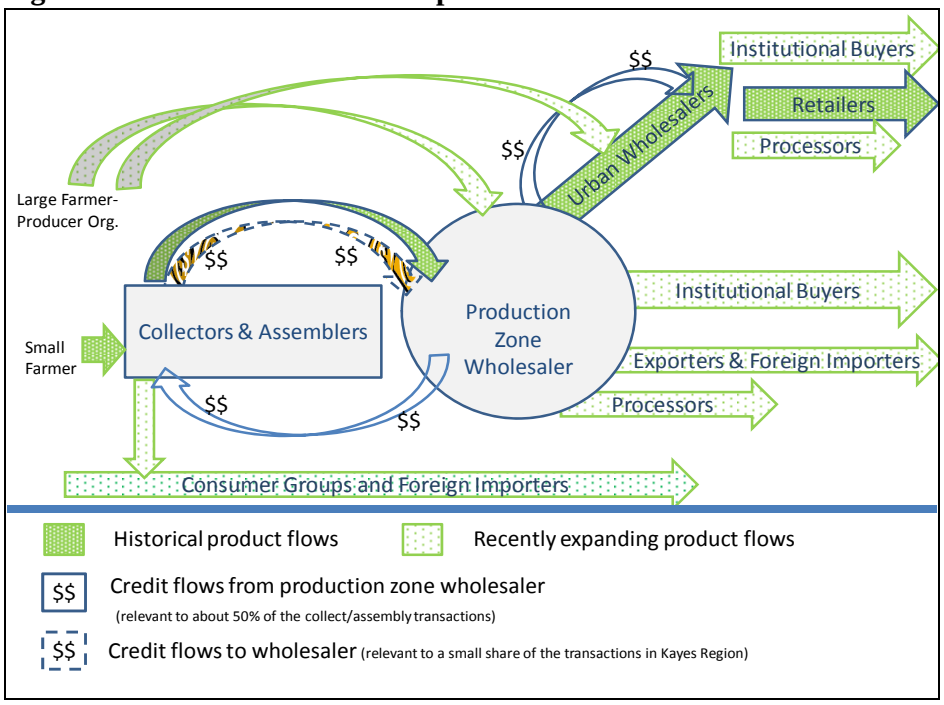
6.1. Evolution of Cereal Market Structure and Coordination Practices

6.1.1. Coarse Grain Markets

The coarse grain market structure that emerged at liberalization in the 1980s was dominated by multiple vertically integrated networks of collectors and distributors tied through financing to a central wholesaler operating out of one or more major assembly markets in the coarse grain production zones. Several studies provide detailed descriptions of the different actors in the system (see Galtier 2002; Diakité 2006; S. Diarra 2008; Samaké et al. 2008), so we focus on observed changes in the nature of the relationships between different actors during the past 10-20 years and changes in credit and cereal flows.

The Actors: Figure 21 illustrates some key aspects of market structure showing the general flows of cereals and of financing among actors following liberalization, but also incorporates some of the newer actors and relationships.

Figure 21. Actors and Relationships in Malian Coarse Grain Markets



Source: Authors.

Actors in the forward coarse grain markets are predominantly urban wholesalers who supply retailers. Market surveys suggest that both urban wholesalers and retailers do not specialize in coarse grains but also sell rice and other products. Distribution functions are characterized by loyalty relationships established between coarse grain wholesalers and a network of their preferred retailers. Retailers also seem to develop a network of loyal customers. These loyalty relationships are primarily the result of credit being offered at each level, which has the effect of maintaining the relationship over time. Some have suggested that these credit relationships have a tendency to diminish the possibility of negotiations over price, but this is difficult to confirm (Galtier 2002). In many cases, the production-zone wholesalers kept the entire value chain moving by offering credit not only to collectors but also to urban wholesalers.

Over time, the variety of actors at the collection level has increased and the relative importance of some has changed; among the new actors (or new roles for old actors) we find:

- Large farmers and producer organizations who are selling directly to both production-zone and urban wholesalers; these actors are particularly active in maize markets; Consumer groups and foreign wholesalers/importers going directly to independent collectors and assemblers, bypassing the production-zone wholesalers;
- Processors, with new demands for better quality coarse grains, who are sourcing their grain from both production-zone and urban wholesalers;
- Institutional buyers (OPAM, WFP, and NGOs) who are now sourcing from both production-zone and urban wholesalers (WFP also going directly to producer associations); and
- Collectors and assemblers in the Kayes region who are providing grain on credit to the production-zone wholesalers (reversing the traditional flow of credit from wholesaler to collector that is characteristic of other regions in in Mali).

While we do not have a clear understanding of why the credit flows in the Kayes region differ from those in other regions, one hypothesis is that the foreign remittances coming into households in the zone (much more important in Kayes than elsewhere) are providing liquidity for the assemblers and collectors. The absence in Kayes of large production zone wholesalers and the kinship relationships characteristic of their networks in other zones may also limit the potential for credit to be extended to collectors and assemblers.

The consumer groups range from consumer associations in the Kayes region to rebel movements and drug dealers in the North. Foreign importers (primarily wholesalers from Mauritania, Niger, Burkina Faso, and Côte d'Ivoire) and consumer groups began bypassing the established networks about five years ago. Both arrive in the rural collection markets with their own financing and coordinate their own transportation. Some foreign importers also rely on border town brokers to coordinate transactions. Despite the growth in the diversity of buyers, the vertically integrated networks remain a dominant feature of coarse grain markets. A recent study reported that 70% of wholesalers maintain their own network of collectors and 67% work with their own network of distributors (S. Diarra 2008). In many cases these networks are broader than they were in the 1980s, as wholesalers become increasingly diversified into a range of products going beyond coarse grains. Interviews with collectors, assemblers, and wholesalers confirm that competition has increased at all levels. For example, the Sikasso trader association *Acheteurs des Produits Locaux de Sikasso* (APLS) created in 1989 started with 10 members and now has more than 60; cotton-zone cereal traders in Kanico claimed that 20 years ago there were 20 traders covering the zone and now there were more than 100 (Boughton and Dembélé 2010).

Pricing: Because the production zone wholesalers play an important role in financing the entire market chain, one might expect them to also have more power than other participants in determining prices. Historically, the opportunity to control prices was muted by the large number of independent collectors present in most markets and by the practice of production-zone wholesalers allowing their network of collectors and assemblers to negotiate price and credit terms when market conditions differed from expectations. More recently, the influx of other buyers in rural markets (particularly foreign buyers with independent financing) and increases in the private flow of information via cell phones has further reduced the relative importance of the traditional production-zone wholesalers in temporal and spatial arbitrage. Several traders reported that the presence of these new actors at the beginning of the harvest period has reduced the harvest-season price drops, providing farmers with higher overall prices. Many of the new entrants in the market are willing to pay higher prices because (1) their opportunity cost for physically staying in the production zone is high and (2) the downstream demand structure they face is such that they will ultimately command a higher price than those selling on the Malian market. It appears at present that despite their control of somewhat more than 50% of the market, the production-zone wholesalers do not play a controlling role in price determination. There is evidence from the late 1990s that urban wholesalers were setting the prices at which their retailers could sell, thereby eliminating the possibility of consumers negotiating with a retailer for a better price. The line of credit extended by the urban wholesaler to the retailer ensured that the prescribed prices were respected (Galtier 2002). It is not clear if this price setting is still in place today.

Efficiency: Improved transport infrastructure and communications have contributed to the increase in actors and competition as well as to efficiency. For example, exports to Senegal are reported to be moving directly from production-zone wholesalers to Senegalese importers without passing through agents in Bamako because the production-zone exporter has access to good price information and is also able to receive constant feedback on the progress of the shipment up through final delivery. Prior to the fall of the city to separatists in March 2012, coarse grains were also moving directly north to Gao from the production zones without transiting through Mopti, as they did in the 1980s and 1990s.

Contracting: Official contracting has also become more important than it was, but remains more limited for supply than for distribution. In the 1980s, all transactions were based on verbal agreements and mutual trust. Since the beginning of the 1990s, 54% of wholesalers reported using procurement contracts (written or not) and 74% used sales contracts (especially with institutional buyers) (Samaké et al. 2008). The creation of *La Coordination nationale des opérateurs économiques du secteur agro-alimentaire du Mali* (CONOESAM) in 2000 and its regional affiliate *Reseau des opérateurs économique du secteur agro-alimentaire de l'Afrique de l'Ouest* (ROESAO) also contributed to a greater emphasis on both contracting and contract enforcement, as did the creation of local trader organizations such as APLS (see Ag Akeratane 2005 for a discussion of APLS). Although contracting has increased, interviews with key actors suggest that the price component of the contract is open to negotiation when deliveries are made if markets have tightened significantly or the purchaser is not satisfied with the quality of the grain (Galtier 2002).

Quality: Coarse grain quality is increasingly important in urban areas where product differentiation is based primarily on cleanliness and uniformity of grain. Retailers competing in the urban quality market (often dominated by women with limited financial resources) operate on a small scale, purchasing grain and cleaning it themselves to benefit from the

value added. At the beginning of market liberalization, clean grain was not a product offered. Clean and uniform grain also becomes important at wholesale if the intended client is an institutional buyer, urban processor or exporter. There continues to be a lack of attention to quality at the collection and assembly levels, reflecting poor price transmission from the urban to the rural areas for improved quality. This is particularly true for maize, which is in high demand by animal feed processors. Maize imports are thought to be filling some of this quality demand because Malian farmers are not yet supplying the quantity of better quality grain demanded.

6.1.2. Differences between Malian Coarse Grain and Rice Marketing Structures

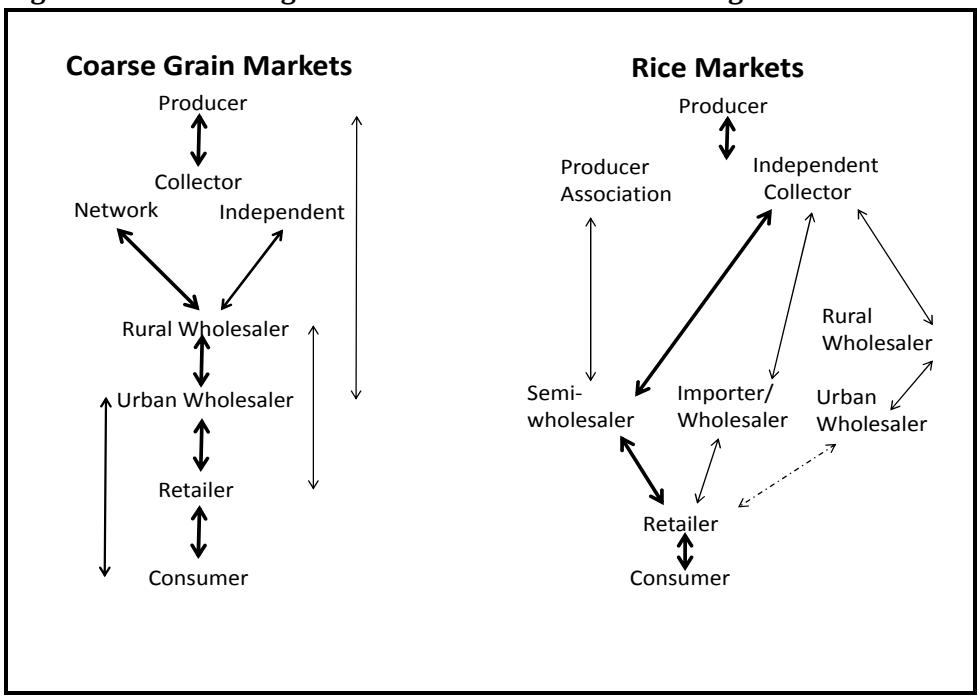
Rice Marketing Channels: A recent study of the rice value chain in Mali identified three categories of final demand: production-zone demand, mass urban demand for lower quality rice processed by small rice mills, and high-end demand for better quality rice processed by industrial or mini rice mills. These demands are supplied through the six marketing channels described below (percentages shown are estimated shares of production for the Segou region for 2008/09 calculated from data in USAID 2009):

- Processed rice consumed by producers or sold into production-zone consumer markets (26-28% of production)
- Traditional small-scale trade channel based on farmers' sales of hulled rice to local collectors who sell downstream to wholesalers and retailers (represents 57% of production and 80% of traded quantities);
- Industrial rice milling channel, which is making a timid come-back through investments by the importer/wholesalers after having stopped entirely in the late 1990s (2% of production);
- Farmer association channel, representing 58 associations linked to the FasoJigi apex organization and another 100 associations operating without an apex structure (6% of production);
- Mini rice mill channel selling rice that is purchased as paddy and processed for sale (3% of production); and
- Commercial farm channel, which by-passes wholesalers selling directly to retailers or consumers (6% of production).

According to the above analysis, the traditional small-scale processing sector dominates the market (80% of traded quantities); yet policy and donor discussions in recent years have focused on interventions to increase the quantity of better quality rice marketed to the upscale consumer. While these discussions may be prescient, one must not lose sight of the current reality, which is that most Malians are consuming primarily the less expensive types of rice calories.

The Actors. Since most of Mali's marketed rice production comes from the *Office du Niger*, we describe the ON marketing system in this discussion. Figure 22 illustrates the major differences between the coarse grain and rice markets. The weight of the arrows provides a rough idea of the relative importance of the product flows in terms of volume. The most

Figure 22. Contrasting Coarse Grain and Rice Marketing Structures



Source: Adapted from Galtier 2002.

outstanding difference is at the collection level. In the rice market, there is very little activity by production zone wholesalers and all of the collectors in the ON are independent actors who are contracted on a day to day basis by the urban wholesalers (i.e., the phenomenon of networks of production zone wholesalers tied to collectors through kinship and credit arrangements that is found in the coarse grain zones does not exist in the rice zone).

This has a number of implications for relationships among the different actors, credit flows, and price negotiations. Rice collection is driven by a large number of semi-wholesalers based primarily in Bamako. Most of them are small operators with more limited financial assets than the production zone wholesalers in coarse grain zones. They work with collectors who live in the production zone and have good relationships with producers. The semi-wholesalers lay out the terms for their collectors, setting the quality, quantity, delivery conditions, and the price they will pay. Collectors working for the semi-wholesalers do not have the liberty of negotiating prices or offering credit to farmers, as is the case with the coarse grain networks of collectors. Farmers dealing with a collector in the rice zone must accept the offer price or look elsewhere. Another difference between the coarse grain and rice markets is that most of the coarse grain transactions take place in large markets where transactions and prices are easily observed and communicated while most of the rice transactions take place in villages where the transactions are less public.

In some cases, credit for rice purchases may flow downstream from the collector to the semi wholesaler, who sells directly to consumers and to other retailers. At each stage, however, the credit is short term (a few days), and product turnover is fast.

The large importer/wholesalers, which form the backbone of the industrial milling sector described as the third marketing channel, operate in a way that is more similar to what is observed in the coarse grain markets. First of all, these actors are primarily importers. Their number is limited (3-10, depending on the year) because of their import activity, which

requires a GOM license. These actors are often traders who accumulated substantial financial resources prior to liberalization by marketing rice for the *Office du Niger*; this enables them to benefit from bank credit at favorable terms. The bank credit facilitates upstream and downstream financing. The importers tend to purchase local rice more actively in years that government restricts imports. When they do participate as wholesalers in purchasing local rice, they contract large numbers of collectors. The collectors are local residents in the rice zone, generally without kinship ties to the wholesalers. Collectors may receive some credit from the wholesaler but credit is not as common as in the coarse grain zones. The overall influence if the importer/wholesalers is relatively small given the estimated 2% share of production attributed to them. Because the importer/wholesalers are well financed, it would appear logical for them to increase investments in local rice processing and trade, but past behavior suggests that while they are willing to make timid investments to penetrate the high-end urban markets, these investments are not sustained when government policy exonerates imports from taxes, making the import business more profitable for them (USAID 2009).

Although producer organizations appear to be better organized, trained, and financed in the *Office du Niger* than elsewhere (Traoré and Spinat 2002), their sales account for only 6% of rice production. They often own or rent warehouse space to store common stocks obtained through member repayment of input loans or the personal stocks of their members. Access to storage and some training in basic marketing skills has permitted the organizations to play a greater role in controlling the timing of sales than is evident in the coarse grain value chains. Individual rice farmers are also more inclined than coarse grain farmers to sell continuously throughout the year, albeit with major sales in February/March to pay water fees and in April through June to pay for inputs for the upcoming cropping season. Both farmers and their organizations sell primarily to collectors in the production zones representing the semi-wholesalers from Bamako, although there is some evidence of direct negotiations between semi-wholesalers and producer organizations.

At the distribution level, the market seems to be characterized by the same types of credit and loyalty relationships described for the coarse grain markets. While all coarse grain retailers appear to also sell rice, it is noteworthy that some rice retailers do not sell coarse grains.

Although the variety of buyers observed in the coarse grain markets exists in the rice markets, the share of the market going to institutional buyers and foreign importers has tended to be smaller, with most local rice going to domestic consumers. Since 2007, however, there have been some changes. Foreign buyers from Mauritania have been participating actively in Malian rice markets since 2007 and buyers from Burkina and Niger participate when there are production shortfalls in those countries (particularly in 2011/2012). In 2008, the *Initiative Riz* directed OPAM to become more involved in local rice purchases as a way of ensuring that increases in local production did not lead to market gluts. Previously, OPAM's mandate was to purchase coarse grains. It was only in 2010, however, that OPAM intervened in rice markets in a significant manner (Table 36).

OPAM makes purchases using public tenders that cite prices they are willing to pay and the quantities needed. Respondents can be producer organizations, but cereal traders dominate the tender process.

Table 36. OPAM Rice Purchases: 2005 to 2011

Type of Rice Purchase	2005	2006	2007	2008	2009	2010	2011
	Metric Tons						
Imported	8,995	32,906	6,069	11,653	22,297		
Local			2,158	6,629	143	15,328	4,059
Total	8,995	32,906	8,227	18,282	22,440	15,328	4,059

Source: Official OPAM statistics.

In 2008 and 2009, OPAM used available funding to significantly increase imports instead of purchasing local rice at the relatively high prices that were being demanded by Malian farmers.[23] Newspaper articles in March of 2010 suggested that many farmers were sitting on large stocks of cereals waiting for OPAM to purchase and growing increasingly concerned about their ability to pay their water fees that were due in March. Despite numerous contracts signed at 300 FCFA/kg between farmers and traders responding to the OPAM tenders, few purchases were made at that price. Farmers were subsequently offered prices as low as 220 or 240 FCFA/kg (Coulibaly, March 2010). In December 2010, news stories continued to describe large stocks of unsold rice in the ON and negotiations between the Director Generals of OPAM and the ON to increase OPAM purchases at a price not to exceed 125 FCFA/kg of paddy (Daou 2010). In sum, OPAM has not lived up to expectations for the marketing component of the IR. The inability of OPAM and farmers to agree on prices as well as delayed receipt of funding by OPAM may be partially responsible for the decline in shares of production sold by sample farmers (see Section 5.6).

Pricing: Although the collection-level transactions in the rice production zones appear to be much more atomistic than in the coarse grain zones and therefore more subject to price determination through competitive forces, there are a few caveats — the most important being the concentrated nature of the market for rice imports. The rice import market is an oligopoly because few firms are able to amass sufficient financial capacity and obtain an import license. Imported and domestic rice are close substitutes. As long as local rice is available on the market, prices are determined not only by the costs of importing but also by the prices for local rice — ensuring price competition in the market. Because imported rice is the marginal market, it can have an important influence on prices. Price transmission studies have found a generally high correlation between world market prices for rice, imported rice prices in Bamako, and local rice prices in Bamako (see section 6.2.4 for details). When local supplies become tight, however, the oligopolistic structure of the import market permits importers to exert stronger than usual influence on the local rice market. The role of importers was particularly apparent in 2007/08 when the GOM eliminated value added taxes and most duties on imported rice in an effort to moderate the price spikes; but importers did not pass the benefits on to consumers.

The fact that rice collection transactions generally do not take place in large, transparent markets is a second factor that can potentially weaken competition. Transactions are spread out across the production zone at the village level so it is difficult for both farmers and traders to get a sense of prevailing prices. This is in contrast to coarse grain transactions, which are

[23] One news article claimed that OPAM was offering a price of 270 FCFA/kg for processed rice in January 2009 when OMA data showed Macina market prices at 285 FCFA/kg (http://www.malijet.com/ actualite_economique_du_mali/ 25205-opam_le_dg_nous_crit.html.

more likely to take place in large, open markets. The growth in the use of cell phones by both farmers and traders is probably helping to maintain adequate transparency in pricing despite the non-centralized nature of the transactions.

A third factor is that most prices offered to farmers by collectors are not negotiable (at least not on the spot) because they are set in advance by the semi-wholesalers who have specified the prices they are willing to pay in the contracts agreed to with their collectors. Collectors in the coarse grain zones, particularly those in the wholesaler networks, are generally in a position to negotiate prices with farmers so there is more room for price negotiation on a day to day basis.

A fourth factor is the recent introduction of OPAM purchases to the sector. Although the quantities actually purchased have been small, farmers' expectations are affected by the belief that OPAM will be purchasing, and confusion over the prices that OPAM is willing to pay has perhaps been responsible for slow sales and the stubbornly high prices observed during the 2008 and 2009 campaigns.

A last point is the role played by the Chamber of Agriculture in officially announcing floor prices for producer association sales, particularly during the hungry season when supplies are short and most wholesalers are obliged to deal with associations rather than directly with farmers (Galtier 2002). Although there is no mechanism for enforcing these prices, producers tend to pressure their association leaders to respect them, adding another complexity to the price formation process.

Given all these factors, there is no clear conclusion to be drawn about the relative competitiveness of the coarse grain and rice markets.

Efficiency: Improved transport and communications infrastructure has contributed to greater efficiency in the rice sector as it has in the coarse grain sector; however, the efficiency gains described for coarse grain exports are not very important for the rice sector due to very low levels of rice exports. A number of road improvements within the Segou Region and linking the Segou Region to other regions is thought to have improved rice transport options.

Contracting: Although we found no discussion of differences between contracting in the rice and coarse grain sectors, the smaller role played by institutional purchases in the rice sector probably means a smaller role for official sales contracts at the distribution level. On the other hand, the virtual absence of production zone wholesaler networks in the rice zone may mean more contracting between wholesalers and collectors (albeit, probably more verbal than written) is taking place with rice collection activities than with coarse grain collection.

Quality: As suggested by the quality characteristics differentiating the six rice marketing channels described above, rice sales are much more based on quality than coarse grain sales. The first type of segmentation is imported versus local rice. Much of the imported rice is lower quality and lower cost due to a high (>35%) content of brokens; this product is popular with low-income consumers. Higher quality imports do compete with local rice, but many Malians prefer local rice and there is a willingness to pay higher prices for it. A second segmentation is that between paddy and processed rice. Demand for paddy is limited and comes primarily from the wholesaler/importers that also operate medium-sized rice mills that produce better quality rice than the smaller, more common mills. The next quality category is

hulled rice of mediocre quality processed by small mills, usually on a fee-for-service basis. Most local rice falls into this category and is marketed directly by producers or producer association. Farmers pay a fee for hulling (500-600 FCFA/ 75-80 kg of paddy), recuperate the bran for animal feed, and then sell the processed rice at a premium over paddy. Processing can provide an additional 4800 FCFA/75 kg of paddy or more after paying for processing and not accounting for the value of the bran, significantly increasing value added at the farm-level. This value added makes farmers reluctant to sell paddy, which makes it difficult for processors targeting the high-end consumer markets to purchase adequate supplies of paddy. Sales by producer associations are based on in-kind payments made by members for threshing services and input credit; usually, the associations perform the hulling and then sell to collectors. In addition to the distinction between paddy and hulled rice, there are five different qualities of processed rice (based on varieties, domestic or imported sources, and cleanliness). Although rice consumers are increasingly interested in quality differences and more willing to pay for them than coarse grain consumers, roughly 80% % of marketed rice is still processed by small scale mills that produce mediocre quality. Most analysts complain that a common language defining different qualities does not exist and needs to be developed if the quality market is to expand.

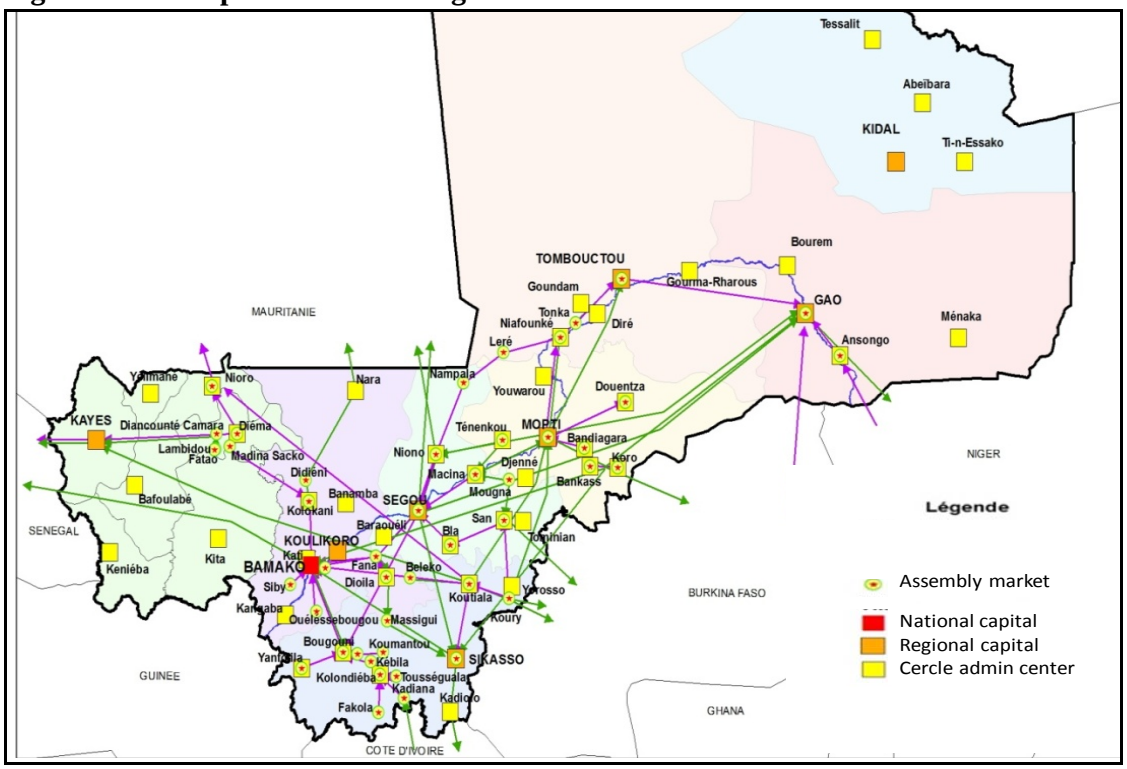
Summary of Key Coarse Grain and Rice Market Similarities and Differences: The discussion of rice markets compared to coarse grain markets has revealed the following differences and similarities:

- Production zone wholesalers linked to networks of collectors through credit and kinship ties dominate the coarse grain markets while urban semi-wholesalers purchasing through independent collectors living in the production zones are the main actors in the rice zone.
- Credit flows in the rice zone often go downstream from collectors and assemblers to wholesalers but are very short-term; credit flows in the coarse grain markets tend to originate with the production zone wholesalers—most flow upstream to collectors and assemblers but some also flow downstream to urban wholesalers and retailers.
- Rapidly growing institutional demand and demand by foreign importers is a more important characteristic of the coarse grain markets than the rice markets.
- Product segmentation (imported vs. local rice; paddy vs. processed) and the quality of processed grain are much more important factors in price determination in the rice sector than in the coarse grain sector; coarse grain markets appear to be weak in transmitting price information about quality.
- Both rice and coarse grain markets have benefited from improvements in transportation and communications infrastructure; these improvements have been particularly important in stimulating exports in the coarse grain sector but also important in linking production and consumption zones for both sectors.
- Urban wholesalers and retailers tend to operate in both the rice and coarse grain markets simultaneously, although there are a limited number of actors who deal in rice but not coarse grains.
- Credit plays an important role in creating loyalty between urban wholesalers and retailers as well as between urban retailers and customers; credit provided by wholesalers may allow them to set prices at the retail level, removing the ability of retailers to negotiate with customers.

6.1.3. Evolution of Domestic and Regional Market Sheds and Trading Channels

This discussion of the domestic trading channels and regional market sheds illustrates how markets have evolved while also providing context for the next section, which looks at price relationships along and across some of the more important channels. We draw heavily on a recent study (PROMISAM 2011) that mapped 114 cereal marketing channels in Mali. The study defined a marketing channel as a trade axis linking a production zone to a consumption zone, often via one or more intermediate assembly markets. Figure 23 maps the principal coarse grain trading channels, showing both domestic and export channels. The Sikasso Region stands out with the most channels (35) followed by Mopti (21), Segou (19), and Kayes (17). Table 37 complements Figure 23 by summarizing the key characteristics of the marketing channels that begin in each region.[24] In addition to noting the number of channels and destination points, Table 37 also includes observations concerning the most important channels and recent changes. Some recent changes are the result of road improvements while others can be attributed to improved production or more confidence between actors in the surplus and deficit zones. The improved confidence is encouraging production zone wholesalers to skip middle-men and deliver directly to some domestic and regional consumption zones. During the 1980s and 1990s much of the grain moving within Mali involved traders in Bamako or Mopti, often significantly increasing the physical distance as well as other transactions costs (storage, loading and unloading, etc.).

Figure 23. Principal Cereal Trading Channels in Mali



Source: Adapted from PROMISAM 2011.

[24] PROMISAM 2011 also reported on channels with supply points that are external to the region and the destination is within the region. Table 9 does not list these destinations, which generally concern cereal deficit regions or ones that import rice from other regions.

Table 37. Principal Cereal Marketing Channels in Mali by Region

Region	Number of trade channels*	Domestic destinations	Foreign destinations	Observations
Kayes	17	Koulikoro Bamako	Senegal Mauritania	Kita is the principal assembly/out-shipment point for the region. Growth in cotton and gold mining will stimulate demand in the region and create new channels. A return to normalcy in Côte d'Ivoire could reduce some of the trade with Senegal.
Koulikoro	10	Sikasso Bamako Diéma	Mauritania Burkina Faso	In bad production years supplies move from Bamako to the North and South, but the two Dioila channels do not change. Nara is the principal assembly/export out-shipment point to Mauritania. Brokers (Malian-Mauritanian) help coordinate transactions across the border.
Sikasso	35	All Regions Bamako	Senegal Burkina Faso Côte d'Ivoire	The *cercles* of Koutiala and Sikasso are the principal assembly points. Cereals move in all directions from these two points (Bamako, all regions, neighboring countries).
Segou	19	All regions but Sikasso Bamako	Mauritania Niger Burkina Faso	In bad years, imported rice becomes dominant in the channels to and from the Ségou Region. In normal years, the region imports no cereals. Bamako is the principal destination, but during the past 10 years there has been a diversification of destinations and an increase in volumes.
Mopti	21	Segou, Tombouctou Bamako	Burkina Faso	Much of the transport to/from Mopti is by boat on the Niger River. Rice comes mostly from the flooded production zones and moves toward zones without access to flood plains. Coarse grains come from Seno and San, going by boat to consumers in the interior of the region. Millet from Seno also goes directly to Bamako from Koro and Bankass, trucks returning with imported rice. Millet also goes to the Sikasso region and border towns of Burkina Faso.
Tombouctou	2	Segou Mopti		Two supply routes function. One from Segou via Nampala, Léré, Tonka, and Niafunké; the other from Mopti via Niafunké.
Gao	10	Segou, Bamako, Mopti		Recent road and irrigation investments are expected to increase trade passing through Gao.

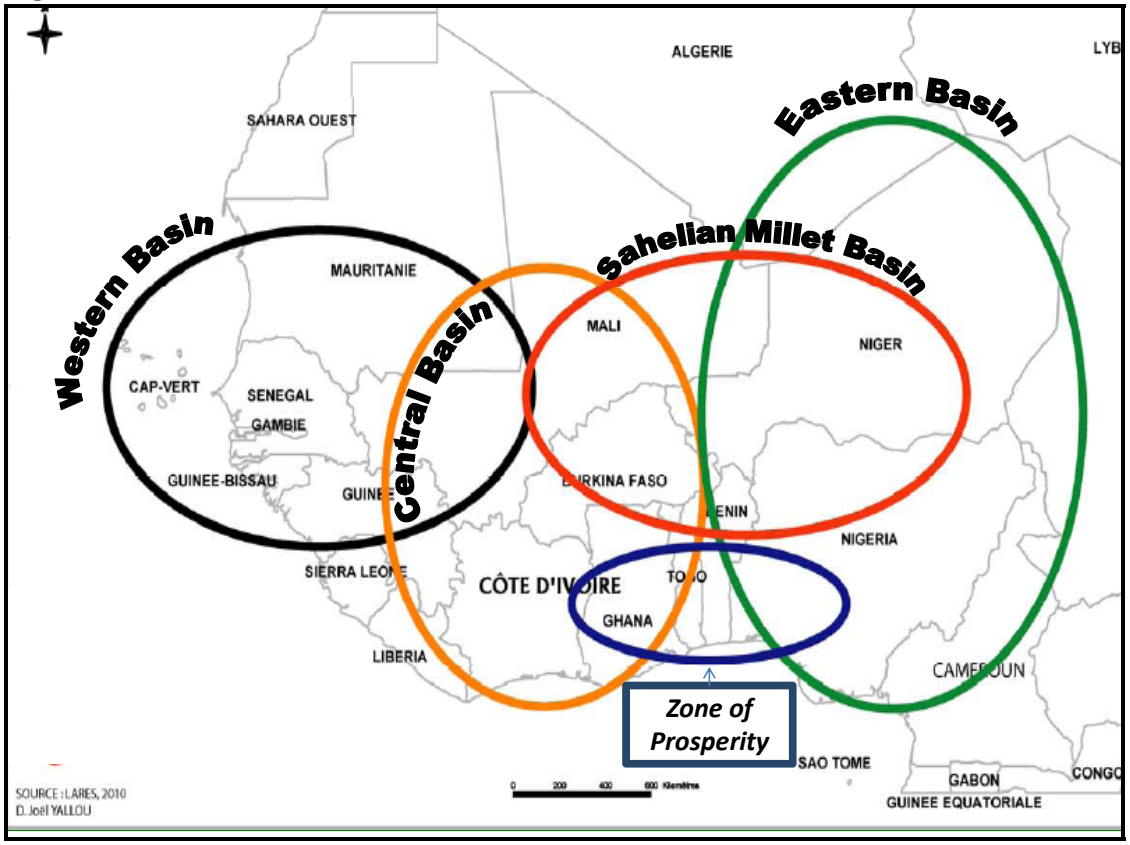
* Number of channels includes ones exporting from as well as importing into the region.
Source : Compiled from information in PROMISAM 2011.

Figure 24 shows Mali's central location among five market sheds that serve the region.

- Western zone, dominated by Senegal which imports more than half of its cereal needs.
- Central zone, which is primarily a maize trading zone where Côte d'Ivoire and Ghana dominate but Mali, Togo, and Burkina Faso also participate.
- Eastern zone, dominated by Nigeria and its neighbors, with large flows of millet, sorghum, maize and cowpeas as well as re-exports of rice—all of which account for about 60% of the entire regional cereal trade.
- The Sahelian band, characterized by flows of millet and sorghum between Mali, Mauritania, Burkina Faso, Nigeria, and Niger in response to inter-annual changes in production levels in each of these countries.
- Zone of prosperity covering Nigeria, Benin, Togo, and Ghana, where the salient characteristic is large re-exports of imported rice from Benin to Nigeria, driven by differences in official trade policies between the two countries (e.g., periodic Nigerian bans on imported cereals from overseas).

Mali is well placed to serve multiple markets in the region given its location in the Central and Sahelian zones, which overlap with both the Western and the Eastern zones, while being contiguous to the zone of prosperity. Traders in Sikasso recently reported that about 60% of their collection was destined for export markets (Boughton and Dembélé 2010), confirming reports from market integration studies that Sikasso and Koutiala tend to be better integrated with Burkina Faso markets than with Malian markets (Araujo, Araujo-Bonjean, and Brunelin 2010; Vitale and Bessler 2006).

Figure 24. West African Cereal Market Sheds



Source: Adapted from Soulé and Gansari (2010) who used a map from LARES (2010).

The regional trading channels of today are largely a continuation of channels that existed in the1970s (and earlier), but volumes are increasing and the directions of the flows can change, depending on harvests across the region (Soulé and Gansari 2010). The impetus for increased regional trade flows since 2000 comes from a combination of improved transportation, improved information flow via ICT, and trade agreements (e.g., WAEMU, ECOWAS), with the latter promoting investment in the two former. Population growth and urbanization are also contributing factors as well as income growth (particularly for some coastal countries); these factors are increasing demand beyond domestic supply. Two recent papers on West African regional cereal markets provide some insights into the organization and performance of these markets over time, but also highlight the major gaps in our knowledge because there are no credible statistics available on the size of the different trade flows (Soulé and Gansari 2010; Haggblade et al. 2012). What we know is that cereal production has increased not only in Mali but throughout West Africa (see Figure 5 presented earlier), yet the region has become more dependent on imports. Imported cereals represented roughly 20% of regional cereal consumption in 2008 (due largely to tax-exempt rice imports); this was an increase in share from the average of 18% between 2004 and 2006.

The notable challenges to increased regional trade are at the level of national marketing policy and regulations and support to farmers. Traders continue to incur important costs due to unofficial road taxes and export bans, and farmers' supply response is often weak due to limited access to inputs, credit, and extension services as well as poor price transmission of quality attributes demanded by consumers.

6.1.4. Summary of Major Structural and Coordination Changes

The salient changes in Mali's overall cereal marketing structure and organization during the recent past include:

- More actors and more diverse sources of financing;
- More competition in price formation (particularly at the rural market level) enable by communication and transportation improvements;
- Some shortening of marketing channels (both in distance and number of transactions) in both domestic and foreign markets;
- More contracting (though still relatively informal);
- More attention to quality for rice;
- Inadequate attention to quality for coarse grains going to commercial buyers; and
- More external pressure on Malian cereal prices by foreign actors, encouraged by regional trade agreements that became effective in 2000.

6.2. Measuring Performance through Price Analyses

In this section we look at three categories of price-based indicators often used to assess market performance:

- marketing margins, which reflect the cost of transferring cereals from producers to consumers;
- measures of competitiveness such as parity prices and the nominal and effective protection coefficients; and
- indicators of price transmission showing how well markets are connected.

6.2.1. Marketing Margins

Net marketing margins (the difference between producer and consumer prices minus marketing costs) are often used as indicators of marketing efficiency. Markets with lower net margins are considered more efficient than those with higher net margins and markets with declining net margins over time are considered to be increasing their efficiency. There have been a few case studies of net marketing margins based on interviews with selected traders (Samaké et al. 2008; Diakité 2006; M.M. Diarra 2008), but in general the results have been unsatisfactory due to small sample sizes, lack of a time perspective, high variability in the estimated margins, and the difficulties involved in finding traders who are willing to reveal their true costs. Given the difficulties associated with estimating net marketing margins, analysts in Mali have used alternative margin analyses and other methods to describe various aspects of market performance. A recent cereal market diagnostic study (Diarra and Diallo 2011) and a subsequent proposal for improving the cereal marketing sector prepared for the Minsitry of Agriculture (Diarra, Soule, and Staatz 2011) provide some insights on market performance from a variety of perspectives..

Diarra and Diallo (2011) examined the producer share of the consumer price for the same marketing channels, the assumption being that if the producer share of the consumer price was increasing it would suggest a reduction in marketing costs. It is possible that the reduced marketing costs could reflect increased marketing efficiency, but one cannot draw this conclusion without more information about marketing services provided. For example, the market may have become more efficient with intermediaries providing more services for the same margin (e.g., more product differentiation, cleaner grain, better quality processing). If this were the case, the producer share would have remained relatively stable while the marketing functions became more efficient. Unfortunately, adequate data on the nature and costs of marketing services over time are not available to sort out these details. Thus, the results from these types of analyses do not offer conclusive proof of changes in marketing efficiency. However, they do help us to see if the shares are moving in the anticipated direction given what we know about changes in prices, demand, and factors that might have contributed to increasing or decreasing margins.

For coarse grains Diarra and Diallo (2011) reported that the producer share had remained relatively stable during the past 20 years, but with two distinct periods. From 1990 – 1999, the producer share actually fell, but then rose in the 2000s. The authors noted that improvements in the organizational and marketing skills of producer organizations; increased use of market information to decide on timing, place and prices of sales; and the expansion of cell phones could have contributed to improved efficiency in the post-2000 period. For rice, the producer share increased over the two decade period, with most of the increases occurring before 2000 (considered a result of the devaluation and improved marketing skills of producer organizations in the ON) and remained relatively stable after 2000 (due, in part, to the GOM's use of imports to moderate prices).

The analyses presented below add to the Diarra/Diallo work by taking into account some of the differences in margins and price transmission along many of the other marketing channels that have emerged in Mali in recent years. Tables 38 – 40 present the absolute values of the margins (deflated by the general CPI for Bamako) and the margins as a share of the consumer price using OMA price data. The tables for millet and rice compare average values for 1993-1999 to averages for 2000 – 2009. The table for maize compares this same period but also presents a breakdown for 1993-2004 and 2005-2009 to better reflect the more recent development of the maize market in Mali, which still remains thin in terms of volume compared to other cereals. These marketing margins, defined simply as the difference between prices in market A and B, reflect many things such as transport costs and value-added activities through sorting and

repackaging, among others. They are noisy and must be interpreted with care. For example, declining absolute margins over time may be an indicator of increased competition or decreased transport costs. On the other hand, constant absolute margins over time could be an indication that any gains in competitiveness over time are being cancelled out by losses from increasing transport costs (a possible result of deregulation of the transport sector in the mid-1990s). Without actual data about the structure and conduct of these particular markets across space and time, we can only speculate about what may occur along the marketing axes studied and encourage other researchers to pursue these issues in more depth.

Results are mixed for millet, with six of nine markets showing reductions in the margin's share of consumer prices and four of eleven showing reductions in absolute margins (statistically significant differences at .05 or better). Interviews with traders suggest that improved information flow due to the extension of cell phone service to zones like Monimpébougou have contributed to direct trader-farmer/producer group transactions that could be contributing to reduced margins. The same phenomenon could be working on the Bankass to Gao channel. The Bankass to Mopti channel, however, has long been dominated by traders with strong ethnic/family ties, where changes in access to ICT are less likely to have had an impact. Given the difficulty in understanding the underlying causes of changes in margin shares, a prudent approach to using these results to inform policy decisions would be to focus on markets with the highest mean shares (e.g., 35% or more); there are five such cases in Table 10. Investments to improve the marketing system when margins are this high may yield gains to consumers similar to those that would accrue from very significant yield increases at the farm level. In many cases, these are channels associated with long and relatively high transport costs.

The rice margins are the most difficult to interpret as we have many statistically significant increases in margins, with all the decreases associated with market channels beginning in Niono and going to Bamako, Segou, Koutiala, or Sikasso. Declines in the margins range from 5 to 11 FCFA/kg while the increases are generally larger, ranging from 7-21 FCFA/kg. Niono to Tombouctou shows no significant change, while all the other channels show statistically significant increases in shares and/or absolute margins between the two periods compared. Significant road improvements between Segou and Niono in the mid-2000s may account for some of the decline in margin. Another hypothesis explaining these differences is that there is a quality factor that is not yet being captured by the OMA prices.

Table 38. Millet Margins for Selected Market Channels

	Marketing margin as a share of the consumer price		Real mean margins by period	
	1993-99	2000-09	1993-99	2000-09
Marketing channel	**(Mean Shares)**		**(deflated FCFA/kg)**	
Macina to Segou	0.20	0.14*	20	16*
Macina to Bamako	0.38	0.35*	47	49
Macina to Kayes	0.52	0.47*	87	86
Monimpébougou to Segou	0.30	0.22*	30	24*
Monimpébougou to Bamako	0.46	0.40	62	57
Monimpébougou to Kayes	0.61	0.52*	118	94*
Monimpébougou to Nara	0.35	0.36	40	47
Bankass to Mopti	0.32	0.30	37	39
Bankass to Gao	0.41	0.35*	53	48*

Source: Calculated by the authors from the OMA data base.
Notes: '*' = statistically significant decline between the two periods; '+' statistically significant increase.

Table 39. Rice Margins for Selected Market Channels

	Marketing margin as a share of the consumer price			Real mean margins by period		
	1993-99	2000-09		1993-99	2000-09	
Marketing channel	**(Mean Shares)**			**(deflated FCFA/kg)**		
Niono to Bamako	0.24	0.217	*	61.02	55.6	*
Niono to Segou	0.149	0.113	*	34.31	25.80	*
Niono to Koutiala	0.217	0.18	*	54.38	43.81	*
Niono to Sikasso	0.234	0.195	*	59.25	48.43	*
Niono to Kayes	0.27	0.306	+	74.63	90.13	+
Niono to Tombouctou	0.21	0.18		54.85	46.92	
Macina to Bamako	0.138	0.207	+	35.13	53.10	+
Macina to Segou	0.053	0.101	+	12.04	23.16	+
Macina to Tombouctou	0.09	0.17	+	23.67	44.21	+

Source: Calculated by the authors from the OMA data base.
Notes: '*' = statistically significant decline between the two periods;
'+' statistically significant increase.

For example, the consumer price in Segou, Bamako, Koutiala, and Sikasso could represent a price of partially cleaned rice, with the reduced margin between Niono and these consumer markets the result of the cleaning being done at the source (Niono) and the cleaning being done at the destination for rice purchased in Macina (Perakis forthcoming). It is also possible that rice prices in Kayes are more influenced by what is happening with imported rice coming from Senegal and perhaps a preference for higher quality rice that is not captured in the available data. The results provide guidance on the types of additional research that will be needed to correctly assess marketing efficiency. The need to learn more about quality improvements and where they take place in the value chain seems particularly important.

Using the same periods for maize as we did for millet and rice, we found that for the Koutiala to Gao marketing channel both shares and absolute values declined. For Koutiala to Segou both shares and the absolute margins appear to have declined, but only the decline in shares is statistically significant. Declining margins in this case may suggest that consumer prices are rising faster than marketing costs due to rising demand for maize; but lack of firm data on marketing costs makes it difficult to know if this is the case.

When we made the comparisons for the pre/post December 2004 periods (Table 12), all market channels but one (Koutiala to Sikasso) showed statistically significant declines in the marketing margin's share of the consumer price, but only the Koutiala/Gao channel also exhibited a significant reduction in the absolute margin. The less significant results for the Koutiala to Sikasso channel may be related to the much shorter distance traveled, which makes transport costs only a small part of the overall margin, and to both locations being influenced by the general price, production, and infrastructure environment in the cotton zone.

For all the cereal and marketing channels examined, there is some evidence of declining margins, but with substantial noise in the results (probably more for maize than for the other cereals) and we end up with only a few untested hypotheses about what is driving the changes (or lack thereof). Ultimately, given the dearth of actual marketing cost data, the best way to tease out the

Table 40. Maize Marketing Margins for Selected Markets

Marketing channel	Marketing margin as a share of the consumer price			Real mean margins by period		
	1993-2004 (Mean Shares)	2005-2009		1993-2004 (deflated FCFA/kg)	2005-2009	
Koutiala to Segou	0.31	0.27	*	33	30	
Koutiala to Bamako	0.44	0.41	*	53	54	
Koutiala to Kayes	0.54	0.44	*	81	63	*
Koutiala to Gao	0.46	0.43	*	59	58	
Koutiala to Sikasso	0.25	0.22		23	22	

Source: Calculated by the authors from the OMA data base.
Notes: '*' = statistically significant decline between the two periods;
'+' statistically significant increase.

determinants of spatial market performance from year to year (roads, communications, supply, demand, policy, and shifting vertical and horizontal coordination strategies) will be to conduct more sophisticated multivariate analyses.

Some authors have begun to address these issues within the sub region using time series methods (Araujo-Bonjean and Combes 2010; Aker 2010; Perakis forthcoming). Araujo Bonjean and Aker use samples of 60+ market pairs to look at how road quality (current) and the introduction of ICT influence different indicators of market performance (cointegration parameter in the former and price dispersion in the latter). Neither paper allows the authors to say something about individual marketing corridors—a shortcoming as some of the markets used were more important than others in terms of the quantities traded.

6.2.2. Competitiveness

Coarse Grains: Studies of the competitiveness of coarse grains in Mali's domestic and regional markets are not common; however, a recent analysis conducted for USAID/Mali estimated financial profitability at the farm level and at the value chain level plus economic profitability using domestic resource costs for several coarse grain market channels (Stryker and Coulibaly 2011).[25] Domestic resource costs (DRC) are reported as the ratio of the economic value of non-tradable (domestic) value added and tradable value added of a particular product in a particular market.[26] A DRC that is positive but less than 1 indicates a comparative advantage (CA) because it is more profitable for Mali to produce and sell rice in the market of interest than for that market to import from international sources. If the DRC exceeds 1, Malian rice would not be competitive.

The coarse grain market channels examined involved different intensification strategies proposed by the GOM in their national plan for priority agricultural investments. The results for millet and

[25] Traoré and Diarra (2010) tried to analyze maize competitiveness but found that they could not distinguish Malian maize from imports (primarily from Côte d'Ivoire) in local markets, making it impossible to build the price data base needed for the estimates.

[26] Because millet and sorghum are infrequently traded and trade statistics are poor, the authors used the domestic wholesale sales price for a particular value chain as both the financial and the economic price. The price of maize imported to Bamako was used as the economic price for analysis of domestic value chains ending in Bamako; for other value chains local wholesale prices were used as both financial and economic prices.

sorghum, both of which included fertilizer use because that is what is proposed for the future, were not encouraging. The authors concluded that:

> …it is premature to move forward rapidly with intensification of millet and sorghum production until the improved technologies for these crops have been thoroughly tested under scaled-up conditions. Furthermore, the magnitude of this expansion under the Plan is such that the financial costs, and probably losses, would be huge. (Stryker and Coulibaly 2011, page 30).

Of the eight millet scenarios examined, the only one that was financially profitable was production in the Mopti Region for sale in the same region; the profitability seems due in part to lower applications of fertilizer. Three scenarios had DRCs indicating that production could be economically profitable; these involved production in the Kayes, Mopti, or Tombouctou Regions with sales in those same regions.

Of the eight sorghum scenarios, only production and sales within the Region of Koulikoro was financially profitable, and only production and sales within the Region of Kayes was economically profitable. As with millet, levels of fertilizer use have an important influence on the results.

By contrast, the authors did conclude that maize offered some development potential:

> ..it is relatively safe to invest in intensification of maize production, especially in relatively well watered areas (Stryker and Coulibaly 2011, page 30).

Given estimated costs and output prices, maize was financially profitable if produced in the Sikasso Region and sold in Bamako or if produced in Tombouctou for sale in Tombouctou; it was economically profitable (DRC<1), however, for the Sikasso/Bamako scenario and production for local markets in the regions of Koulikoro, Segou, and Tombouctou.

Rice: We turn now to competitiveness studies for rice, which has been the subject of multiple studies over time in Mali. A review of the different results illustrates well that competitiveness is not static but changes over time and needs to be monitored carefully as Mali invests in developing its rice value chain.

All studies of the competitiveness of local rice versus imported rice sold within Malian borders have shown local rice to be highly competitive, beginning with earlier studies in the 1990s (Barry 1994; Barry, Diarra, and Diarra 1998), and continuing with various updates (Diarra 2004; Koné 2011; and Adjao 2011). The most recent results from Adjao (2011) estimated DRCs for irrigated rice in the *Office du Niger* (improved, rehabilitated plots only) and for low-land rice production in the Sikasso Region using data for the 2008/09 production season. Adjao found that for both production systems, Mali had "a very pronounced comparative advantage" within national borders, with ON rice being more competitive than low-land (lower DRC) in all markets but Sikasso. Malian rice also had a CA in the Northern Côte d'Ivoire (Korhogo and Bouaké) and Bobo Dioulasso in western Burkina Faso, but only the ON production system had a CA in Senegal, and only east of Tambacounda. DRCs for irrigated rice in markets with a CA ranged from 0.71 to 0.99, depending on the marketing destinations; the range for low-land rice was similar (0.72 to 0.97). These recent DRCs are more favorable than earlier ones, largely because of the sharp increase in rice prices on world markets (e.g., $177/ton in 2003 and $530/ton in 2009).

The Stryker and Coulibaly (2011) study did not look at irrigated rice in the *Office du Niger* but did look at improved low-land production proposed for the Sikasso Region with sales in Bamako. The analysis was done using two different assumptions for both the CIF import price (201 and 274 FCFA/kg) and the domestic price (268 and 372 FCFA/kg) to better represent the changing price environment. Although the low-land production system was the most financially profitable of the different production systems examined (from 117 to 220 FCFA/kg of profit, depending on the price assumptions)[27], they were far from economically profitable (DRCs of 1.20 and 1.67). The low economic profitability is due in large part to the high costs of investment and interest (assumed to be at a 10% market rate rather than at the concessional rate of about 1% actually paid by the GOM); but fertilizer subsidies and taxes on rice imports were other important factors accounting for the large difference between financial and economic profitability. The Stryker and Coulibaly results for low-land rice differ considerably from the Adjao results reported in the previous paragraph because Adjao analyzed returns to intensification on existing low-land fields and did not include investments to develop new low-land areas.

Results from the Diarra (2004) study using 2003 data analyzed a wider range of ON production systems, finding ON rice competitive in Bamako markets for both improved and unimproved irrigated parcels (average DRC of 0.92 to 0.95 for improved and 0.85 to 0.88 for unimproved, depending on the production zone) but not competitive on average for rice produced on the *hors casiers* land that does not have the same level of water control as other parcels (exhibiting average DRCs of 1.02 to 1.06) (see section 6 for more details). A somewhat surprising finding was the better competitiveness of the unimproved parcels, largely because of the lower land access costs of the latter that were not completely offset by lower yields. The key exceptions to the general rule of domestic competitiveness in the Diarra study were Kayes and Sikasso, given that transport costs from the nearest ports (Dakar for Kayes and Abidjan or Tema for Sikasso) were less than those from the production zone. The Adjao analyses show that this situation has changed, with Malian rice now being competitive throughout the country.

Earlier studies (Barry 1994; Barry, Diarra, and Diarra 1998) had found Malian rice competitive in regional markets—similar to Adjao's current findings; but Diarra's 2004 analyses showed that during the early 2000s, a number of factors combined to reduce competitiveness. Due largely to changes in exchange rates and to subsidies on rice exports from several Asian countries, Malian rice was not competitive in Côte d'Ivoire, Burkina Faso, Guinea, and Senegal in 2003. A 16% shift in the exchange rate (moving it from 519 to 600 FCFA/US$-a movement over which Mali has no control) would have made Malian rice competitive again in Tambacounda, Korhogo, in northern Côte d'Ivoire, Bobo Dioulasso in Burkina Faso and Siguiri in Guinea as well as in Kayes.

Koné (2011) also used 2008/09 data from the *Office du Niger* to estimate the DRC at the farm gate for the single case of a typical ON farmer cultivating rice on an unimproved irrigated plot. Koné did not extend the analyses to various markets, as was done by Diarra and Adjao. The Koné result suggests an improvement in farm gate competitiveness over time, as his DRC was 0.45 compared to Diarra's equivalent farm gate DRC of 0.49 for unimproved parcels, but one must be cautious in interpreting this as a real improvement in competitiveness given numerous differences in the types of data used for the underlying budgets and the aggregation across multiple zones in the Koné work.

Parity price analyses by Traoré and Diarra (2010) for rice using data for 2008 confirmed that Malian rice is competitive with imports of medium quality Thai rice (25% brokens), considered

[27] Controlled flooding and small scale irrigation were the other options.

to be comparable in quality to local rice. The study also revealed that imported rice actually on the market was being sold below the parity price of Thai 25% brokens, confirming that Malian importers have been able to satisfy the demands of low income consumers by importing lower quality rice (35% or more brokens).

6.2.3. Price Transmission

Price transmission is the study of how a change in one price affects another price. In general, there are three different categories of price transmission of interest:

- Spatial (e.g., how the producer price of maize in Sikasso affects the consumer price in Bamako);
- Vertical (e.g., how the price of maize affects the price of poultry feed); and
- Cross-commodity (e.g., how the price of imported rice affects the price of local rice or the price of coarse grains—in other words, do changing prices cause consumers to substitute one product for another).

The preferred situation is to have high levels of price transmission across markets and products that are close substitutes; this means that markets are communicating price information and eliciting behavior that will balance supply and demand. Price transmission can be weakened by a variety of factors (Minot 2010):

- Transportation costs are so high that trade does not take place;
- Long transportation routes that slow down transmission from market to market;
- Trade barriers (e.g., official and unofficial taxes) make trade unprofitable;
- Two products are not good substitutes for each other (e.g., millet and rice); and
- Lack of information about prices in other markets.

One of our major concerns in this paper is whether consumer prices are transmitted back to producers in a manner that stimulates supply response when shortages or gluts are occurring. If rising consumer prices are not transmitted back to farmers via rising producer prices, the supply response is blocked and shortages that provoked the initial response may continue. Similarly, if demand is falling but lower prices are not transmitted back to farmers, too much of the product will be produced relative to what consumers want to consume, leading to economic losses. Such a situation also contributes to continued poverty among farmers, who are unable to fully benefit from rising prices associated with supply shortages. On the other hand, if the full force of rising prices is borne by consumers in a country such as Mali where a large percent of the population is living in poverty, food security will decline and political instability may follow. Diarra and Diallo (2011) and Diarra, Soule, and Staatz (2011) described dealing with these two opposing forces as the major policy challenge for the GOM in its efforts to evaluate the performance of markets and design cereal sector development strategies that encourage increased cereal supply while protecting consumers from high prices that increase food insecurity. This is the classic food price dilemma described by Timmer, Falcon, and Pearson (1983). As noted in Section 3.2, the GOM does intervene in rice markets via import licensing and tax policies to keep consumer prices of imported rice low. This makes it particularly important to understand the degree of price transmission from the imported rice market to the local rice market. Administrative measures to restrict coarse grain exports in 2007 and 2008 may also have had the same effect, though traders' ability to circumvent some of these measures makes it more difficult to understand the price effects.

Minot (2010) describes the various methods used to look at price transmission and market integration:

- Ratio of percentage changes between two time periods;
- Correlation coefficients;
- Regression analysis; and
- Co-integration analysis.

The first two methods listed are rudimentary, not permitting one to look at more than two prices at once and thus ignoring trends over time. Regression analysis is preferred because it provides information on transmission elasticities (the percent change of price in one market transmitted to another market), can test relationships statistically, and can include lagged effects, more than two prices, and factors such as seasonality and inflation. Co-integration analysis is even better, however, because it permits one to control for the presence of non-stationary series that tend to incorrectly give statistically significant results.

We were able to find only four studies of price transmission in Mali that used econometric techniques. Vitale and Bessler (2006) used data for the early post-liberalization period up through 1999 to look at the flow of millet price information among the major staple food markets in Mali. An underlying objective was to determine if the private sector was adequately transmitting prices from one market to another (something the GOM feared would not happen with liberalization). They concluded that all of the ten markets analyzed behaved in a manner consistent with open market behavior, with non-stationary prices returning to their historical means—a sign that government interference was not a problem. Results on market integration were less robust, with only five of a possible nine co-integrating (long-run) relationships found, suggesting that there were some constraints on information flow among markets preventing full adjustment to long-run equilibrium in these markets. The Kayes Region was singled out as one that was poorly integrated with other markets, perhaps because it is more dependent on supply from Senegal than from Malian production zones. Price information generally moved from northern, deficit zones (e.g., Mopti) to southern, surplus zones (e.g., Koutiala). The important role played by the Malian market information system was also highlighted.

A second study (Bessler and Kergna 2002) using methods similar to Vitale and Bessler (2006) looked at millet price formation in Bamako and concluded that price discovery for millet took place in a large urban wholesale market (Niarela) and was then transmitted to other markets via a cost-plus process. This contrasts to the Vitale and Bessler finding that prices between regions were more reliant on a demand-pull information flow.

A third study (Aubert, Bignebat, and Egg 2006) examined econometrically (vector error-correction model) the relationship between spatial integration of markets and product segmentation using market data for maize and millet from 1990 – 2004 for regional markets in central and northern Mali (Gao, Tombouctou, Mopti, Segou, Sikasso, Kayes, and Bamako). The authors found evidence that spatial co-integration had improved during the study period, but in addition, that incentives for traders to invest in new market segments (maize or rice, for example) increased as spatial price differentials decreased. These results suggest that if spatial integration improves, the weaknesses noted earlier in both farmer and trader response to demand for improved quality in coarse grains (particularly maize for animal feed) may also improve as well as processors' response to what appears to be a slowly growing preference for improvements in the milled quality of local rice.

The fourth econometric study, using vector auto-regression (VAR) techniques, aimed to determine if price information could be used to signal future food security problems (Araujo, Araujo-Bonjean, and Brunelin 2010). The data set uses millet prices from 50 markets covering Mali, Burkina Faso and Niger, over the period 1990-2008. The underlying hypothesis was that if millet markets throughout the Sahel were well enough integrated, then early price spikes in bellwether markets could be used to predict potential problems, thereby supplementing the current, largely biophysical, methods used to predict problems. The authors conclude that it should be possible to predict crises that tend to occur in April or May as early as November by monitoring prices primarily in Maradi (Niger), but also in Dori (Burkina Faso) and to a lesser extent Gaya (Niger) and Tenkodogo (Burkina Faso). Of most interest to our current concerns is the authors' classification of Malian markets by their degree of regional integration. The Malian markets of Koulikoro and Nara were considered leader markets, but of less importance than the four leader markets singled out above for forecasting problems. Other integrated (but not leader) markets included Bankass, Mopti, Djenne, and Sirakorola. Markets in Kayes and Nioro were listed as poorly integrated; the Kayes results supports the Vitale and Bessler findings discussed above.

An earlier paper using similar analytical techniques and data (Araujo-Bonjean, Egg, and Aubert 2008), had drawn a more negative conclusion about market integration, noting:

- Better performance of Nigerien markets compared to those in other countries, but perhaps due to the choice of markets, which tended to have many more in Niger located on main transport routes;
- A tendency for price shocks to be transmitted from Niger to markets in Mali and Burkina Faso, due probably to the relatively large size of the millet markets in Niger and bordering Nigeria; and
- Poor integration of the markets across the three countries due largely to transportation costs associated with long distances and poor roads and the unquantifiable costs of transiting international borders (e.g., unofficial taxes).

For the authors, these results put in question the concept of a regional market for millet, but they cautioned that repeating the analyses with a different set of markets would be a prudent next step. While the subsequent study (Araujo, Araujo-Bonjean, and Brunelin 2010) found 16 markets examined were reasonably well integrated, there remained nine that were poorly integrated (seven in Niger and two in Mali) and three that were isolated (one in Niger and two in Burkina Faso).

It is difficult to draw any strong conclusions for Mali from this eclectic collection of price transmission studies. One gets the impression that markets are becoming more integrated over time, particularly within Mali (i.e., Vitale and Bessler 2006; Bessler and Kergna 2002), but transport and communications challenges plus policy uncertainty and unofficial taxes seem to still be blocking price transmission and the better integration of Mali into many regional markets.

We now turn to studies that have looked at price transmission in Mali using more rudimentary approaches such as correlation coefficients and transmission elasticities. Diarra and Diallo 2011 illustrated that from 1990 through 2010 producer prices for millet in Koutiala and for rice in Macina tracked consumer prices in Bamako closely enough that one could conclude there was a perfect correlation between the two and, therefore, the markets at the two ends of the value chain were well integrated. Given the weaknesses cited above about correlation coefficients, these conclusions seem a bit strong, but they do provide some support for the hypothesis that there is price information being communicated from production to consumption zones and back again.

A recent study by Traoré and Diarra (2010) looked at the question of price transmission in a broader context, analyzing a variety of price transmission channels using correlation coefficients and estimates of the percent of price variability transmitted from one market or product to another. The following price relationships were examined:

(1) *World rice prices* vs. consumer prices of *imported rice* in Bamako;
(2) Consumer prices of *imported rice* vs. consumer prices of *local rice* in three urban centers: Bamako, Kayes, and Sikasso;
(3) Consumer prices of *imported rice in Bamako* vs. consumer prices of *imported rice in Kayes and Sikasso urban centers*;
(4) *World rice* prices vs. consumer prices of *local rice* in Bamako; and
(5) *Producer prices for local* rice in Niono (the center of ON rice supply) vs. *consumer prices of local* rice in Bamako and regional capitals;

We summarize the salient results in the same order below.

(1) Although the two price series traced each other closely up to 2008, there was an unusual break in this trend with world prices declining in early 2008 while prices of imported rice in Bamako continued to climb until early 2009. For the entire period prices of imported rice in Bamako were much less variable (CV of 15%) than world prices (32%). The authors believe that the concentrated nature of the imported rice market in Mali contributed to this result.
(2) The correlations between imported and local rice prices were high in each of the three urban centers examined: 0.87 for Bamako and Kayes and 0.90 for Sikasso.
(3) The correlation coefficients between Bamako (Niarela) consumer prices for imported rice and comparable prices in the two other urban centers were high: Bamako-Kayes 0.87 and Bamako-Sikasso, 0.90. Regression analysis suggests that a 1 FCFA/kg increase in the Bamako imported rice price results in a 1.01 FCFA/kg price rise in Kayes but only a 0.89 FCFA/kg increase in Sikasso, suggesting that the Kayes market is more closely linked to Bamako price changes than the Sikasso market. This is expected as Sikasso is likely to get imported rice from multiple sources without it passing via Bamako. Recall that for coarse grains, studies cited earlier found Kayes was not integrated with other markets.
(4) Comparisons of the world market price of rice and local rice prices in Bamako revealed a 47% price transmission for the entire 1998 – 2009 period. From 1998 to 2002, when world prices were declining, transmission was only 11%; but from 2003-2009, when world prices were rising, the transmission was much stronger (22%). These results led the authors to conclude that price transmission from world to local rice markets is much stronger when prices are rising than when they are falling. The fact that transmission was lower (22%) in the more recent period than during the entire period (47%) is attributed to GOM tax policies which removed value added taxes and some import duties to counteract rising consumer prices. Opinions are mixed about how quickly and what share of these tax benefits for imported rice were passed on to consumers; but these results can be interpreted as evidence that the measures did have some muting effect on the transmission of international prices to prices of local rice.
(5) Correlation coefficients for producer prices in Niono (ON) and consumer prices in urban consumption zones ranged from 0.82 in Kayes and Gao to 0.94 in Segou (Mopti, Sikasso, and Bamako were 0.90, 0.92 and 0.93, respectively). As expected, the correlation decreases as the distance from the production zone increases. Both Gao and Kayes get a large share of their rice supply from outside the ON (Senegal for Kayes and San, Office Riz Segou, for Gao). Regression analysis for these same marketing channels showed that a change in Niono prices was transmitted exactly to Segou markets (e.g., a 1 F change in Niono was associated with a 1 F change in Segou). For markets in Gao, Mopti and

Sikasso, a 1 F change in Niono was associated with less than a 1 F change (0.92 to .0.95, depending on the zone), a reflection of the multiple sources of rice available for these zones. The price transmission to Bamako and Kayes was amplified, with prices in those urban centers increasing by more than the price increase in Niono (1.04 and 1.02 FCFA change, respectively, for each 1 F change in Niono.); this may be picking up rising costs in some components of the margin that occurred at the same time as the producer price rises in Niono.

The most important finding from these analyses is that a 1 FCFA change in market X was generally associated with a change of similar magnitude (slightly more or slightly less than 1 FCFA) in market Y. This result suggests good transmission without intermediaries absorbing much of the change

The Traoré and Diarra paper did not explicitly estimate price transmission coefficients from imported or local rice to consumer or producer prices for coarse grains; however, the relatively low correlation between rice and coarse grain prices (e.g., 0.26 for millet in Kayes and 0.51 for millet in Mopti) suggests that there is little interaction between the prices of these different cereals as consumers become more reliant on rice and less likely to replace it with coarse grains, particularly in urban areas. It will be important for analysts to develop a better understanding of the relationships between rice and coarse grain prices to ensure that agricultural investment strategies are consistent with market signals.

The relatively strong correlations between consumer and producer prices of local rice and the tendency of local rice prices to stay relatively high even when imported rice prices are lower suggests positive incentives for increased rice production, but more analysis of production and marketing constraints is needed to see whether the prices offered are high enough for farmers to be able to overcome the variety of production and marketing constraints described in Section 5.

In terms of policy implications, Traoré and Diarra had three recommendations:

- When prices of imported rice rise, the GOM should support the local processing industry so that it can respond to consumer demand that normally relies on imported rice.
- When implementing policies to protect consumers from the full impact of rising world prices, the GOM needs to keep in mind the concentrated nature of the imported rice sector, which can result in non-compliance with the full intent of the GOM policies and deprive consumers of intended benefits.
- The GOM should put in place an office of ex-ante price/policy analyses of exogenous shocks to improve policy formulation concerning food security and food prices.

6.3. Key Findings and Implications of the Evolving Cereal Markets in Mali

The discussion to this point has shown that cereal markets are evolving. Some of the key characteristics of this evolution include:

- Changes in quantities an qualities of product offerings in response to changes in consumer demand;
- Increase in the number of actors and competition;
- Improved efficiency in some marketing channels (reduction in numbers of intermediaries on some channels, improved transportation infrastructure, lower margins);
- Growing influence of regional actors and world prices on domestic cereal price; and

- Preliminary evidence of strong integration of world and domestic rice markets coupled with weak integration of rice and coarse grain markets.

These changes in the marketing component of the value chain have taken place in an environment of intermittent government intervention to keep consumer prices down (e.g., export restrictions, negotiations with traders, tax wavers for rice imports) and to stimulate production (input subsidies and some assistance with input credit) (see Traoré and Diarra 2010 for details and Appendix 1).

7. CONCLUSIONS AND IMPLICATIONS FOR RURAL POVERTY REDUCTION

We began this paper with the following list of research questions:

- How have national and regional cereal markets evolved over time in response to market liberalization, changing demand patterns, and the recent globalization of cereal markets?
    - What have been the structural changes in markets (market basins, numbers of actors, extent of cross-border trade, etc.)?
    - What do price and marketing margin analyses tell us about market performance?
    - Are there significant differences in how markets for different cereals function?
    - To what extent do agriculture and trade policies help or hinder markets from playing their role in the economic development process?
- Do the combined effects of market performance and policies encourage farm-level supply response?
    - If so, which types of farmers are most responsive and what is the impact on their production decisions and incomes?
    - Which types of farmers are least responsive and what are the factors that limit their response?
- What is the potential contribution of the cereal sector to rural poverty reduction in Mali; how does it differ by zone and farm type?

We provide a summary of answers to the first two sets of questions and then turn to a discussion of the implications of those findings for increasing the cereal sector's contribution to rural poverty reduction.

7.1. How Have National and Regional Cereal Markets Evolved

The three most striking changes in Malian cereal markets during the past 20 years include: (1) market liberalization, (2) changes in demand, and (3) increased exposure to regional and global markets.

Market liberalization transformed Malian cereal markets from ones that were constrained by heavy government regulation and intervention to ones that are now managed primarily by the private sector. Since the mid-1980s, government has focused on managing national security stocks and providing partial support (the rest covered by private sector contributions) for market information systems so that all actors have access to basic price information. At the same time, government has invested in irrigation infrastructure and crop research to increase agricultural productivity and reduce production risk.

In general, we found the private sector willing and able to perform the role of matching demand and supply once the GOM stepped down. This is illustrated by the aggregate production response that has not only kept abreast of growing demand but increased cereal availability from 183-185 kg/capita before 2005 to 201 kg/capita in 2007. Traders have managed to move increased production from surplus to deficit zones and to centers of urban demand as well as to neighboring cereal deficit countries. Nevertheless, there is some continued weakness in supplying cereal-deficit zones that have low purchasing power and high transactions costs and some shortcomings in terms of satisfying demand for better quality grains. Private sector trade has been facilitated by government support of transparent price information systems and road investments; but it continues to be hindered by unofficial road taxes and administrative measures such as export bans designed to protect Malian consumers from higher prices.

Changes in cereal demand are largely a function of population growth and urbanization. These forces have significantly increased total cereal demand while reducing demand for traditional coarse grains (millet and sorghum) and increasing demand for urban cereals such as rice and, to a lesser extent, maize, which is now used for both human consumption and by the animal feed industry. Other changes in demand include a significant increase in the share of household cereals that are purchased (rather than home produced) and some changes (primarily for rice) in a willingness to pay for better quality.

Exposure to global markets is most evident in the phenomenal cereal price hikes experienced throughout West Africa in 2007 and 2008 as commodity prices world-wide skyrocketed. Mali is not only more exposed to world prices than it was several decades ago, but it is also affected by demand in neighboring countries (most of whose consumers have greater purchasing power than Malian consumers). Harvest short-falls elsewhere in the region often put pressure on Malian prices as traders attempt to fill the gaps with Malian cereals. Exchange rate fluctuations are also a factor influencing trade as not all of Mali's regional trading partners share the same currency.

Our review reveals important structural changes in markets since liberalization. Of most interest is the growth in numbers of traders, taken as a sign of increased competition, and the growth of cross-border trade, which signals progress toward the development of a regional market that should be better able to move cereals from surplus to deficit zones. There appears to be more use of contracts than previously, particularly covering sales to institutions (OPAM, WFP, hospitals and schools). There is also good evidence of trade channels becoming shorter: less distance traveled due to road improvements and fewer intermediate transactions due to improved communications and increased confidence among trading partners. Although there has been some progress in expanding the share of farmers actually participating in cereal markets, Lorenz Curve analyses of survey data for three production zones confirm that a large share of marketed production is still coming from a relatively small share of farmers (see below for details).

Price trends and margins analyses conducted to date do not provide many conclusive insights about changes in market performance. Nevertheless, the following points appear to be fairly well substantiated:

- Prices of all domestic cereals moved in tandem from 1993 to 2010, exhibiting approximately the same peaks and valleys by year, but the size of the inter-annual changes were generally greater for coarse grains than for rice.
- Since 2000, millet prices have tended to be the highest prices among the coarse grains and maize the lowest prices.
- Before 2005, local rice prices were generally lower than imported rice of roughly equivalent quality; but since 2005, prices for local rice have been equal to or higher than the imported equivalent.
- A linear time line (1993-2010) shows that nominal prices increased at an average rate of 8.6 FCFA/kg/year for local rice and 5.8 FCFA/kg/year for millet (used as a proxy for all coarse grains); real prices increased at a slower rate of 1.4 FCFA/kg/year for local rice and 2.2 FCFA/kg/year for millet, despite the much stronger growth in demand for rice.
- Rapid productivity growth and declining unit costs of production for rice were important factors contributing to the lower rate of price increases.
- Despite the popular belief that Mali's greater integration into regional and world markets has increased price volatility, an analysis of coefficients of variation for consumer prices shows lower variation since 2000 for every cereal crop, with considerably less variability for rice than for coarse grains.

- Margins remain extremely high along some marketing channels suggesting that investments in reducing marketing costs (including unofficial road taxes) might be more conducive to low consumer prices than improvements in agricultural technology;
- Evidence of margins rising or falling over time is very mixed and not accompanied by supplementary information on whether the quality of the product or the services covered by the margins have changed, making it difficult to draw any conclusions from margins about whether markets have become more or less efficient.

The study revealed important differences in the way the rice and coarse grain markets are organized, yet both seem to be performing the basic functions of collection, transfer, wholesaling, and retailing in a competitive manner that meets most of the demand for the different products. Prior to liberalization, the irrigated rice sector was almost entirely controlled by government from production all the way through processing by large-scale government owned mills. Following liberalization, markets for domestic rice became characterized by relatively atomistic marketing channels with large numbers of small scale semi-wholesalers (usually Bamako based) acting as the lynchpins of the system. After reforms in the *Office du Niger*, farmers began milling their own rice using small-scale mills run by producer associations or private firms. The semi-wholesalers use short-term contracts with local buyers in the production zones to obtain processed rice that is sold directly by individual farmers and producer organizations. Credit is seldom involved, but when it is it tends to flow downstream and be of very short duration (e.g., days). The wholesalers transfer the rice to the urban markets and sell it both wholesale (direct to consumers who purchase monthly) and retail, via a network of agents who are tied to the wholesaler through credit arrangements. Retailers appear to sell at prices set by their wholesaler but are able to compete with other retailers by offering credit or other services to their customers. Although the domestic rice market is now relatively free of government interference, it does compete with imported rice, which is still controlled by government through the issuance of a limited number of import licenses and indirect controls on prices through manipulation of VAT and import taxes.

By contrast, the coarse grain markets are characterized by a limited number of well financed production zone wholesalers with long-term vertical relationships (often cemented through credit and kinship) to upstream collectors and assemblers and to downstream urban wholesalers. Competition in the system is maintained by a large number of smaller scale independent operators who compete with the collectors and assemblers operating in the vertically integrated networks. Although there have been recent issues of export bans for coarse grains, there is no equivalent in the coarse grain sector to the rice import licensing situation described above. At the level of urban wholesalers and retailers, we appear to have the same situation as in the rice market (most cereal retailers sell both coarse grains and rice), with wholesalers providing retailer credit and generally suggesting appropriate retail prices, leaving retailers to compete via the quality of the services that they offer.

It is difficult to draw any clear conclusions about the pros/cons of the differences between the rice and coarse grain marketing structures. Although some analysts suggest that one sector is more openly competitive than the other, this is difficult to assess with the data available. The potential for the coarse grain production zone wholesalers to exercise oligopolistic control over the market seems to have been diminished by the large number of smaller, independent operators and, more recently, by a sharp increase in foreign buyers from neighboring countries who are competing in the local collection and assembly markets. The potential for the oligopoly of rice importers to unduly influence domestic prices is diminished by the relatively small share of the total rice market covered by imports in most years (<20%) and the Malian consumer's preference for domestic rice. Both sectors seem to be responding well to changes in consumer demand. The rice sector has been more responsive than the coarse grain sector to changes in demand for

improved quality but hindered to some degree by a lack of credit needed to invest in better performing mills and by farmers' preference for milling rice themselves rather than selling paddy. While the licensed importers are well financed and have invested to some extent in processing of domestic rice, they seem to lack consistency in their efforts, withdrawing from local processing when the GOM authorizes large shipments of imported rice, which is apparently a more profitable activity. The coarse grain sector appears to be well financed from personal as well as bank sources, but the sector has been slow to adapt to demand from processors who are looking for more uniform and cleaner grain. This has been particularly constraining for the animal feed industry.

Agricultural and trade policies in place for most of the past 20 years have fostered increased production and marketing of cereals. Irrigation investments and crop research that resulted in major productivity improvements for rice and maize (but very limited improvements for millet and sorghum) have been a significant factor; however, the verdict is not yet in on the productivity results of the recent reintroduction of input subsidies. The subsidies do not appear to have significantly increased farm-level input use, but they did buffer farmers to some extent against the sharp increases in fertilizer prices. A newly emergent agricultural policy issue concerns the appropriate mix of family and commercial farms—a topic being hotly debated as the government signs agreements transferring large tracts of land to foreign governments and commercial firms to speed up irrigation development while family farms in the *Office du Niger* are facing serious land shortages.

The regional trading channels of today are largely a continuation of channels that existed in the1970s (and earlier), but volumes are increasing and the directions of the flows can change, depending on harvests across the region. The impetus for increased regional trade flows since 2000 comes from a combination of improved transportation, improved information flow via information and communication technology (ICT), and trade agreements (e.g., WAEMU, ECOWAS), with the latter promoting investment in the two former. Population growth and urbanization are also contributing factors as well as income growth (particularly for some coastal countries), which is increasing demand beyond domestic supply. Although it is clear that regional trade has increased, numerous problems exist: weak enforcement of the rules, porous borders, inadequate efforts to control unofficial road taxes, and a willingness on the part of member states to circumvent the rules through administrative measures such as export bans and unilaterally declared exemptions of cereals from import taxes and VAT. All these unresolved issues tend to increase transactions costs and limit the ability of cereal markets to become more efficient and pass the savings on to farmers and consumers. Understanding the extent to which savings are passed through and what government can do to increase the pass-through remains a challenge. For example, consumer price monitoring after government suspension of taxes on imported rice in 2007 and 2008 suggest that this type of policy instrument did not result in much pass-through of benefits to consumers. Mali also has to deal with the threat of regional buyers from countries with higher purchasing power moving into Malian markets and pushing prices up beyond the reach of Malian consumers.

7.2. Does the Market and Policy Environment Encourage Farm-level Supply Response

Since 2000, Mali has demonstrated an ability to meet its domestic cereal demand and also export coarse grains to neighboring countries, particularly ones that have structural cereal deficits (e.g., Senegal and Mauritania) or are heavily reliant on rainfed production that does not follow the same ups and downs as Malian rainfed production (e.g., Niger and Nigeria). Malian aggregate cereal supply from domestic production has increased over the past two decades at an average rate of about 4% (just 1% above the population growth rate). Increases have been primarily for

rice and maize (roughly 7% annual growth). Millet grew at roughly 3% and sorghum at only 1%. This growth is an important accomplishment and, as noted above, it is largely the result of reforms in the irrigated rice sector that encouraged farmers to invest in yield enhancing practices, and of market liberalization in the rice and coarse grain sectors that provided both farmers and traders incentives to respond to changing demand. In addition, from 1989 to 2006 the share of purchased foods in total expenditures increased by 13.5% for urban and rural households combined. Since cereals account for 40% of food expenditures, this change suggests that the market is substituting purchased for home produced cereals for a growing number of households.

Survey evidence suggests, however, that most of the marketed surplus of cereals continues to come from a small share of farmers. In the traditional coarse grain zone (Tominian) average cereal sales per capita were low (5 kg/capita) and 20% of households accounted for 92% of all sales, with 69% of households not selling at all. These results are not surprising for a zone with low rainfall and little government investment in agricultural research, extension and infrastructure. Sales are less concentrated in the cotton/coarse grain zone (Koutiala) which had average sales of 44kg/capita; 20% of farms accounted for 60% of sales and just10% of farms made no sales. While not fully comparable, these results do suggest some improvement over the level of concentration found in the mid-1980s (Dioné 2000), when the top 28% of farms in the cotton zone accounted for 90% of sales (survey data shows that currently the top 28% account for only 78% of sales). In the irrigated rice zone (Macina), where rice is the main cash crop, average sales per capita were high (417 kg) and the concentration is even less: 20% of farms account for 52% of all sales and only 8% of farms have no sales at all. Although we see declining concentration across zones, even the best case scenario in the irrigated rice zone means that 20% of farms are earning roughly 50% of the revenue from rice sales, leaving the remaining 80% of farms to share the other 50% of revenue.

At the same time, a large share of rural farm households in the three production zones studied do not produce sufficient cereals to meet their basic needs (76% in Tominian, 30% in Koutiala, and 29% in Macina). The farm-level survey data show strikingly that even in the more favorable cotton/coarse grain and rice zones, some 30% of households are far (not a little, but far) below the per capita cereal requirement. Despite the aggregate increase in cereal available per capita reported in FAO food balance sheets, many farmers in the more productive cereal systems have not achieved sustainable levels of productivity for their own families, let alone being in a position to feed a growing urban population at low cost. These findings do not bode well for the prospects of moving farm families out of poverty by getting them better integrated into the supply side of cereal markets. The findings suggest that a relatively important share of rural households must deal with their own food security before thinking about increasing their production for the market.

These production shortfalls, coupled with the relatively concentrated nature of cereal sales, suggest that many farms have not been able to reap the benefits of the market reforms and accompanying government investments. If marketing systems have become more competitive but supply response is still timid then more attention needs to be given to farm-level cereal production constraints. We think these constraints are of two types: structural constraints that keep a large share of rural households in perpetual poverty because they cannot access the necessary productive assets and (2) technical constraints that prevent farmers who do have access to a minimum set of productive assets from mastering yield increasing technologies and practices capable of closing the yield gap.

Analysis of survey data suggests that access to land is the salient structural constraint to increased supply response. In all zones, net seller farms owned and cultivated a statistically significant greater amount of land than other farms. Other factors also differentiate net sellers

from others, but the results are less robust across zones. For example, net sellers own more agricultural equipment than others in the higher productivity irrigated rice zone (Macina) and the cotton/coarse grain zone (Koutiala), but not in Tominian. Membership in producer associations and location in a village with easy access to markets differentiate net sellers from others in Tominian and Macina but not in Koutiala. Farms with younger household heads and a higher level of educational attainment are also more likely to be net sellers in Tominian and Macina but not in Koutiala. The net sellers across all zones produced more cereal per capita and were more likely to meet minimum cereal needs per capita. In general, inadequate access to land is exacerbated by generalized asset poverty (low levels of agricultural equipment, vehicles, and phones), poor access to inputs, and lower levels of education—all of which perpetuates poverty among the one-third of rural households that are unable to cover minimum cereal needs.

7.3. What Is the Potential Contribution of the Cereal Sector to Rural Poverty Reduction and How Can that Potential Be Realized?

There are a number of factors that make us pessimistic about the ability of the cereal sector to significantly reduce rural poverty in Mali by creating more net sellers of cereals. First of all, there is no easy path to alleviating the structural constraints that prevent at least 30% of farm families from producing enough cereal to feed themselves. The problem of access to land and equipment will be more difficult to solve as population continues to grow rapidly, land becomes more constraining, and access to irrigated land becomes ever more important because of climate change. Land policy may be the elephant in the room that policy makers have not yet focused on; but the prospects for a land redistribution capable of pulling the poorest third of Malian farmers out of poverty is unlikely. As in other agrarian societies that have transitioned to more modern economies, it will be necessary to work on structural changes that can promote rural income diversification and employment. It will be important to do this in a way that is compatible with farming activities so that rural families can improve their food security through both income diversification and better cereal production while slowing the pace of permanent migration from rural to urban areas that is likely to put additional pressure on the cereal sector. The higher levels of education found among households in the agriculturally disadvantaged Tominian zone, suggest that perhaps the farmers have already seen the writing on the wall and are making the investments in education needed to move into other income generating activities. Government needs to accompany them in promoting the creation of jobs that are complementary to their farming activities.

While asset poverty seems to be an underlying cause of many farmers not producing marketable surpluses of cereals, there is also a question about the extent to which producing marketable surpluses of traditional coarse grains (millet and sorghum) will provide a road out of poverty given the weak prognosis for growth in demand for these two cereals.

Malian cereal demand has been increasing in response to a high population growth rate (about 3% annually), urbanization, and income growth, which has stimulated demand for feed grains and more expensive cereals such as rice. This trend is expected to continue into the future. Demand for coarse grains for animal feed is poorly documented but considered by most analysts to represent an important area of future growth as incomes rise and consumers demand more eggs, meat and dairy products. Another area of growth is better quality processed rice and coarse grains that meet the needs of food processors (more uniform grains and grains free of foreign matter). In short, the potential for increased cereal demand is strong, but the greatest growth area is likely to be rice (particularly better quality) and maize. Demand for other coarse grains is likely to grow at a slower pace and be more specific to particular processing needs, with

increased rural demand due to population growth being the main driver. This does not bode well for farmers who have few options other than millet and sorghum production.

We are more optimistic about farms that are already meeting their minimum cereal requirements, as there appears to be scope for increasing production and incomes through alleviation of technical production constraints. Most of these farms are in Macina and Koutiala and are already producing some rice or maize—cereals for which demand is increasing rapidly. In our view, progress in this area calls for a better empirical understanding of the level of technology adoption by farmers and the causes of varying yield response. For example, new maize and sorghum varieties have been released but the level of adoption and effect on adoption are unknown. Malian research on soil and water management practices has shown remarkable growth in yields through the use of improved land preparation practices, but adoption of these practices is poorly documented and believed to be relatively limited (Kelly et al. 2005). Rice yields in the ON appear to be declining after spectacular growth for more than a decade—research on the causes of and cures for this decline is urgently needed.

Mali's agricultural extension systems were not discussed in this paper, but they have been underfunded for years and poorly linked to research programs developing new technologies (Kelly et al. 2005). One of Mali's better extension systems was in the cotton zone, but uncertainty about the future of the cotton sector has resulted in serious cutbacks on extension and a focus on cotton to the exclusion of the rotation crops of maize and sorghum. The recovery of global cotton prices could help the process of intensification of cereal production in the cotton zone, but the planned privatization of the cotton companies will require a clear definition of roles in regard to support for cotton/cereal production systems between the public and private sectors to ensure that potential synergies are fully captured.

Understanding of technology adoption needs to be accompanied by more aggressive on-farm experimentation integrating technical scientists, social scientists and extension specialists to identify pathways to sustainable increases in productivity in all of Mali's cereal production environments. When making decisions about on-farm research and improvements in extension services, the zone's agroclimatic potential will need to be taken into account (including the potential effects of climate change) as well as the capacity of different types of farmers to adopt improved technologies. All zones that produce cereals will not be good candidates for cereal-centered production and income-generation programs, although even zones with relatively low cereal production potential (e.g., the Tominian study zone) could benefit from better extension of low-cost technologies or improved practices that do not require cash outlays but can reduce crop risk and improve food security. In zones of higher potential such as the irrigated rice zone and the cotton zone, programs will need to be designed differently for different types of farmers—taking into account the farm family's overall income strategy, its asset base (particularly land access, which is now inadequate for many farmers in the *Office du Niger*) and potential interest in using cereal production as a vehicle for increased income and food security.

A critical element for improving the well-being of coarse grain producers who are interested in generating marketable surpluses will be the development of risk management tools to protect them against loss when expenditures on inputs to increase production are lost following a poor rainy season or other negative cropping event. These risk management tools must be developed in tandem with the development and testing of improved cereal production technologies and practices to ensure broader adoption by farmers living with few resources to fall back on in case of crop failure. For the vast majority of Malian farmers in the rainfed production zones, improved cereal productivity for food security purposes will be important but other sources of complementary farm and/or nonfarm income will be needed by most to adopt improved practices capable of increasing cereal productivity up to just basic needs. For farmers in the *Office du*

Niger, there is more potential for higher incomes through rising demand, but access to land and to affordable inputs available in a timely manner is a major constraint. For the cotton zone, maize demand for animal feed should provide incentives for many to increase maize production, but access to credit and the costs of improved seeds and fertilizer are particularly constraining for farmers who do not also grow cotton as is the lack of understanding on the part of farmers on how to respond to the quality needs of animal feed processors.

In closing, we conclude that market reforms and agricultural policies promoted by the GOM during the past 20 years have made an important contribution to increasing cereal availability and food security nationally; but most of the farm-level income benefits of these policies have been concentrated among a relatively small share of farmers, with the majority of farmers not able to overcome structural constraints that prevent access to productive assets and/or inputs needed to producer regular marketable surpluses. More progress can be made in decreasing marketing costs and making markets more efficient; but changes in marketing efficiency are not likely to draw many poor farmers into cereal markets. Other measures will be needed to overcome the structural poverty that appears to constrain at least one-third of farm families. As the GOM moves forward in designing programs and policies to ensure national food security while simultaneously reducing poverty and promoting market development, they must keep in mind the tradeoffs between different constituencies. For example, when price policy decisions favor urban consumers over rural producers, they are unlikely to provide farmers with an incentive to produce more cereals. Similarly, land policy decisions often pit the interests of family farms against those of commercial farms, exacerbating problems of land constraints that are already quite sever in the *Office du Niger*. A final example is the targeting of agricultural subsidies, which raises the question of how to balance assistance to the poorest farmers versus those most capable of significantly increasing aggregate cereal availability and national food security. There are no clear answers to what polices will be the best in the long-run for Mali, but informed decision making based on solid research by well-trained analysts working on good quality longitudinal data bases will improve the outcomes, so investments must be made in policy analysis capacity and market research to accompany direct investments in rural infrastructure and farmer capacity building.

APPENDICES

APPENDIX 1. TIMELINE OF POLICIES AND EVENTS IN MALI WITH RELEVANCE TO CEREAL MARKET PERFORMANCE

Year	Policy/Event	National Implications	Implications for producers	Observations
Pre-1990	Cereal market liberalization in 1986		Rice producers still required to sell production to the ON. CG producers can sell/transport cereals as they like.	
	Restructuring of ON involving end of government role in cereal processing/marketing (88-94)	Malian rice more freely available on the market.	Rice farmers able to sell and process rice as they like but still benefit from a minimum guaranteed price; they respond by increasing production and marketing.	
1990	CMDT/Producer disagreements re cotton prices		No cotton strike, but producer dissatisfaction and GOM refusal to honor prices negotiated with CMDT for 90/91 led to creation of producer syndicate.	
	Full liberalizations of paddy prices with no guaranteed minimum price		They must assume more risk, but benefits of being able to market as they want improves production and sales.	
1991	Nothing of note			
1992	Creation of SYCOV by cotton producers		Gradual transfer of more CMDT functions to farmers via the syndicate.	
1993	Nothing of note?			
1994	Devaluation and accompanying measures	Domestic products more affordable relative to imports	Made imports more expensive relative to local production for both rice and dry season onion production. Appears to have increased ON production by 27% through increased fertilizer use, generalized adoption of transplanting of seedlings, and continued efforts to rehabilitate the irrigation infrastructure. Favored competitiveness of Malian cotton production.	Improved competitiveness of local cereals *vis à vis* imports; gave fonio sector a boost.
	Import taxes for rice at 46% in 1994			
	Unusually large credit defaults by rice producers leads to numerous changes in input credit system in subsequent years.	Many defaults apparently associated with poor marketing decisions and traders not honoring their commitments. Mali is still struggling today to build viable input credit systems for the irrigated rice sector.	Unable to achieve full yield potential due to inadequate use of inputs	
	First contract plan signed between the GOM and ON	ON focuses on water supply and providing extension services.		

Year	Policy/Event	National Implications	Implications for producers	Observations
1995	Import taxes for rice reduced to 11% in 1995			
	Industrial rice mills owned by ON shut down.	All rice processing now being done by privately owned small-scale rice mills.		
1996	Strong cereal demand from Senegal due to problems with their harvests			
	Import taxes for rice temporarily reduced to 6% from July through September and then back to 11%			
1997	Industrial rice mills sold by ON to Société des Rizeries du Mali (SERIMA), but do not function very long due to low profitability.			
1998	Bad cereal harvests in Mali			
	Tax policy changes for rice imports; GOM attempts to set a fixed tax/ton (58,752 F) in exchange for promise from traders to keep wholesale prices below 24,000 FCFA/50 kg sack.		Efforts to protect consumers keep producer prices lower than they would have been otherwise.	
1999	Nothing of note?			
2000	Implementation of a common tariff system for UEMOA/WAEMU effective January 1st.	National import tariff rules replaced by regional rules which allowed for free movement of goods and people among member states but imposed taxes on imports from others; rates for members of CEDEAO/ECOWAS were more favorable than for others.		Improved opportunities for regional trade but reduced GOM ability to control its own tax policies. During crisis periods, common rules often abandoned (see 2007 below).
	Cotton producers boycott	Severe impacts on GOM budget receipts.	Stimulated by a drop in the producer price of cotton for the 1999/2000 campaign announced at harvest (Farmers expected 185 (including *ristourne*) and were offered 150 F/kg; 60% of farmers who regularly grew cotton switched to cereals. Production dropped from 442.415 tons to 218.000 tons.	

Year	Policy/Event	National Implications	Implications for producers	Observations
	Beginning of political crisis in Côte d'Ivoire (VK: should this be 2000 or 2002??)	Forced Mali to import/export via more distant ports raising transport costs for trade. Brought about in influx of Malians who had been living/working in Côte d'Ivoire for many years and sending home remittances.	Some of returned migrants invested in cereal processing and trade and also extensively in oil processing (cotton, groundnuts, etc.)	
2001	Nothing of note?			
2002	End of CMDT's indirect subsidy to cotton inputs		Higher input prices for cotton farmers as CMDT no longer subsidizing the transport/storage; reforms begun in 1998 were transferring increasing share of CMDT transport to private operators, making it difficult to hide the expense.	
	*Stratégie Nationale de Sécurité Alimentaire (*SNSA) adopted. Bad harvests in Mali and increasingly difficult political situation in the Côte d'Ivoire			
2003	Nothing of note			
2004	Poor harvests due to locust invasion			
2005	Test case with Cereal Banks			
	Loi d'Orientation Agricole (LOA) adopted.	Establishes a long-term vision for the agricultural sector—the promotion of a sustainable, modern and competitive agricultural sector based primarily on family farms. It aims to guarantee *food sovereignty* (a term not defined explicitly) and to make agriculture "the engine of the national economy in order to promote the well-being of the [Malian] population." It (1) reaffirms the state's withdrawal from direct production and commercial activities, (2) endorses the creation of regional and international common markets and (3) places Mali's agricultural development strategy squarely in the context of the country's decentralization strategy.		

Year	Policy/Event	National Implications	Implications for producers	Observations
2006	Rapid expansion of Cereal Banks	Private sector had to compete with lower cost cereals sold by the cereal banks, but remote areas assured of supply.		
	Rice imports exonerated from taxes for the 2005/06 campaign and marketing season	201,194 MT of imported rice exonerated from 18% VAT; other customs and tariffs in effect.		
2007	Rapid increases in prices of basic food commodities during the last quarter of 2007 led to following protective measures:	Higher food prices led to demonstrations in urban areas throughout the Sahel		
	"Unofficial" trade bans announced in December 2007 and appear to have continued through 2008.	Cereal exports to Senegal, Mauritania, Burkina were not to take place. Was followed by some stabilization in cereal prices. Market reconnaissance studies (Diarra and Dembele, August 2008) suggest that bans made coarse grain exports more costly but did not stop them (especially maize).	Price transmission back to farmers is held captive to GOM's desire to hold down consumer prices.	
	Rice imports exonerated from VAT and all customs duties and tariffs for campaign 2007/08	5,504 MT of imports exonerated (2007/08)	Imports should have kept prices of local rice down, but evidence for that is not strong.	
	"Social" sales by GOM	From national stocks		
	Consumer price subsidies	Used in neighboring countries but not in Mali.		
	Subsidized animal feed	Helped livestock sector avoid massive sales and price declines.		
2008	Initiative Riz (IR)	Objective of increasing domestic rice supply by 50% to stem the tide of rising food prices.	Subsidies on fertilizer (12500 f/50 kg) with credit guaranteed by GOM for those not having access. Nerica seed subsidized for rice production outside the ON, but in short supply. Equipment subsidy + 5 year credit (70 motoculteurs distributed in the ON, rice processing equipment for rice produced in other zones went to farmers organizations rather than to private sector processors). Where low-lands available for rice production the IR gave cotton farmers an alternative crop option. National statistics, however, show no increase in rice area in Sikasso until 2009/10.	

Year	Policy/Event	National Implications	Implications for producers	Observations
2008	Rice imports exonerated from VAT and all customs duties and tariffs from April 1 - Sept 30. 2008	Imports of 5504 MT exonerated.Rice to be sold no higher than 300 FCFA/kg wholesale and 310 FCFA/kg retail.Also reduced GOM revenue by an estimated 50 billion FCFA.	Little immediate effect on prices as traders unwilling to reduce prices on stocks for which taxes had already been paid. Some news articles implied that all traders could import (not just those who typically benefited from licenses).	
	Partial boycott of cotton production because farmers did not receive payment for 2007 production until after September 2008 (too late to be able to use it for 2008 inputs).		Needed to find alternative sources of income to supplement for cotton. Also needed alternative sources of inputs if had been getting them through cotton program.	
	Large scale land development/leases began in 2008 in the ON and remain on-going	Malibya agreement signed in 2008. Investment in farmland by foreign investors rose 60% between 2009 and 2010. Most of these land deals were struck with just 22 foreign investors. Estimates of more than 544,500 hectares of Malian land have been leased or were under negotiation for lease by the end of 2010. Implications unclear but many analysts have raised questions about impact on farmers in the ON and their loss of land, trees, etc.	Expectation is rapid development of irrigation infrastructure in the ON relying primarily on foreign investment. Some in the Macina sample (see section 6) claim to have lost land to Malibya.	
2009	Expansion of IR	Program expanded to cover maize, millet, and sorghum producers.	Subsidies on fertilizer (12500 f/50 kg) but credit guaranteed by GOM discontinued. Farmers in cotton zone were able to get subsidized fertilizer through non-CMDT channels for cereal crops.	
	ECOWAP endorsement	ECOWAP is synonymous with the regional CAADP plan, endorsed in Abuja in November 2009. Emphasis on joint action across member states to promote key value chains (including maize, rice, roots and tubers, and animal products), improve policy environment for agricultural growth and trade within the region, and develop innovative tools to deal with food social safety nets.		

Year	Policy/Event	National Implications	Implications for producers	Observations
2009	Plan de Passage à l'Approche Sectorielle	Analysis identified 22 separate officially validated rural development strategies with a total of 117 different priorities (i.e., a country with 117 different priorities really had no priorities at all); hence there was a need to develop much narrower, strategic set of priorities, while still maintaining coherence with the overall orientation for economic and rural development laid out in the CSCRP, the LOA, and the SNSA.		
	OPAM makes limited local purchasees, failing to meet its IR mandate, and unusually large purchases of imported rice.	OPAM rice operations for 2008/09 season were 142.650 MT of local production purchased at 270 fcfa/kg and 22,297.250 MT of imported rice for a total rice expenditure of 5.641.307.500 FCFA (OPAM *: Le DG nous écrit*, Ciwara Info 03 Juin 2010).	For the most part, prices remained higher than the 270 FCFA offered by OPAM. OPAM imports arrived very late in 2009 (funding was not arranged until September of 2009for OPAM purchases) and was on the market when the new 2009/2010 harvest became available.	
2009	Rice imports exonerated from TVA and import taxes (March through May and July through October 2009).	Unsuccessful OPAM marketing efforts following 2008/09 campaign in the ON and elsewhere coupled with continuing high prices led to an extension of import tax holiday and use of OPAM funds to purchase imported rather than local rice. Total imports exonerated for 2008/09 were 105,789 MT (USAID 2009)	2009 imports still on the market and competing with 2009/10 rice harvest.	
2010	Continuation of IR, which was expanded to cover wheat. Livestock/dairy initiative undertaken	These initiatives involve heavy government expenditures for subsidized inputs and seeds, subsidized equipment for production and processing, expansion of extension support, and government involvement (through OPAM) in some output marketing.		
	Tenders announced for sale of CMDT		Continued uncertainty for cotton farmers as the accepted proposals not announced early and no awards have been made?	

Year	Policy/Event	National Implications	Implications for producers	Observations
	Plan National d'Investissement Prioritaire dans le Secteur Agricole (PNIP-SA)	The plan was elaborated in 2010 and favorably reviewed by an ECOWAS/African Union team in October of that year; it focuses on strategic investments in four cereal value chains (rice, maize, millet and sorghum), on inland fisheries, livestock products (both meat and dairy) and cross-cutting activities to strengthen nutrition education.		
	Rice tax exonerations NOT announced and OPAM beefs up its rice purchasing activities	OPAM announces 1.5 billion FCFA for rice purchases in December 2010, amid signs that farmers are holding very large stocks and unable to sell them at prices deemed adequate to cover input obligations (inputs acquired assuming a 295 F/kg price and OPAM offering 270 FCFA/kg. The DG of OPAM replaced in 2010 amid controversy about whether poor performance in 2009 was his fault or that of other government units (e.g., *Primature and Finance*, which failed to get funding to OPAM in a timely manner).	Should have helped farmers market their rice BUT there are news reports of over-stocked warehouses, farmers unable to pay their input credit in March, and farmers still waiting for OPAM in December. Some farmers accused OPAM of offering higher prices (300-310 F/kg) to get contracts and then offering less (270 FCFA/kg) at delivery. Not YET able to confirm quantities actually purchased by OPAM, at what prices, and when. According to some informants, the OPAM price offered did become the de facto producer price in the ON for the 2009/10 and 2010/11 seasons even though the overall quantities purchased by OPAM did not represent a large share of the market (personal communication, Perakis)	
2011	IR continued OPAM continues to be active in rice markets and no rice tax exonerations offered.			

APPENDIX 2. KEY DOCUMENTS SHAPING MALI'S AGRICULTURE POLICIES

The *Cadre Stratégique pour la Croissance et la Réduction de la Pauvreté* (CSCRP) provides the overall framework for all public investment planning aimed at promoting economic growth and poverty reduction. The CSCRP covering the period 2007-2011 has three strategic foci: strengthening of the productive sectors of the economy (of which agriculture receives top priority), continuing reform of the public sector, and strengthening of social safety nets. For the agricultural sector, the CSCRP emphasizes improved water control and intensification through: (a) improved access to inputs (seeds, fertilizer, equipment) and to financing, (b) greater use of a value-chain approach aimed at strengthening processing and other value-added activities, (c) improving physical access to markets (e.g., through construction of feeder roads), and (d) better animal and plant disease control.

The *Loi d'Orientation Agricole* (LOA) establishes a long-term vision for the agricultural sector based on the promotion of a sustainable, modern and competitive agricultural sector based primarily on family farms. It aims to guarantee food sovereignty (a term not defined explicitly) and to make agriculture "the engine of the national economy in order to promote the well-being of the population." It (1) reaffirms the state's withdrawal from direct production and commercial activities, (2) endorses the creation of regional and international common markets and (3) places Mali's agricultural development strategy squarely in the context of the country's decentralization strategy.

The *Stratégie Nationale de Sécurité Alimentaire* (SNSA) lays out a vision of long-term sustainable food security based on improved food availability, access, utilization and stability, and establishes a set of tools to deal with transitory food crises and food security management through broad-based agriculture-led economic growth and the creation of market-compatible social safety nets. The document states that poverty is the chief cause of food insecurity in Mali, and hence stresses the importance of promoting sustainable income growth in Mali—primarily through a vibrant rural sector. Key SNSA institutions include the *Commissariat à la Sécurité Alimentaire* (CSA), housed within the office of the Presidency, the *Conseil National de Sécurité Alimentaire* (CNSA), which meets twice a year to review the food situation in the country and to set overall policy orientation, the SAP and the Market Information System (OMA), both of which provide regular updates to the CSA on market conditions and transitory food insecurity.

The *Plan National d'Investissement Prioritaire dans le Secteur Agricole* (PNIP-SA, now in effect) and the *Plan National d'Investissement du Secteur Agricole (*PNISA, also known as the Comprehensive Africa Development Plan (CAAD) investment plan, which will be coming on line to replace the PNIP) focus on strategic investments in five value chains: rice, maize, millet and sorghum, inland fisheries, and livestock products (both meat and dairy) and cross-cutting activities such as nutrition education. Key elements of the PNISA will include (a) capacity building (of public, private, and civil society organizations involved agricultural development activities, with strong emphasis on monitoring and evaluation); (b) investments, especially in improved land tenure systems, natural resource management, and in irrigation systems and water management; (c) actions aimed at spurring production and competitiveness in select crop and livestock value chains; (d) training and research; and (e) improved social safety nets to deal with problems of transitory as well as chronic food insecurity.

The Economic Community of West African States Agricultural Policy (ECOWAP) is the ECOWAS agricultural policy aimed at promoting economic integration of the agricultural sectors of the West African sub-region. ECOWAP is synonymous with the regional CAADP

plan, which was endorsed in Abuja in November 2009 by heads of state who agreed to allocate sufficient budget to agriculture to increase production at an annual rate of 6% . The plan puts major emphasis on joint action across member states to promote key value chains (e.g., maize, rice, roots and tubers, and animal products), improve the overall policy environment for growth and trade within the region, and develop innovative tools to deal with food social safety nets and food crisis prevention and mitigation (ECOWAS 2010). The public-sector investments are expected to focus on irrigation infrastructure, rural roads, the generation and dissemination of new technologies, training and the creation of an environment conducive to private investment.

Appendix 3. List of Research Reports Developed from the IER/MSU Panel Data Base

Lazarus, B. Forthcoming. A Study of Household Income Determinants and Income Inequality in the Tominian and Koutiala Regions Of Southern Mali. MS thesis, Michigan State University.

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