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# EXPANDING COARSE GRAIN UTILIZATION IN MALI: CURRENT SITUATION, CONSTRAINTS, OPPORTUNITIES, AND PROGRAM OPTIONS

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# EXPANDING COARSE GRAIN UTILIZATION IN MALI:

# CURRENT SITUATION, CONSTRAINTS, OPPORTUNITIES AND PROGRAM OPTIONS

**Submitted to**
**USAID/Mali and PPC/WID (AID/W)**

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| | |
|---|---|
| ACDI | Agence canadienne du développement international |
| AMIS | Agricultural Marketing Improvement Strategies Project (of USAID, Bureau for Science and Technology) |
| ATI | Appropriate Technology International |
| AV | Associations villageoises (Village associations) |
| BECIS | Bureau d'études, de conseils et d'interventions au Sahel |
| BRALIMA | Brasseries du Mali |
| CERECOM | Marketing organization affiliated with CMDT and its village associations, which assembles processed maize at the village mills, transports it to Koutiala and Bamako, and wholesales it. |
| CERPOD | Centre de recherche sur la population et la démographie |
| CESA | Commission nationale d'évaluation et de suivi de la stratégie alimentaire |
| CG | Coarse grain, coarse grains (millet, sorghum, maize) |
| CIDA | Canadian International Development Agency |
| CILSS | Comité permanent interétats de lutte contre la sécheresse dans le Sahel |
| CMDT | Compagnie malienne pour le développement des textiles |
| CRDI | Centre de recherche pour le développement international |
| CRZ | Centre de Recherche Zootechnique (à Sotuba) |
| DIAPER | Projet diagnostic permanent |
| DMA | Division du machinisme agricole |
| DNA | Direction nationale de l'agriculture, Ministère de l'agriculture |
| DNSI | Division nationale de la statistique et de l'informatique, Ministère du Plan |
| DSRPR/IER | Division des recherches sur les systemès de production rurale |
| FAC | Fonds d'aide et de coopération |
| FCFA | CFA francs (Malian currency; $1.00 = 250-256 FCFA during Nov.-Dec. 1990) |

| | |
|---|---|
| FED | Fonds européens de développement |
| GMM | Grands moulins du Mali |
| GRM | Government of the Republic of Mali |
| GTZ | German technical cooperation (Gesellschaft fur Technische Zusammenarbeit) |
| HUICOMA | Huilerie et cotonnerie malienne |
| IAS | Impôt sur affaires et services (10-20% tax paid by Malian businesses on sales of products or services) |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropic |
| IDRC | International Development Research Centre (Canada) |
| IER | Institut de l'économie rurale, Ministère de l'agriculture |
| INSAH | Institut du Sahel |
| INTSORMIL | International Sorghum and Millet Collaborative Support Agreement |
| ISRA | Institut sénégalais de recherches agricoles |
| MOA | Ministry of Agriculture |
| MSU | Michigan State University (espec. Department of Agricultural Economics) |
| ODIPAC | Office de développement intégré des productions arachidières et céréalières |
| ON | Office du Niger |
| OPAM | Office des produits agricoles du Mali |
| OSCE | Office statistique des Communautés Européenes |
| PAM | Programme alimentaire mondial |
| PPC/WID | USAID's Bureau for Program and Policy Coordination, Women in Development Office |
| PRL | Prairie Research Laboratory (Saskatchewan, Canada) |
| PRMC | Programme de restructuration du marché céréalier au Mali |
| PROCELOS | Programme régional de promotion des céréales locales au Sahel |
| RDTM | Radio diffusion et télévision du Mali |

| | |
|---|---|
| RIIC | Rural Industries Innovation Centre (Botswana) |
| SIM | Système d'informations sur les marchés céréaliers |
| SISMAR | Société industrielle sahélienne de méchaniques, de matériels agricoles et de représentations |
| SOMAPILE | Private firm that produces batteries in Mali |
| SRCVO/IER | Service de recherches sur les cultures vivrières et oléagineuses |
| S&T/RD | USAID's Bureau for Science and Technology, Rural Development Office |
| TCDC | Third country development cooperation |
| TVA | Taxe de valeur ajoutée (Value-added tax) |
| UCODAL | Unité de conditionnement des denrées alimentaires |
| USAID | United States Agency for International Development |

## PREFACE

This report was prepared for and financed by USAID/Mali and the Women in Development Office of the USAID/Washington Bureau for Policy and Program Coordination (PPC/WID). Funding was channeled through the Agricultural Marketing Improvement Strategies Project (AMIS) of the USAID/Washington Bureau for Science and Technology. Abt Associates Inc., the prime contractor on the AMIS Project, did the study in collaboration with staff from BECIS, a Malian consulting firm. The findings of the study are based on five weeks of fieldwork in Mali, AMIS work on coarse grain processing in Senegal in late 1988, and a review of available literature and data.

The principal objective of the study was to examine possibilities for expanding coarse grain utilization particularly for human consumption in urban areas of Mali. Secondary objectives were to ascertain the extent to which utilization of coarse grains could be expanded through alternative activities, such as baking bread, feeding animals, and brewing beer, as well as selected industrial processes.

An initial motivation for commissioning the study was the above-average production of coarse grains in Mali during the past several years and the anticipation of burdensome surpluses. As estimates of the 1990-91 coarse grain crop were revised downward from earlier projections, fears of an emerging disposal problem subsided. A key underlying issue continues to be the need to assess Mali's medium- to long-term coarse grain production and consumption prospects, and to advise USAID, PRMC, and GRM of program options vis-a-vis coarse grain production, marketing. processing, and utilization.

This study complements the excellent consumption study done by Tufts University (Rogers and Lowdermilk, 1988) which examines current coarse grain consumption patterns in detail. It carefully reviews existing coarse grain processing techniques in urban areas and identifies constraints and areas for improvement. The study examines the relationship between processing techniques and consumer preferences for coarse grain products. Although the study was not intended to be a choice of technique analysis, it does make recommendations for improving the performance of processing machinery used widely in urban areas and for introducing experimental dehulling units that have been tested in Senegal.

A key finding of the study is that human coarse grain utilization needs to be discussed and understood in the context of the broader, ongoing diversification of urban dietary patterns in Mali and throughout the Sahel. Hence, policymakers and analysts are advised to consider not only possibilities for substituting coarse grains for rice, but also ongoing and likely future substitution among coarse grains (e.g. maize for sorghum) and substitution of tuber crops (yams, manioc, sweet potatoes, potatoes, and plantains) for rice and coarse grains.

The writing of this report was very much a team effort. John Holtzman, Research Director of the AMIS Project, was the director of the study and coordinating author. He drafter Chapters 1-3 and 8, and prepared Chapter 7 from sections drafted by Lichte and Tefft. John Lichte, agricultural economist and independent consultant with extensive Mali experience, conducted the structured informal survey of urban households in Bamako; the results of this survey are summarized in Chapter 4 and Annex 4. Lichte also drafted Chapter 5 and much of Chapter 7 as well as provided significant input into the policy and program options of Chapter 8. James Tefft, agricultural economist, conducted structured informal interviews with dehuller and plate mill owners and operators, and wholesale and retail traders of coarse grain products, and drafted Chapter 6 and part of Chapter 7.

Bagotigui Bagayoko worked closely with Tefft and provided input into Chapter 6. Mme. Fanta Mantchiny Diarra worked closely with Lichte and drafted Annex 5, which was expanded and finalized by Lichte. Thomas Wittenberg, agricultural economist at Abt Associates, contributed Annex 2, with assistance from Theresa Bradley.

As with all of the AMIS Project reports, getting the draft in final form required a team effort. The authors listed on the title page were assisted by senior editor Paula Hirschoff and AMIS Project staff Stefani Olsen, Kathleen Poer, Thomas Wittenberg and Theresa Bradley in producing a polished final draft. Thomas Wittenberg and Theresa Bradley deserve special mention for help in analyzing price data.

The authors acknowledge excellent, in-depth reviews of the draft report by David Atwood of USAID/Mali, Philip Steffen of Michigan State University and Edgar Ariza-Nino of PPC/WID. Philip Steffen also shared wholesale and retail price data that proved invaluable in doing price analysis and provided a wealth of useful reports and analytical papers. Helpful comments were also provided by Carl Bielenberg, Jeanne Downing, and Glenn Patterson of Appropriate Technology International, Andrea Baumann and Tom Mehen of S&T/RD, and Chantal Dejou of the World Bank. The authors are responsible for any errors or omissions, and the report reflects their views rather than those of Abt Associates or USAID. AMIS hopes that this effort will stimulate further economic analysis of coarse grain technology, marketing, policy, and utilization issues.

## EXECUTIVE SUMMARY

### Overview of Coarse Grain Production, Marketing, Consumption, and Utilization

Methods. The findings presented in this report are based on a five-week study of coarse grain processing, consumption, and marketing carried out primarily in Bamako in November-December 1990. Conclusions are drawn from an extensive review of the literature; in-depth interviews with GRM and donor officials, formal private sector operators, CMDT/CERECOM, and others; and structured informal interviews with women responsible for food preparation in 58 households, 27 operators of dehullers and plate mills, numerous wholesale and retail traders of coarse grain products, and selected restaurant proprietors.

Underlying Assumptions. A key assumption underlying this work was that coarse grain substitution possibilities for rice in urban diets are limited by processing constraints and costs. A recent consumption study (Rogers and Lowdermilk, 1988) found rice and coarse grains are not substitutes within the observed price ranges. A related assumption underlying this AMIS study was that the inherent instability in the supply and prices of coarse grains acted as a brake on development of a commercial grain processing, storage, and marketing system.

Coarse Grain Production Instability. Analysis of the variability and trends in grain production in Mali over the last 20 years shows a good deal of instability in output, as well as in marketed surplus. Maize production showed the greatest variability (highest coefficient of variation), but maize output increased the most rapidly and steadily at a compound growth rate of 7.1 percent per annum, and its trend coefficient was the most statistically significant. Paddy production was less variable than maize and millet/sorghum/fonio output (lowest CV), but it increased at the slowest rate (2.1 percent with lowest R-squared).

Instability in Marketed Surplus. Marketed surplus in Mali is unstable, although there are no reliable estimates to document this. The magnitude of marketed coarse grain surpluses depends on several key variables: annual rainfall, its temporal and geographic distribution, aggregate grain output, the extent of regional surpluses and deficits, interseasonal and interlocational price differentials, the size of the grain crop relative to earlier years, food aid and commercial grain imports, commercial and farmer storage decisions, and other factors. While the reliability of GRM crop forecasts and estimates has improved with outside assistance (UNDP's PADEM Project and the EC-funded OSCE), grain quantities available for human consumption appear to be overestimated. As a group, seed requirements, post-harvest losses, and dehulling conversion ratios seem to be underestimated.

Coarse Grain-Rice Substitution. While the conventional wisdom holds that processing inconvenience and cost are major constraints limiting urban coarse grain consumption, the coarse grain-rice substitution issue is considerably more complex. The color of grain products, their cleanliness, appeal of presentation, and perceptions among groups of urban consumers about the image and desirability of particular cereals are key factors affecting consumption.

Rice consumption is largely an urban phenomenon in Mali. Although more costly than coarse grains on a per volume or per calorie basis, rice offers several important advantages. It is already processed and ready to cook. Energy costs for cooking are generally lower than for most coarse

grain-based dishes. In many urban households, women work outside the home, which severely limits their food preparation time. This factor works against increased coarse grain consumption, although the fact that many households employ maids offsets this disadvantage somewhat.

Expanding Maize Production and Human Consumption. Rice production has stagnated in Mali during much of the past 20 years, although the output of the past three years was above trend. Maize production has expanded more rapidly than the output of other Malian cereals since 1971-72. World Bank and GRM investments in southern Mali during the 1990s promise to bring a lot more maize production capacity on stream (52,063 metric tons above and beyond the forecast production increases without project investments by 1998-99). As maize marketed surplus expands, prospects for increasing maize utilization, particularly human consumption, are unclear. A fundamental question is whether urban consumers will buy more maize and processed maize products as substitutes for sorghum, millet, and rice. Maize consumption is highest in production zones of southern Mali but remains limited in urban areas of central and northern Mali.

Using Coarse Grain for Livestock Feed. The livestock sector is now using almost 500,000 tons of agro-industrial by-products as feed, yet farmers and herders complain that such products are difficult to find at affordable prices in the dry season when they are most needed. Cash producing enterprises within the livestock sector like dairy and commercial egg production activities are already using rations which incorporate 15 to 60 percent coarse grains, depending on relative prices. This trend toward the use of coarse grains for livestock feed will continue, given the critical shortage of forage. The substantial supplies of high-protein supplements like bran and cotton seed cake can be mixed with coarse grains to provide a more complete ration if input/output price relationships will allow it. The potential for coarse grain use is vast, but it will likely be severely constrained by price relationships in the future. This could change in the longer term if coarse grain production increases significantly and prices drop.

Maize in particular offers long-run promise. Maize farm prices can and will likely trend downward over time as long as increased productivity leads to higher enterprise returns per hectare and per person-day. High-yielding, fertilizer-responsive varieties of maize have been introduced in Mali. Informal reports of lower than recommended fertilizer use on maize, in response to soft farmgate prices of maize following OPAM's cessation of grain buying in 1986, are mildly discouraging, suggesting that farmers find returns to high-input maize production insufficiently attractive. Farmers will, of course, make planting decisions based on rough calculations of net returns to alternative crops (which may not always follow relative prices). Complementary investments in animal traction and farm equipment can increase maize productivity and help to relieve critical constraints (such as weeding) or enable farmers to put more land under cultivation (extensification). The AMIS team did not find adequate sensitivity analyses of financial and economic returns to alternative crops under different sets of assumptions regarding input use/costs, equipment level, yields corresponding to different levels of input use and equipment, and producer prices. The limited available analyses show maize production to be more profitable than millet or sorghum production (but less profitable than cotton production) under favorable scenarios. It would be useful to incorporate risk in a probabilistic analysis of returns to maize production (showing returns varying as a function of the amount of rainfall and its temporal distribution). The sensitivity of maize yields to the level and temporal distribution of rainfall represents a considerable risk to producers, whose cash outlays for maize (particularly for fertilizer) are far greater than for more drought resistant millet and sorghum.

Other Coarse Grain Uses. Potential alternative uses for coarse grains include beer brewing (maize grits) and battery and textile manufacturing (starch). These uses are likely to be very limited in the medium to long term in Mali.

Urban Consumption of Coarse Grain and Other Foods

Household Consumption Survey. An informal consumption survey was conducted of 58 households in 12 selected neighborhoods. While not a stratified random sample, it does provide a cross-section of socio-economic conditions in Bamako. This survey was used to determine food consumption patterns in Bamako, and the patterns were correlated with different income levels. The daily per capita expenditure on condiments is used as a proxy for per capita income, since it is a value which has real meaning and is readily available and used in most Bamako households.

The patterns derived from this survey imply that even in the lowest income quartile, families are beginning to switch from a diet of all coarse grain to one that includes rice at noon. Families in the second lowest income quartile are already eating rice dishes at noon and coarse grain dishes at morning and evening meals. Families in this quartile are beginning to enrich their sauces and to use certain more expensive sauces to accompany increased quantities of meat, fish, or fresh vegetables. The third income quartile continues this pattern of eating rice dishes at noon and coarse grain dishes mornings and evenings, but is beginning to diversify the evening meal away from coarse grain dishes toward meat and milk products, tuber crops (yams, irish potatoes, sweet potatoes, and cassava) and plantains, lettuce and vegetable salad, and bread and spaghetti. Coffee and bread have also begun to replace porridge at the morning meal. The highest income quartile continues this trend away from coarse grains, adding a number of other prepackaged products to increase variety. A few small wealthy families at the upper end of the fourth quartile carry this trend to the extreme of almost eliminating coarse grains from their diets.

Merchants selling grain by the kilogram do not sell grits or flour products, but they do carry dehulled products in a minority of the neighborhood markets visited. Grits and flour are available only from relatively small-scale retailers who sell largely from uncovered pans in less standardized units, open to the elements. Some of these women are also known to buy grain from beggars. Most housewives will not buy from these retailers unless they know a specific individual, because they fear the non-hygienic conditions and sources. As a result, many families have no acceptable source of grits and flour in the market.

Household Coarse Grain Processing. The vast majority of families buy whole grain and process it in-house to make grits or flour with which to prepare coarse grain dishes. The majority buy their grain by the sack, rather than in smaller quantities on a daily basis. Dehulling is commonly done manually by household maids. Grinding is done by mechanical mills in 95 percent of the families. Maids have had a significant impact on this percentage, because they refuse to work for families who do not grind mechanically. Dehulling and grinding are done daily in most families, providing the fresh, non-fermented flour products that are preferred in Bamako. In-house processing also enables housewives to ensure that the processed grain is clean and white, critical factors in processed cereal quality.

Recently Introduced and Potential Coarse Grain Utilization. Prepackaged maize grits are available along the street in small quantities at a very high cost (250-300 FCFA/kg). They are prepared entirely by local households concerned with producing a high-quality product for a high-

income market. GMM and CMDT/CERECOM maize products were not acceptable in this market niche, because they were prepared from maize which had been stored for over a year. Most consumers refuse to buy grain which has been stored for long periods.

White sorghum grits have some potential as a rice or fonio substitute, but the major market for such a product is in the bottom two expenditure (income) quartiles. To be successful, any such rice substitute must be inexpensive and maintain a narrow margin over the cost of whole grain. Parboiled sorghum grits could serve as such a substitute, but they have lower consumer acceptance than white sorghum grits. Parboiling significantly increases the cost of processing, which is likely to be unacceptable in this low-expenditure market.

Urban women seem to feel that they are adequately meeting the needs of weaning-age children with homemade products, if they can afford to make specific weaning products for their children. Enriched cereal-based weaning foods are probably more appropriate for rural areas. The effective demand for such products appears to be somewhat limited, unless agencies provide them free or highly subsidized as a social service.

Coarse Grain Processing and Prospects for Expanded Human Consumption

Urban Mechanized Grain Processing. Urban households increasingly use local mechanical milling in the district of Bamako to process maize, millet, and sorghum for family consumption. The number of vertical plate mills used to wet-grind cereals into grits and flour has increased significantly over the last few years in all quartiers in Bamako. The resulting competition has reduced the consumer milling cost from 10 FCFA/kg to approximately 8 FCFA/kg. The more profitable electric motor-driven mills are preferred. Quartiers without electricity are limited to using the higher operating cost diesel motors to power plate mills. Based on data collected from mill operators, preliminary calculations show that the energy cost of milling one kilogram of sorghum is approximately 2.0 FCFA with a diesel motor and 1.4 FCFA/kg with an electric motor.

Mechanical dehulling, however, exists only in quartiers equipped with electricity. The consumer cost of dehulling one kilogram of coarse grain has remained relatively stable at 10 FCFA. The higher operating costs and energy consumption of the Engleberg dehullers, originally conceived for dehulling rice, can be attributed to their imperfect adaptation to the processing of coarse grains. This results in low dehulling rates and frequent replacement of parts. The cost of maintaining dehullers and mills is increased through the use of less robust and typically substandard spare parts manufactured in Mali, Nigeria, and Côte d'Ivoire. The energy cost of dehulling a kilogram of maize with a typical Engleberg dehuller is estimated to be more than double the cost incurred by the Botswana RIIC dry abrasive-disk dehuller used in the CMDT mini-mills project.

The high price of purchasing imported machines and spare parts through formal sector commercial representatives has resulted in the development of informal import channels through Côte d'Ivoire and Nigeria as well as local artisan manufacture of dehullers and spare parts. The demand for machines and parts through this alternative supply source will undoubtedly increase in response to a new higher import tax structure to be introduced in 1991.

At least five local artisans in the Bamako area are manufacturing dehullers. The continued expansion of this activity may be constrained by the fact that the work is done secretly in their primary place of employment, where equipment is available. Efforts to further develop this sector

could focus on exchanges with the more highly developed local artisan industry in Senegal. This might include a joint attempt to produce more durable spare parts or even a more efficient dry abrasive-disk dehuller similar to the Botswana model used by the CMDT or another version manufactured in Senegal. The focus of the Division du Machinisme Agricole's CEEMA machine-testing division at Samanko could be altered from simply testing equipment to facilitating local artisan manufacture and collaborating with Senegalese institutions. Finally, any effort to develop equipment locally that differs from that currently used in Bamako will have to be evaluated not only on its engineering and economic merits but most importantly, on its success in producing a product desired by urban consumers.

Demand for and Storability of Processed Coarse Grain Products. The increasing availability and demand for maize grits as well as dehulled grain in urban markets indicate the potential demand for processed coarse grain products. The dry abrasive-disk dehullers and hammermills used in the CMDT mini-mills project for commercial production of maize grits and flour are promising for the further development of transformed products. To the extent that consumers demand transformed products processed on a semi-industrial level, processing technology based on a dry method is required to assure a longer storage life. Although the focus on the production and marketing of maize grits is important, the potential market demand for a fresh, clean, and storable maize flour cannot be ignored. CMDT's difficulty in selling maize flour should be viewed not as a sign of little demand but as an indication of the importance of producing a clean product with the characteristics desired by the consumer. Mill staff observed that villagers prefer the high-quality maize flour produced from grinding the whole grain rather than as a byproduct of grits production. It would be worthwhile to test-market and assess the economic viability of this product.

The storability of and potential demand for coarse grain products processed on a semi-industrial level will, however, be limited by the quantity of germ that remains, thus increasing early rancidity and limiting storage life. At this stage, attention must be directed to degerming technology that is economically feasible only at the industrial level. The economic viability of industrial production by Grands Moulins du Mali (GMM) hinges on the existence of a larger market to absorb the higher-volume production. It also depends on an assured supply of a clean raw product at a stable price. While coordinating mechanisms may take time to establish, they would benefit both buyer (GMM) and seller (producers).

Find Prospective Markets for Coarse Grain Products. Every potential outlet for local cereal products requires careful study of the prospective market, the desired characteristics of the product, and complementary actions needed at different levels. The successful mixing of maize flour with wheat flour for bread production, for example, requires importation of a high quality wheat with specific gluten requirements. The Government and donors may need to examine the terms for wheat and wheat flour imports, as they influence the price relationships among alternative flours and the economic feasibility of producing a competitively priced product. Promoting consumption of bread having maize flour mixed with wheat flour would probably require a government decree, as GMM and bakers would not take the risk of testing a new bread product on urban markets independently.

Improve Raw Product Quality. All grain processing would benefit from a cleaner raw product. A large percentage of the repair costs of Engleberg dehullers consists of replacing sieves that have been punctured by stones and other foreign matter in the grain. Filling sacks with a cleaner product would greatly reduce processing costs and revenues lost by delays. It would also reduce the need for housewives or maids to perform time-consuming grain washing. Semi-industrial or

industrial production of cereal products would require significant improvement in the existing system. Increased CMDT distribution of Bamba mechanical threshers is an important step in this direction.

Key Program and Policy Options for USAID, PRMC and GRM Consideration

A Strategy for Expanding Coarse Grain Utilization. We propose a fourfold strategy for promoting expanded coarse grain consumption in urban areas. The first element in such a strategy would be to lower processing and preparation costs for sorghum, the cheapest and dominant coarse grain consumed in urban areas, particularly among low-income families who consume primarily coarse grain dishes. Cheaper sorghum-based dishes would increase the real income of low-income households and expand sorghum consumption at the margin.

The continuing research on sorghum should focus increasingly on developing coarse grain-based dishes prepared from medium and fine sorghum grits rather than parboiled sorghum grits. This research could benefit urban households in the two lowest quartiles which consume sorghum at both meals or at the one major daily meal. Parboiling sorghum increases processing costs, which cannot be borne by lower-income urban households. One of the major advantages of parboiling, longer sorghum storage life, is not a key consideration for these households, which buy small quantities of grain on a regular basis or in a single sack that is consumed in a month or less.

The second component of a strategy to stimulate coarse grain consumption would be to continue developing novel dishes based on sorghum (and millet) based dishes that could partly substitute for toh and help forestall the shift away from sorghum among wealthier urban consumers and the young.[1] New sorghum products that would be unlike toh could respond to consumers' desire for greater dietary diversity and would not carry the same stigma as toh. Developing new sorghum-based dishes would also benefit low-income urban consumers if these dishes could be prepared quickly and cheaply from inexpensive, processed sorghum. It would diversify their diets and provide a cheaper source of calories than rice.

A third component of the coarse grain promotion strategy should be to identify, adapt, develop, and test maize-based dishes. Although many households in the central urban belt do not consume much maize, processed maize products (flour and grits) would help diversify diets. Since maize consumption would be new to many households, it would not suffer from the stigma that sorghum has. Maize is probably the coarse grain most likely to be accepted among medium and higher income families (i.e. households with the income to buy higher quality processed products and which set urban consumption trends). Hence, the new maize dishes should be targeted initially to the upper half of urban households (in per capita income terms). If maize prices fell significantly due to expanded maize output during the 1990s, maize could also become the least expensive coarse grain. In that case, lower-income households would also consume greater quantities.

A fourth, lower priority component of a coarse grain promotion strategy would be to tap the market potential for pre-packaged millet couscous and tiny flour balls used in preparing moni. Demand for these products is particularly strong during Ramadan, when prices of millet products are

[1] The IER/SRCVO Food Laboratory has recently hired two more food technologists to work primarily on sorghum. USAID has provided the resources for this and is clearly committed to this second component of the strategy for promoting coarse grain consumption.

reported to rise. The higher marketing margins during Ramadan would encourage commercial production of such products.

Specific elements of this strategy are discussed in detail below.

Improve the Quality, Storage Life, and Attractiveness of Coarse Grain Products. Our informal survey shows that urban consumers, particularly women in middle to upper income strata, stressed the importance of clean, hygienic and high-quality grits and flour. Based on this finding, we recommend that food technology research also focus on increasing the quality, cleanliness, attractiveness, and storability of existing coarse grain products using known processing techniques. In an era of increasingly constrained resources, this implies placing a somewhat lower priority on developing a sorghum-based rice substitute. This research will require more agricultural engineering work than laboratory development of new coarse grain products. In addition, development and introduction of simple, low-cost packaging techniques will be critical in promoting greater sales and consumption of coarse grain flour in urban areas.

Develop Maize-Based Food Products. We recommend that a program of food technology research be initiated that will develop and introduce maize-based products in the major urban areas. Maize production is forecast to increase significantly in Mali during the next decade and into the next century. Yet for maize to become increasingly important in the diet, it is necessary to develop new maize-based dishes or to promote those in southern Mali that are unknown in the central urban belt. Given the financial viability of maize production using improved varieties, production costs per unit of output should decline over time. How quickly production costs decrease will be an important factor influencing maize consumption; a significant decline in the price of maize relative to competing coarse grains and rice could expand consumption. On the other hand, open-market maize prices could decline precipitously if marketable surplus increases severalfold while urban demand remains flat.

We recommend that the GRM and donors act to stimulate demand through maize food technology development and tests, promotional campaigns in the media and other means. As of the end of 1990, there seemed to be little GRM and donor consideration of market outlets, the forms in which maize will be consumed in urban areas, and how to integrate maize more fully into urban diets. Developmental and promotional efforts should include consideration of how the new high-yielding white maize varieties will be processed and prepared and most effectively introduced to the Bamako market, where consumption of yellow maize varieties dominates.

Identify Maize Processing and Preparation Techniques Used in Other Countries and Test Them in Mali. Opportunities to develop and introduce new maize products in Mali, perhaps using well-known technologies from South and Central America, hold more promise and take on a special urgency given the forecast increases in maize production (and marketed surpluses).

Strengthen the Testing, Extension, and Outreach Capability of the Cereals Technology Laboratory. The Cereals Technology Laboratory clearly has insufficient staff to take on the role this team views as necessary in food processing and outreach. To fill this role the laboratory needs at least one other sorghum/millet technologist, as well one to two maize technologists. It also needs to improve its extension and outreach capabilities, which are presently limited. The ineffective management and quality control over sori production and testing clearly exemplify how limited testing and extension capability can undermine the efforts of even the best laboratory. Staff need to be

trained and hired to provide this capability. More importantly, they need to be fully integrated into the laboratory's work.

Strengthen Economic Analysis and Marketing Extension Capabilities in the SRCVO. One area in which IER needs institutional strengthening is the economic analysis of alternative processing techniques and coarsegrain products, as well as ways to gauge market acceptance and potential for new food products. With this capacity, the laboratory could make better informed choices on how to allocate scarce research and development resources among products and processing methods.

Develop and Fund Promotional Campaigns for Specific Coarse Grain Products. Coarse grain products that are unfamiliar to urban consumers, which have been developed by particular ethnic groups in different regions of Mali or conceived in the Food Laboratory, are candidates for broader media dissemination. The most effective media for reaching large numbers of urban consumers are radio and television. Radio advertising spots are far cheaper, but they are less effective than television in introducing new products.

One potentially effective dissemination medium is Amy Sow's half-hour television program. Donor agencies could contribute to the further success of this program and diffusion of new dishes as part of a dietary diversification strategy. They could fund personnel, travel, materials, and food preparation costs and tests for a broader program that explored ethnic dishes and creative recipes from different rural areas of Mali. Donors could also fund advertising spots for new, improved coarse grain products appearing on the Malian market.

Promote Third Country Development Cooperation in Transfer of Grain Processing Technology. Mali has adopted grain processing technology from other countries in a haphazard manner. The machinery adopted is not well-adapted to the Malian context and promotion of an efficient grain processing industry. Dehullers developed in Botswana and Senegal are better suited to dehulling coarse grains than the Engleberg machines. While CMDT has introduced the Botswana model, the Senegalese dehuller should be acquired and tested in Bamako and perhaps in rural areas. Donor support will be needed for the purchase and transport of these machines, consultative missions by engineers, and visits by Malian engineers to test sites in Senegal.

Develop Low-Cost, Effective Grain Cleaning Technology. Adopting an improved dehulling technology will require either thorough washing, cleaning, and drying of coarse grain before dehulling, or use of low-cost, mechanical and transportable threshers, such as those that have been introduced into CMDT zones. These machines produce a threshed grain product that is far superior to grain processed by traditional threshing techniques. The mechanical threshers (the Bamba) are economically viable only in zones where commercial agriculture is well-established, however. There may also be scope to develop low-cost grain cleaning technology that would be used prior to mechanical dehulling.

Progress Toward a Semi-Industrial or Industrial Coarse Grain Processing Technology? CMDT has established 10 semi-industrial units in rural areas of southern Mali under the management of associations villageoises. Processing of coarse grain in rural production zones makes good economic sense on a number of grounds. First, value is added in rural areas, rural incomes are increased, and rural employment is generated. Second, processed rather than raw coarse grain products are transported from production zones to urban areas. Since 18-20 percent of the weight of the undehulled grain is lost during the dehulling process, transport costs are reduced. Third, the

coarse grain bran remains in rural areas, where it can be used as livestock feed. The fundamental disadvantage of this technology is that maize is not effectively degermed in processing, which limits the storage life of processed maize products to two or three months.

A crude comparison of processing and marketing costs facing the semi-industrial mills in the CMDT zone and the GMM is inconclusive. The comparison takes into account CMDT/CERECOM transfer costs to Koutiala and Bamako and the estimated costs of GMM procuring maize in Koutiala from local assemblers, transporting it to Koulikoro for milling and packaging, and transferring it to Bamako wholesale traders for distribution. CMDT/CERECOM benefits from transport of finished products from rural mills to the urban market of Bamako. While GMM would face higher transport costs in moving unprocessed maize from Koutiala to Koulikoro, it would benefit from scale economies in processing. There appears to be potential for competition between semi-industrial, rural mills and a GMM alternative maize procurement, processing, and distribution system. Rather than legislating a statutory monopoly and a protected market for one transformation system or another, the two should be allowed to compete without outside subsidy.

One way to encourage greater investment in both urban and rural small and medium scale grain processing would be to reduce taxes on imports of equipment and spare parts. Exonerating imports of CMDT equipment for semi-industrial mills constitutes a considerable advantage relative to commercial artisans, who pay high duties.

# 1. INTRODUCTION

## 1.1 Broad Terms of Reference

The effective and economic disposal of intermittent coarse grain (CG) surpluses has emerged as an important policy issue in Mali, where there is a high degree of interannual variability in coarse grain supplies and prices. Three broad categories of possible uses for coarse grains are examined in this report, as follows:

- Increasing the consumption of traditional coarse grain dishes (thereby substituting coarse grain for some rice consumption) by reducing women's opportunity costs in food preparation. This would involve either spreading accessible low-cost grain dehulling and/or milling services more widely, or creating and selling packaged or marketed forms of dehulled or milled grain.

- Increasing the consumption of coarse grains vis-a-vis rice by creating and marketing coarse grain-based convenience food products which have some of the attributes of rice desired by consumers.

- Initiating the use of grains in non-food areas, such as livestock feed or industrial uses (e.g. beer production and materials usages).

The multi-donor PRMC (Cereals Market Restructuring Program) has supported several modest activities which address processing constraints. PRMC will continue to support these activities, and if they show promise, it may make more resources available.

This report examines industrial coarse grain processing activities carried out by the Grands Moulins de Mali (GMM), CMDT/CERECOM maize dehulling, milling and marketing at the semi-industrial level, and artisanal dehulling and milling near and within Bamako. The prospects for different scales of coarse grain processing will also be assessed. The report also looks at efforts under way to develop and market innovative coarse grain products, such as sori (parboiled sorghum), blended grain/legume weaning foods, and other grain-based foods supported by the PROCELOS (coarse grain cereals processing) research network (CILSS/Club du Sahel). The potential for blending coarse grain and wheat flour to make bread is also assessed as an alternative use of plentiful coarse grains.

A key consideration is the extent to which consumers and women food preparers are likely to change their consumption and food preparation habits in response to relative price changes, and the extent to which each process or processed food product examined is likely to change the relative price ratio of cooked rice to the cooked product in question. Maize, in particular, appears to offer promising possibilities as a rice substitute in local urban consumption patterns as maize production and surpluses expand during the 1990s.

The report considers how ongoing and likely future innovations in coarse grain processing affect urban women's time allocation and food preparation practices, as well as employment opportunities for women food processors and vendors in urban areas. We pay a good deal of attention to urban women's perceptions and opinions of alternative coarse grain food products and their comparability in ease of

preparation with rice-based dishes, as well as their competitiveness on price/quality grounds with rice-based dishes.

This report also recommends future actions to be taken by PRMC and/or USAID in collaboration with the Government of the Republic of Mali (GRM) in the following areas:

- Policy or regulatory changes to relax constraints on greater processing of coarse grains.
- Assessment of the extent to which artisanal, semi-industrial, or industrial approaches to processing are likely to be economically viable and effective.
- Recommendation of effective ways for current public actors in the grain marketing/processing sphere to encourage expanded use of improved coarse grain processing and products.
- Specific research and development to be undertaken in the short and medium term which could increase the market for processed coarse grain products, including policy measures, applied research, and advertising or product promotion.

## 1.2 Methods of Inquiry

This study is based on earlier efforts and employs several methods of inquiry. The team found the work of the following organizations to be very useful:

- INTSORMIL collaboration with the Food Technology Laboratory in IER in developing new sorghum processing methods and dishes (see Annex 7).
- The taste and market test of parboiled sorghum developed by the Food Technology Laboratory and BECIS and BECIS's evaluation of that test;
- The CMDT program to promote local cereals, which has led to the establishment of ten semi-industrial mills in southern Mali; and,
- Analysis of maize marketing and processing in Mali by the German consulting firm Agroprogress.

Furthermore, the AMIS team has drawn heavily on IDRC-led and funded efforts to develop improved abrasive-disk dehullers in Africa. Papers and workshop proceedings of the Club du Sahel/CILSS network PROCELOS (Programme régional de promotion des céréales locales au Sahel), including the December 1990 workshop held in Bamako, have also proved to be a rich and valuable source of information.

In addition, the AMIS Project conducted a similar study of coarse grain processing in Senegal in late 1988. Two team members have also participated in the Food Security in Africa (FSA) Cooperative Agreement research program in Sub-Saharan Africa, although not in the Mali FSA activity. The third team member carried out data-intensive farm surveys in southern Mali in 1980-82 as part of an IDRC-IER farming systems research program and has returned to Mali several times since then as a consultant.

Key methods of inquiry are as follows:

- Review the available and abundant literature.
- Design structured informal interview guidelines for conducting in-depth interviews with urban women consumers and food preparers, as well as urban artisanal dehullers and millers in Bamako.
- Conduct limited fieldwork in the Koutiala zone of CMDT, where semi-industrial mills were visited and mill managers and leaders of village associations were interviewed.
- Conduct in-depth interviews in Bamako and Koutiala with private operators and representatives of public agencies, including GMM, CERECOM, CMDT, the Cereals Technology Laboratory, NGOs, the PRMC, donor agencies, and many other firms and institutions.

## 1.3 Organization of the Report

This report is organized generally in the following manner. It provides a broad overview of issues and coarse grain production trends and possibilities in Chapters 2 and 3. It then describes and analyzes in-depth coarse grain consumption patterns in urban areas and processing techniques in Chapters 4 through 6. Chapter 7 discusses the implications of the study's findings for women and small and medium scale enterprises. The final chapter (8) presents policy and program recommendations for PRMC, USAID and GRM consideration.

Chapter 2 discusses common perceptions and assumptions regarding coarse grain production, consumption, and processing, and in several instances challenges the conventional wisdom. Chapter 3 provides a broad overview of recent trends and developments in Malian coarse grain production, marketing, processing and policy, and the impact of changes in marketing, processing and policy on productivity of the coarse grain subsystem. Chapter 4 describes coarse grain- and rice-based dishes consumed by urban households in the broader context of dietary patterns and trends towards increasing diversification. Chapter 5 discusses novel and alternative uses of course grains that could expand utilization significantly over time. Description and analysis of cots, benefits, and constraints associated with different processing technologies are the focus of Chapter 6. Chapter 7 discusses the improved processing techniques, the emergence of different scales of processing technology, and their implications for women and small and medium scale enterprises. Chapter 8 summarizes key findings from the informal survey and recommends policies for expanding consumption and programs.

## 2. CHALLENGING ASSUMPTIONS UNDERLYING CONVENTIONAL WISDOM ON COARSE GRAIN PRODUCTION, PROCESSING AND CONSUMPTION

### 2.1 Perceptions of Coarse Grains

GRM policymakers and officials perceive coarse grains as highly variable in supply and price interannually and interseasonally. Since coarse grain production is rainfed, aggregate production varies across years, as can be seen in Exhibit 2-2. A simple linear regression of coarse grain production against time (see Exhibit 2-1) reveals a compound growth rate of 4.2 percent from 1971-72 through 1990-91 with a standard error of 0.95, R-squared of 0.52 and coefficient of variation (CV) of 0.36.

Decomposing coarse grains into two categories, millet/sorghum/fonio and maize, shows greater variability in maize production than for the other coarse grains. However, the compound growth rate for maize production (7.1 percent) is well above that for millet/sorghum/fonio (3.9 percent), and the linear trend coefficient for maize has a higher degree of statistical significance than for the other coarse grains. Note that the rate of growth in output for both categories was pulled up by the good harvests of the last six years of the series (when rainfall was above average).

**Exhibit 2-1**

**Summary Statistics for Coarse Grain Production Trends, 1971-72 to 1990-91**

| | Compound Growth % | Stand. Error | R. Sq. | Mean '000 MT | Stand. Deviat. | CV |
|---|---|---|---|---|---|---|
| Millet/sorghum/fonio | 3.85 | 0.95 | 0.47 | 956.6 | 325.1 | 0.34 |
| Maize | 7.12 | 1.32 | 0.62 | 113.1 | 63.6 | 0.56 |
| Total Coarse Grains | 4.17 | 0.95 | 0.52 | 1069.7 | 328.8 | 0.36 |
| Paddy | 2.14 | 1.22 | 0.15 | 199.7 | 63.0 | 0.32 |
| Total Cereals | 3.84 | 0.97 | 0.47 | 1269.4 | 433.7 | 0.34 |

Source: Base production data from DNA series, as reported in OSCE, Statistiques de base: agriculture-élevage, 1989

Note: CV refers to coefficient of variation (standard deviation/mean). It provides a unit-free measure of variability for comparison with other CVs for the same period.

Maize production is more highly variable than millet/sorghum/fonio production; the coefficient of variation is nearly twice as high for maize as for the other coarse grains over the twenty-year time-series. One would expect a priori that maize production would be more highly variable over time than millet or sorghum production, since maize yields are more dependent on rainfall and fertilizer application, which tend to fluctuate with variable weather and fertilizer/output price relationships.

Exhibit 2-2

COARSE GRAIN PRODUCTION
IN MALI, 1971-72 T0 1990-91

(all figures in '000 metric tons)

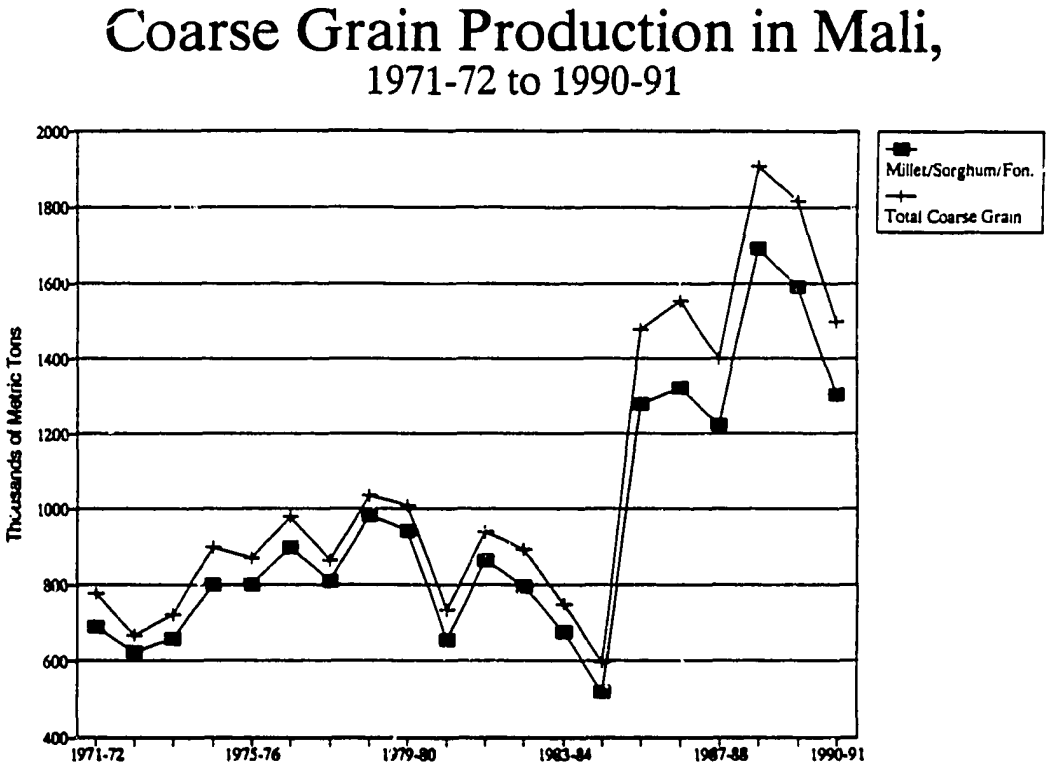
| Trend | Year | Millet/ Sorghum/ Fonio | Maize | Total Coarse Grain | Paddy | Total Cereals | Crop Year |
|---|---|---|---|---|---|---|---|
| 1 | 1971-72 | 691 | 87 | 778 | 171 | 949 | 1971-72 |
| 2 | 1972-73 | 624 | 44 | 668 | 116 | 784 | |
| 3 | 1973-74 | 660 | 63 | 723 | 130 | 853 | |
| 4 | 1974-75 | 800 | 100 | 900 | 250 | 1150 | |
| 5 | 1975-76 | 800 | 70 | 870 | 218 | 1088 | 1975-76 |
| 6 | 1976-77 | 900 | 80 | 980 | 237 | 1217 | |
| 7 | 1977-78 | 808 | 55 | 863 | 200 | 1063 | |
| 8 | 1978-79 | 983 | 53 | 1036 | 252 | 1288 | |
| 9 | 1979-80 | 942 | 66 | 1008 | 165 | 1173 | 1979-80 |
| 10 | 1980-81 | 655 | 80 | 735 | 165 | 900 | |
| 11 | 1981-82 | 863 | 76 | 939 | 175 | 1114 | |
| 12 | 1982-83 | 796 | 96 | 892 | 130 | 1022 | |
| 13 | 1983-84 | 675 | 75 | 750 | 129 | 879 | 1983-84 |
| 14 | 1984-85 | 521 | 76 | 597 | 103 | 700 | |
| 15 | 1985-86 | 1279 | 200 | 1479 | 187 | 1666 | |
| 16 | 1986-87 | 1322 | 232 | 1554 | 209 | 1763 | |
| 17 | 1987-88 | 1222 | 179 | 1401 | 237 | 1638 | 1987-88 |
| 18 | 1988-89 | 1693 | 214 | 1907 | 288 | 2195 | |
| 19 | 1989-90 | 1592 | 225 | 1817 | 338 | 2155 | |
| 20 | 1990-91 | 1306 | 191 | 1497 | 294 | 1791 | 1990-91 |

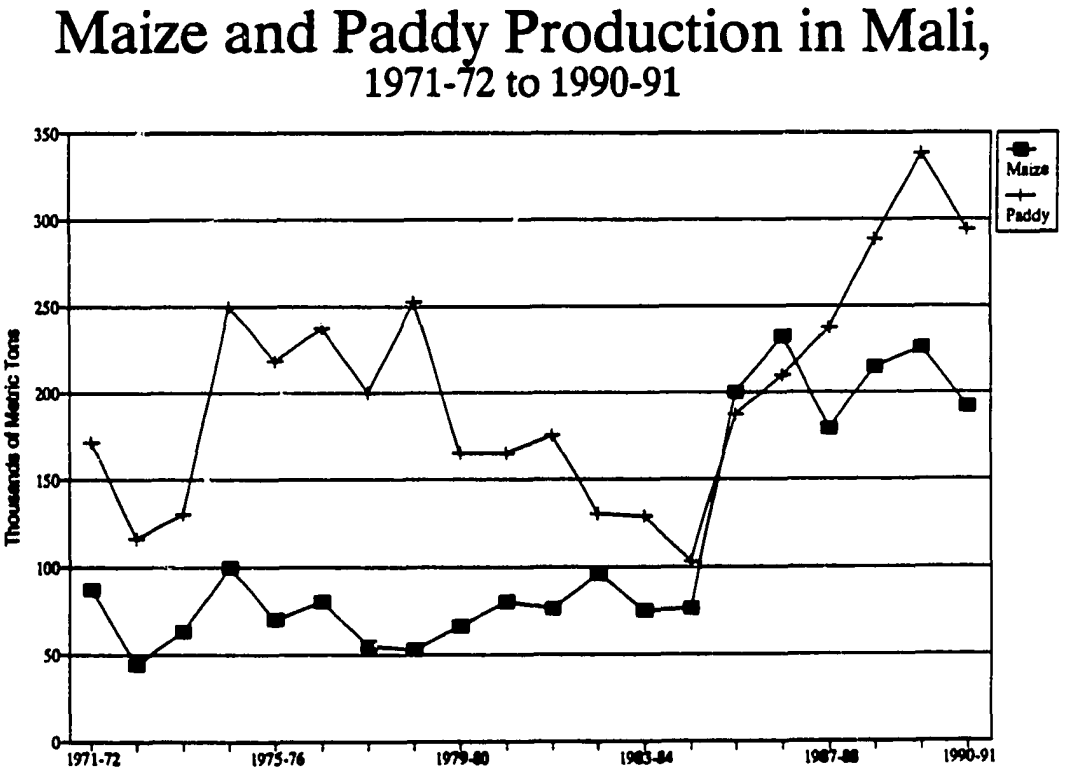
Source: Ministere de l'agriculture, Direction nationale

Note: There are two independent series of production estimates for the years 1971-72 through 1986-87. The Ministry of Agriculture estimates are shown for those years.

EXHIBIT 2-3

PLOT OF GRAIN PRODUCTION IN MALI
1971-72 TO 1990-91



The perception of coarse grain supply and price instability has encouraged, over many years, significant investments in irrigated rice production, which is regarded as less risky. The statistics on paddy production in Exhibit 2-1, however, show this perception to be false. The paddy production CV over 20 years is nearly as high as the CVs for millet/sorghum/fonio and total coarse grains. Paddy output has also trended upward at the slowest rate among the principal grains (2.1 percent per annum). The standard error is also largest relative to the computed growth rate for paddy.

Coarse grain price variability across years and seasons is also viewed as problematic. The longest available, consistent time-series is the Bamako retail price series. Storable commodities such as grains are supposed to follow a pattern of seasonally low prices after harvest, steadily rising prices through the dry season and into the rainy season, and peak prices during the rainy season, typically right before harvest. In years of bumper crops, prices may peak earlier, as farmers and traders sell from stocks, reflecting expectations of depressed post-harvest prices and returns to storage. This seasonal pattern of grain price behavior is most valid for commercial agriculture, where farmers are producing essentially for the market. In the Malian context of variable supply and considerable rural food insecurity, the classic seasonal price pattern does not often hold. Where possible, farmers maintain multi-year stocks, which get drawn down for their own household use during drought years and reconstituted following good years. These farmer-held stocks tend to dampen price seasonality and interannual variability. In the months following a bumper crop which comes after a year of poor to mediocre harvest, prices may not fall as much as one would expect a priori, as farmers rebuild their stocks. In the months following poor harvests, prices may not rise as high as anticipated, because deficit farm households draw down on their own stocks before buying grain on the open market.

Thus, interannual farm storage is very important in Sahelian countries such as Mali, where there is considerable rural food insecurity. Variable rainfall leads to significant swings in grain output, and a small proportion of the total coarse grain crop actually enters commercial channels. Coarse grain markets in the Sahel tend to be thin; many grain transactions take place outside of market channels, and the market serves as a residual source of grain supply. Agriculture is still relatively uncommercialized in Mali, with the exception of larger farmers in CMDT zones, who are well-equipped, in some cases even owning tractors. In recognition of the importance of farm-level storage, the Direction nationale de la statistique et de l'informatique (DNSI) and the Direction nationale de l'agriculture (DNA) carried out rural surveys in 1989 and 1990 to estimate the magnitude of farm stocks (see Enquête Stocks Paysans 1989, June 1990).

A factor which may work against stable grain prices in some rural areas is farmer sales of grain to generate revenue to pay taxes, school fees, and various social obligations in the immediate post-harvest period (see Dione, 1989). Such sales tend to depress farm-level prices, putting a particular burden on smaller, less productive, and poorly equipped farmers. These farmers do not produce cotton (or another cash crop), and they are typically forced to sell grain at low prices after harvest when they need cash. This phenomenon is far more prevalent in the OHV zone than in CMDT areas, where cotton revenues lessen the need to sell cereals shortly after harvest.

DIAPER estimates of farm-level stocks are useful and provide needed information to policymakers on the extent of farm-level storage well after the previous year's harvest, yet a couple of months before the millet/sorghum harvests. The DIAPER surveys have been conducted in September during the past two years.

Another phenomenon that seems to exacerbate grain price swings in urban areas is consumer reaction to misinformation about upcoming harvests in the pre-harvest period. Rumors of drought and grain production shortfall can trigger panic buying in September-October, as consumers fear high post-harvest prices. This bids up prices in the September-October period to levels from which prices fall as the new harvest comes in. Herd-like reaction to partial and erroneous information is common in the Sahel, where market information is not well-diffused to urban consumers despite improvements in governments' capability to forecast crop production during the 1980s.

## 2.2 Uncertainty about the Extent of Coarse Grain Surpluses

Estimating the magnitude of coarse grain surpluses in Mali has proved to be a risky effort. GRM official estimates of the magnitude of grain surpluses following the 1989-90 cropping season are regarded by most analysts as far too high and have been revised downward.

Coarse grain surpluses historically have been incidental, unpredictable, and highly correlated with annual rainfall.[2] Farmers typically have aimed to meet their own household consumption requirements. Surpluses following years of poor rainfall and low coarse grain output are stored on the head. Following years of good rainfall and high coarse grain output, surpluses are partly sold at harvesttime at relatively low prices by farmers who need cash, yet stored by other farmers without pressing cash needs (who are net sellers) over the medium term in anticipation of higher prices. Beginning in August, coarse grain prices may drop well before harvest in some years following good harvests if farmers anticipate a second consecutive good crop and attempt to sell grain from the previous harvest in order to make room for new stocks (i.e. stock rotation).

Medium- to long-term commercial storage by wholesale traders could smooth out intra-annual price variability and result in a more predictable and orderly cross-seasonal movement of prices. Such commercial storage is not widespread, however, although a PRMC cereals credit program for traders has promoted it. Most wholesale traders prefer to hold stocks for short periods, in part due to working capital constraints but probably more importantly due to irregular and unpredictable price movements.

## 2.3 Reliability of Coarse Grain Production and Consumption Data

As Michael Lipton (1986) and others have argued, a critical priority for data collection and analysis in African countries remains reliable, timely, and publicly available forecasts of national (and regional) area planted and production. Data-intensive, micro-economic surveys are no substitute, despite their usefulness in generating knowledge of farmer behavior and determinants of the status of rural households as grain net surplus or deficit.

Development of a national capacity to forecast output of key staple crops well before harvest and to estimate it at harvesttime has benefitted from financial and strategic assistance from the regional PADEM project (funded by the UNDP) and the Office Statistique des Communautés Européenes (OSCE). Separate data collection methods used by the DNA and the DNSI for many years were harmonized. The

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[2] As maize output represents an increasingly large proportion of total CG production, spatial and temporal distribution of rainfall within a given crop year will become important determinants of coarse grain output. For example, drought in southern Mali at the time of maize flowering in August 1990 led to a significant decline in output relative to farmer and GRM expectations.

two sets of estimates under the earlier system had resulted in wide discrepancies in estimates of area cultivated and production (see OSCE, 1988/89 Statistiques de Base). There was only one set of official GRM estimates for 1987-88 and 1988-89.

In addition to important methodological and institutional issues associated with data collection, questions arise regarding interpretation of actual production estimates. National production estimates presumably represent biological yield, based on extrapolations from crop cuts, rather than economic or actual into-storage yield. Historically, global conversion coefficients have been applied to production estimates to account for seed use, post-harvest losses, and dehulling losses. Coefficients of 15 percent have been applied to national production estimates of millet and sorghum, 20 percent to maize, 10 percent to fonio and 49 percent to paddy in order to calculate quantities available for consumption. Although such coefficients are likely to have an historical empirical base, they appear to be too low (except for paddy) to reflect accurately harvest and post-harvest losses, dehulling conversion rates and seed requirements. The coefficients cited above probably capture only dehulling conversion rates. Crop losses alone likely increase these conversion factors another 5 to 10 percentage points for coarse grains. Hence, official GRM estimates of grain available for human consumption are likely to be exaggerated. By extension, the magnitude of coarse grain surpluses is probably an overestimate.

By way of illustration, Exhibit 2-4 shows adjusted quantities of each type of grain available for human consumption following the 1989-90 and 1988-89 harvests based on a different set of assumptions, namely: 10 percent post-harvest losses and seed requirements applied to whole grain; and dehulling conversion ratios (losses) of 18 percent for millet/sorghum, 20 percent for maize, and 45 percent for paddy.

The difference in the magnitude of the two sets of methods for calculating grain availabilities appears in the bottom row of the table. In the aggregate, the difference is quite striking.

# EXHIBIT 2-4

## CEREALS PRODUCTION IN MALI BY REGION, 1988-89

| | Region | Millet | | Sorghum | | Maize | | Total Coarse Grains | | Fonio | | Paddy | | Total Cereals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MT | % Total | MT | % Total | MT | % Total | MT | % Total | MT | % Total | MT | % Total | MT | % Total |
| | Kayes | 62,301 | 5.7% | 251,047 | 31.1% | 96,241 | 45.6% | 409,589 | 22.5% | 192 | 0.6% | 431 | 0.2% | 410,212 | 19.2% |
| | Koulikoro | 147,493 | 13.5% | 173,702 | 21.5% | 22,265 | 10.5% | 343,460 | 18.8% | | | 4,624 | 1.6% | 348,084 | 16.3% |
| | Sikasso | 103,612 | 9.5% | 201,631 | 25.0% | 74,827 | 35.4% | 380,070 | 20.9% | 7,798 | 25.7% | 20,756 | 7.2% | 408,624 | 19.1% |
| | Segou | 377,412 | 34.5% | 105,698 | 13.1% | 17,187 | 8.1% | 500,295 | 27.5% | 22,337 | 73.7% | 134,440 | 46.9% | 657,072 | 30.7% |
| | Mopti | 365,409 | 33.4% | 41,395 | 5.1% | 648 | 0.3% | 407,452 | 22.4% | | | 88,410 | 30.8% | 495,862 | 23.2% |
| | Tombouctou | 36,490 | 3.3% | 10,397 | 1.3% | | 0.0% | 46,893 | 2.6% | | | 29,055 | 10.1% | 75,948 | 3.5% |
| | Gao | | | 23,516 | 2.9% | | 0.0% | 23,516 | 1.3% | | | 8,981 | 3.1% | 32,497 | 1.5% |
| (1) | Total Product. | 1,092,723 | 100.0% | 807,384 | 100.0% | 211,168 | 100.0% | 1,822,510 | 100.0% | 30,327 | 100.0% | 286,697 | 100.0% | 2,139,534 | 100.0% |
| (2) | Less Seed/Post Harvest Losses | 109,272 | | 80,738 | | 21,117 | | 211,128 | | 3,033 | | 28,670 | | 242,830 | |
| (3) | Adjusted Prod. | 983,451 | | 726,646 | | 190,051 | | 1,900,148 | | 27,294 | | 258,027 | | 2,185,489 | |
| (4) | Less Hulls | 147,518 | | 108,997 | | 38,010 | | 294,525 | | 2,729 | | 103,211 | | 400,465 | |
| (5) | Net Production | 835,933 | | 617,649 | | 152,041 | | 1,605,623 | | 24,565 | | 154,816 | | 1,785,004 | |
| (6) | Difference Betw. (5) & Conventl. Estimate | 92,381 | | 68,628 | | 16,893 | | 178,403 | | 2,729 | | (8,601) | | 172,531 | |

Source: Ministere du plan, Direction nationale de la statistique et de l'informatique; Ministere de l'agriculture, Direction nationale de l'agriculture. Enquetes agricoles de conjoncture, plusieurs annees.

# EXHIBIT 2-4a

## CEREALS PRODUCTION IN MALI BY REGION, 1989-90

| | Region | Millet MT | Millet % Total | Sorghum MT | Sorghum % Total | Maize MT | Maize % Total | Total Coarse Grains MT | Total Coarse Grains % Total | Fonio MT | Fonio % Total | Paddy MT | Paddy % Total | Total Cereals MT | Total Cereals % Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kayes | 21,113 | 2.5% | 115,910 | 15.9% | 23,896 | 10.6% | 160,919 | 8.9% | 3,651 | 19.3% | | | 164,570 | 7.6% |
| | Koulikoro | 116,176 | 13.8% | 225,123 | 30.8% | 28,872 | 12.8% | 370,171 | 20.6% | 379 | 2.0% | 2,350 | 0.7% | 372,900 | 17.3% |
| | Sikasso | 147,344 | 17.5% | 204,049 | 27.9% | 154,416 | 68.5% | 505,809 | 28.1% | 5,355 | 28.3% | 24,539 | 7.3% | 535,703 | 24.9% |
| | Segou | 386,093 | 45.9% | 105,391 | 14.4% | 17,362 | 7.7% | 508,846 | 28.3% | 6,767 | 35.7% | 160,014 | 47.4% | 675,627 | 31.4% |
| | Mopti | 132,159 | 15.7% | 11,648 | 1.6% | 848 | 0.4% | 144,655 | 8.0% | 2,777 | 14.7% | 91,539 | 27.1% | 238,971 | 11.1% |
| | Tombouctou | 38,909 | 4.6% | 67,966 | 9.3% | | | 106,875 | 5.9% | | | 27,035 | 8.0% | 133,910 | 6.2% |
| | Gao | | | 779 | 0.1% | | | 779 | 0.0% | | | 32,172 | 9.5% | 32,951 | 1.5% |
| (1) | Total Product. | 841,794 | 100.0% | 730,866 | 100.0% | 225,394 | 100.0% | 1,798,054 | 100.0% | 18,929 | 100.0% | 337,649 | 100.0% | 2,154,632 | 100.0% |
| (2) | Less Seed/Post Harvest Losses | 84,179 | | 73,087 | | 22,539 | | 179,805 | | 1,893 | | 33,765 | | 215,463 | |
| (3) | Adjusted Prod. | 757,615 | | 657,779 | | 202,855 | | 1,618,249 | | 17,036 | | 303,884 | | 1,939,169 | |
| (4) | Less Hulls | 113,642 | | 98,667 | | 40,571 | | 252,880 | | 1,704 | | 121,554 | | 376,137 | |
| (5) | Net Production | 643,972 | | 559,112 | | 162,284 | | 1,365,369 | | 15,332 | | 182,330 | | 1,563,032 | |
| (6) | Difference Betw. (5) & Conventl. Estimate | 71,552 | | 62,124 | | 18,032 | | 151,708 | | 1,704 | | (10,129) | | 376,137 | |

Source: Ministere du plan, Direction nationale de la statistique et de l'informatique; Ministere de l'agriculture, Direction nationale de l'agriculture. Enquetes agricoles de conjoncture, plusieurs annees.

## 2.4 Conventional Wisdom: Processing as the Key Constraint to Increased Coarse Grain Consumption

A typical finding of many studies of coarse grain production, marketing and consumption in the Sahel is that time-consuming manual processing methods and inconvenient mechanical processing techniques requiring cash outlays limit coarse grain consumption and put coarse grains at a disadvantage vis-a-vis processed and ready-to-cook rice. It is argued that urban women in particular are time-constrained, because they work outside the home (in the formal or informal sectors) and therefore have limited time to spend preparing the mid-day meal. Urban food vendors and restauranteurs in urban centers have also been shown to prefer to prepare dishes based on rice due to its convenience and lower energy requirements (see Reardon, Delgado, and Thiombiano, 1988). Many studies of coarse grains recommend promotion of mechanized processing to stimulate coarse grain consumption and offset increased rice consumption.

The conventional wisdom is accurate in some respects but partial and limited. Processing time and expense are indeed constraints to expanding coarse grain consumption, but other key factors are typically not addressed. One is the issue of coarse grain cleanliness and hygiene. Many urban women are skeptical regarding the quality of grits, flour, and other processed coarse grain products sold without packaging in open air markets. Potential buyers complain of contamination by dust, stones, and other foreign matter. In addition to the hygiene issue, potential buyers report rejecting any grits or flour that are slightly discolored. Consumers perceive the color of a processed coarse grain product as very important. In Bamako, the whiter the color of sorghum grits or flour, the more likely the product will be accepted. They strongly prefer yellow maize varieties and hence yellow grits and flour, because impurities are highlighted against the bright yellow backdrop and also because the color of freshly ground maize products differs visibly from that of two to three day old products. Despite the preference for yellow maize in Bamako, CMDT extension agents are promoting white maize varieties as higher-yielding in the productive southern zones.

It is commonly assumed that urban housewives process coarse grain, but in Bamako, that is the exception rather than the rule. Typically, maids do the dehulling manually and take the dehulled, washed grain to a neighborhood mill for grinding. The opportunity cost of a maid's time is presumably far lower than that of an urban housewife, unless the maid is actively involved in an enterprise that generates income for the urban household. In addition to maids, some housewives hire itinerant hand pounders to do the dehulling. While transaction and financial costs are associated with hiring hand pounders, the urban housewife does not actually perform the labor.

Cross-generational differences in perceptions of coarse grain-based dishes also affect coarse grain consumption. Young urban men and women regard coarse grains as food for rural and backward people, that is, as patently inferior to rice-based dishes. Older members of many urban households, who may have grown up in rural areas, strongly prefer a coarse grain-based evening meal. Since many young people and children will not eat coarse grain-based dishes in the evening, some households prepare more rice than can be consumed at one time for the midday meal to produce leftovers that can be reheated as an evening meal or snack for the younger household members.

The above discussion demonstrates that processing time or cost/convenience (assuming mechanical processing) is not necessarily the only important or even the most important factor limiting urban coarse grain consumption. The issue is far more complex. Cosmetic factors such as color come into play. Perceptions of cleanliness and hygiene affect willingness to purchase processed coarse grain products. Perceptions of coarse grain inferiority and a decidedly hick image associated with coarse grain

consumption affect the food consumption habits of younger urban people. Chapter 4 discusses these factors in greater depth and Chapter 6 suggests ways to address factors limiting coarse grain consumption.

## 2.5 Increasing Urban Population and Rising Urban Rice Consumption

Rice consumption in Sahelian countries is primarily an urban phenomenon that increases with rising urbanization. Senegal is a partial exception to this pattern in that rice consumption has made considerable inroads in rural as well as urban consumption patterns (see Goetz, 1988 and 1990). Rice consumption in rural Mali is generally limited to special occasions, such as holidays and marriage ceremonies. Rural people in most of the Sahel tend to view rice as a light, almost dessert-like food that is not a suitable substitute for coarse grains. The apparent contradiction can probably be explained by the fact that rural people (outside the major rice-growing zones) consume rice far less frequently and in far smaller quantities per meal than urban people. The hand-pounded and ground coarse grains consumed by most rural Sahelians contain more protein and other nutrients than dehulled rice, particularly highly polished imported rice. Eating hearty coarse grain-based meals is perceived as a prerequisite to performing demanding agricultural tasks.

With increases in the numbers of urban women working outside the home and urban people commuting to work (from distant suburbs), rice consumption could continue to rise, perhaps at an accelerating rate. If cooking technology remains relatively unchanged (i.e. wood and charcoal cooking predominates), and as the demand for increasingly scarce wood-based fuels expands, energy costs in food preparation will become increasingly important. Since rice-based dishes generally require less energy to prepare than coarse grain-based dishes, continued use of wood-based fuels could further promote rice consumption. On the other hand, technology is unlikely to remain static. GTZ has introduced more fuel-efficient stoves with modest success. Increased demand for wood-based fuels could also induce a positive supply response for wood. Under good management, commercial woodlots could at least partly meet expanding demand for wood-generated energy, thereby dampening price increases. Petroleum-based fuels could also expand in use, particularly if world oil supplies increase and prices decline.

Rice is unlikely to be a superior good over moderate to upper income ranges, although it will most likely be a superior good for low-income consumers. Yet urban rice consumers complain of constipation. Given the large quantities of rice consumed relative to vegetables, legumes, and animal protein in typical rice-based dishes, this comes as little surprise. As urban incomes increase, the desire for a less monotonous diet is likely to translate into greater purchases of tuber crops (e.g. yams, cassava, sweet potatoes, Irish potatoes), fresh fruit and vegetables (including plantain and vegetables used in salads), and animal protein. Most urban households responded to specific questions about how increases in incomes would be spent on foods by stating a strong preference for diversification of their diets. Hence, the coarse grain-rice substitution debate reflects a limited understanding of trends in diversification in consumption underway in urban areas in the Sahel and limited consideration of substitution (for rice) alternatives. This issue will be discussed in greater depth in Chapter 4.

## 2.6 GRM Coarse Grain and Rice Production Strategies

As with many African governments, the GRM aims to increase grain self-sufficiency. The supporting argument has been that relying on regional and world markets for cereals is inherently risky, given historical price volatility and questions regarding the long-run sustainability of subsidies for grain production in Europe and North America. Furthermore, Mali's geographic isolation, high transport costs in shipping grain from Abidjan, Dakar and Lomé, and lags in shipping grain from surplus countries

outside Africa to Mali all reinforce the perception among policymakers that too much dependence on foreign suppliers entails unacceptable political and humanitarian risks.[3]

In order to promote greater rice self-sufficiency, the GRM and donors plan to continue to invest in irrigated rice production in the ON and ODIPAC zones. The Ministry of Agriculture forecasts that rice production will expand over threefold from the 1989-90 estimate to 1.137 million metric tons by the year 2010 (see Perspectives de la production céréalière: 1985-2000, 1986). The same study forecasts a 122 percent increase in maize production from 225,400 MT in 1989-90 to 495,900 MT by 2010. In both the cases of rice and maize, these forecasts are highly optimistic.

Maize production will be promoted under the World Bank-funded Mali Sud III project, which will open up and settle high-potential dryland production zones around Bougouni, which is closer to the Bamako market than the Sikasso and Koutiala zones. According to the World Bank appraisal document, maize production in southern Mali due to the project is forecast to increase at an annual rate of 4.0%, as shown in Exhibit 2-5. This exceeds the forecast growth rate of 1.6% without the project. By 1998-99 maize production in Southern Mali will increase 81,703 metric tons over the base year of 1989-90, a 42.3% expansion in nine years and 52,063 tons over the forecast "without project" growth.

Considering the desire for more diversification in urban diets, a strategy for expanding tuber crop production and consumption is conspicuously absent. There also seems to be little appreciation at official levels of how improved livestock production and a more efficient and competitive livestock marketing system could lead to more food security through expanded exports of livestock products and imports of staples including tuber crops, plantains, oilseed and legume crops, and fresh fruits and vegetables. As the longer-term preconditions for economic growth are laid in place by the ongoing structural adjustment program in Mali, per capita income will begin to increase again over the next decade and demand for imported staples will expand. Local import-substituting production of these staples will also be stimulated in suitable growing areas, such as southern Mali and selected OHV horticulture-producing zones (see Martin, 1990).

## 2.7 Rural and Urban Employment Considerations

GRM and donor officials view promotion of coarse grain production and marketing as a strategy for keeping people in rural areas suitable for dryland agriculture and as a means of increasing rural incomes. GRM and donors regard the promotion of artisanal and semi-industrial coarse grain processing in rural areas as a way to develop rural agro-industry and to add value to agricultural products in rural areas rather than shipping out the raw material. Rural processing also contributes to rural employment and income generation. Shipping semi-processed grain in dehulled form from rural areas to urban markets could also reduce transport costs, assuming away potential technical problems.[4]

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[3] Mali's geographic isolation provides significant protection for domestic rice production. High transport costs from the coast to major urban in Mali push up import parity prices for rice.

[4] Grain dehulled in rural mills using currently available technology is not degermed. Hence, the storage life of the dehulled grain or coarse grain products that are further processed from the non-degermed grain is likely to be limited to two or three months.

Exhibit 2-5

**Forecast Increases in Maize Production Due to Mali Sud III Project in Southern Mali, 1990-91 to 1994-95**

| Year | Forecast Maize Production | Incremental Maize Production | Increase Over Base |
|---|---|---|---|
| | | | |
| 1989-90 | 193,008 (base year production in project zone) | | |
| 1990-91 | 200,728 | 4,632 | 4.0% |
| 1992-92 | 208,757 | 9,524 | 8.2% |
| 1992-93 | 217,108 | 14,686 | 12.5% |
| 1993-94 | 225,792 | 20,132 | 17.0% |
| 1994-95 | 234,824 | 25,873 | 21.7% |
| 1995-96 | 244,217 | 31,923 | 26.5% |
| 1996-97 | 253,985 | 38,295 | 31.6% |
| 1997-98 | 264,145 | 45,003 | 36.9% |
| 1998-99 | 274,711 | 52,063 | 42.3% |
| | | | |
| Note: Incremental maize production is expanded production due to the project, above and beyond the assumed 1.6% annual growth rate without the project. With Mali Sud III support, maize production is forecast to increase at 4.0% per annum. | | | |

Promoting expanded rural processing of grain and shipment of semi-processed or ready-to-cook coarse grain products to urban markets could, however, negatively affect urban employment. During the 1980s urban grinding mills and dehullers proliferated in Bamako and other major towns.[5] This growth generated employment for typically non-literate males, as well as income streams for urban mill owners. At the same time, mechanized coarse grain processing in urban areas may have reduced employment opportunities for poor urban women or peri-urban women who specialize in custom hand-dehulling coarse

[5] The reasons for the expanded investment in plate mills and dehullers are not entirely clear. Several hypotheses can be advanced, however. First, urban population grew rapidly, and investment in processing equipment expanded to meet the growing aggregate demand for processing services. Second, reductions in government spending led to an absolute decline in public sector employment. Incentives in the form of sizeable severance pay were offered for some public employees to take retirement early. Some of the people who took the early-retirement option invested their severance pay in urban grain processing units, which looked as if they would generate steady streams of income to substitute for a regular public paycheck.

grains for urban households. Based on our interviews, few urban households are currently using these itinerant coarse grain processors to dehull their grain. To the extent that some of these women may have been hired by urban households that could afford a maid, mechanized processing may not have had a negative impact on balance.[6] This depends in part on the range of alternative employment opportunities for poor urban and peri-urban women. One such set of opportunities lies in urban food processing, preparation, and vending of coarse grain-based foods such as millet cakes or gruel.

[6] Interestingly, maids in Bamako refuse to grind local cereals into flour, although manual dehulling is still quite common.

## 3. COARSE GRAIN PRODUCTION AND MARKETING SUBSYSTEM IN MALI: A SELECTIVE OVERVIEW

This chapter provides a brief and necessarily partial review of coarse grain production, marketing, processing, and consumption in Mali. The interested reader is referred to the bibliography for more in-depth discussions. (This chapter will be expanded in the U.S. following review of the general literature and more complete analysis of secondary data).

### 3.1 Trends in National Coarse Grain Area and Production

This chapter provides a descriptive (but necessarily incomplete) analysis of time-series crop area and production estimates of DNA available in the OSCE's Statistiques de base: agriculture-élévage (1989), coupled with DNA estimates for cereals in 1989-90 and 1990-91. We chose to use the DNA series for consistency, although DNSI and DNA estimates diverge widely in quite a few years. This is a serious problem that has already been discussed in section 2.3. Since an assessment of the accuracy of different sets of estimates is beyond the scope of this paper, we chose the DNA series. Nevertheless, we recommend that the reader treat the following observations with some skepticism.

Despite these caveats, a few observations about recent trends follow:

- Millet/sorghum/fonio area expanded steadily at the modest compound annual rate of 1.5 percent from 1971-72 to 1988-89, despite sharp declines in area cultivated during the dry years of 1983-84 and 1984-85. M/S/F production was highest in 1988-89 (1.693 million metric tons) and remained at or above the level of the previous record harvest (of 1.322 million MT in 1986-87) in 1989-90 (1.592 million MT) and 1990-91 (revised provisional estimate of 1.306 million MT). The compound growth rate was 4.0 percent over the 1971-72 to 1988-89 period.

- Maize area cultivated from 1985-86 through 1988-89 averaged twice that of maize area from 1977-78 to 1984-85. Production more than doubled in the later period relative to the earlier one, peaking in 1986-87 at 232,000 MT yet remaining at high levels in 1989-90 (225,400 MT) and 1990-91 (191,300 MT). The lower output in 1990-91 has been attributed to an August drought in major maize growing areas at the critical time of maize flowering. Compound growth rates for area and production were 3.0 percent and 9.5 percent respectively. Yield increases were a key determinant of maize output expansion.

- Paddy area increased at the sluggish rate of 0.4 percent over the 1971-72 to 1988-89 period, and output growth was equally unimpressive (0.9 percent per annum). According to DNA estimates, however, average paddy output over the three-year period of 1988-89 to 1990-91 (306,600 MT) was 30.5 percent above the highest previous three-year average output of 235,000 MT (for the 1974-75 to 1976-77 period).

What tentative conclusions can be drawn from looking at these longer-term trends in area and production and judgments based on field observations and interviews? First, millet/sorghum/fonio area and output will probably continue to grow in area and yield (comparing years of good rainfall) in the medium run, given the extensive nature of M/S/F production, declining available good quality, accessible

land for cultivation, and low levels of fertilizer and agro-chemical application. Sharply higher crop prices could induce a positive supply response, most likely from a shift in other crops. This is improbable, however, given the limits of existing millet and sorghum agronomic production technology and the unlikelihood of much lower fertilizer and agro-chemical prices (relative to crop prices) in the short term.

In contrast to M/S/F, maize area and output expansion have been impressive over the long term and offer promise for further growth. This is due primarily to continued possibilities for extensification of maize production (in selected areas of Sikasso and particularly in Bougouni zone), as well as intensification of maize production in zones where extensification opportunities are limited. The development of improved maize production packages (especially improved seed and fertilizer), coupled with growing acquisition and use of animal traction in CMDT zones, are key determinants in the growth of maize culture. Given the responsiveness of maize to fertilizer application, output has considerable room to expand over the medium term. The negatives associated with maize culture are that maize has higher and more regular rainfall requirements than the more drought-tolerant M/S/F and that expanded output could lead to significant price declines. The drop-off in maize output in 1990-91, due to the August drought, is clear evidence of the increased risk faced by maize producers under conditions of dryland agriculture. The peaking of maize area and output in 1986-87 was due in part to good rainfall but also to OPAM's massive buying of grain in 1985-86 (at the guaranteed floor (farm) price of 55 FCFA/kilogram). Now that OPAM is out of the maize buying and selling business, farm-level maize prices have dropped relative to 1985-86 and returns to maize production appear to have stagnated or dropped.[7]

It is important to note, however, that farmgate prices are not the only determinant of maize profitability. Fortunately, maize productivity has considerable room to expand. While yields peaked at slightly more than 2.5 metric tons per hectare in 1986-87, further substitution of improved maize varieties for traditional ones and greater fertilizer use could perhaps double average yields over the longer term. At higher levels of maize productivity, maize prices can decline in real terms at the farmgate over the longer run without greatly sacrificing profitability of maize culture. This would be a desirable longer term development that would shift relative grain prices in favor of maize (and away from rice and other coarse grains), thereby stimulating greater human consumption. Furthermore, maize prices will need to decline in real terms over the next decade or two in order to stimulate greater use of maize as animal feed. Expanded maize area, higher maize productivity, greater maize output, lower farmgate prices, yet increased farmer returns from maize culture, are all consistent with a significant upward shift in maize culture and expanded human and animal feed usage.

### 3.2 Regional Differences in Coarse Grain Production and Consumption

As illustrated by production figures for the crop year 1988-89 in Exhibit 2-4, there are marked regional differences in coarse grain production. Millet is produced primarily in the drier Segou Region (45.9 percent of total millet output), with Sikasso being a distant second. Koulikoro (30 percent) and Sikasso (27.9 percent) lead in sorghum production. Sikasso Region dominates in maize production, growing 68.5 percent of Mali's maize. Paddy production is concentrated in the irrigated zones of the Segou and Mopti Regions.

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[7] OPAM bought only 10,000 metric tons of millet/sorghum for the national food security stock in 1986-87. No maize has been bought for the food security stock. Last, OPAM has not, in principle, bought maize since 1985-86 (personal communication, Philip Steffen).

Despite Sikasso Region's emerging reputation as the grenier du Mali, total coarse grain production (including millet, sorghum, maize, and fonio) was higher in Segou Region in 1989-90 (515,600 MT) than in Sikasso (511,200 MT).[8] Although the population of Segou Region is greater and denser than that of Sikasso Region, the leadership of Ségou in coarse grain production probably cannot be sustained during most years of the 1990s (barring major drought or a collapse in maize prices relative to other grains). Given its suitability for maize production, particularly in rotation with cotton and millet/sorghum among CMDT farmers, Sikasso Region should outproduce Segou Region in coarse grains during most years of the 1990s.

### 3.3 The Promise of Maize Profitability Yet the Reality of Thin Markets

Available analyses of costs of production for major crops in Mali show maize to be second in profitability only to cotton. As part of an integrated cotton-maize rotation in CMDT zones, maize culture is decidedly superior to millet or sorghum culture. These judgements depend in large part on assumptions about maize prices and yields.

One recent review of agriculture in Southern Mali (see Projet Mali-Sud III: Etude socio-économique de la région CMDT de Bougouni, 1989) shows maize culture to yield the second highest financial returns per person-day among the major crops for the better-equipped farms (two highest equipment levels among four). Maize is the most profitable crop for those farms at the two lower equipment levels. Exhibit 3-1 shows the base assumptions regarding crop yields and prices,[9] as well as financial returns per person-day for four key crops. Some sensitivity analysis is performed by lowering yields 25% for each crop produced on each type of farm (by equipment level) as well as prices received by farmers. The absolute financial profitability of maize culture declines, and its profitability decreases proportionally more than that of millet/sorghum. Maize becomes the third most profitable among four crops on the best-equipped farms with a 25% decrease in yields. Farms equipped at the lower three levels find that maize is the most profitable crop under this scenario, however.

Despite the apparent profitability of maize in Southern Mali, the market for maize in Mali, particularly urban Mali, is thin. Under the assumption of marginal increases in maize marketed surplus, prices would probably be about 40 FCFA/kg on average across the marketing season and likely decline no more than 25%. If production increases lead to a doubling or tripling of maize marketed surplus, farm prices could collapse in the short term. Given the thinness of the urban market for maize, particularly outside Sikasso Region, the forecast production increases under Mali-Sud III are cause for serious concern. While maize offers the best short-term potential for yield and output expansion, the urban market for maize in the central belt is limited.

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[8] Malians sometimes refer to Ségou as the Autonomous Republic of Ségou, due to its CG and rice production (personal communication, Philip Steffen).

[9] The interested reader is referred to the original document for a more detailed discussion of inputs and technology levels.

# EXHIBIT 3-1

## ESTIMATED RETURNS TO PRODUCTION OF MAIZE AND MILLET/SORGHUM BY FARM TYPE

| | FARM TYPE A | | | | FARM TYPE B | | | | FARM TYPE C | | | | FARM TYPE D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cotton | Mil/Sorg | Corn | Rice | Cotton | Mil/Sorg | Corn | Rice | Cotton | Mil/Sorg | Corn | Rice | Cotton | Mil/Sorg | Corn |
| **BASE ASSUMPTIONS** | | | | | | | | | | | | | | | |
| Area Cultivated (ha) | 4.5 | 6 | 3.7 | 1.58 | 2 | 4 | 2.66 | 1.63 | 2.25 | 4 | 2.4 | 1.95 | 1.3 | 2.25 | 1.8 |
| Yield (Kg.) | 1517 | 771 | 1114 | 950 | 1409 | 650 | 2000 | 928 | 1175 | 672 | 1600 | 800 | 1045 | 543 | 1700 |
| Price FCFA/Kg. | 85 | 35 | 40 | 70 | 85 | 35 | 40 | 70 | 85 | 35 | 40 | 70 | 85 | 35 | 40 |
| Return/Day | 900 | 303 | 406 | 540 | 770 | 224 | 758 | 568 | 535 | 227 | 596 | 511 | 397 | 169 | 506 |
| **WITH A 25% DECREASE IN YIELDS** | | | | | | | | | | | | | | | |
| Yield | 1138 | 578 | 836 | 713 | 1057 | 488 | 1500 | 695 | 881 | 504 | 1200 | 600 | 784 | 407 | 1275 |
| Return/Day | 579 | 214 | 247 | 313 | 470 | 151 | 491 | 386 | 287 | 156 | 383 | 353 | 397 | 169 | 506 |
| **WITH A 25% DECREASE IN PRODUCER PRICE** | | | | | | | | | | | | | | | |
| Price FCFA/Kg. | 64 | 26 | 30 | 53 | 64 | 26 | 30 | 53 | 64 | 26 | 30 | 53 | 64 | 26 | 30 |
| Return/Day | 579 | 214 | 247 | 353 | 470 | 151 | 491 | 386 | 287 | 156 | 383 | 353 | 198 | 112 | 293 |

SOURCE: Projet Mali-Sud III: Etude Socio-Economique de la Region CMDT de Bougouni, May 1989

Several key factors to monitor during the 1990s are:

- The extent to which nominal and real maize producer and consumer prices decline;
- The response of consumers to lower maize prices relative to millet, sorghum and rice prices. The possibility that consumers will shift to the cheapest source of calories; and
- The effect of lower nominal maize producer prices on maize plantings and production practices (i.e. purchased input use) in successive years.

We argue later (in sections 4, 5 and 8) that expanded maize consumption in urban areas will probably require promotional efforts in addition to lower maize prices relative to other grains. Because maize is mainly consumed seasonally (typically as a fresh vegetable) in Bamako and other urban centers outside the central urban belt and is therefore not well-known, promotional efforts could take advantage of this novelty. Demand development efforts will be needed to spur human consumption of maize in urban areas.

### 3.4 Coarse Grain Price Behavior

Coarse grain prices are reported by farmers, traders and consumers to be highly variable across seasons and across years. Producer prices for coarse grains have reportedly dropped as low as 25-30 FCFA/kg following record harvests in surplus production zones. These prices are unattractive for those farmers who need to sell grain at harvest time to pay taxes or meet other cash needs, and hence cannot store grain on the farm to benefit from seasonal price upswings. Farmers who are able to store on the farm can realize positive returns to storage.

In this section we will analyze the seasonality of coarse grain prices in Bamako (i.e., retail prices) and examine the prices of coarse grains relative to rice. The interested reader is encouraged to consult the SIM bulletins, and papers by J. Dione, N. N. Dembélé and P. Steffen for more in-depth analysis of intermarket price correlation (market integration analysis), analysis of marketing margins, and analysis of returns to grain trading and storage in Mali.

#### 3.4.1 Coarse Grain Price Seasonality

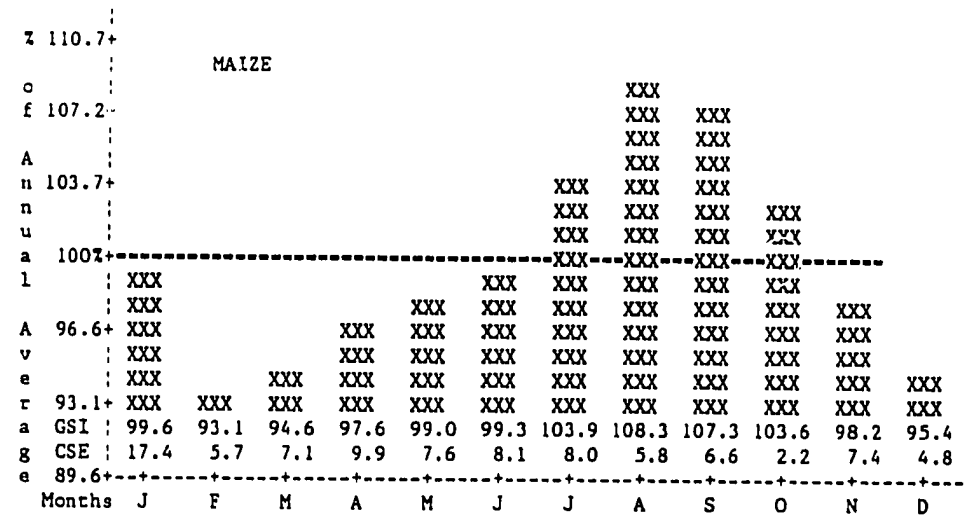
Seasonal price indexes, generated from a 1982-1990 Bamako retail price series using the ratio-to-moving average technique, show the expected seasonal pattern for millet, sorghum and maize, as shown in Exhibit 3-2. As storable commodities grown during one cropping season, the coarse grains show the following seasonal pattern, on average:

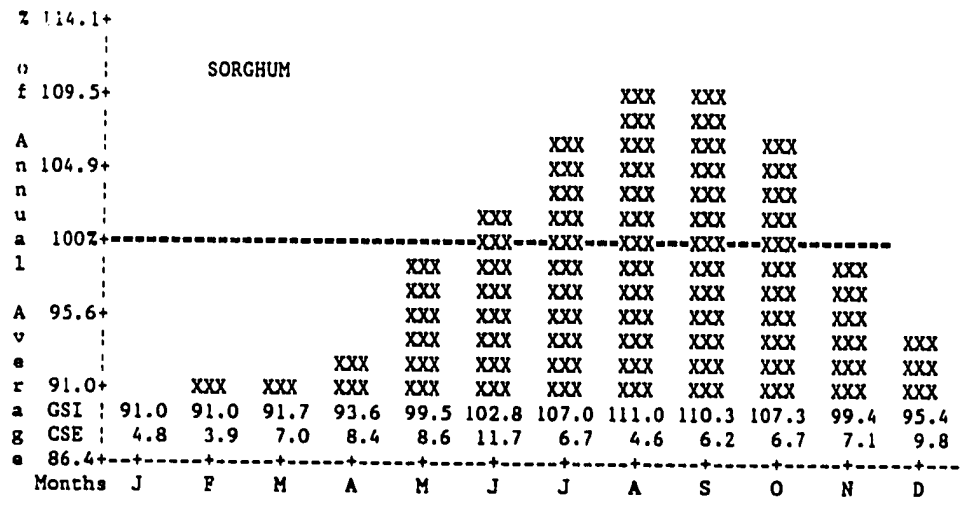
- Prices peak during August and September;
- Prices drop off slightly during October as expectations regarding the probable size of the upcoming harvest are well-informed, and as farmers turn over their stocks in anticipation of the new harvest;
- Prices drop further in November as the new harvest comes on the market;
- Prices are seasonally lowest from December through March during the post-harvest period; and,

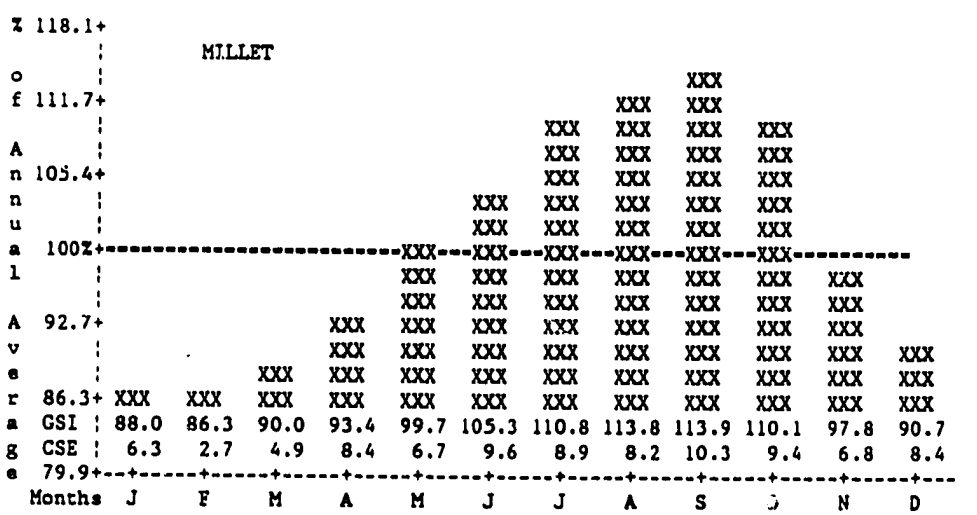
EXHIBIT 3-2

GRAND SEASONAL INDICIES

RETAIL PRICES IN BAMAKO, JANUARY 1982 TO MAY 1990 (EXCLUDING 1988)




GSI. IS THE GRAND SEASONAL INDEX

CSE. REPRESENTS THE CORRECTED STANDARD ERROR

- Prices rise seasonally from April through August-September, as coarse grain supplies on the market decline and rural demand for grain rises (especially as net grain buyers begin buying grain on the market to meet household requirements).

The magnitude of the seasonal highs and lows is most pronounced for millet and least pronounced for maize. The corrected standard errors associated with the coarse grain price indexes (see Annex 2) show that there is considerable variability in the seasonal pattern of price movements, however. The indexes show how prices behave seasonally on average, but they should not be interpreted as the pattern that is repeated in each and every year. In some years, prices do not rise strongly after the harvest and returns to storage are likely to be low or negative.

On-farm storage by typically better-equipped, commercially-oriented farmers substitutes in large part for commercial storage by wholesale traders, who turn over their stocks quickly. Rapid stock rotation reflects wholesalers' limited working capital, as well as risks associated with long-term storage. In the absence of a medium-term wholesale price series, we plot nominal monthly retail prices for millet, sorghum and maize in Bamako for the 1982-1983 through 1987-88 marketing seasons (see Exhibit 3-3). The marketing season begins in November of the earlier year and ends in October of the second year. Based on this retail price series, we can make some inferences about likely returns to storage, given the seasonal pattern of grain price movements. In several years (1985-86, 1986-87) nominal prices rise little following the harvest or actually decline. Wholesale traders who would have bought at harvest (November) and held grain for 5-8 months would have lost money, taking storage costs and losses into account, handling costs (in and out of storage), costs of chemical treatment of the stored grain, and the opportunity cost of capital tied up in stored grain. In other years (1982-83, 1987-88 for millet), returns to storage would have been positive. Further analysis in Annex 2 shows that returns to storage of millet, sorghum and maize from November through the middle of the following year would be negative in three of eight years.[10]

Annex 2 also shows that there is a very weak seasonality to retail rice prices in Bamako. Retail rice prices are essentially flat, with an average though insignificant tendency to be higher in April-May and lower in December. Rice consumer prices have varied so little, because one of the key suppliers, the Office du Niger, sells polished (processed) rice at a fixed price across seasons. This could change as small-scale, transportable dehullers process a higher proportion of the paddy crop.

### 3.4.2 Coarse Grain Prices Relative to Local Rice Prices

Historically and currently, coarse grain prices have been reported for threshed whole grain, the form in which these cereals are typically sold in urban markets. In contrast, rice prices are reported for a dehulled rice product that is ready-to-cook. In order to compare relative coarse grain and rice prices, the cereals prices need to be reported for comparable stages of processing. Hence, it is necessary to adjust coarse grain prices to reflect processing costs.

We have adjusted coarse grain prices for nearly two years of wholesale price data in Bamako. The prices represent prices received by wholesalers for grain sales in Bamako (prix de gros/vente),

[10] The returns to storage are calculated using the retail price series for Bamako.

EXHIBIT 3-3

# MONTHLY RETAIL PRICES OF MILLET
(IN BAMAKO, BY MARKETING YEAR)

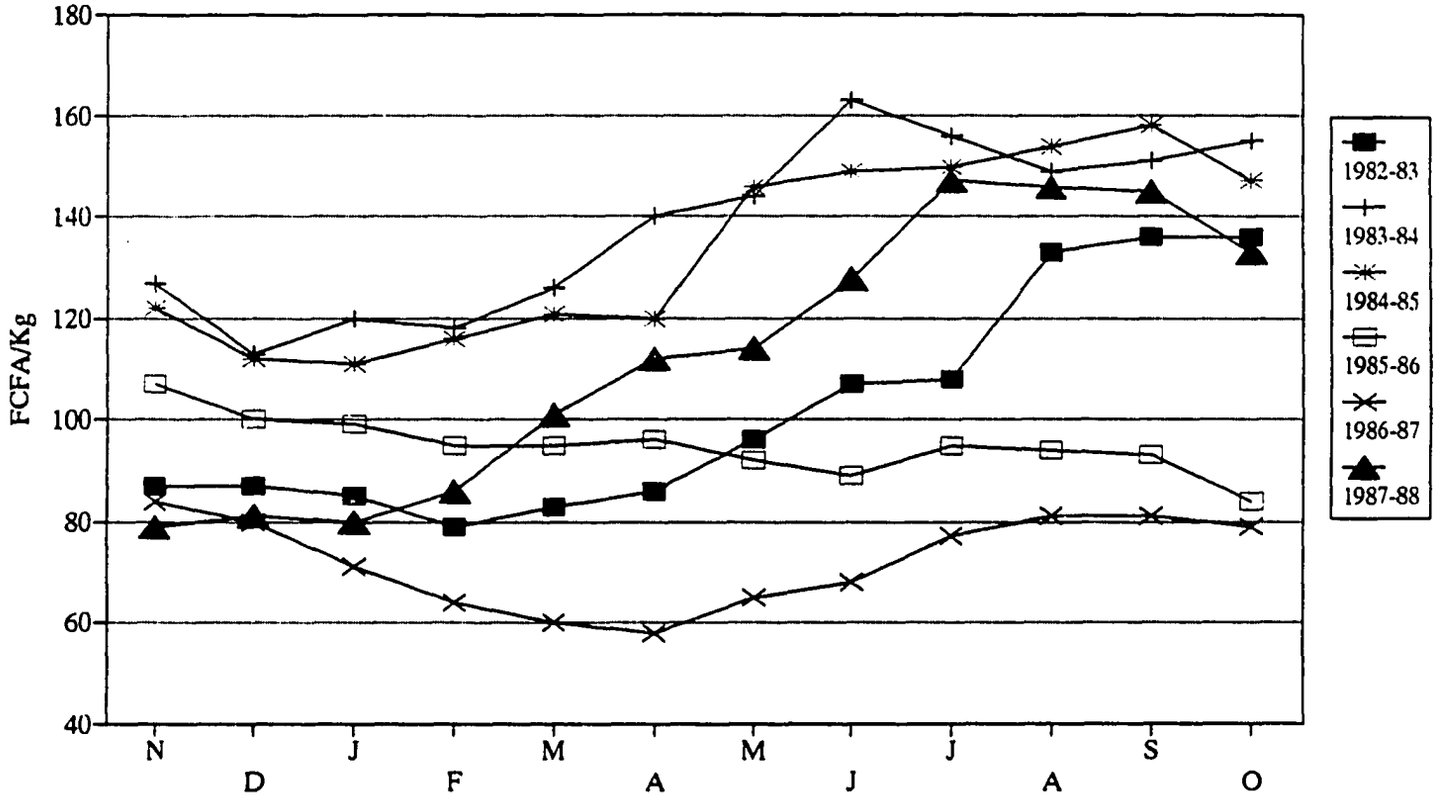


EXHIBIT 3-3

## MONTHLY RETAIL PRICES OF SORGHUM
(IN BAMAKO, BY MARKETING YEAR)

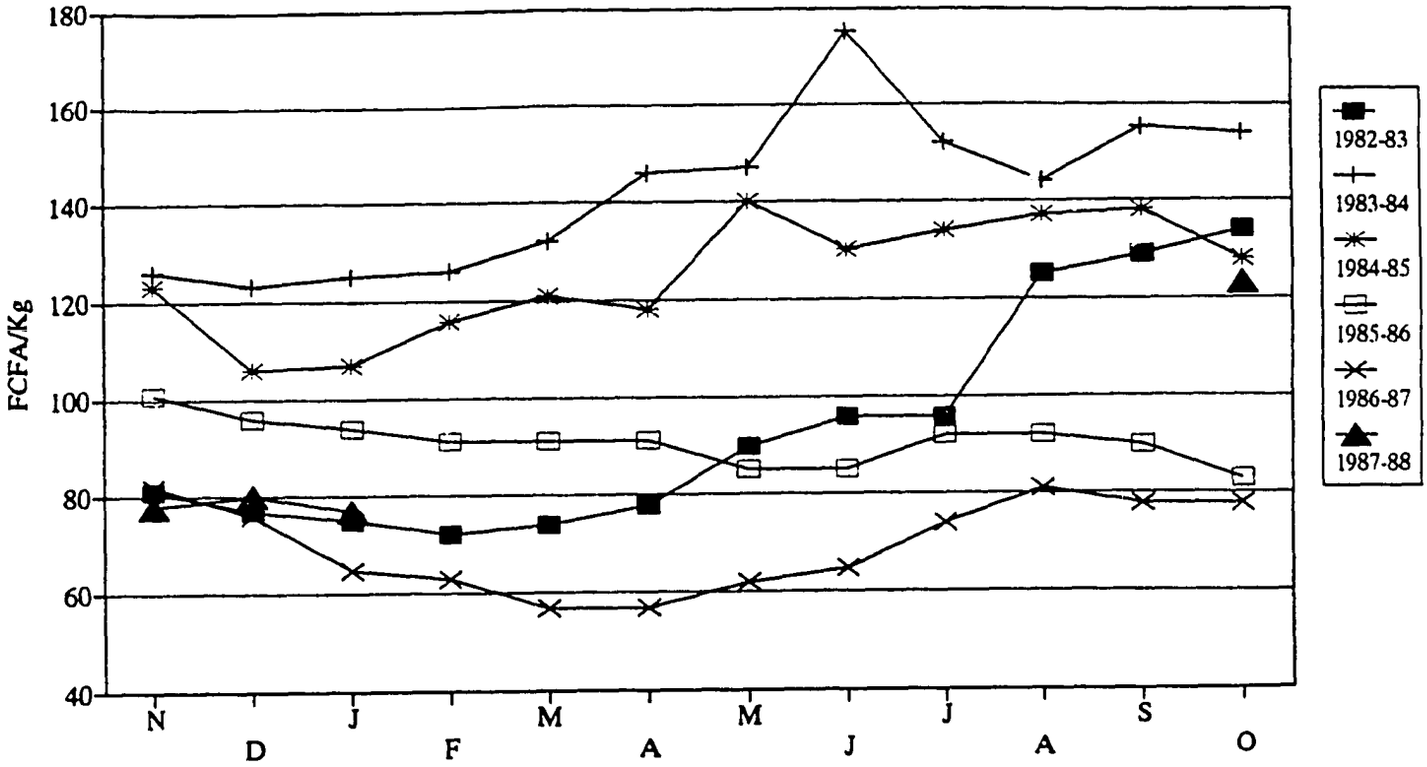
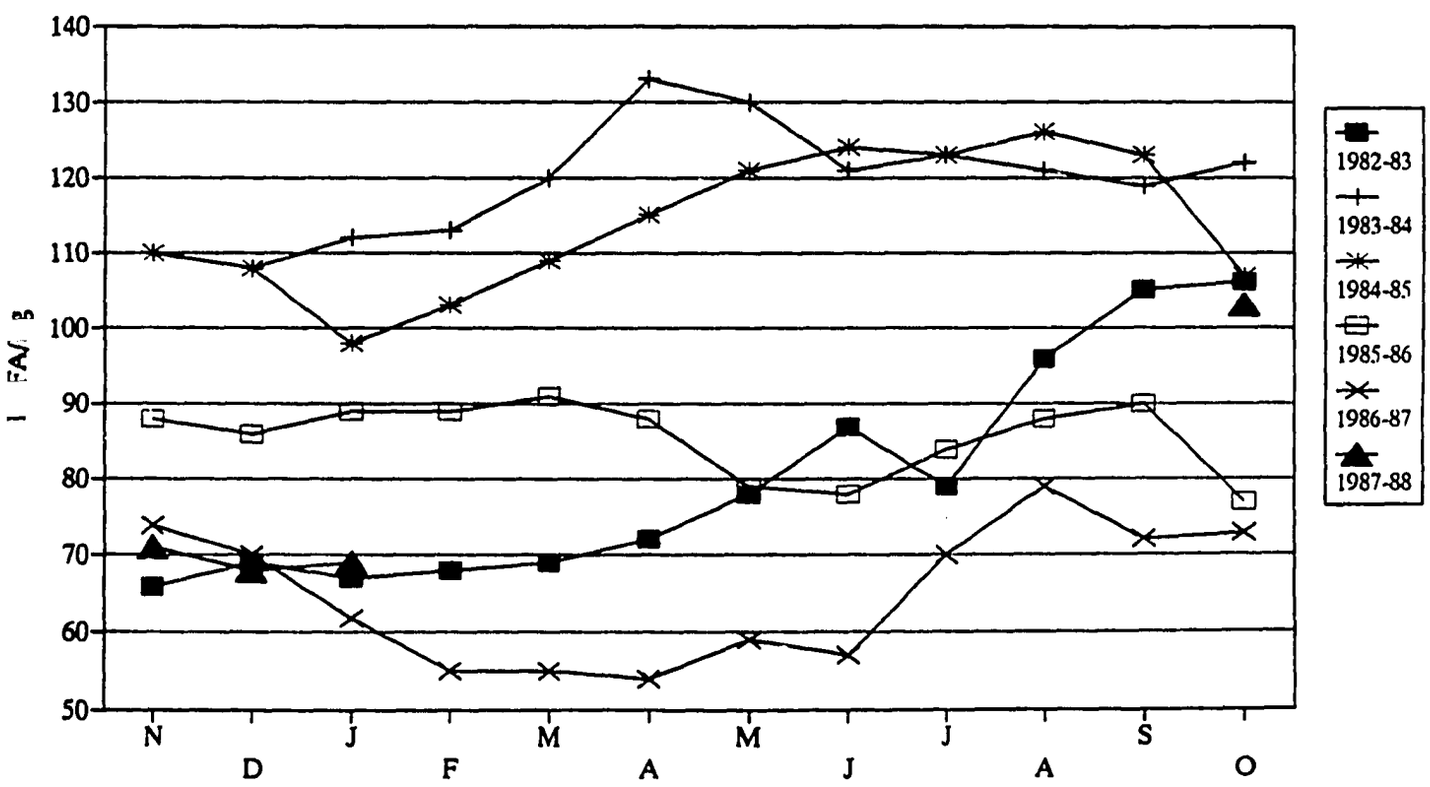



EXHIBIT 3-3

## MONTHLY RETAIL PRICES OF MAIZE
(IN BAMAKO, BY MARKETING YEAR)



presumably to retailers in most cases, for the period March 1988-October 1989.[11] The following adjustments have been made to the wholesale prices for millet, sorghum and maize in order to render them more comparable to rice prices:

- Dehulling losses of 20% are assumed. The person or processing unit providing the dehulling services has the right to the bran.

- A dehulling charge of 12 FCFA/kilogram of whole grain is assumed. A grinding or milling charge of 10 FCFA/kilogram of dehulled (and ground) grain is also assumed.

- An opportunity cost of labor of 10 FCFA/kg is assumed to value the time and inconvenience associated with transporting grain to/from a processing unit, waiting (where applicable) for processing services to be rendered, and cleaning and winnowing of whole and dehulled grain.

The transformation can be expressed as follows:

$$\text{Adjusted CG Price} = \{(\text{Whole Grain Price}) + ((12 + 0.8*(10)) + 10\}/0.8$$

Note that 0.8 is the dehulling conversion ratio. Dehulling losses as high as 30% have been reported, which would lower the conversion ratio to 70%.

The effect of these adjustments is to increase the effective price of coarse grain by 52-107%, depending on the level of prices paid for the whole grain. This pattern is shown in Exhibit 3-4. To illustrate by example, assume that ten kilograms of whole grain sorghum are purchased in the Bamako market for 100 FCFA/kg (1,000 FCFA in total). Dehulling costs 120 FCFA @ 12 FCFA/kg. Dehulling losses of 20% yield eight kilograms of dehulled sorghum. It costs 80 FCFA to grind the remaining eight kilograms; zero transformation loss is assumed. The 10 FCFA/kg opportunity cost is applied to the whole grain. Hence, eight kilograms of ground sorghum (grits or flour) cost 1,300 to produce; the effective price is 162.5 FCFA/kg for the eight remaining kilograms.

It is this adjusted price which needs to be compared with the price of dehulled rice. The gap between coarse grain prices (originally expressed in whole grain form) and dehulled rice prices is considerably narrowed once the above adjustments have been made. The adjusted coarse grain price represents the real cost paid by urban households to procure and process coarse grain. Once the dehulling and grinding have been completed, the coarse grain is ready to cook, as is polished rice. Making the above adjustments approximates the types of calculations that urban households make when considering the costs of preparing rice and coarse grain based dishes. We have not accounted for differences in cooking time and energy requirements for cooking; rice generally cooks faster than coarse grain and hence requires less firewood or charcoal. Yet as elaborated in Annex 5, not all coarse grain-based dishes take longer to prepare than rice based dishes.

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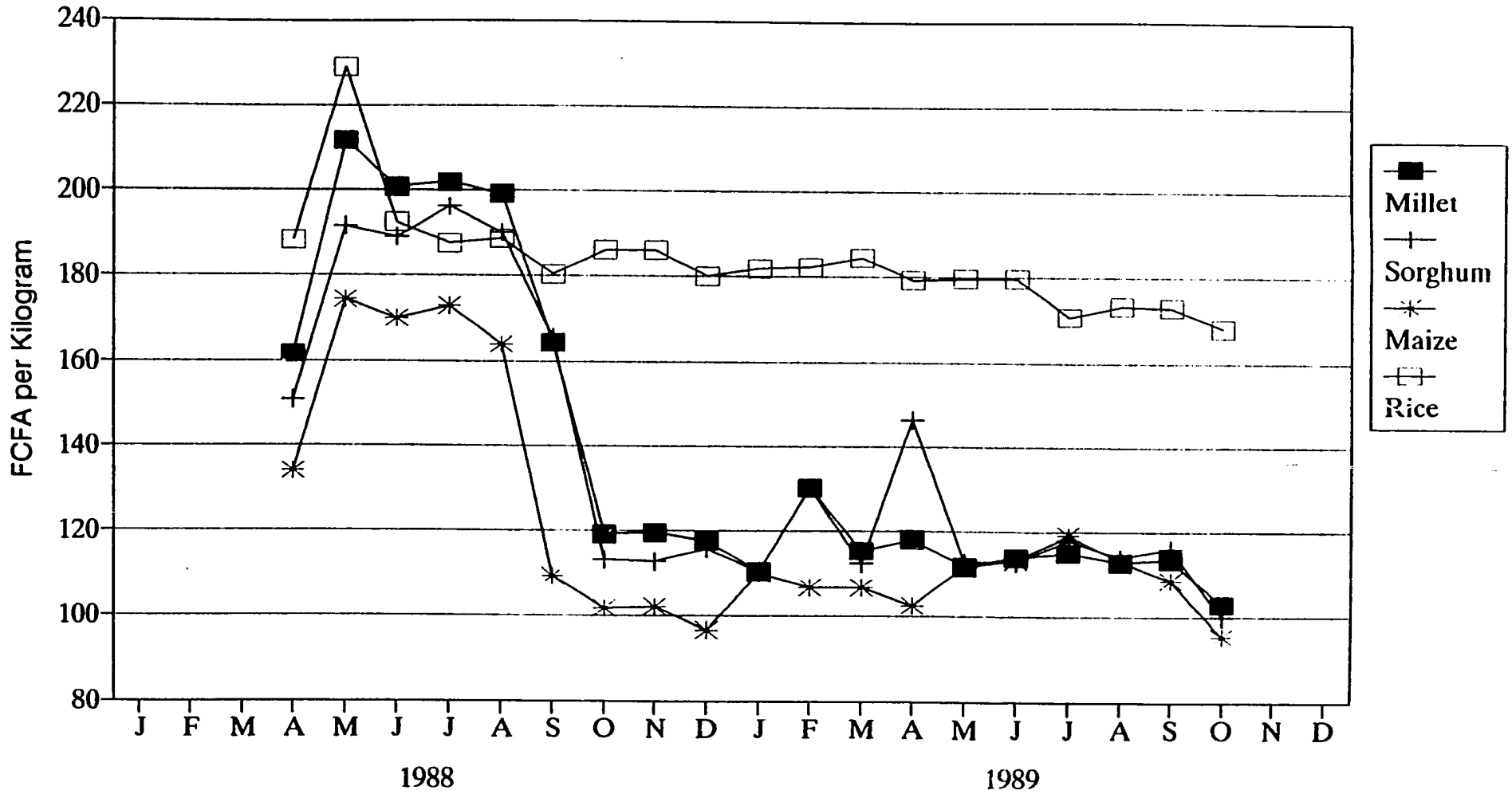
[11] Philip Steffen of the Department of Agricultural Economics of Michigan State University provided the data series. The price data were collected in the course of survey research conducted by the Food Security in Africa Cooperative Agreement and funded by USAID/Mali.

# WHOLESALE GRAIN PRICES IN BAMAKO
## (FOR CEREALS AT COMPARABLE STAGES OF GRAIN PROCESSING)




Note: Wholesale prices for millet, sorghum and maize have been adjusted by accounting for dehu... losses and adding processing costs to allow comparison with processed rice.

Source: Michigan State Univeristy, Department. of Agricultural Economics, Food Security in Africa Progra...

The ratios of nominal prices of each of the three coarse grains (adjusted prices) relative to rice are as follows (for the March 1988-October 1989 wholesale price series):

**Relative Coarse Grain and Rice Prices**

| | Average | Range | |
|---|---|---|---|
| | | High | Low |
| Millet: Rice | .75 | 1.08 | .61 |
| Sorghum: Rice | .74 | 1.05 | .60 |
| Maize: Rice | .66 | .92 | .54 |

Rice is more costly on average than coarse grains but not by as much of a margin as is typically assumed (rice is two or more times as costly as coarse grains).

### 3.5 Coarse Grain Marketing System Organization

Coarse grain marketing has been progressively liberalized and the roles of public agencies redefined under PRMC. Whereas OPAM was once a major buyer of local coarse grains, it has been transformed from a trading parastatal that competed with private, informal grain traders to a public agency that manages and turns over periodically a strategic grain reserve stock of some 40,000-58,000 MT and collects and disseminates market information to policymakers and private traders (see Steffen, 1990b, for a detailed description of the change in OPAM's mandate and roles under the PRMC).

Coarse grain marketing is dominated by private subsystem participants, including rural assemblers, urban-based wholesale traders, and myriad retailers selling whole, dehulled, and processed coarse grain products. Wholesale traders, semi-wholesalers (demi-grossistes) and village associations have benefitted directly from GRM/OPAM interventions, especially the various PRMC credit programs (see Staatz, Dione and Dembélé, 1989; Cook, 1988; and Dembélé and Steffen, 1989) and improved market information (see Steffen, 1990a). In addition, these participants in the grain marketing system have benefitted indirectly in that the credit programs have helped to moderate intra-annual price variability.

While much of the coarse grain marketing subsystem is privately organized and operated, several key participants are public agencies or were fostered by public or parastatal organizations. Village associations, created by CMDT, are able to apply for and receive loans for medium-term grain storage. Ten AVs in the CMDT (and ODIPAC) zones have also received FAC-donated semi-industrial mills and storage facilities. CMDT has also created, in collaboration with FAC, a parastatal-like agency (CERECOM) to market processed maize products generated by the 10 semi-industrial mills. In addition, the Office du Niger remains a major buyer and processor of paddy, although it has lost ground to a vibrant artisanal dehulling industry in paddy-growing areas, whose processed rice is superior to the discolored and foreign matter-laden output of the ON industrial mills. Other project authorities are

involved in agricultural marketing to one degree or another in their respective spheres of operation. Horticultural assembly and export is dominated by a parastatal company, FRUITEMA.

### 3.6 Programs and Policies Under the GRM Grain Market Reform Program (PRMC)

Key features of PRMC policy and program reforms and initiatives during the 1980s included the following:

- Legal recognition of private, informal trade in coarse grains.
- Removal of interregional coarse grain movement restrictions on grain shipments.
- Restructuring of OPAM and a shift in its mandate and functions from a grain trading organization and statutory monopoly to a public sector market-facilitating agency.
- Establishment within OPAM of a limited strategic grain reserve.
- Provision of financing and technical assistance for establishment of a grain market information system (SIM) (especially for coarse grain) and broad dissemination of consumer prices in key national grain markets.
- Creation of a marketing credit program targeted to urban-based wholesale grain traders, with the intent of expanding liquidity and providing working capital for medium-term grain storage.
- Exploration and identification of market opportunities for coarse grain exports following surplus crop years and provision of credit to selected exporters.
- Legal recognition of the private trade in paddy and polished rice, as well as consent for a private sector dehulling industry to emerge in paddy-growing zones.
- Orchestration of far better donor cooperation in identifying food aid requirements and coordinating food aid shipments.

A program related to the PRMC, but not funded by it, is the investment in a greatly expanded and improved GRM capacity to identify emerging grain production shortfalls and food needs, called the système d'alert précoce (SAP) or early warning system. UNDP investments in more reliable and consistent forecasting of crop production have also been independent of the PRMC.

Limited funding of several initiatives in coarse grain processing has come from bilateral sources. USAID has strengthened the Food Technology Laboratory and provided support for the development and testing of an experimental parboiled sorghum product (sori). The FAC has funded the establishment of ten semi-industrial mills in the CMDT zone.

PRMC is widely recognized as one of the most successful and innovative policy reform programs in Sub-Saharan Africa. This is not to say that liberalization of cereals marketing has been a smooth and painless process. OPAM purchases of coarse grain from all comers at an excessively high floor price following the 1985-86 bumper crop led to heavy financial losses. During the first year of the marketing

credit program, very large-scale urban wholesale grain traders managed to capture a large proportion of the available credit. It is doubtful that this provided any additional liquidity or expanded working capital used for grain purchases (see Dembélé and Steffen, 1987).

Despite some mistakes, PRMC has demonstrated a flexibility and ability to learn from early errors and problems in programs and policy and has made the strategic adjustments to move policy reform along. Part of this learning process has been due to a conscious effort by certain donors and the PRMC to fund data collection and analysis that have provided an empirical foundation for monitoring the impact of policy reform and for testing various hypotheses about grain marketing system organization and operation. Fortunately for the GRM and the PRMC, good rainfall has coincided with policy reform during the second half of the 1980s and in 1990. Grain production has been above the longer trend over the past five years. The acid test of the durability and workability of many PRMC reforms will be the next major drought.

Although improved coarse grain processing and promotion of greater coarse grain utilization are areas of interest to the PRMC, little work has been funded multilaterally. PRMC realization of the importance of this knowledge gap, however, inspired the request for this particular report. There is scope for better conceived and focused efforts in improving coarse grain processing and promotional efforts.

### 3.7 Coarse Grain Consumption Patterns and Disappearance

Coarse grain consumption can be only indirectly estimated in the aggregate as a residual, after netting out assumed rates of seed use, post-harvest loss, and dehulling conversion ratios. Such estimates of coarse grain disappearance are very broad-gauged and need to be taken with a grain of salt. Their validity is based in large part on the underlying accuracy of national production estimates.

Coarse grain production expanded over the period 1971-72 to 1990-91, but not rapidly enough over much of this period to keep pace with population growth in Mali (see Atwood and Elliot, 1989). Beginning in 1985-86, coarse grain production shifted upward in the aggregate, due primarily to good weather. The upward shift was so marked as to make it appear as if output growth exceeded population growth over the entire period of 1971-72 to 1990-91.

However, favorable trends in total cereals output over the 1971-72 to 1990-91 period (4.2 percent compound growth rate) mask a great deal of rural and urban food insecurity. The Food Security in Africa Project surveys of rural producers in the contrasting OHV and CMDT zones show that food security, particularly the status of rural households as net grain buyers or sellers, is strongly associated with the level of farm equipment (i.e. availability of animal traction), the number of able-bodied farm laborers, and the extent of improved input use (seed and fertilizer especially). Grain sales and marketed surplus are concentrated among the top quintile of rural households in the OHV and CMDT zones. In overall terms, rural households in the cotton-growing CMDT zones are better off as measured by grain availability, level of grain sales, and household income.

Regional food insecurity is a problem in chronically grain deficit zones, such as Gao and Tombouctou, and in parts of Kayes Region. In years of low or no rainfall, large volumes of cereals need to be imported into these remote regions.

The Tufts study analyzing DNSI urban consumption and expenditure data show that the lowest two quartiles of urban households consume less grain than the recommended FAO/WHO standard (see Rogers and Lowdermilk, 1988). Our informal survey of 58 urban households in Bamako indicates that 26 percent of the sample families prepare only once for the two major meals of the day. While the percentage that eat only once a day is probably much lower (5 percent or less), it is likely that some urban consumers do not obtain sufficient calories from their income-constrained diets.

Other major findings of the Tufts study are as follows:

- Cereals dominate food consumption in every city surveyed and in every expenditure class. Rice accounts for over half the calories and is followed by coarse grains in importance as a source of calories.

- Regional variation in cereal consumption is not very significant. Gao and Tombouctou consumers purchase and consume relatively more maize than consumers in the other cities (Bamako, Kayes, Segou, Sikasso, Mopti, Koulikoro) but maize consumption is far lower in all cities than rice and millet/sorghum consumption.

- Increasing household expenditure is accompanied by an increase in the consumption of all foods, across all levels of household expenditure. Hence, no one food can be classified as an inferior good. Furthermore, the proportions of rice and coarse grains in cereal consumption do not vary by economic level.

- Expenditures on all types of food are own-price elastic. In addition, rice and coarse grains are not substitutes in consumption. That is, the demand for either rice or coarse grains is not cross-price elastic with the other. Rising rice prices do not lead to substitution of relatively cheaper coarse grains; rather, real income and food expenditures decline, resulting in a net loss of calories.

In discussing policy considerations, Rogers and Lowdermilk hedge their findings in stating that consumers do not appear to substitute coarse grains for rice in consumption when rice prices rise or coarse grain prices fall (within the range of prices observed in the study). They suggest that "the dominance of rice may be explained by the much reduced amount of labor, time, and fuel required to prepare it, compared to millet, sorghum, and maize. Appropriate technologies to facilitate preparation of coarse grains might promote the substitution of coarse grains for rice when rice prices rise" (p.5).

This otherwise excellent study has a few potential weaknesses. First, the price and cross-price expenditure elasticities are computed from a cross-sectional sample of households over a one-year period. Ideally, panel data over several years would generate more reliable estimates. Second, as suggested above, limited possibilities for substituting coarse grain for rice may be largely a function of a rather narrow range of coarse grain and rice price movements. Third, millet and sorghum are lumped together, which results from a constraint imposed by the data collected. Fourth, tuber crops are not separated out as a separate analytical category; instead, they are lumped into the category "other foods."

As discussed at greater length in Chapter 4, another set of insights emerges from analyzing alternative dishes based on rice, millet, sorghum, maize, and fonio, rather than focusing more narrowly on the cereal serving as an input into the preparation of these dishes. While our informal survey of urban households agrees with many conclusions of the Tufts study, our findings differ in a few significant ways:

- Sorghum appears to be an inferior good for those consumers in the upper two quartiles.

- Tuber crops and plantains may well be superior goods, particularly for the two upper income quartiles.

- Expenditures on "condiments," broadly construed to mean animal protein, vegetables, tuber crops, and other sauce ingredients, is a useful proxy for urban household income and allows for a meaningful breakdown (by per capita expenditures on condiments) in interpreting rice and coarse grain consumption patterns.

While consumption surveys have focused on urban expenditure and consumption patterns, little work has been done on rural consumption (other than by Sundberg and Steffen (both forthcoming). From the literature and our own observations, however, it is clear that rural people eat far less rice and more coarse grain-based dishes than urban dwellers do. Millet and sorghum are more important in rural diets, and maize is consumed in large quantities in maize-producing zones.

## 4. HOUSEHOLD UTILIZATION AND COARSE GRAIN PROCESSING

### 4.1 Methodology

This chapter is based on a structured informal survey implemented between November 23 and December 6, 1990. The sample consisted of five households in each of 12 neighborhoods (quartiers) in Bamako chosen from about 70 neighborhoods in the city. These included old, established neighborhoods such as Niarela and Bamako-coura, formal housing developments such as Badala-SEMA and Faladje-SEMA, and more recent spontaneous neighborhoods on the outskirts of the city such as Sabalibougou, Djikoroni Para, and Banconi. While not a random statistical sample, this survey reflects a cross section of socioeconomic conditions in Bamako. The households were selected with the help of local representatives of the Union des femmes or of the neighborhood Social Affairs Office, who were asked to provide a representative sample of living conditions in each neighborhood. Thus, while it may not be a statistically random sample, we feel that the 58-household survey represents a broad cross section of socioeconomic characteristics of Bamako households.

The survey was informal but used a set of guidelines (see Annex 3 for guidelines and Annex 4 for a table of summary results) to ensure that it was structured and focused. The guidelines helped ensure that certain questions were asked in each household but did not limit the interviewers from pursuing certain topics in greater depth when the opportunity arose. The team member responsible for the survey was assisted by a local Bambara-speaking woman, who has 10 years of work experience with Social Affairs and who has worked on several recent surveys of the urban area.

### 4.2 Urban Food Consumption Patterns

This survey examines coarse grain utilization in the context of urban food consumption patterns. It was based on the belief that coarse grain use can be understood only in terms of the meals consumed by Bamako residents. The survey thus explores the three primary meals, the dishes consumed during each of those meals, and the proportion of cereal, sauce, and/or other products in those dishes.

The survey also attempts to characterize consumption patterns with regard to different levels of expenditure on food, using the daily prix de condiments (the expenditure on condiments) as a crude proxy for food expenditure. Since certain changes in food consumption patterns seem to correspond to different levels of per capita daily expenditure on condiments, it is believed that this is an effective although rough indicator of likely consumption patterns. The crude and rough nature of per capita condiment expenditures as a proxy for income needs to be stressed. The relationship between the two variables is unlikely to be linear; rather, per capita condiment expenditures are likely to fall off proportionally as income rises in upper income ranges. Nevertheless, the findings of the informal consumption survey suggest that per capita condiment expenditures are a valid proxy for income over the range of most incomes observable in urban Mali.

The expenditure on condiments has the advantage of being a value which most households recognize and use daily. Per capita expenditure is important, because even obviously wealthy families in affluent neighborhoods may have 30 or 40 people to feed. The consumption habits and per capita

expenditure of such families are often comparable to those of much smaller families with more modest incomes.

The survey findings for the 58 households are reported in a summary table in Annex 4. One interesting finding is that 31 percent of the households reported receiving grain from the village, growing some of their own cereal, or receiving other gifts of grain. The average amount reported was over 200 kg per year. Receiving grain from the village seems to be most prevalent in recent spontaneous neighborhoods, especially when some family members return to the village each year to help the extended family cultivate. These contributions can be expected to decrease as younger, city-born generations replace the older village-born migrants.

### 4.2.1 Diversification Within Family Budget Constraints

Most families say that they would prefer a more varied diet but cannot afford it. Yet, diversification takes place at different levels. We find an increasing diversification of sauce ingredients, sauces, and dishes, as per capita food expenditure increases, as illustrated by the following description.

Poor families generally eat sorghum dishes at all their meals since it is usually the cheapest cereal available and expands in volume when cooked. Seri porridge is likely to comprise the morning meal, while toh and sauce or coarse grits and sauce are likely to predominate in the other meal(s). Frequently a meal is prepared at noon and reheated in the evening. Adults may eat only in the morning and at noon, but every attempt is made to provide a third meal for the children. While the single preparation for the noon and evening may be due simply to a lack of means to prepare twice, it may also serve to free time for the women of the household to generate income. This pattern of a single preparation is observed in 26 percent of the sample families, including households with substantially greater means. It is particularly observed in families where the women are civil servants or merchants who need to spend the day in the market to generate income. Families that receive grain from the village or as gifts may have a somewhat more diverse diet, but often grain received as a gift is sold to purchase sorghum, which is always cheaper than millet and feeds more people than a similar volume of maize. These families might purchase rice for a special occasion like a baptism, but the poorest would expect to receive rice from their neighbors on major holidays, rather than to purchase their own. Neighbors also often send over a plate of food if they see no smoke rising from a compound at noon and/or allow the children to come and eat in their compounds.

With a small increase in means, families are likely to prepare somewhat larger quantities of these dishes to be able to eat three times a day. They also slightly improve or increase sauce ingredients. Initially, they might add a few francs worth of okra or peanut butter to the appropriate sauces, green leaves to the peanut butter sauce or a maggi cube or a little soumbala.[12] In addition, they might increase the amount of dried fish meal in the sauce and purchase a small quantity of meat to add to the sauce once or several times a week. They might also on occasion substitute fresh okra (in season) for dried okra in the sauce. If they can afford it, they diversify by preparing other slightly more expensive sorghum dishes like moni porridge and couscous. Moni is prepared with lime, vinegar, or tamarind juice, and most people interviewed say that it requires sugar for

[12] Soumbala is a seasoning made by fermenting the seeds of the leguminous Nere (Parkia biglobosa) tree. Soybeans are sometimes substituted for the Nere seeds.

sweetening. Seri porridge can be eaten with little or no sugar if necessary. Couscous must be steamed three or four times, requiring substantially more wood and more time for cooking. Its fine granulation also requires more sauce for a given volume than toh or the coarser grits. As one woman said when asked about eating salad: "The salad ingredients themselves are not so expensive in season, but I can't afford the oil and vinegar to put on the salad."

With a small increase in means, families purchase millet for consumption during Ramadan, if at no other time of year.[13] Millet is the preferred cereal for preparing couscous, which is the traditional dish of poorer families during many Moslem holidays. Wealthier families often eat rice instead.

At a relatively low per capita condiment expenditure level of about 30 or 40 FCFA per day, families begin to diversify by adding rice dishes at noon. Rice is without question the preferred cereal in Bamako, in terms of both taste and social acceptance. We encountered more sauces and more variety in the sauces for rice than for any other dish. In addition, young people reportedly consider it shameful to come from a family that does not eat rice daily. This attitude in urban Malian society, particularly among the young, exerts severe social pressure on families to consume rice. With a daily per capita condiment expenditure of 30 or 40 FCFA, families may be able to afford only two rice dishes a week, but at the 50 to 60 FCFA level, most families consume six or seven rice dishes a week. In most cases families of modest means consume the rice dishes only at noon and continue to eat coarse grains at their morning and evening meals. Even wealthy families do not eat rice in the evening, except families who reheat the noon food for the evening meal. A few families diversify their porridge preparation by using a rice base once or twice a week for the morning meal or dessert after the evening meal.

When asked why rice is eaten at noon only, interviewees tend to reply, "It lasts longer in the stomach than other cereals and helps you get through the afternoon."[14] Although this explanation is not entirely convincing, no better rationale was ever provided. However, the constipating properties of white rice are often mentioned. Coarse grains, particularly toh dishes with their viscous sauces of okra or other green leaves, are considered to have laxative properties helpful to older adults, which may also help determine the meals at which different cereals and dishes are eaten.

Time constraints also affect when rice is consumed. Most women who prepare family meals, whether housewives or maids, are very busy in the morning preparing breakfast and getting the children to school and other family members to work. Then they have to do the daily shopping (in the absence of refrigeration) and many other daily household chores. Yet the noon meal needs to be ready when the children arrive home at about 12:30 so they can eat, digest their food, and return to school from 2:30-4:30. Rice and sauce require less cooking time than any principal coarse grain dish except toh and less preparation than any coarse grain. Many women get home from market too late in the morning to prepare many coarse grain dishes before the children get home, which seems to be one of the stronger reasons for preparing rice at noon. Waiting until the evening meal to consume

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[13] In some families only fasting adults eat the more expensive millet, while children continue to eat sorghum dishes.

[14] Ross (1979) found that urban dwellers in Dakar felt that coarse grain dishes sit too heavily in the stomach, causing drowsiness and impeding afternoon (office) work.

coarse grains also allows women to deposit the dehulled and washed grain at the neighborhood mill for grinding on their way to market and pick it up on the way home, without having to wait for it to be ground.

Having achieved this basic diversification of cereals by eating rice dishes at noon and coarse grain dishes morning and evening, families with slightly more means continue to enrich their sauces, particularly with additional meat and fish. While families with less means may eat meat only once or twice a week, families at 60 to 80 FCFA daily per capita expenditure on condiments will probably add meat or chunks of smoked fish to their sauce five or six meals a week and consume fresh fish once or twice a week. They are also likely to expand their consumption of milk products, particularly as eaten with porridge. Families continue to enrich their sauces with increased quantities of other ingredients like oil, peanut butter, and green leaves, and fresh okra and other vegetables in season. They also add still more expensive dishes like riz au gras with fresh fish or fonio with sauce and chicken or guinea fowl to their diets, often alternating these two dishes as special Sunday dinners. In addition, they tend to add an evening dessert of porridge with lait caillé (clabbered milk and sugar).

At the 80 to 100 FCFA per capita per day level, diversification turns sharply away from the consumption of cereal dishes. These families diversify by eating more tubers, grilled meat, salad, and vegetables at the evening meal. While midday rice consumption may remain relatively constant or even expand slightly, other types of food begin to replace the coarse cereal dishes traditionally consumed in the evening. Depending on the expenditure level, these diversifying dishes may accompany coarse cereal dishes, or replace them once or twice a week as the expenditure level increases. Families above the 100 FCFA per capita per day level also tend to replace morning porridge with coffee and bread, perhaps accompanied by omelettes on Sunday.

At levels between 100 and 150 FCFA per capita per day, this trend continues until a rotation is established in which toh, couscous and maize, or sorghum grits prepared like rice or fonio is each prepared one night a week. In addition, yams, Irish potatoes, and sweet potatoes are served fried or in a stew (ragout) several nights a week in season. On occasion tubers are also prepared as yam or cassava foutou, cassava atcheké, or mashed potatoes often accompanied by grilled meat or a soup prepared with substantial quantities of meat or fish. Lettuce and vegetables prepared as a salad with oil and vinegar often accompany other dishes and may partially replace sweetened porridge as a sort of dessert. Fried plantain may be eaten as a principal dish or more often as an early evening snack for the children. Families also begin to consume store-bought foods such as pasta, canned peas or white beans, Moroccan couscous, and prepackaged yam (Bonfoutou).

Very few small families were observed spending more than 150 FCFA per capita per day on condiments. On a day to day basis, these families had almost eliminated coarse grains from their diet. At noon they continue to consume rice dishes almost exclusively but in the evening eat in what might be considered almost a European manner. In these families, grilled or fried meat, French fries or plantain (or yams or sweet potatoes in season), a lettuce and vegetable salad, bread, and fruit might be considered staples of the evening meal. Coarse grain dishes are likely to be relegated to occasions like holidays, special events, and the presence of less urbane guests. In some cases traditional dishes are prepared on Sunday, when working women have more time for dishes which require more preparation.

### 4.2.2 Preparation and Cooking Properties

Interviewees were asked to rank the different grains according to ease of preparation. Nearly 90 percent consider rice easier to prepare than any coarse grain. Most respondents feel that sorghum and millet are about equal in difficulty of preparation but more difficult than rice. Maize is traditionally considered harder to prepare than millet and sorghum, a view reflected in interviewees' responses. Maize is especially difficult to dehull manually, but several respondents stated that if it can be mechanically dehulled (and ground), it is actually easier to prepare than sorghum and millet. This, the expanding use of mechanical dehulling and grinding may lead to more consumption of maize relative to millet and sorghum. Eighty percent of respondents feel that fonio is the hardest cereal to prepare. Its tiny grains must be washed five to 10 times to remove all dirt and sand.

Numerous dishes can be prepared from each coarse grain. Some common dishes prepared from cereals differ in texture depending on whether they are boiled or steamed:

| | Flour | Fine Grits | Medium Grits | Coarse Grits |
|---|---|---|---|---|
| **Boiled** | moni toh | seri | seri rice substitute | seri rice substitute |
| **Steamed** | couscous | fonio substitute | | |

Sorghum, maize, and rice may be used to prepare any dish in the above table. Millet is limited by the size of its grains to flour, fine grits, and whole grain. Whole grain fonio is only about the size of fine grits but can be ground into flour. (See Annex 5 for a more complete description of different dishes.)

While many respondents were willing to rank dishes by cooking time, about a third of them furnished specific time estimates. The cooking times provided vary by 200 to 400 percent for any given dish. It is obvious that cooking technology, quality of wood used, amount of water added, and personal cooking techniques vary widely.[15] Results indicate that seri typically requires 20 to 30 minutes to cook; moni, 30 to 40 minutes; and toh and rice, 45 to 60 minutes. Steamed dishes like couscous, fonio, and fine grits prepared like fonio need two to three hours of cooking. Results also indicate that coarse grits prepared like rice also require two to three hours of cooking time.

### 4.2.3 The Economics of Rice Versus Coarse Grain Consumption

Households interviewed do not agree on the economics of preparing rice dishes versus coarse grain dishes. Several women with moderate food expenditure levels argued that rice was as economical to prepare as coarse grains because you can eat all the rice that you purchase whereas five to 10 percent of a sack of whole coarse grain is sand, gravel, and dirt from the threshing floor and

[15] Most Bamako families now use some form of improved wood stove of clay or metal. Other technologies observed include charcoal stoves, kerosene stoves, gas stoves, and the traditional three stones to support pots over a wood fire.

bits of stalk and twigs. The coarse grain has to be winnowed and washed before dehulling to produce a relatively clean product. In addition, most people obtain only a 70 to 80 percent conversion when grain is dehulled, whether manually or by machine. The preference is for very white cereal products, requiring removal of all the bran, so after eliminating impurities and dehulling, only 65 to 75 percent of what was purchased remains. This product also needs to be winnowed and washed before being ground at the mill, a process that takes time or additional payment, as does the grinding. As one woman explained, the time added for winnowing and washing the grain and the additional cost of dehulling and milling services "almost doubles the real cost of the coarse grain."

Rice cooks faster and uses less wood than most coarse grain dishes that families eat at noon. The one exception is toh, which takes approximately the same cooking time as rice but has the economic disadvantage of needing to be prepared with two sauces: a viscous okra or green leaf sauce and a tomato and meat soup. While toh with a single viscous sauce may be as quick as and more economical to prepare than rice and peanut butter sauce, it loses much of this advantage if tomato and meat soup is also prepared with it.

Many women believe that rice expands in volume during cooking more than other cereals, particularly more than maize or millet. Although we asked, we never got a clear idea of how much women think rice expands relative to other cereals. The literature cites expansion rates for rice of 1.25 times the volume of sorghum/millet (Rogers and Lowdermilk, 1988) to more than twice the volume of millet (Freudenberger, 1988). Depending on the percentage of foreign matter in the rice, the conversion rate for dehulling, the amount of wood used, and the comparable expansion in volume, it is easy to find scenarios in which rice is cheaper to prepare than coarse grains if the price of the latter is more than 40 percent of the rice price. Although the families who are eating rice find these relative economies to be convincing, we find the fact that the very poor families are not eating rice to be more convincing.

The idea that rice may be as economical as coarse grains to consume does not necessarily conflict with the fact that the very poor families eat only coarse grains, considering the cash outlay necessary to purchase a month's supply of rice. Even most relatively poor families try to buy cereal in 50- or 100-kg quantities if they have an adequate source of revenue (88 percent of families interviewed claim to purchase cereal in 50 or 100 kg quantities). A 13-member family (average for the 58 households interviewed) needs about 10 kg of whole grain sorghum per day. For a month, this average family would need the following for an all-sorghum diet:

10 kg/day sorghum X 30 days = 300 kg/month

300 kg/month X 80 FCFA/kg = 24,000 FCFA/month

To diversify by adding rice dishes at noon, this family would need about 4 kg of rice and 5 kg of whole grain sorghum per day.[16] This would require the following:

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[16] Assuming an all-sorghum grain diet and a 70 percent dehulling rate, average daily sorghum consumption per capita would be 0.538 kg. This would equal 196.5 kg per annum, an estimate that falls within the GRM norms of 167 kg and 212 kg per capita per year. The provisional norm of 212 kg/year is based on the preliminary findings of a 1988 PADEM survey.

150 kg/month sorghum X 80 FCFA/kg = 12,000 FCFA/month for sorghum

120 kg/month rice X 220 FCFA/kg = 26,400 FCFA/month for rice

26,400 FCFA/month + 12,000 FCFA/month = 38,400 FCFA/month

Thus, the increase in cash outlay necessary to consume rice at noon and sorghum in the morning and evening is 14,400 FCFA per month. For the household head trying to decide how to feed his/her family for the month on a limited budget, this 60 percent increase in cash outlay may be the decisive factor, whatever the additional costs and conversion rate once the outlay has been made.

If the head of the family is willing and able to make this cash outlay, then there may be perceived savings as a result of fewer kilograms of cereal used, less use of wood, and reduced use of the daily condiment fund. While most male household heads apparently do not mind if women use money provided for condiments to pay for machine grinding of grain, they also do not increase the condiments funds to cover this cost. The woman must cover that cost with improved management or with her own additional contribution to the condiment funds provided by the male household head.

### 4.3 Household Coarse Grain Consumption

Perhaps the first implication of the pattern described above is that coarse grains are inferior goods in Bamako. At higher per capita expenditure levels (and presumably at higher per capita income levels), families reduce the quantities of coarse grains consumed. While poor families may be substituting rice for coarse grains at the noon meal, much of the urban population is already past this stage of diversification. Our sample shows only 22 percent of the families with per capita daily expenditures on condiments less than 50 FCFA, a level at which most families have converted to eating rice at noon. In our sample, 45 percent of the families spent between 50 FCFA and 100 FCFA per capita daily on condiments, while 53 percent spent between 50 FCFA and 125 FCFA. In this range of what might be considered typical per capita daily expenditure (where a majority of our sample falls), families which prepare noon and evening meals separately are already eating rice almost exclusively at noon. Instead, they diversify their diet by substituting meat, tubers, plantain, milk, bread, eggs, fruit, and prepackaged store-bought products for coarse grain dishes. These then seem to be the superior goods in the Bamako consumption system.

Rice consumption is expanding with rising income and expenditure only among families with low expenditure levels. At typical family expenditure levels, rice is consumed at six to seven meals per week, but at higher income levels, rice consumption appears to remain constant, even with additional increases in income. Urbanization will undoubtedly continue to move people from a coarse grain-based rural consumption system to a more diversified urban consumption system which includes an important rice component. It seems doubtful that people financially able to have some flexibility in their consumption decisions can be persuaded to reverse this trend toward greater diversification. Coarse grains are less likely to be dropped from the diets of families with typical income levels, if coarse grain products are made available which are economical and easier to prepare. Greater maize consumption is a step toward diversification for many families. Also, because maize is relatively new to many families, it seems more acceptable than sorghum and millet to young people, who have a strong influence on family consumption patterns.

However, the many families who cannot afford to eat rice at noon every day would benefit from the marketing of an economical rice substitute like medium or fine sorghum grits.[17] This group in our survey seems to correspond to approximately the lowest quartile of families with regard to income and expenditure. In addition, many families, particularly large ones, will continue to eat grits-based dishes as part of their diversified evening meal rotation of foods. In this case, grits-based dishes would compete with such dishes as toh, couscous, and tuber crops in season. Once again, economy is a very important aspect of whether grits-based dishes are competitive. Unless sorghum grits can be marketed at a very narrow margin above the cost of whole grain, it is unlikely that poor families will be able to afford it.

Medium and fine maize grits potentially can be used in similar dishes by families with somewhat higher expenditure levels, who prefer maize to sorghum for reasons of diversification or social acceptance. The higher productivity of maize and the emphasis extension services placed on its production in the productive southern zones (CMDT, OHV) indicate that some day maize may actually be cheaper than sorghum. Until then, poor families will continue to use sorghum unless the price of maize falls to about 10 FCFA below the price of sorghum.[18]

Millet is preferred to sorghum by many families interviewed, but it is more expensive per kilogram and does not increase in volume as sorghum does. In the urban setting millet is consumed primarily during the month of Ramadan, which in some cases appears to be linked to the grain's traditional and religious significance. Whether or not families believe they should eat millet for religious reasons, the tradition creates an atmosphere in which it is socially appropriate to eat millet during Ramadan. Many of the families surveyed eat little millet at other times of the year, but eat it during Ramadan if only as part of their strategy to diversify consumption over the year. Some households report that millet prices increase and that the amount of grain brought to neighborhood mills for grinding doubles during Ramadan.[19] Food expenditure and preparation time increase with extra meal preparations during Ramadan, when meals are prepared for children and the elderly during the day, and for adults before dawn and after sunset. A processing system which produced prepackaged millet couscous and millet moni balls might be competitive with Ramadan season millet whole grain prices, which should practically guarantee their market. If these products are of good quality and easy to use, they should have a substantial market throughout the year, as well as during Ramadan.

Survey results indicate that the typical family now substitutes fonio (banagrass) for rice at least every other Sunday, and frequently as often as once or twice a week. This use of fonio is the

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[17] As mentioned in Section 4.2.2, medium grits are often prepared with a rice sauce and substitute directly for rice. Fine grits are often prepared in a similar manner and can substitute for fonio. Fonio is also a direct substitute for rice, but is relatively expensive.

[18] Sorghum expands in volume when cooked; maize does not. Many families of modest means will purchase maize if it costs less than sorghum, because it is a relatively low-cost means to diversify consumption. Maize prices must fall far enough below sorghum prices to offset sorghum's expansion in volume before maize becomes more economical than sorghum.

[19] According to the SIM bulletins for 1988-90, millet retail prices did not increase significantly during the months corresponding to Ramadan. Perhaps demand and prices for processed millet products rose.

main indication that some substitution for rice is possible. Yet fonio is too expensive for poor families and the three hours of washing necessary to clean three kilograms of it discourages wealthy families from consuming it often.

Economical processed grits and flour would most likely affect the consumption of families spending 80 FCFA or more per person per day on condiments. This impact would probably be largely to slow the conversion from coarse grains to tubers and other products for the evening meal, rather than to reduce rice consumption at noon. Most families still eat coarse grain dishes at night so there is no need to reverse a longstanding trend toward more diversified consumption. One reason for this second switch away from coarse grains is the drudgery and time required in traditional preparation. The strong trend toward hiring maids to do the household work does not seem to be relieving this problem. Steak and fries or steak and ragout can be prepared quickly on a modern gas stove rather than spending an hour or longer stirring a pot on a smoky fire. The availability of grits, flour, and pre-processed couscous or moni balls could significantly reduce the preparation time and drudgery.

This survey demonstrates that higher income families are diversifying consumption toward products which require less preparation and drudgery. Given the lack of processed coarse grain products, this trend is presently manifested in reduction of coarse grain consumption. Since these families set consumption trends, it is likely that many other families will adopt similar patterns whenever it is economically feasible. The data from this survey does not allow us to determine whether marketing processed coarse grain products will increase coarse grain consumption. Marketing processed coarse grain products may help reverse or at least limit the trend to reduce coarse grain consumption in the diets of medium- and upper-income families. Sorghum may be the choice of low-income families for economic reasons, but existing maize, millet, and fonio dishes are more socially acceptable for medium- and upper-income families.

### 4.4 Availability of Processed Coarse Grain Products

Processed coarse grain products are typically not available in most neighborhood markets in Bamako in significant quantities or under conditions of acceptable quality. We did find dehulled grain available by the sack in a minority of the neighborhood markets. Coarse grain grits and flour were never seen in the possession of merchants who sold products by the sack or even by the kilogram. Grits and flour products were found only in the possession of women selling small quantities of them by the measure.

During the household surveys we encountered considerable hostility toward these small-scale vendors of grits and flour and the products they sell. Women repeatedly complained that these products were not clean and hygienic. They argued that these products are sold in open pans and are constantly exposed to the sand and dust in the air, as well as other possible sources of contamination like flies and honey bees. Housewives also complained that they did not know the source of the grain, or the method of handling it. As we learned through interviewing a few of these market women, this last factor is really quite critical with regard to social acceptance. Several of these very small-scale flour and grits retailers told us that beggars are one of their major sources of whole grain cereal. In fact, we observed this in one market. Beggars arrived with a handful of whole grain sorghum or whole grain maize, which they sold to these women at perhaps half or less of the normal grain price. Other women in the market also reported that some of these flour and grits sellers spend part of their time begging to get the cereal that they sell. We did encounter a number of women in

major markets like Dibida, who sell 40 or 50 kg of flour and grits a day and buy their grain from wholesalers. Most housewives (poor as well as wealthy) view this whole grits and flour sector of the retail market with great suspicion, considering the products unfit for family consumption, unless they personally know the individual merchant. It is interesting to note that the families that produce the maize grits sold along the city thoroughfares sell their flour in the family compound, not in the market. While this strategy reduces travel and labor for selling, its main purpose may be to avoid having their products associated with those of the small-scale retail sellers in marketplaces.

### 4.5 Characteristics of Processed Grain Quality

When asked what characteristics women seek in processed grain, most responded by mentioning at least two of the following three characteristics: clean, white, and odorless, or having a pleasant odor. The first two characteristics are a combination of several factors.

Being clean, in part, refers to not having any foreign matter in the processed cereal, whether it is dehulled grits or flour. Since most sacks of coarse grain which can be purchased in Bamako contain gravel, sand, dirt, stalks, twigs, and weed seed, a clean cereal is one which has been winnowed and washed to remove this foreign material. Obviously, no one likes to eat food with sand or gravel in it. Some women report that the male head of the family will get up and walk away from the meal if he discovers sand or gravel in the dish he is eating. Being clean also refers to hygienic treatment of the cereal during processing. It should not be exposed to sand and dust in the open air, flies and other insects, or wandering sheep, goats, and chickens. However, much of the grain is processed wet and must be dried in the sun in a protected area on a clean cloth. Many women mentioned that "one never knows the condition of the cloths on which these small market retailers expose their flour or grits, or how they might be handled." Although never mentioned specifically, it also appears that women fear that grain products may be exposed to disease if handled by beggars.

Whiteness also connotes being clean. If a product, particularly sorghum, is not white or at least light-colored, women often suspect that it has not been properly cleaned and that it contains sand or dirt. Any dark-colored specks are assumed to be foreign matter and must be removed to have a quality product. White also means thoroughly and completely dehulled. Women want all bran removed so that dehulled grain is white or at least very light. They prefer a dehulled sorghum product close to polished white rice in color. This preference has the impact of reducing the dehulling conversion rate, since women consider any coloration as a sign of improper dehulling.

The whiteness test does not seem to apply to maize, since many Bamako consumers prefer yellow maize to white. This preference is probably based on tradition and the fact that many more people are familiar with yellow maize than with white. But another argument heard is that the off-white color of processed white maize is very similar to that of sand and gravel. It is argued that bright yellow maize permits easier visual evaluation of whether it is clean than does white maize.

Odor is associated with grain that has been stored for a long time, attacked by insects, or wet and not properly dried. One male household head who was interviewed said that he now lets his wife buy all the cereal. He recently purchased a sack of rice which his wife said smelled like it was old. Moreover, it tasted like it had been in storage too long. Since she can smell the difference, he will now have her select the family's cereal. A major problem with the parboiled sorghum, according to participants interviewed, was that the sori had this odor of old grain. It is not clear whether this was

due to a problem with the sorghum that was used in the test, or whether it was a result of the parboiling and drying process.

Odor is also a test for fermentation. Although Senegal consumers like to let their cereal ferment overnight before using it to prepare dishes, Mali consumers do not. Women in the survey constantly expressed a preference for "fresh" flour. At least in part, this insistence seems to be related to being able to test products for the odor of poor storage conditions or too lengthy storage. In the survey sample, 93 percent of the women grind cereal the same day that it is used.

One of the few problems mentioned concerning neighborhood milling services is that occasionally processed grain returns with what was described as a machine smell. Such smells are unacceptable to consumers. Given the strong odor of diesel fuel, it is likely that electric mills have an advantage over diesel mills with regard to odor.

## 4.6 Household Coarse Grain Processing

Traditionally, coarse grain processing was done within the household. Even with the use of neighborhood mills, much processing is still done at home. The portion of grain needed daily is removed from storage early in the morning. It is usually winnowed and inspected to remove any large pieces of foreign matter, and then washed to remove sand, gravel, and dirt. Once washed, it is pounded in a mortar to dehull it. Then it is often sifted to remove any flour and winnowed to separate the bran from the grain. If any bran remains, it is returned to the mortar and the process is repeated. After proper dehulling, sifting, and winnowing, the grain is again washed more carefully. Large-grain cereals like maize or sorghum may need to be washed only two or three times. Millet may require four to five washings. Fonio may need 10 washings, requiring two to three hours to get enough for a family meal. After the grain is thoroughly washed, it is ready to be pounded into flour. Wet grain can be more easily processed into flour. If grits is the desired product, the grain is sun-dried for 30 minutes to an hour so that it cracks more readily. During the pounding process, the product is sifted to check on and produce the desired granulation. If flour is desired, any grits left in the sifting screen are thrown back into the mortar for additional pounding. This process is repeated until all of the product passes through the appropriate sifting screen. If grits are desired, the product will still be sifted to eliminate flour and to ensure fairly even granulation.

Many households follow a strategy of eating dishes which require coarse grains of different degrees of granulation, in order to reduce processing time and effort. For example, they may process grain into flour for toh for the evening meal, but save the grits and prepare seri porridge for the following morning. Alternately, they might prepare grits with a rice or fonio sauce for the evening meal, saving the resulting flour by-product to make moni porridge the following morning. These strategies of combining dishes make full use of the products resulting from grain processing and reduce the need to repeatedly pound particles which are coarser than desired. Similar strategies continue to be followed when plate mills are used for grinding, where the plates can be adjusted to simultaneously produce varying proportions of coarse, medium, and fine grits and flour.

When mills are used to grind the grain as is common now in Bamako, they replace only the pounding process necessary to achieve the desired granulation. The cleaning, pounding for dehulling, winnowing, washing, and sifting still take place at home. When mechanical dehulling is used, as in a few households in the sample, the cleaning, winnowing, washing, and sifting are still done manually

in the household. Until a clean product can be guaranteed by the mechanical milling process, dry-milling is unlikely to be acceptable.

In our survey sample, 95 percent of the households report that they use mills to grind their coarse grains at least part of the time. Ninety-three percent do the milling the same day that the product is to be eaten. Most households report that they have easy access to mills for grinding grain which provide them with a good product. One or two women did report that grain occasionally returns with a machine smell. They could not say whether this problem was more prevalent with diesel than with electric mills, because they usually did not know what type of mill they (or their maids) were using. One woman also admitted that many young women have been raised on mechanically milled grain products and would not know the difference between mechanically and manually ground grains. Many of the older women said that they and/or the household head preferred manually-ground grain. The women felt that the convenience and time savings of mechanical milling were well worth the slight reduction in quality. Several men volunteered that they disagreed, but said that the woman/women of the house refused to grind flour manually.

Two households produce their own grits, which they store up to a month before use. Two women grind only every two or three days in order to save time. They also say the mill gives them a better price when they do a larger batch. Households report an average estimated milling cost of 11 FCFA/kg.[20]

The influence of household maids is a major factor in the use of mills for grinding. Almost 75 percent of the households surveyed report that they have a maid and that maids refuse to work for families in which they have to grind grain in a mortar. Maids are typically young village women who come to Bamako to earn money for about nine months of the year. Most of them return to their village during the cropping season. Many families complain that being without a maid during the rainy season constrains their ability to prepare coarse grains and complete other household chores.[21]

While 95 percent of families regularly grind mechanically, only 29 percent report using mechanical dehulling. In several neighborhoods where we interviewed, households reported no dehulling machines nearby, so grain had to be transported elsewhere for mechanical dehulling. An additional 47 percent report that the maid does the dehulling. Thus, only the lowest quartile (with regard to food expenditure) actually do their own manual dehulling. It seems that the use of mechanical dehulling will expand slowly, except during the rainy season, as long as most families have maids who agree to do the dehulling.

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[20] The accuracy of this figure is doubtful. Most households report milling the same quantity of cereal that was dehulled. Using an 80 percent conversion rate, we know that most larger families should be milling a kilogram or two less than was dehulled. Note also that this estimate diverges from the finding of 8 FCFA/kg in the informal mill survey.

[21] Maids may be as young as 12 or 13 years old or slightly older women with or without children. Some of them come to Bamako while their husbands do seasonal work in Côte d'Ivoire. They are paid about 4,000 FCFA a month plus room and board and typically stay with the family they work for, so they are available all day long. Most families prefer younger childless women, because they say children distract them from their work and slow down their accomplishment of errands outside the house. Also, if families have small children of their own, they generally fear that items, particularly food, purchased for their children will end up benefiting the maid's children.

Seventy-eight percent of the families interviewed report that they dehull the same day that the grain is consumed. However, approximately 14 percent of the women interviewed said that they dehull a 50- or 100-kg sack at a time, which often means storing dehulled grain as long as a month before using it. Five percent said they dehull every two or three days, and about 3 percent said they dehull weekly. Households report paying about 10 FCFA/kg to have grain dehulled, particularly when it is done by the sack.

Most women who do not dehull daily work outside the home, usually as merchants or civil servants. Many said that they thought the product is inferior with less frequent dehulling but they lack the time to dehull daily.

## 5. RECENTLY INTRODUCED AND POTENTIAL CEREAL UTILIZATION

### 5.1 Maize Grits

Both GMM and CMDT have attempted to introduce processed maize products to the Bamako market. However, individual households produce the maize grits sold along the major streets each evening as people return from work, not these two industrial concerns.

In the mid-1980s GMM bought 1,000 tons of maize from OPAM, which it processed to produce grits and flour. The GMM system involves degerming equipment, so the processed product can be stored for a relatively long period. Yet GMM had difficulty selling the products and had to reduce the price to 80 FCFA/kg to liquidate its stock. According to Mr. Achcar, the GMM managing director, maize dishes were not common in Bamako at that time. Unfortunately, the maize had been in storage at OPAM for two years and was not good quality. One vendor of maize grits recalled that when he sold "factory-processed" maize some years ago, clients complained that the factory-processed maize smelled and tasted like grain that had been stored too long. Since that experience, GMM has been unwilling to process and sell coarse grains, even though it has modern processing equipment. Mr. Achcar claims that there is no reliable source of maize for an organization like GMM, which needs to operate on an industrial scale. He also says that launching a maize consumption campaign requires government and donor support, particularly to finance the publicity.

CMDT, working through a marketing organization called CERECOM, has set up 10 semi-industrial maize mill in village associations in the Koutiala area. The first two were established in 1986-87, but most were set up in 1988. In 1988-89, these associations produced 600 tons of processed maize products, much of which CERECOM marketed to wholesalers in Bamako. As with GMM, they had trouble selling their products, especially the maize flour. In 1989-90 the villages processed only 300 tons, which was sold by the end of August. A maize grits seller said that his family had attempted to sell the CMDT maize grits several years ago when maize was hard to find. Clients complained that CMDT grits smelled and tasted like grain that had been stored too long and refused to buy from sellers who admitted they had the CMDT product.

Eighteen of 28 maize grits vendors observed on a given afternoon were concentrated at a single location along the Koulikoro road, an important city thoroughfare providing access to several affluent neighborhoods. Other small groups of maize grits sellers were encountered near the central market, near the Shell station in front of USAID, and at the duruni[22] parking area across from the Cathedral. None of the sellers interviewed gave any specific reason for their choice of location, and none had attempted to sell at other locations. Most vendors are located along major city thoroughfares or near transportation centers. Most clients purchase maize grits as they return home from work in the late afternoon. Vendors rush to vehicles which stop along the edge of the road, so clients need not leave their vehicles to purchase the grits.

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[22] Duruni refers to the pickup trucks and minivans which constitute most of Bamako's mass transit system.

Twenty-seven of the 28 maize grits sellers observed were female.[23] The one exception was a teenage boy who sells with his older sister as part of an important family enterprise. Most of these vendors sell only in the afternoon, leaving their mornings free for processing maize, doing housework, or engaging in other activities. All vendors said that preparing and selling maize grits is an individual or family enterprise. Every maize seller interviewed said that she bought whole maize and transformed it as a household activity.[24] Most of the women interviewed dehull and grind the maize mechanically at neighborhood mills.[25] It is manually winnowed and washed between dehulling and grinding. After grinding, it is sifted to separate out the flour and separate the three sizes of grits. The grits are rewashed and black particles are removed so the color is uniformly yellow. After three hours of drying in the sun, they are put in plastic sacks. Sellers report that they can be stored for two months or longer in this manner.

Most women limit the amount processed at a time to 100 kg or less, probably more because of cash flow and time constraints than storage life. Many sellers claim that they sell the grits produced from 100 kg of maize in three to seven days; 10 days was the longest time reported. A few process a 50-kg sack every two to three days. Vendors were selling grits in small plastic bags priced at 100, 150, and 200 FCFA each. Most appeared to offer 15 to 30 plastic sacks of produce, a total of approximately 10 to 15 kg. Several samples weighed by the team indicate a price of 250 to 350 per kilogram, well above the cost of rice.

All the women interviewed agreed that the medium grits used primarily in seri porridge sell best. Fine grits sell second best and are used in seri or prepared with a rice or fonio sauce as a substitute for those dishes. The large grits used in seri or as a rice substitute sell poorly. Women report that they use the flour produced when grinding the maize in home consumption or sell it at their homes.[26]

A rough estimate indicates that of the maize grits vendors observed, each sells 10 to 15 kg a day or sell 100 to 150 tons per year. Adding a percentage for dehulling loss and flour, this activity absorbs an estimated 130 to 200 tons of whole-grain maize per year. Although this is not a large quantity of cereal, the price at which grits are sold seriously limits effective demand for most Bamako residents. The fact that demand does exist even at these high prices supports the hypothesis that such products would be in significant demand if sold through lower-cost marketing channels (for example, by the kilogram by wholesalers or demi-gross retailers in the markets, assuming quality remains good).

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[23] Another intriguing fact is that 20 of 28 sellers live in the same neighborhood, Djikoroni-Para, and many others live in adjacent Lafiabougou. No one had any explanation for this concentration of maize grits sellers/processors.

[24] Given the reported experience with GMM and CMDT products, maize sellers and clients appear to be suspicious of the quality of industrial/semi-industrial grits products.

[25] Women avoid mills with new plates, because they produce too much flour and fine grits. Older plates produce a majority of the better-selling, medium-sized grits.

[26] It appears that it is sold in the home to avoid being classified with unacceptable products sold by small-scale retailers in the markets.

## 5.2 Parboiled Sorghum--Sori

In April-May 1990, USAID/Bamako financed a taste and acceptability test of a parboiled sorghum product sometimes referred to as sori (sorghum-rice). This test was financed at the request of INTSORMIL and the Food Technology Laboratory of IER/ICRISAT, based on a product on which they had collaborated. BECIS (Bureau d'Etudes de Conseils et d'Interventions au Sahel) was contracted to help implement the test and assess its results. Although BECIS' general assessment is that test results were "encouraging," a close reading of their report leads to a somewhat different conclusion. This team interviewed most of the restaurant owners who participated in the test, as well as a few of the housewives who prepared sori for their families. In many respects the test was inconclusive because of problems encountered in the testing process.

The different groups of women contracted to participate in the parboiling of the sorghum were not sufficiently trained and supervised to produce a uniform product. The mill which normally prepares products for the Food Technology Lab could not prepare enough sori in the timeframe desired. Other mills were contracted, but they did not receive enough training and supervision to produce a uniform product either. The origin of the problem is unclear but the product was not clean and lacked the desired near-white transparent color. It also had the odor (and taste) of grain that had been stored too long, whether due to the grain used or to the parboiling and drying process. Therefore, the product used in the taste test was substandard from the outset. Although the BECIS report tries to put a good face on this experience, it describes many of these problems.

Although many consumers surveyed by BECIS did not think that sori tasted better than rice, a number of them were willing to give it a "good" rating or say that it tasted like rice. The restaurant owners interviewed were often more direct and critical. One owner summed it up best by saying: "More people disliked sori than liked it. Of those who did like sori, all preferred rice to sori." He concluded that he would continue to serve rice rather than sori. Another owner said that she would be happy to serve sori if we gave it to her, but she would not buy it. Not all the restaurant owners were this negative. Two in particular said that they would be interested in learning how to prepare parboiled sorghum.

Sori seemed to be most appreciated in neighborhoods with a high concentration of Malinké, one of the few ethnic groups in Bamako who often use parboiled rice. The Malinké also seem to use white (unparboiled) sorghum grits prepared as rice or fonio more often than people from other ethnic groups. Because of these habits, sori seemed less foreign and more acceptable to them.

Many restaurant owners said that they originally had trouble preparing the sori, because they had no experience with parboiled products, nor with white (unparboiled) sorghum grits to be served in the manner of rice or fonio. They admitted that it took several attempts to learn how much water to use, how long to cook the parboiled sorghum, and how best to prepare it.[27] However, the products of these less than successful efforts were used in the taste tests.

Given the results of our consumption survey, it is unclear what niche sori might fill in the market for coarse grain products. White sorghum grits are a better known and more flexible product

[27] This implies that the restaurant owners received no instruction in how to prepare dishes using parboiled sorghum.

than sori. If a household does not want to use a quantity of white sorghum grits in a rice or fonio type dish, the grits can be ground into flour to produce the entire range of dishes made from sorghum flour. As a substitute for rice, sorghum grits seem to be aimed primarily at a fairly narrow market of low-income families who cannot afford to eat rice at noon. Since this would be roughly the lowest-quartile income group, a rice substitute could not cost much more than whole grain. In the Bamako context, it appears that parboiling will considerably increase the cost of sori over both whole-grain sorghum and white sorghum grits. If any product has a chance to substitute for rice in this low-income market, it would appear to be the cheaper, better-known white sorghum grits. If parboiling is to have any chance as a processing technique, it would have to be done at very low cost by farm families before being shipped to Bamako.

Sorghum products face the dilemma of being made from the coarse grain most widely consumed in Bamako, yet having the lowest social acceptability. Dishes which substitute for rice can also be prepared from maize. They are less known but seem acceptable among a wider range of income groups. In the long run, if the higher productivity of maize can be converted into lower consumer prices through an efficient marketing and transformation system, maize may be cheaper and more acceptable than sorghum as a rice substitute.

## 5.3 Flour and Grits

This team believes that the first step of a grain transformation strategy should be to improve the quality and increase the supply of known products in the market, rather than to search for new products to replace those now in use. This is particularly true because the grain products most often used to produce cereal dishes (i.e. flour and grits) are not available in neighborhood markets in a form that is acceptable to most consumers.[28] In addition, few of the dozen neighborhood markets visited offered the dehulled coarse grain products that allow households to avoid a major step in the transformation of grain into products used in cooking. Thousands of Bamako households use flour and grits every day. These products have a market if they are acceptable in quality and can be produced at reasonable prices. What is less obvious is why a system has not emerged which processes these products and makes them available to busy Bamako women. The rapid expansion of neighborhood mills and the prevalent use of household maids to dehull and transport grain to the mill has apparently satisfied the demand of many women with time constraints. The fear of non-hygienic products and the short storage life of flour in particular are also constraints. Yet it should be possible to find solutions to these constraints. Such products should be cheaper to develop and easier to market in quantity than new products and/or highly processed products. Keeping costs low is essential to establishing a market for processed grain products.

## 5.4 Weaning Foods

The consumption survey found that a majority of the women interviewed report that they prepare and use weaning foods for small children. Those who say they use baby formula and other store-bought products are largely civil servants, but most women with young children report that they

[28] As mentioned above, maize grits are available in small packages along some of the major streets in Bamako, but this is a distinct and separate marketing channel which handles only a small volume at very high prices.

regularly prepare and use homemade weaning products consisting primarily of a mixture of water and flour or milk and flour, and a puree of vegetables and fish or meat.

Weaning-age children consume the porridge which many families eat as a morning meal and an evening dessert. Children, including very young ones, are sometimes given coffee and bread for breakfast. Several women mentioned that laro[29] is often prepared for the elderly who have difficulty chewing and can be fed to small children who are being weaned.

DRSPR is testing the nutritional results of using the Food Technology Laboratory's enriched-flour weaning food. For test purposes this consists of enriching three units of millet flour with one unit of cowpea flour. Mothers in several of DRSPR's research villages have received this product free of charge to feed 67 undernourished children between 6 and 36 months old. The height and weight of these children is periodically compared to norms for their age group. DRSPR reports that fewer than 10 percent of the women in these villages make porridge as a weaning supplement for their children.

UCODAL, a private food processing and packaging company in Bamako, is also interested in test-marketing infant weaning foods. The product is a mixture developed by Mme. Mariko (the director, a trained food technologist) and consisting of maize, sorghum, cowpea flours, and other ingredients. Successful production of weaning foods depends on collaboration with the IER Food Technology Laboratory and acquisition of the proper equipment for sterilization.

Although officially recorded imports of baby formula and other baby foods were valued at 86 million FCFA in 1989, the size of the urban market for the enriched flour product promoted by the Food Technology Laboratory is unclear. In the consumption survey, most women who have the financial means responded that they made the weaning foods mentioned above. Many of the women who do not prepare these products cannot afford to do so. Although some children could certainly benefit from this product, their parents tend to lack the means to purchase it. It also is questionable whether wealthy families would convert from the imported products, whose use confers and reinforces the perception of a higher socioeconomic status. Therefore, there is not likely to be much of a market for this type of product unless agencies and NGOs purchase and provide it initially as a social service.

## 5.5 Precooked Fonio

In August 1989, UCODAL began test-producing and marketing precooked fonio, having successfully produced and sold local spices and peanut butter in the Bamako market. The decision to test-market fonio was based on its increasing popularity among urban populations but extremely difficult and time-consuming preparation. Cleaning alone requires two to three hours to obtain enough for one meal. Fonio can be prepared in several ways, steamed like couscous or prepared in a manner similar to riz au gras (see annex). The production process consists of dehulling, extensive washing, draining, steaming, sieving, drying, and packaging in sacks of 500 grams and 1 kg. Seven permanent workers are involved in the production process along with occasional temporary workers. The processing steps are similar to those undertaken by women preparing fonio at home, which should result in a familiar and acceptable product.

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[29] Laro is a dish prepared from fonio and peanut flour.

Consumer demand has been limited by the relatively high price and limited promotion of the product. Precooked fonio is currently selling for 600 FCFA/kg and 450 FCFA/half kilo. This price includes a 10 percent business tax (IAS, Impôt sur Affaires et Services on the business turnover tax). Sales in 1990, primarily to local grocery stores, will likely attain 4,000 kg. With publicity, UCODAL hopes to increase sales to 10,000 kg in 1991, as the current market outlets reach only one type of client. UCODAL will also market a washed and dried uncooked fonio and cowpea flour. To avoid the type of marketing problems encountered by CERECOM, UCODAL does not stock large quantities and treats the cereal to protect against insects.

In a similar vein, the Coopération Canada Cellule PME/PMI is helping fund the marketing and promotion of precooked fonio that is being produced by a participant in the Projet de Jeunes Diplomés, Ainea Ibrahim Camara. Plans call for the product to sell for 350 FCFA/kg, considerably cheaper than that produced by UCODAL. The project will use a three-pronged advertising strategy consisting of radio, television, and free distribution of the product. This is similar to the advertising strategies used by successful commercial products, like maggi cubes. It will be interesting to monitor the performance of two similar products competing for a currently very thin market.

## 5.6 Livestock Feed

As shown in row four of Exhibit 2-4a, dehulling losses in processing grain for human consumption generated an estimated 376,138 metric tons of coarse grain and rice bran in 1989-90, or 17.5 percent of total grain output (before netting out seed requirements and post-harvest losses). This impressive volume of by-product is reserved entirely for livestock feed. Bran provides a protein-rich feed supplement for cattle, small ruminants, and poultry during the dry season, when available forage decreases significantly. In addition, some of the grain lost after the harvest (see row 2 of Exhibit 2-4a) is undoubtedly fed to livestock, although there is no way to estimate the amount.

The bran from the dehulling process is sold by artisanal units in Bamako and the semi-industrial mills in the CMDT zone at 15-20 FCFA/kg. Rice bran from both the Office du Niger industrial mills and transportable rice dehullers in Mopti Region is also sold to herders and farmers. In custom dehulling, the miller gets to keep the bran as partial payment in kind for services rendered. Informal evidence indicates that bran sales keep dehullers out of the red in a competitive industry. Assuming a 20 percent dehulling loss for coarse grain, a dehulling charge of 10 FCFA/kg for unprocessed grain, and sale of the bran at 20 FCFA/kg, bran revenue represents 29 percent of gross coarse grain dehulling revenue. Assuming a 40 percent dehulling loss in converting paddy to rice, a dehulling charge of 10 FCFA/kg for paddy, and sale of the bran at 15 FCFA/kg, bran revenue represents 38 percent of gross rice dehulling revenue in rural paddy production zones.

The estimated supply of agro-industrial by-products used for livestock feed, including bran from gain milling, was approximately 467,500 metric tons in 1989 (see Exhibit 5-1).[30] Cereals processing byproducts represented over 80% of estimated supply, excluding GMM wheat bran and Office du Niger rice flour (which are included in the agro-industrial byproducts category). Coarse grain processing byproducts totaled 254,584 MT or 54.2% of estimated supply.

As shown in Exhibit 5-1, agro-industrial byproducts used for feed reached 90,948 MT in 1989. Note that this figure is for actual sales. Office du Niger rice flour sales of 2,584 MT fell short of actual marketable surplus of 3,067 MT. Similarly, SUKULA molasses sales fell far short of marketable surplus of 4,354 MT.

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[30] Amadou Camara's working paper "The Use of Cereals in Livestock Production in Mali: A Quick Survey of Constraints and Potentials" (December 1990) was an important source of information in preparing this section of the report.

## EXHIBIT 5-1

## ESTIMATED AVAILABILITY OF AGRO-INDUSTRIAL FEEDS IN MALI, 1989

| FEED TYPE | QUANTITY METRIC TONS | PERCENT TOTAL | |
|---|---|---|---|
| | | CATEGORY | SUBCATEGORY |
| **Cereals Processing Byproducts of which:** | 376,138 | 80.2% | |
| Millet | 113,642 | | 24.2% |
| Sorghum | 98,667 | | 21.0% |
| Maize | 40,571 | | 8.6% |
| Rice | 121,554 | | 25.9% |
| Fonio | 1,704 | | 0.4% |
| **Agro-Industrial Byproducts** | 90,948 | 19.4% | |
| GMM Granulated Wheat Bran | 7,500 | | 1.6% |
| ALIBET (Cottonseed cake-based) | 77,780 | | 16.6% |
| HUICOMA Peanut Cake | 1,496 | | 0.3% |
| ODIPAC Peanut Cake | 639 | | 0.1% |
| SUKULA Molasses | 949 | | 0.2% |
| Office du Niger Rice Flour | 2,584 | | 0.6% |
| **Cereal Grain** | 2,148 | 0.5% | |
| Maize as Poultry Feed | 1,500 | | 0.3% |
| Millet Used in Sheep Fattening | 648 | | 0.1% |
| **TOTAL** | **469,234** | **100.0%** | **100.0%** |

Source: Own estimates; Camara, A., "The Use of Cereals in Livestock Production in Mali: A Quick Survey of Constraints and Potentials, " USAID/Mali, December 1990.

Note: Cereals processing byproducts are estimated from 1989-90 cereals production data, assuming post-harvest loss and seed withholding rates, and fixed dehulling rates.

The principal agro-industrial byproduct used as livestock feed was a mixture of cottonseed cake, cottonseed hulls and maize prepared and sold by HUICOMA. HUICOMA produced and marketed 77,780 MT of this cottonseed-based feed, of which 70,280 MT at its main oil-processing plant in Koutiala and 7,500 MT at Koulikoro. The HUICOMA plant at Kita also produced 1,496 MT of groundnut cake in 1989. ODIPAC also produced 639 MT of groundnut cake.

It is important to point out that the HUICOMA feed is important for oxen during periods of feed scarcity and a significant input into commercial dairy production in Mali. In conjunction with CRZ, HUICOMA plans to use part of the 78,000 MT of the cottonseed product to produce 30,000 MT of a product called ALIBET, designed specifically for lactating cows. This product will uses 16 to 35 percent maize grain along with cottonseed meal, cottonseed hulls and rice bran. The exact proportion of maize grain depends on the relative costs of the different products available. HUICOMA also plans to produce 20,000 tons of a second livestock ration which will also incorporate maize.[31] Using the proposed maize percentages for Alibet, this will use 8,000 to 17,500 tons of maize.

Another source of livestock feed is wheat milling by-products (bran) sold by GMM at Koulikoro. GMM reports capacity to produce a pelletized livestock feed, composed of the bran from several grains, at the level of 50 MT per day or 18,250 MT per year. Actual output and sales for 1989 was 7,500 MT and averaged 7,016 MT over the 1985-89 period. GMM is able to sell most of its feed to herders during the dry season at 20 FCFA/kg, but stocks move slowly during the rainy season when pasture conditions improve. In addition to GMM wheat bran, the Office du Niger sold 2,584 MT of rice flour in 1989, as well as 1,302 MT of rice bran. The Office du Niger rice bran sales are not listed as a separate item in Exhibit 5-1 to avoid double-counting. Instead, rice bran available for use as livestock feed is estimated from 1989-90 paddy production data (see Exhibit 2-4a); appropriate reductions are made for estimated seed and post-harvest losses.

Commercial egg producers are also using feeding maize in their chicken rations. No numbers seem to be available concerning the amount of feed they use, or even the number of chickens raised under commercial conditions. Several commercial egg producers report feeding rations which use from 45 percent to 60 percent maize. Anecdotal information indicates that many chicken producers feed 40 to 90 grams of supplemental feed per chicken per day rather than the recommended 120 grams.[32] Extrapolation from partial information on commercial chicken enterprises around Bamako and Segou leads to an estimate of perhaps 70,000 to 80,000 chickens in commercial egg production at those two centers, and 100,000 chickens in commercial egg-producing enterprises in Mali. Anecdotal information indicates that these producers feed each chicken 20 to 40 grams of maize per day. These numbers permit an estimate that 2-4 tons of maize a day are used in commercial egg production, or 730 to 1,460 tons per year. The move to improve the productivity and the genetic composition of village flocks will also require substantial increases in supplemental feeding.

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[31] These feeds reportedly cost 12 FCFA/kg.

[32] Different producers report feed costs ranging from 70 FCFA/kg to 150 FCFA/kg depending on season, location, and the producer's ability to buy grain or dried fish in quantity at harvest. One Segou producer with good records indicated that his average feed cost throughout 1989-90 was 110 FCFA/kg.

Most cattle and small ruminant fattening and maintenance within the semi-modern sector is based on the use of forage and agro-industrial by-products. In the dry season, however, many farmers report that these products are in short supply. Some farmers report being forced to feed some grain to their animals during periods when cottonseed cake is not available. Camara (1990) estimates that millet used for sheep fattening equals 648 MT, based on data collected under the USAID-funded Mali Livestock Sector Project.

The CMDT produces a complete livestock feed at Klela called Mali Mix, which contains rice straw, molasses, cottonseed cake, Telemsi rock phosphate, and salt and is sold at 7 FCFA/kg. The CMDT will expand its potential to produce such livestock feeds in the Mali Sud III Project. The project will also build a mill at Sikasso which produces chicken feed, part of the project strategy to increase maize use. The Canadians are also reported to be working on a project to produce livestock feed in southern Mali.

It is not clear what quantities of coarse grain can be absorbed in livestock feed over the next few years. This is in large part a question of relative feed/output prices. What is obvious is that insufficient forage is available for the substantial livestock populations in many areas of the country. Any livestock enterprise which generates regular cash flow (dairy, laying chickens, livestock fattening) is already using some local grain products, a trend that is likely to expand. If one looks at the quantities of high-protein cotton and peanut seed cake and grain brans available to mix with grain to make a more complete ration, the potential for using coarse grains as the energy complement for livestock feed is substantial. The present high cost of grain relative to bran, cottonseed cake products, and molasses does not make substantial increases in grain fed to livestock seem likely in the near future. However, the critical lack of forage may push farmers to that solution faster than anticipated. The livestock sector is now using almost 500,000 tons of agro-industrial by-products which are purchased products or products that can be sold for cash value. The prevailing belief that Malian farmers would not feed grain to animals or plant forage crops to feed animals is changing. If the livestock sector can take advantage of the 20-40 FCFA/kg maize prices reported in southern Mali after harvest in years of good production, rapid change is quite possible.

## 5.7 Industrial Uses

Maize Grits in Brewing. BRALIMA uses imported malt to brew beer. Local maize grits could substitute for a portion of the imported malt if the quality of local grits were high enough and if the maize were properly degermed. BRALIMA estimates that it could use 10 metric tons of maize grits per month, or 120 tons per year if grits of an appropriate quality were available. The need for a degermed product rules out the use of CMDT/CERECOM grits in local brewing. GMM could meet BRALIMA's requirements if it processed maize industrially at Koulikoro. Even if this were the case, 120 metric tons per annum is a minor quantity relative to GMM processing capacity or to existing coarse grain utilization.

Materials Usages. Starch from maize or other coarse grains can be used in battery production and textile manufacturing. As with maize grits, these are likely to remain relatively minor coarse grain uses in Mali. SOMAPILE buys 10 metric tons of grain-based starch from GMM per year. Many Malians use imported cassava starch to starch and press clothes. Starch from coarse grains could also substitute in this use.

# 6. COARSE GRAIN DEHULLING AND MILLING IN BAMAKO, THE CMDT/KOUTIALA ZONE, AND BY THE GRANDS MOULINS DU MALI

This chapter discusses three types of coarse grain processing in Mali: artisanal units in the district of Bamako that dehull and mill small quantities for consumers; semi-industrial units in the CMDT region that produce flour and grits for resale; large-scale industrial processing by the Grands Moulins du Mali (GMM) in Koulikoro. The purpose of this analysis is to describe current processing activities and to assess the relevance of this technology to efforts to increase consumption and utilization of coarse grain. The first section briefly explains grain structure, as it has an important bearing on processing and food quality traits.

## 6.1 Coarse Grain Components and Mechanical Processing

In very general terms, a kernel of grain consists of three main parts: pericarp, endosperm, and germ. The pericarp, the outer covering with few nutrients, is referred to as bran in the milling industry. The endosperm contains proteins and starch and consists of both corneous and floury components. The germ is the portion of the grain containing oil. Some grain varieties have an additional colored layer immediately below the pericarp called the testa (Rooney et al., 1986; François, 1988; Bassey and Schmidt, 1989).

Previous studies by INTSORMIL researchers have shown that the preferred food and processing characteristics of millet and sorghum to produce couscous and thin or thick porridge are varieties with a thick, white pericarp (without a testa) and an endosperm with a corneous texture. This research has demonstrated that varieties with a thicker pericarp and a higher percentage of corneous (harder) endosperm are less prone to insect attack and when dehulled, have a smaller number of broken endosperm pieces and consequently a higher dehulling yield. They also grind into a finer flour that produces a less sticky, firmer porridge with good storage quality. As reported in Chapter 4, 26 percent of the households interviewed reported cooking only one meal per day and keeping part of it for the evening or morning meal. Keeping quality is thus an important characteristic in varieties used in Mali. The white color pertains to the consumer preference for a light-colored porridge. Many of these characteristics (shape, size, proportion of pericarp relative to the whole grain; nature of the endosperm, germ and pericarp; presence or absence of sub-coat; and color of the pericarp) can be genetically controlled through breeding (Rooney et al., 1986; Galiba et al., 1987; Galiba et al., 1988).

Dehulling removes the pericarp and testa layers. The pericarp represents from 3 to 11 percent of kernel weight, depending on the variety, leaving the edible portion -- germ and endosperm -- between 97 and 89 percent. The amount of time required to remove these layers thus varies as their proportions by weight and thickness differ by variety. The dehulling yield is the proportion of dehulled grain relative to the original weight of the undehulled grain. Ideal dehulling would remove only that portion of the grain that makes up the pericarp. However, what constitutes an acceptable extraction rate is a subjective assessment that depends on the user's preferences. In Mali, the extraction rate is determined by subjective evaluation of the appearance and feel of the dehulled grain (Bassey and Schmidt, 1989; Rooney and Miller, 1982; Scheuring et al., 1983).

An increasing number of operators insist that the grain be poured through a sieve in order to remove stones and other foreign matter prior to dehulling. The operator moistens the grain before

placing it in the dehuller since the addition of water causes the pericarp to swell, reducing its adherence to the kernel and making it easier to remove. Operators believe that the addition of water also reduces the percentage of broken endosperms and decreases the wear on the dehuller.

The actual dehulling is achieved by the action of a rotating steel bar-ribbed cylinder that propels the grain against a stationary steel blade where the bran is scraped off. The bran that is removed falls through a perforated steel screen at the bottom of the dehuller case, while the dehulled grain is discharged through a steel chute at the top. Approximately 50 percent of the bran becomes detached from the grain during the dehulling; the other half adheres to the discharged, dehulled grain. This imperfect separation requires that the grain be winnowed and washed to completely clean it before it is ground.

Field tests confirmed other researchers' findings that the dehulling yield with the mechanical Engleberg-type dehullers used in Bamako is roughly equivalent to the 70 percent level obtained manually. This low dehulling rate is affected by the consumers' preference for a white product that requires removal of more grain layers than just the pericarp. It is accentuated by the high percentage of cracked endosperm whose reduced size allow it to pass through the perforated screen with the bran. The heterogeneous size and shape of the local grain in each dehulling batch makes it difficult to precisely adjust the dehuller and leads to uneven dehulling. Large grains may be broken while small grains pass through without being dehulled. Subsequently, each batch may need to be dehulled two or three times, adding significantly to the dehulling cost.

Prior to grinding, the washed dehulled grain is piled in a thick layer for one to two hours to allow the moisture to penetrate to the interior of the kernel. The moisture content of the grain increases to 20-24 percent during the washing and resting period before milling, thus decreasing product storage life to less than 24 hours (Vanek, 1981). Interest in storing a processed grain product for a longer period would require that the moisture content remain at approximately 13-16 percent, a small increase from the 10 percent base level of grain.

Milling involves grinding the dehulled grain (endosperm) into either flour or a variety of different size grits. In Bamako, most if not all of the grain processed mechanically is ground by plate mills with cast-iron or cast-steel disks (plates). Grain is placed in the hopper and pushed manually into the grinding chamber. The rubbing of the grain between the fixed and the mobile plates produces the flour or grits. The higher moisture content of the grain helps produce a finer flour. The fineness of the flour or the size of the grits is determined by the distance between the two plates, which is controlled by a wheel in front of the machine. Some grain, particularly maize, is ground dry, sometimes without having been dehulled.

The wide use of plate mills in Mali is due to their earlier conception, dissemination, and promotion by import firms. Plate mills appear to satisfy Malian consumer needs as they are able to wet or dry grind both cereals and oilseeds and can also grind a very fine flour. The heterogeneous final product provides consumers with both flour and grits. This differs from a hammer mill in which the end-product is more homogeneous.

As reported in Chapter 4, a common processing method in Bamako is manual dehulling combined with mechanical grinding. The widespread increase in the use of mechanical mills has occurred partly because the whole process is similar to the manual method. The extraction rate, moisture content, and fineness, as well as the subsequent processing steps, are substantially the same

for mechanical processing and for manual processing. The weaker demand for mechanical dehulling is probably due to several reasons: the large number of maids willing to dehull; the shorter time required to dehull in comparison to grinding; the higher dehulling fee; the loss of bran that could be fed to animals; and the smaller number of dehullers in the city and resulting higher transaction costs associated with using them relative to plate mills.

## 6.2 Artisanal Dehulling and Milling in Bamako

This section discusses the artisanal coarse grain processing sector in the district of Bamako. The information presented was collected by a two-person team through an informal survey of 27 custom processing installations in eight neighborhoods, representing a socioeconomic cross section of the city. The interviews were conducted with the aid of an interview guide that outlined the issues to be discussed with each respondent (see Annex 3). The guide assured us that the same set of issues would be discussed with each respondent but was flexible in allowing more in-depth discussion where interesting issues and opinions were expressed. The information collected indicates the type and operation of coarse grain processing units in Bamako.

### 6.2.1 Type of Artisanal Processing Installations

The type of processing equipment used in Bamako is strongly influenced by the availability of electricity. In neighborhoods with electricity, almost all installations are powered by electric motors and contain both a plate mill and a second machine (dehuller, stone disk mill for peanut and karité [shea nut] butter, or cutting disk for sharpening grinding plates). Three of the processing installations were specialized units for dehulling or producing peanut butter and lacked a plate mill. In spontaneous housing developments without electricity, all 12 processing installations surveyed are single-machine mills containing a diesel-powered plate mill. Almost all dehullers in Bamako are powered by electric motors and thus are rarely found in spontaneous neighborhoods. Operators said that dehullers are hardly profitable when powered by a diesel motor.

All dehullers used in Bamako are the Engleberg type. They were initially developed for dehulling coffee and then widely used to dehusk paddy in Asia but have since been used to process sorghum, millet, and maize (François, 1988). They are manufactured in various countries including China, India, France, Nigeria, Côte d'Ivoire, and Mali. One-third of the dehullers surveyed were purchased from local artisans in Bamako. Many of the other processing units established in the last three years were purchased from informal sector merchants who import machines through Nigeria and Côte d'Ivoire. Since the dehullers vary little from firm to firm, price is the major influence on the specific brand of processing machine purchased. A locally manufactured model can be purchased directly from the artisan for approximately 250,000 FCFA. Many dehullers currently available through either informal channels or from a commercial dealer are manufactured in India and range in price from 460,000 FCFA to 1.2 million FCFA. Many of these dehullers are actually designed to husk paddy and must be fitted with a different cylinder to dehull coarse grains, which may cost another 50,000 FCFA.

Over 70 percent of the plate mills surveyed in the Bamako area were the Grinding 1A plate mill manufactured in India, an imitation of the British-made Hunt model. Other brands of mills operating in Bamako are the British Bentall and the French Champenois and Renson. Plate mills with cast-iron and cast-steel plates are not used to grind groundnuts and karité nuts; they are ground primarily with stone disk plate mills manufactured by Champenois.

Plate mills require approximately 8 horsepower (hp) diesel motors or 5.5 kilowatt (kw) electric motors, whereas dehullers need a 15 hp diesel motor or a 7.5 - 9 kw electric motor. These higher energy requirements correspondingly affect processing costs. Many diesel motors used currently in Bamako are Lister and Lion models produced in France and India respectively. All electric dehullers and mills require three-phase, 380-volt electric motors. Processing units use models from China, India, France, Germany, and Italy.

The Grinding 1A model without a motor costs 275,000 FCFA when purchased from a commercial outlet. When purchased with an 8 hp diesel motor, priced separately at 600,000 FCFA, the total cost including taxes is approximately 775,000 FCFA, a reduction of 100,000 FCFA. When purchased through informal contacts, the same mill may cost a total of 700,000 FCFA, 75,000 FCFA less than the commercial dealer's price. Diesel motors range from approximately 500,000 FCFA to over 1 million FCFA depending on the power, brand, and place of purchase. Electric motors are generally cheaper than diesel motors but range from 350,000 FCFA to over 1 million FCFA.

Each type of energy has a different [illegible] [illegible]lation requirements. The common water-cooled diesel units require four barrels and [illegible] [illegible]ect to the engine and fuel storage containers. Along with equipment supports and cement, initi[illegible] [illegible]-up costs for a diesel-powered operation can attain approximately 40,000 FCFA. The installation cost of an electric-powered operation is much higher because of the specific type of electrical counter and branching that must be established for the three-phase, 380-volt motors. Costs are in large part determined by the distance of the unit from an electricity branching point. Informal interviews found the installation charges between 75,000 and 300,000 FCFA.

The owners of processing units come from a variety of different backgrounds for which there is no specific pattern. A few recent investors were former civil servants who received early retirement packages. One mill owner has now moved into the importation and sale of mills, dehullers, and spare parts. Several owners possess more than one processing unit. Most owners of the processing equipment used their own money or loans from family or friends to purchase their material. Few of them explicitly set aside money with the thought of purchasing replacement equipment in five to 10 years. The exceptions are participants in a credit program financed by the European Community.

The actual dehulling and milling work is carried out by a salaried worker. Two workers are occasionally found in larger processing units with more than two machines or very high-volume operations. Almost all operators interviewed in the sample were young men with little formal education. All operators learned the trade by watching others and occasionally grinding grain as apprentices to friends or family members who worked as operators. Most mills are open from 8 a.m. to 1 p.m. and again from 3 to 7 p.m. The operators generally remain at the mill throughout the day. Most business occurs from 10 a.m. to 1 p.m. and 4 to 7 p.m., a total of six hours per day. They are paid, on average, 5,000 FCFA/month plus meals. Using an average price of 100 FCFA for a plate of rice and sauce at a market restaurant as a base, the value of meals is estimated at 9,000 FCFA/month (assuming three meals are paid for).

### 6.2.2 Costs of Operation

It was very difficult to determine the exact operating costs of the processing units, as most owners keep no records. Attempts to assess the operating costs, revenues, and efficiency of various

pieces of equipment are hindered by many factors that influence costs and revenues including energy source, machine type, grain type and variety, condition of machine and parts, continuous or batch processing, dehulling time, speed of the motor, skill of the operator, and type of product requested (flour or grits). Operators determine the volume of business by the sum of money remaining at the end of the day. Mill owners or operators do not keep track of the quantities of cereal processed, especially since there is no fixed price for milling cereal. Revenues from different machines are not differentiated. Collecting data on daily revenues is very important as operating costs are always explained in the context of the amount earned.

All mill owners complained of excessive taxation of their business. The incidence and type of taxation differs according to municipality, with more taxation in neighborhoods with electricity than in spontaneous neighborhoods. Almost all mill operators reported paying a municipal tax, usually about 2,000 FCFA. In addition, the Minister of Health, Department of Hygiene, collects a tax of about 2,500 FCFA per month. A few operators reported that non-payment of these taxes resulted in the tax collector removing the belt that drives the mill or dehuller. Further, some owners reported paying a patente or license fee of about 5,000 FCFA/month.

Maintenance is another primary operating cost. Major maintenance required on plate mills is the frequent cutting of the grooves or sharpening of the grinding plates. The frequency of this operation depends on the volume of business. On average, disks were used to grind 3.5 to 4 tons of grain before being sharpened. The average mill processes this amount every 10 to 15 days. The cost of sharpening varies with the size of the disk and neighborhood but generally runs about 1,500 FCFA for two disks. New disks must be purchased approximately once a year. Local or African manufactured disks cost 17,500 FCFA/pair while imported disks cost up to 37,000 FCFA depending on the manufacturer and place of purchase.

Aside from disk maintenance, the main feature distinguishing different mill operations is energy costs. Mills in electrified neighborhoods benefit from the lower energy charges. Information collected from several different operators confirmed that one kilowatt of electricity can generate between 350 and 400 FCFA of revenue with a mill. With average daily earnings of 2,000 FCFA (250 kg/day at 8 FCFA/kg), a plate mill uses roughly 5.3 kw/day at a cost of 73 FCFA/kw (68 FCFA/kw plus taxes) totalling 389 FCFA. The energy cost per kilo for an electric-powered mill is approximately 1.56 FCFA/kg. For a diesel mill, operators confirmed that one liter of diesel fuel can generate 1,000 FCFA in revenue. On an average daily income of 2,000 FCFA/day (250 kg), the mill uses 2 liters of diesel fuel costing 250 FCFA/kg or 500 FCFA/day. The fuel costs of a diesel mill are approximately 2 FCFA/kg. Over a one-month period a diesel mill operator pays an extra 4,125 FCFA to process 7,500 kilos of coarse grain.

The energy costs for a dehuller are almost double those of a mill. As stated earlier, very few dehullers operate on diesel motors in the Bamako area. Owners of dehullers determined through their own tests that one kilowatt of electricity generates 200 FCFA in revenue. On an average day's revenues of 2,000 FCFA (200 kg/day at 10 FCFA/kg), the electricity to power a dehuller costs 730 FCFA (10 kw at 73 FCFA/kw). The energy cost per kilo for an Engleberg-type dehuller is approximately 3.65 FCFA/kg. This higher cost arises primarily from the need to use a 13 to 15 hp diesel motor or 7.5 to 9 kw electric motor to dehull coarse grains with an Engleberg-type machine.

Aside from the extremely high energy costs for an Engleberg-type dehuller, the imperfect nature of the equipment for dehulling coarse grain cereals results in extensive weekly maintenance and

repair. The steel or iron sieves at the bottom of the dehulling case used to sift the bran are frequently punctured by stones and metal objects in the grain. This problem is especially acute when large sacks of grain are brought for dehulling without any prior winnowing or cleaning. Some dehullers have begun to demand that all clients pour the grain through a sieve prior to dehulling in order to remove the largest stones and other foreign matter. One processing unit used an additional worker to sift and moisten the grain. Sieves are repaired every one to two weeks at a cost of approximately 3,000 FCFA. Dehuller owners are increasingly using these locally manufactured iron sieves rather than the imported steel sieves that cost 4,500 FCFA. The choice is based solely on cost; most dehullers do not believe the imported sieves are better.

These repairs can be reduced in two ways. First, dehullers can insist that the grain be cleaned and winnowed prior to arrival at the mill. Manual winnowing may, however, be insufficient to remove small stones that do not blow away. Using a mechanical grain cleaner would probably work effectively but is financially infeasible for most small-scale operations. Beyond this, the problem lies at the farm level and the quality of the bagged grain. When grain is manually threshed on the ground, foreign matter inevitably enters the bag. Facilitating the further use of mechanical threshers similar to the French-manufactured Bamba threshers (1.85 million FCFA) in the CMDT region can contribute to a much cleaner product as it reduces the amount of sand, straw, stones, and other foreign matter in the grain.

The second most frequent repair is the replacement of the circular pieces of iron bar that are welded onto the adapted cylinder and perform the actual dehulling in tandem with the stationary iron blade. The bimonthly repair of this cylinder is due to the imperfect construction and fit of the cylinder and the harder pericarp of maize, sorghum, and millet. This repair amounts to approximately 3,000 FCFA per month.

A final type of repair involves the dehuller bearings. The frequency of repair differed substantially among units due to the different types of bearings used. Many dehullers are fitted with old bearings from cars at a cost of 1,500 FCFA per bearing. These must be replaced on a monthly to bimonthly basis. Other operators reported using imported bearings which cost from 6,000 to 9,000 FCFA, depending on the place of purchase, and last three times longer.

### 6.2.3 Spare Parts and Import Tariffs

The preceding discussion illustrates the high cost of operating and maintaining existing types of processing equipment, especially the dehuller, and the inefficiency of using many inexact spare parts. In part, this behavior results from an effort to minimize out-of-pocket expenses by purchasing cheaper but substandard parts rather than more expensive but more durable officially-imported spare pieces. Owners and operators did not report any problems in finding mechanics or parts to repair equipment. When asked about the purchase of spare parts, mill owners commonly reported different prices for imported parts sold in commercial stores and locally made parts. The term "local parts" refers to those found in local markets or manufactured by local artisans. They may thus include unofficially imported parts from Nigeria and Côte d'Ivoire, which are sold by merchants working out of their homes, as well as used equipment found in markets.

As Exhibit 6-1 indicates, current taxes, in accordance with a new value-added tax system initiated in 1991, have recently increased from 11 to 28 percent for dehullers and mills and 37 to 53 percent for spare parts. Given this increase and the tendency to purchase the cheapest equipment,

demand for locally manufactured and unofficially imported dehullers, mills, and spare parts is likely to increase.

In terms of locally made dehullers and spare parts, one cannot assume that artisans have the necessary resources and tools to permit them to respond to the increased demand. Further growth of the repair sector may require the importation of cutting, grinding, drilling, and welding tools. Growth may be equally constrained because this equipment is subject to the new tax structure.

**Exhibit 6-1 Existing and Planned Import Taxes on Processing Equipment**

| Existing Import Taxes | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Item** | **Customs** | **Import Tax** | **Turnover Tax** | **Service Fees** | **Price Stabilization Tax** | **Community Solidarity "Contribution"** | **Total Taxes** |
| Mills and Dehullers | 5.0% | 0.0% | 0.0% | 5.0% | 5.0 F/kg net | 1.0% | 11.0% + 5F/kg |
| Spare parts | 5.0% | 10.0% | 11.1% | 5.0% | 5.0% | 1.0% | 37.1% |
| Value Added Tax System 1991 | | | | | | | |
| **Item** | **Customs** | **Import Tax** | **Value Added Tax** | **Service Fees** | **Price Stabilization Tax** | **Community Solidarity "Contribution"** | **Total Taxes** |
| Mills and Dehullers | 5.0% | 0.0% | 17.0% | 5.0% | | 1.0% | 28.0% |
| Spare parts | 5.0% | 25.0% | 17.0% | 5.0% | | 1.0% | 53.0% |

### 6.2.4 Processing Charges and Quantities and Net Profit

Every mill owner and operator expressed concern about the growing number of plate mills in their neighborhoods and the resulting downward pressure on prices. They reported that only a few years ago, grain was measured with a small dish that weighed approximately one kilogram when filled. Customers were charged 10 FCFA/dish. Customers are no longer requested to measure out their grain in their calabash. Rather, the operator visually estimates the quantity and discusses the price with the customer. The customer often hands the operator money without discussion. Grain brought to the mill is measured after the price has been negotiated. The price per kilo of the different coarse grains averages roughly 8 FCFA/kg.

Operators felt that their bargaining power with customers was limited given the large number of mills in most neighborhoods. A customer will go to another mill if the operator charges more than the customer wants to pay. Regular customers generally pay the operator the same price every day, even if they purchase more than their usual amount. To minimize fuel consumption, operators with diesel-powered mills prefer to wait for a number of clients to arrive before they start the motor. Several operators said that they are often forced to start the mill with grain from only one customer or lose the business. Operators fully understand that consumption of diesel fuel increases with frequent start-ups but feel that they are powerless to regulate it. This phenomenon partly explains the higher cost of operating a diesel mill. Starting a diesel motor consumes approximately the same quantity of fuel needed to mill 3 kg.

The fee to dehull maize, sorghum, or millet is 10 FCFA per dish used as the unit of measurement. One dish filled with grain is equal to approximately 1 kg due to the heaping quantity placed on the dish. Even if the dish is not used to measure the grain, operators said that they are not as flexible in discussing the price of dehulling.

In addition to the per kilo charge, most dehuller owners keep a large portion of the bran which they can in turn sell for at least 5 FCFA/kg. With a daily volume of 200 kg, a 70 percent dehulling yield, and half of the bran adhering to the grain, the average dehulling operation collects 15 percent of the quantity dehulled or 30 kg of bran per day or 150 FCFA (4,500 FCFA/month). In some larger volume dehulling operations, in which people bring 100-kg sacks of grain, the client keeps the bran from their cereal.

Quantities dehulled per customer range from a few kilos for one meal to a few 100-kg sacks. Some households dehull larger quantities that are used over the course of a week but most large-volume customers are market retailers who sell dehulled grain, grits, flour, or flat cakes (galettes). Milling is done almost exclusively on a daily basis, with the quantity determined by household needs.

Operators keep track of daily revenues but not exact quantities of grain dehulled and milled. For milling, revenues average approximately 2,000 FCFA per day. Assuming a per kilo milling fee of 8 FCFA, this translates into approximately 250 kg of grain ground per day. The breakdown by type of cereal is not known. During the rainy season, daily milling revenue drops off considerably to approximately 1,200 FCFA and 150 kg. During the holy month of Ramadan when millet consumption increases, the average mill volume reaches 425 kg, generating 3,400 FCFA/day. Average gross revenues for an Engleberg-type dehuller approach 2,000 FCFA which at 10 FCFA/kg is approximately 200 kg dehulled per day. While it is clear that some dehullers earn three times this amount on a given day when many clients bring 50 and 100-kg sacks, this volume fluctuates considerably and some days very little is dehulled.

Exhibits 6.2, 6.3, and 6.4 summarize the operating budgets for a typical diesel-powered mill, an electric-powered mill, and an electric-powered dehuller. They summarize the cost and revenue information collected in interviews and indicate the general order of magnitude of operating expenses and profitability of urban mills and dehullers. They do not, however, represent a definitive assessment of the financial viability of the equipment. At the very least, they may provide the basis for further research and more precise financial analysis.

The average diesel mill makes a net profit of 1.51 FCFA/kg or 377.5 FCFA/day or 11,325 FCFA/month. An electric mill generates a net profit of 2.3 FCFA/kg or 568 FCFA/day or 17,025

FCFA/month. The net profitability of a dehuller, including the revenues from the sale of bran, is 0.99 FCFA/kg or 200 FCFA/day or 5940 FCFA/month. Since most equipment is purchased with cash and no loans are used to finance the purchase of equipment, no amortization cost is included. If replacement costs of roughly 10,000-13,000 FCFA per month for the mills, dehullers, and motors were factored into the analysis and spread over 7 to 10 years, profit figures would change considerably. Although the incidence of taxation has been increasing in recent years, with many processing operations paying taxes for the first time in 1990, some owners/operators reported not having to pay some taxes, which would have considerable impact on their profitability.

It is more accurate, however, from the standpoint of actual existing operations, to consider the electric-powered dehuller and mill together in the same budget, thus spreading the fixed costs between the machines. In this case, the net profitability of the unit is 3.43 FCFA/kg, or 46,290 FCFA/month. This estimate does not include the often lower price charged to clients who dehull and mill their grain.

## 6.3 CMDT Mini-Mill Project

As mentioned in Chapter 4, the CMDT, with financing from the French Fonds d'Aide et de Coopération (FAC), has established 10 semi-industrial mills, principally in the CMDT zone of Koutiala, to produce and sell maize grits and flour. The principal project objectives are to promote the development of village associations and create additional outlets for surplus maize production. This section discusses the dehullers and mills used in this project and examines their experiences in marketing processed maize products.

The processing equipment used to produce maize grits and flour is different from that used in the Bamako area. Dehulling is performed by two imported dry abrasive-disk dehullers, one manufactured in Botswana by the Rural Industries Innovation Centre (RIIC) and a modified version of the RIIC constructed by Nuhull in Canada. Both were conceived to dry dehull coarse grains and evolved from the dehuller design of the Prairie Regional Laboratory (PRL) in Canada. These machines differ from the Engleberg-type dehullers in two fundamental ways. First, grain is dehulled dry by 13 rotating carborundum grinding stones mounted on a horizontal shaft enclosed within a case. Second, bran is separated from the dehulled grain by aspiration using a fan and cyclone system and resulting in a clean product that can be ground immediately without an intermediate washing step. Both machines can produce over 500 kg/hour on a continuous basis, as well as perform smaller batch jobs of 5-15 kg powered by an 8 or 10 hp diesel motor or 5.5 kw electric motor. Mill staff report a dehulling yield of approximately 80-82 percent for yellow maize and 78-80 percent for white maize. The extraction rate is thus 10 percent higher than that of the Engleberg-type dehullers currently used in Bamako.

Mill operators estimate fuel costs to vary between 1.25 FCFA/kg and 2.5 FCFA/kg depending on the throughput (kilograms/hour) and whether white or yellow maize is produced. Either rate is, however, less than the 3.5 FCFA/kg fuel cost of the Engleberg-type dehullers used in Bamako, especially given that the rate for the abrasive dehullers was recorded using the less energy efficient and higher cost diesel motors.

| Exhibit 6-2 Monthly Budget for Diesel-Powered Plate Mill (in FCFA) | | |
|---|---|---|
| **INVESTMENT COSTS** | | |
| Mill and Diesel Motor | 775,000 | |
| Installation | 40,000 | |
| Total | 815,000 | Not factored into the calculation |
| **OTHER FIXED COSTS** | | |
| Rent | 1,500 | |
| Operator Salary/Food | 14,000 | |
| Taxes | 9,500 | |
| Total | 25,000 | |
| **VARIABLE COSTS** | | |
| Lubricant | 4,250 | 5 liters of oil @ 850 FCFA/liter |
| Disk Repair | 3,000 | 2 changes/month |
| New Disk | 1,460 | 1 set of new disks per year |
| Diesel Fuel | 13,500 | 1000 FCFA in revenue/liter; 2000 FCFA/day average gross revenue;<br>2 liters fuel at 225 FCFA/liter = 450 FCFA/day |
| Other Repair-Replacement Costs | 1,500 | Annual and biannual contingency costs to replace belt, bearings, bushings, and parts for motor |
| Total | 23,710 | |
| **TOTAL COSTS** | 48,710 | |
| Revenues | 60,000 | 2000 FCFA/day * 30 |
| Net Profit | 11,290 | |
| Kilos Milled | 7,500 | 2000 FCFA day/8 FCFA=250 kg * 30 days |
| Cost per Kilo | 6.49 | |
| Net profit per kg | 1.51 | |

| Exhibit 6-3 Monthly Budget for Electric-Powered Plate Mill (in FCFA) | | |
|---|---|---|
| **INVESTMENT COSTS** | | |
| Mill and Electric Motor | 675,000 | |
| Installation | 125,000 | |
| Total | 800,000 | Not factored into the calculation |
| **OTHER FIXED COSTS** | | |
| Rent | 1,500 | |
| Operator Salary/Food | 14,000 | |
| Taxes | 9,500 | |
| Total | 25,000 | |
| **VARIABLE COSTS** | | |
| Lubricant | 850 | 1 liter @ 850 FCFA/liter |
| Disk Repair | 3,000 | 2 changes/month |
| New Disk | 1,460 | 1 set of New disks per year |
| Electricity | 11,673 | 1 kilowatt of electricity generates 375 FCFA; 2000 FCFA/day average gross revenue uses 5.33 kw @ 73 FCFA/kw = 362 FCFA/day * 30 |
| Other Repair-Replacement Costs | 1,000 | Annual and biannual contingency costs to replace belt, bearings, bushings, and parts for motor |
| Total | 17,983 | |
| **TOTAL COSTS** | 42,983 | |
| Revenues | 60,000 | 2000 FCFA/day x 30 |
| Net Profit | 17,017 | |
| Kilos Milled | 7,500 | 2000 FCFA day/8 FCFA=250 kg * 30 days |
| Cost per Kilo | 5.73 | |
| Net profit per kg | 2.27 | |

| Exhibit 6-4 Monthly Budget for Electric-powered Dehuller (in FCFA) | | |
|---|---|---|
| **INVESTMENT COSTS** | | |
| Dehuller and Electric Motor | 650,000 | |
| Installation | 125,000 | |
| Total | 775,000 | Not factored into the calculation |
| **OTHER FIXED COSTS** | | |
| Rent | 1,500 | |
| Operator Salary/Food | 14,000 | |
| Taxes | 9,500 | |
| Total | 25,000 | |
| **VARIABLE COSTS** | | |
| Lubricant | 850 | 1 liter @ 850 FCFA/liter |
| Bearings | 1,000 | |
| Belt | 700 | |
| Sieves | 6,000 | |
| Cylinder | 3,000 | |
| Blade | 125 | |
| Electricity | 21,900 | 1 kilowatt of electricity generates 200 FCFA; 2000 FCFA/day average gross revenue uses 10 kw @ 73 FCFA/kw = 730 FCFA/day * 30 |
| Total | 33,575 | |
| **TOTAL COSTS** | 58,575 | |
| Revenues | 64,500 | 2000 FCFA/day x 30 + 4500 for sale of bran (30 kg/day @ 5 FCFA/kg * 30 days) |
| Net Profit | 5,925 | |
| Kilos Milled | 6,000 | 2000 FCFA day/10 FCFA=200 kg * 30 days |
| Cost per Kilo | 9.76 | |
| Net Profit per kg | 0.99 | |

| Exhibit 6-5 Summary of Monthly Budget of Electric-Powered Dehuller and Plate Mill | |
|---|---|
| Shared Fixed Costs (Including Salary for Additional Operator) | 39,000 |
| Total Shared Variable Costs | 51,558 |
| Total Shared Costs | 90,558 |
| Revenues | 124,000 |
| Net Profit | 33,442 |
| Kilos Processed | 13,500 |
| Net Profit per kg | 2.48 |

Aside from the apparent energy economies of these dehullers, the lack of accurate disaggregated data prevents a full assessment of the actual operating costs of the equipment. The CMDT has not updated its records since improvements were made in the functioning of the mill. A more serious constraint to determining the financial viability of these machines is the extensive role that CMDT technicians have played in installing, maintaining, and repairing the machines; this involvement and cost have not been taken into account in their calculations. Evaluations of the RIIC dehuller in Botswana have shown, however, that the only major cost is the replacement of disks every 600 tons at a cost of 60,000 FCFA, which in this context is every four to five years.

After dehulling, the grain is placed immediately in the plate or hammer mill for grinding. It is not necessary to carry out additional winnowing or washing, as the bran has been entirely removed from the grain by the cyclone system in the dehuller. The actual milling cost varies with the type of mill used (plate or hammer mill), the power source, the type of product desired (grits or flour), the desired grit size, and the speed at which the motor and mill are operated.

A hammer mill consists of a metal casing containing short hammer-like plates attached to a disc connected to the end of a rotor shaft. The hammers rotate at very high speeds (3,600 RPM), propelling the grain against the casing walls and screen through which they must pass. The grains remain in the case until reduced in size sufficiently to allow them to pass through the screen. The smaller the perforations of the screen, the finer the end-product.

Following grinding, the grits and flour are placed in a manually operated, rotating, cylindrical sifter that separates flour and the various sized grits. The products are then packaged and sealed.

Grits are sold by the village association and also individually by some of its younger members. The majority of grits and flour produced are sold to CERECOM, CMDT's unofficial marketing wing. Mill sale prices are 100 FCFA/kg for grits and 75 FCFA/kg for flour. The village association believes that the presence of the mill as an additional market outlet for surplus maize production has increased their bargaining position vis-à-vis merchants. Sales have been constrained,

however, by the lack of buyers and even more so by the low quality of the product, which is infested with insects and rancid.

According to Bamako consumers, CMDT grits and flour had a noticeable odor of older stock. Mill staff confirmed that due to lack of sales in the early part of the project, some grits and flour were stored for approximately one year before being sold. The problem of rancidity can be attributed partly to this long storage period and also to the incomplete removal of the germ, whose oil minimizes the storage life of grits and particularly flour. Dehulling efficiency may decrease when the endosperm is weakened by a long storage life and attack from insects and mold (Rooney et al., 1986); this complicates removal of the pericarp, causing some of the endosperm to crack during dehulling (ending up in the bran).

The major marketing strategy and thus the production emphasis has been on maize grits as opposed to flour. Mill operators have experimented with the machinery in order to minimize the quantity of flour produced. They stated that the flour produced, actually as a by-product of the transformation to grits, was not favorable to the preparation of a satisfactory dish of toh, because it lacked the necessary consistent texture. This flour thus can be used only for couscous and porridge.

The difficulty in selling the flour may therefore be due more to dissatisfaction with a poor-quality product lacking the starch to produce consistent toh than to the potential market for flour. This experience underscores the importance of producing a clean, high-quality product that embodies the characteristics desired by consumers. It also illustrates the importance of informing the consumer of the specific product characteristics and uses. If the consumer purchases flour with the intent of making toh and finds the result unsatisfactory, future marketing efforts of different products may be undermined.

On a side note, mill staff and villagers found that wet-grinding the large grits into flour produced a satisfactory flour for toh. Moreover, villagers found that toh produced with flour ground from the entire dehulled grain, as opposed to flour as a by-product of grits production, was very good. This anecdote provides hope that consumers will find satisfactory flour produced by dry-method processing.

The project's experience is also instructive from the standpoint of coordinating marketing strategy with agronomic extension plans. Higher-yielding varieties of white maize are currently being promoted by the CMDT and planted by producers. Producers like the product because it weighs more than yellow maize and is more resistant to insect damage, resulting in a longer storage life. This white maize variety is amenable to higher grits production as well as a highly appreciated toh of good consistency. Mill staff and association leaders said that white maize is preferred in rural areas as it is most similar to rice and can be produced in diverse ways. Since urban consumers are not familiar with white maize, CERECOM markets only yellow maize. But given the production potential and positive characteristics of white maize, efforts should be made to examine the different ways in which it can be prepared and to increase urban consumers' awareness of the product and its uses.

These semi-industrial mills were built primarily to dehull and grind maize for resale and not for local consumption. Some mills thus establish minimum batch limits of 50 kg, charging 25 FCFA/kg for villagers who want to process their grain. Village demand for the services of these semi-industrial machines is limited to peak agricultural labor periods when women's work in the

fields reduces their time to do processing and when agricultural work groups are hired and need to be fed.

The CMDT, collaborating on a different project with Appropriate Technology International (ATI) and Catholic Relief Services (CRS), has installed a Gambian manufactured, IDRC/PRL mini-dehuller in five villages. Project aims are to test technical and commercial viability of mini-dehullers, and to train blacksmiths to manufacture the dehullers. This dehuller is a smaller version of the RIIC dry abrasive-disk dehuller capable of batch- processing 5-7 kg. The small size makes it a more economically feasible operation in a village setting with smaller demand. The machines are managed by blacksmiths trained and equipped to repair agricultural equipment under the CMDT's Rural Artisan Program. The mini-dehuller in the village visited was powered by a 3-kw electric motor, the electricity supplied by a diesel generator also used to operate other equipment. An electric hammer mill and manually operated CeCoCo winnower complete the processing unit. Use of the dehuller is constrained by its cost of 15 FCFA/kg and limits on the use of other equipment when the generator is started.

## 6.4 Relevance of Processing Equipment

This section discusses the relevance of plate mills, Engleberg-type dehullers, and dry abrasive-disk dehullers to efforts to increase coarse grain consumption. The first part examines the effectiveness of artisanal custom mill equipment in Bamako and the potential impact of improvements in this technology on consumption of coarse grains. The second part looks at processing equipment requirements for commercial production of processed products and considers a number of issues that will have to be studied prior to initiating any project.

### 6.4.1 Urban Artisanal Processing and Consumer Demand

Plate mills have so far proven to be effective machines capable of producing flour and grits that conform to the preferences of Malian consumers with minimal changes in the preparation process. In recent years, the apparent overinvestment in plate mills in urban areas has resulted in decreasing utilization rates that make it more difficult to run a profitable operation. It will be interesting to observe whether owners replace existing equipment in the next few years, particularly in mills powered by the more energy-expensive diesel motors in spontaneous neighborhoods.

Current dehulling technology can be improved. Engleberg-type dehullers are inappropriate for dehulling coarse grains with high operating and energy costs and low yields. Replacing Engleberg-type dehullers with dry abrasive-disk dehullers designed specifically for coarse grains would benefit owners and consumers alike. Experiences of the CMDT and in many other countries have shown that dry abrasive-disk dehullers dehull grain more efficiently at lower cost and with lower dehulling losses. Consumers would benefit from the higher dehulling yield -- 80 percent compared to 70 percent achieved manually or with an Engleberg dehuller -- while machine owners would have more efficient and profitable operations.

If one assumes that each member of a 13-person family consumes 156 kg of coarse grains per year, a total of 2,028 kg, a 10 percent increase in dehulling yield raises cereal availability by 202.8 kg at a value of approximately 20,280 FCFA (assuming a consumer price of 100 FCFA/kg). If consumers are satisfied with the dehulled product, the 10 percent additional cereal received from the abrasive dehuller could pay for its use. Assuming daily household consumption of approximately 5.5

kg (2,028 kg/365 days), the extra 0.55 kg saved, valued at 55 FCFA could pay for dehulling charges of 10 FCFA/kg. A family could buy one-half kg less if they used an abrasive-disk dehuller with 80 percent dehulling yield and obtain the same amount of dehulled grain at the same price as they would with manual dehulling at an extraction rate of 70 percent. This calculation does not take into account the potential loss of bran (used for animal feed) when a household uses mechanical dehullers.

For a mill owner, the lower energy consumption and maintenance costs of an abrasive-disk dehuller could make it more profitable than an Engleberg-type dehuller and more financially feasible to install in a spontaneous neighborhood where a diesel motor is required. Whether these savings translate into lower per kilogram milling charges depends on the specific type of machine used, its price and financing costs, and the quantity of cereal dehulled.

The economic viability of abrasive-disk dehullers used for custom processing of grain brought by customers depends on large numbers of households using the machine. The household survey reported 29 percent of those interviewed using mechanical dehullers. It may, however, be more meaningful to report use of mechanical dehulling only for those households with access to them and not to include those households without access to a dehuller (i.e. residents of spontaneous neighborhoods). When considering only these households, the number of users of mechanical dehullers approaches 40 percent. Given an additional 10 percent higher yield obtained from an abrasive-disk dehuller over an Engleberg machine or manual dehulling, one could project increased consumer demand for mechanical dehulling.

All these conclusions hinge in large part on consumer satisfaction with the grain dehulled with an abrasive-disk dehuller. Consumer taste tests conducted by the Cereal Technology Cell of the SRCVO at Sotuba in 1984 showed that the amount of bran removed at a dehulling rate of 70 percent exceeds the necessary amount required to obtain an acceptable product for consumers. In fact, taste panel members were unable to detect a difference in toh prepared with dehulled sorghum at a 90 percent yield from that made with sorghum dehulled at the traditional 70 percent yield. This is a remarkable finding, suggesting a considerable potential for reducing the cost of sorghum products without negatively affecting consumer acceptability. Further taste tests need to be performed not only on toh produced with grain with a higher dehuller extraction rate but also with grain products produced with the dry method and the wet method.

It should be emphasized that the introduction and consumer acceptance of dry abrasive-disk dehullers may lead to smaller cereal losses and more profitable dehulling operations but may not necessarily increase consumption of coarse grain. Whether use of this dehuller increases consumption of coarse grains may depend more on consumer preferences and other factors influencing consumption decisions, particularly economic and time factors. Any project interested in replacing rice-based dishes with those using coarse grains needs to carefully examine the type of people (socioeconomic group) consuming rice and the meals at which substitution could occur. It is clear from the discussion in Chapter 4 that consumer preference for a more diversified diet has led to increased consumption of rice at the noon meal. For the 26 percent of households surveyed who consume only coarse grains, increased consumption of coarse grains seems to be a moot point. For the 50 percent of families eating one rice dish and one coarse grain dish, cereal consumption could be increased if they prefer an additional coarse grain meal periodically but do not prepare it because of economic or time constraints.

It remains unclear whether it is more economical to produce a rice dish or a coarse grain dish. It is also uncertain whether the time required to prepare a coarse grain dish or the equipment used to process coarse grains are constraints affecting consumption decisions. Several factors in addition to price influence the cost of dishes including presence of foreign matter in the grain, dehulling yield, processing fees, labor required, energy consumption, the cost of sauces, and expansion in volume. Simply receiving a 10 percent higher yield or paying a lower processing fee may not be incentive to eat more meals based on coarse grains, especially if consumers think that a rice dish is still cheaper to prepare or if they prefer a diversified diet. Moreover, a coarse grain dish may still require more preparation time than rice.

To the extent that 1) time is a constraint and those preparing food do not have time to go to a mechanical dehuller, return home to wash and lay out the grain for an hour, and then return to the mill to grind flour or grits and, 2) no coarse grain product is available in the market that conforms to their quality standards, consumers may opt to purchase ready-to-cook products like rice even if they prefer maize, millet, or sorghum. For these households, the use of an abrasive-disk dehuller may help reduce preparation time if consumers are willing to use a dry processing method and are satisfied with the final product.

The dry processing method reduces preparation time by eliminating the intermediate step of washing the grain and laying it out prior to milling and allows grain to be ground immediately after dehulling. Acceptance of a dry processing method centers on two points: use of a clean raw product free of sand, stones, and other foreign matter; and satisfaction with flour and grits milled dry. If consumers were not satisfied with the dry method of processing and preferred to return home and wash the grain before milling, this would eliminate the advantages of decreased processing time and longer shelf life. It would not, however, nullify the benefit of the higher dehulling yield from an abrasive-disk dehuller.

Processing as a constraint to the consumption of coarse grains may be particularly acute during the rainy season when the majority of maids return to rural areas for agricultural work. All mill operators reported lower revenues during this period. Without maids, other household members must take responsibility for dehulling and milling. Finding the time to do this may be difficult for those who are not usually responsible for it. Therefore, coarse grain consumption decreases. Access to a less time-consuming, one-stop, dehulling/milling process could increase consumption. However, if time is the primary constraint, then creating ready-to-cook processed products such as flour, grits, couscous, or dried moni porridge reduces preparation time and more directly satisfies the demand, not only during this period but throughout the year.

### 6.4.2 Relevance to Producing Processed Coarse Grain Products

The most promising area in which new technology could contribute to an increase in coarse grain consumption seems to be in the production of processed products. Generating sustained demand for surplus production through the development of processed forms of maize, millet, and sorghum hinges on producing a competitively priced product that is white, clean, and fresh. Cleanliness is affected by the extent to which the production process removes sand, stones, or other foreign matter from the grain that may contrast with the white, processed product. Product color is determined largely by the color of the pericarp and testa of the particular grain variety and the extent to which these layers are removed.

Another important consideration in producing a processed product is its shelf life, which is affected by moisture content, germ and resulting fat content, various contaminants in the grain, and storage conditions. Any semi-industrial effort to develop a processed product requiring a longer storage life than 24 hours will need, at the minimum, to use a processing method that keeps the moisture content of the product under 13 percent. The gist of dry processing is to eliminate the preparation step in which dehulled grain is washed and piled in a layer to allow moisture to penetrate the kernel. If processors deem that washing is required to produce a clean, fresh product, then plans must be made to dry the grain which would significantly increase the processing costs.

Flour and grits that have not been completely degermed tend to become quickly rancid due to the high fat content of germ. Any semi-industrial project that seeks to produce a storable, clean product will require that food technologists and processing engineers more carefully study the effect of varying amounts of germ on product shelf life and the ability of different types of processing equipment (e.g. abrasive-disk dehullers) to partially or completely degerm coarse grain. For commercial projects, the starting point for all research is to define the characteristics desired in the final product and thus in the grain and processing equipment.

The difficult storage and marketing experiences of CERECOM, as well as the presence of a very thin market for coarse grain products, leads to the conclusion that the most logical production strategy would be to produce smaller quantities, avoid large inventories, and monitor sales before making longer term production decisions. This raises the question as to the type of product needed on the market: a degermed, long shelf-life product or one that is partially degermed with a shorter shelf life.

The degree to which the germ is embedded in the endosperm differs with the type of grain (maize, millet, sorghum) and affects the ease with which it is separated. Although abrasive-disk dehullers are not manufactured to remove germ, they may perform partial degerming of maize in the process of rubbing off the hull. The shelf life of coarse grain products processed on a semi-industrial level, however, may be limited by remnants of germ remaining in the processed product causing early rancidity. At this stage, attention must be directed to degerming technology that is economically feasible only at the industrial level.

### 6.4.3 Choice of Equipment for Artisanal and Semi-Industrial Processing and Project Possibilities

It is clear from the prior discussion that dehulling technology could be significantly improved by introducing a different type of machine more suitable to processing coarse grains. For any coarse grain processor, the more efficient operation of an abrasive-disk dehuller would contribute to lower production costs, higher yields, a more attractive price, and thus a better chance of selling the product. For consumers, abrasive-disk dehullers give more product for their money and decrease processing time. Dehullers developed in Botswana, Senegal, and The Gambia are appropriate new technology. The brand of dehuller to use depends on specific processing objectives, desired product characteristics, more precise financial analysis with a complete data set, and discussions between interested parties (investors) and those familiar with the technology.

Extensive mill and dehuller testing was conducted at the Centre d' Exploitation et Equipement du Machinisme Agricole (CEEMA) at Samanko in the early 1980s under FAO financing. This department of the Ministry of Agriculture is a research, testing, and training center in post-harvest technical issues. It is the Malian institution with primary responsibility for developing and testing

agricultural equipment and assessing its potential for adoption and dissemination in Mali. Although funding additional laboratory testing would be redundant, center researchers are knowledgeable about equipment performance and should participate in project design and field tests. Similarly, CMDT personnel involved with the mini-mill project, research institutions and manufacturers in Senegal and Botswana, and Africa region staff of the IDRC are well-informed about milling and dehulling equipment and would probably contribute a great deal to any future discussions.

The abrasive-disk dehullers manufactured by RIIC in Botswana and by SISMAR in Senegal are two models that may be of particular interest in either an artisanal dehulling operation geared to batch processing or a commercial operation that produces processed products on a continuous basis. Despite their higher purchase prices (1.85 million FCFA for the RIIC and 600,000-800,000 FCFA for different SISMAR models), they are potentially more profitable for an urban dehulling operation, as the maintenance costs are considerably lower and the machines are more energy-efficient. Whether the dehuller will be used for batch or continuous production will determine the capacity requirements and type of model chosen. Matching the size of the dehuller with estimated throughput gives the machine a better chance to create a financially viable operation.

Both the RIIC and SISMAR machines contain bran aspiration systems, which are valued for their ability to produce a product free of stones and sand that does not require intermediate washing before grinding. If consumers do not adapt to this dry method, then a mini-dehuller without the bran aspiration system may be an attractive machine for urban processing units as it provides the higher dehulling yield but at a lower investment cost of approximately 250,000 FCFA.

To the extent that Malian consumers are satisfied with the mixture of fine flour and grits ground with a plate mill and are not constrained by the additional sifting required to separate them, there is no reason to suggest replacing plate mills with hammer mills. Evidence conflicts on whether operating costs are higher for a plate or for a hammer mill. Recent research has shown that maintenance costs are higher for a plate mill due to the frequent sharpening and replacement of grinding plates but offset by the lower energy costs (François, 1988). For all practical matters, a hammer mill is inappropriate for wet method processing, as grain with a high moisture content tends to clog the screens. Investing in hammer mills would appear to be worthwhile in the context of dry processing or a commercial operation requiring a homogeneous processed coarse grain product. One advantage of hammer mills is that they can be easily manufactured locally with minimum use of imported parts and therefore sold at considerably reduced cost (as in Senegal).

Given the unfamiliarity of equipment sellers, processors, and consumers with abrasive-disk dehullers and hammer mills, the only way they will be introduced and used is through a government/donor sponsored project. Although one could envision several different projects, one possibility may be to install a dry abrasive-disk dehuller and hammer mill in a few urban processing units. CEEMA engineers could monitor operating costs and machine performance while food technologists could develop a program to monitor consumer attitudes, processing behavior, and preferences for different machines and products, paying particular attention to opinions on dry versus wet processing products.

A later phase could entail work with local artisans to manufacture an abrasive-disk dehuller or hammer mill, the choice of specific type guided by research findings on equipment feasibility and consumer preferences. CEEMA could play a key role in coordinating interaction with other African food technology researchers, CMDT technicians, and local artisans to manufacture machines or spare

parts. The financial feasibility of any local manufacturing effort may be constrained, however, to the extent that taxes increase the price of imported tools and other intermediate inputs (i.e. bearings) needed to build or expand production.

A company such as UCODAL that already produces processed coarse grain products (fonio) and that would like to expand operations may be interested in participating in another project to produce and sell processed products such as couscous, dried moni porridge, and flour for toh. A particularly interesting question is whether flour satisfactory to consumers can be successfully produced at a semi-industrial level. It may be more realistic to think of urban-based, semi-industrial processing operations since grain is a more stable product than flour and can be transported more easily. Before launching this type of project, food technologists and processing engineers should more carefully study why CMDT production of flour has not succeeded. Moreover, future agronomic and cereal breeding research will need to continue to carefully evaluate grain varieties in terms of desired processing and food quality traits in addition to agronomic criteria.

Any future effort to advocate changes in technology needs to consider the nutritional and employment implications. A dry abrasive-disk dehuller with a higher dehulling yield would, for example, reduce cereal losses while still producing a product acceptable to consumers. Even a higher extraction rate would be preferable from a nutritional standpoint, if consumers accepted it, because products containing all or part of the bran and germ are more nutritious than degermed products.[33] Using bran and germ for animal feed does not make up for the lower extraction rate and loss of nutrients in the grain because there is a 90 percent loss of nutritional value when bran/germ is converted into meat.

## 6.5 Grands Moulins du Mali

The comparative advantage of the GMM from a processing perspective is its scale economies in production and its degerming equipment. The economic viability of industrial production by the GMM hinges on the existence of a larger market to absorb the higher volume production. Given the small market for any coarse grain processed product, this large-scale processing facility and the need to cover at least variable processing costs is also its primary drawback in the short term. A week's production on its 50-ton/day maize grits/flour line could probably satisfy most if not all the current market demand for maize products in Bamako for a year.

Industrial processing also depends on an assured supply of a clean raw product at a stable price. Rather than using inconsistent supply as a reason not to initiate production, working to create acceptable consumer products, promote market development, and develop coordinating mechanisms between buyer and seller may result in increased and consistent market deliveries. However, the intra-annual and interannual variability in supply of coarse grain may still make it difficult to maintain a sufficiently high rate of capacity utilization without incurring prohibitively high storage costs.

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[33] In Kenya and Zimbabwe, maize grain is ground directly into flour by artisanal mills avoiding an intermediate dehulling step. Hence, there is virtually no dehulling loss. This yields a bran- and germ-rich processed maize product; it also increases the proportion of tannin and polyphenols in the resulting processed product.

A detailed, current accounting of processing and marketing costs was not fully available from either the CMDT-managed semi-industrial mills or the GMM. Exhibit 6.6 represents an effort to use existing information and knowledge of the marketing sector to approximate processing and marketing costs of a kilogram of maize grits or flour for the GMM and one CMDT mill. Estimates were based on 300 processing days per year, CMDT daily production of 600 kg/day, 180 tons/year, and GMM daily production of 50 tons/day, 15,000 tons/year. Processing costs are extremely sensitive to the volume produced and the inclusion of amortization costs. In its rough form, it indicates the general magnitude of costs of the two organizations. The exhibit is useful not only as an estimation of potential operating costs but as a means to think through some issues related to both processes.

The bottom line of the exhibit shows the retail price of processed maize from the CMDT/CERECOM semi-industrial facility to be 18 FCFA/kg cheaper than that produced by the Grands Moulins du Mali (161.1 FCFA/kg for CMDT and 179.4 FCFA/kg for GMM). Reasons for the difference can be explained at several levels. A rural-based production facility is more economical from the standpoint of reduced transportation and storage costs. The product shipped and stored will already be processed and thus 20 percent lighter than whole grain due to dehulling and the absence of bran. In essence, the GMM would incur higher transportation and intermediate storage costs with non-dehulled grain. There are also arguments for keeping the bran in the production area, which has the most livestock and is closer to export markets. CMDT processing costs are also 7 FCFA/kg less expensive than GMM. This difference can be attributed to CMDT's lower-cost, labor-intensive process and lower energy costs.

One major concern for both organizations is the type of marketing structure needed to procure raw material and to transport and sell the product. CMDT mills incur lower transaction costs in assembling grain at the village level, relying on village associations to organize procurement and farmers to transport grain to the mill. GMM would need, however, to establish an assembly system to purchase grain from producers in the major producing region. Rotated OPAM cereal stocks have been a relatively low-cost and easy way to supply raw products for industrial needs. Because of difficult storage problems, maize is no longer stored in the SNS. Although sales of food aid maize to GMM (for counterpart funds) could be a potential supply source, their irregularity would probably not satisfy industrial production needs. A big question is whether GMM is willing to spend the money necessary to go to the producing area to acquire the necessary stocks.

Procuring a good quality product requires a competitive market price. If the price offered is as attractive as that offered by CERECOM, the buyer has the power to demand a clean product free of foreign matter and stones. For CERECOM, the marketing challenge involves coordinating the complex assembly and wholesale operations between Koutiala and Bamako. Being closer to Bamako, GMM may be more responsive to changes in market demand and urban needs. CMDT mills are in a better physical position, from the standpoint of transportation costs, to supply the other major urban areas in Mali.

Finally, the location and type of processing facility involves equity issues in terms of employment generation and the development of rural-based industry. Future actions will need to involve more careful study of total direct employment per unit of output and the investment cost per unit of employment generated. The biggest impact on the most people will undoubtedly come from developing a market for good-quality, low-cost products that increase demand for maize production.

**Exhibit 6-6 Comparative Processing and Marketing Costs for Semi-Industrial and Industrial Scale Maize Transformation (all costs in FCFA/kilogram)**

| CMDT/CERECOM Semi-Industrial Processing | | GMM Industrial Processing | |
|---|---|---|---|
| Cost Category | | Cost Category | |
| Farm Price for Maize Whole Grain | 50 | Farm Price for Maize Whole Grain | 50 |
| Cost of Bags for Whole Grain | 2 | Cost of Bags for Whole Grain | 2 |
| Rural Storage of Whole Grain | 3 | Rural Storage of Whole Grain | 3 |
| Rural Processing/Packaging | 14 | | |
| Subtotal: Rural (CMDT Zone) Processed Grain Price (Divided by Conversion Ratio of 0.8) | 86.3 | Subtotal: Rural Price of Whole Grain | 55 |
| Less Sale of Maize Bran (15 FCFA/kg) | -3 | | |
| Cost of Bags for Processed Maize | 2 | | |
| Transport/Handling to Koutiala | 5 | Transport/Handling to Koutiala | 6 |
| Assembly Markup (15%) on Whole Grain Delivered to Koutiala | 13.5 | Assembly Markup (15%) on Whole Grain Delivered to Koutiala | 9.2 |
| Koutiala Storage Cost | 3 | Koutiala Storage Cost | 3.6 |
| Subtotal: Koutiala Price for Processed Maize Products | 106.8 | Subtotal: Koutiala Price of Grain | 73.8 |
| Transport/Handling: Koutiala-Bamako | 10 | Transport/Handling: Koutiala-Koulikoro | 13.2 |
| | | Subtotal: Koulikoro Whole Grain Price | 87.0 |
| | | Industrial Processing/Packaging | 20 |
| | | Subtotal: Processed Grain Price (Divided by Conversion Ratio of 0.8) | 133.7 |
| | | Less Sale of Bran (20 FCFA/kg) | -5 |
| | | Transport Koulikoro-Bamako | 2 |
| Storage in Bamako | 5 | Storage in Bamako | 5 |
| Wholesale Trader Markup (15%) | 18.3 | Wholesale Trader Markup (15%) | 20.4 |
| Wholesale Price of Processed Maize | 140.1 | Wholesale Price of Processed Maize | 156.0 |
| Retail Trader Markup (15%) | 21.0 | Retail Trader Markup (15%) | 23.4 |
| Retail Price of Processed Maize | 161.1 | Retail Price of Processed Maize | 179.4 |

Aside from coarse grain production for consumer products, GMM is also capable of supplying processed products to other industries such as pasta products, brewing, biscuits, batteries, and textiles. Each of these outlets is limited in scope and not a source of increasing short-term demand. In the immediate future, producing maize flour and mixing it with wheat flour for the bread-baking industry seems to be the most promising opportunity for GMM to expand production and develop alternative markets for maize products. That does not imply that the demand exists and everything will fall neatly into place, however. On the contrary, using maize flour in bread production involves a number of difficult decisions.

From an economic perspective, given the past subsidized nature of GMM wheat imports, the prospect of mixing maize and wheat flour has been limited until now. The price of maize delivered to Koulikoro has been higher than subsidized imported wheat. However, given the concerted donor action to phase out these subsidies as well as to allow wheat flour imports, GMM may have more incentive to produce a lower cost wheat/maize flour mix. Attempts to use maize flour in bread baking have demonstrated the need to have a high quality wheat flour with specific gluten/protein requirements.[34] Can this type of wheat be purchased at a price conducive to attempting this mixture?

The GMM director stated that maize flour could be mixed up to the 7 percent level with high-gluten wheat flour. Lobbying for a government decree requiring bread to contain 7 percent maize is an easier and more certain way to develop a market than attempting to introduce the mixed-flour bread in competition with bread containing 100 percent wheat flour. This method would avoid the need to test the market demand for this maize/wheat bread and to determine whether consumers prefer the product or to test whether it could be produced at a lower cost than wheat flour. If cost plus pricing formulas are adopted, the risks facing GMM and bakeries are greatly reduced. One could assume many possible scenarios but until an effort is made to produce and market a product, assumptions remain just that. Will there be any cost advantage to this mixed flour given the changes in the wheat and wheat flour imports? At what price could this mixed flour and bread be sold? What is the consumer preference for bread containing 7 percent maize flour? Is government decree the only way to develop this market for maize? If imported flour is the product of subsidized Western exports, donors need to ask to what extent they are really committed to promoting coarse grain products.

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[34] Gluten has the unique property of being able to retain gas produced by the leavening agent during fermentation. In essence, it gives bread its characteristic texture and volume. Coarse grains lack the proteins that produce gluten and thus, when mixed with wheat, reduce the volume of expansion. Using wheat with a higher level of necessary proteins allows use of a higher percentage of coarse grains in the mixture. According to the Grands Moulins du Mali, wheat varieties used in North America have 14-15 percent gluten, whereas wheat grown in Europe has 10-11 percent gluten.

## 7. IMPLICATIONS OF THE STUDY FINDINGS FOR WOMEN AND SMALL ENTERPRISE

### 7.1 Women as Coarse Grain Processors and Preparers of Coarse Grain-Based Dishes for Their Own Household Consumption

Food preparation is one of the major tasks and responsibilities of urban women in Bamako. Food preparation is widely viewed as including food processing and the transformation of whole grain into products that are actually used in food preparation. Most of the transformation activities are either done in the household, or, with the increasing importance of neighborhood mills, supervised by the women of the household. Processing and/or preparing food for sale and selling food products are primary sources of income for urban women and perhaps the major sources of income for female-headed households. In the process of interviewing small-scale grain product retailers, restaurant owners, and food vendors, we talked to a disproportionately high percentage of widows and divorced women who head households.

Changes proposed in food processing and transformation will affect different groups of women in different ways. No strategy will have uniformly positive effects, because producers and consumers of services will both be affected. We believe that the actions proposed will affect many more women positively than negatively.

Manual dehulling and grinding are considered drudgery. Ninety-five percent of the women interviewed said that they use neighborhood mills to grind their grain at least part of the time. Only 29 percent report using mechanical dehullers, but an additional 47 percent say that their maids do the dehulling. Seventy-six percent of women report that they do not personally do dehulling, even though it requires relatively little time and there are far fewer mechanical dehullers than mills.

A distinctly negative stigma is attached to manual grain pounding. Providing this service for payment is a last resort. Women rarely stated that neighbors provide this service, even when they did. Instead, these women were always referred to as strangers, typically rural women who migrate to urban areas and fail to find employment as maids. Maids apparently have a higher social status than women who sell this service.

Most maids refuse to grind grain manually. Maids are village women who return to their homes to help with the crops during the rainy season. Neighbors and even other urban women are rarely if ever stigmatized as women who manually pound grain for payment. This attitude amply demonstrates that manual grain pounding is considered drudgery--a task that urban women avoid if at all possible.

Yet many women do not believe that processed grain products that small-scale vendors sell in the market are acceptable in quality. Women report that these products are exposed to the air and often contaminated with dust, sand, and potentially with airborne diseases. Women are also distressed by the possibility that the grain has been handled by beggars and/or persons afflicted with communicable diseases. This lack of an acceptable source of processed grain products, the drudgery and stigma of manual pounding, and the time constraints of women working outside the household have contributed to rapid expansion of mechanical milling capacity in the Bamako area.

Women in general, and women involved in income-generating activities in particular, find that the time necessary to process grain and prepare traditional cereal-based dishes is a serious constraint. Twenty-six percent of the families interviewed prepare food only once for both the midday and evening meal. This strategy seems to be forced on many women who work outside the home or in commercial activities. The time constraint for them is even greater than for women in general unless they can hire additional help or have other women in the household do the work.

This time constraint is particularly severe with regard to preparing the midday meal. Preparing the morning meal and tasks necessary to get the family off to work and school constrain the early morning hours. But the daily trip to the market, processing grain for the evening meal, other necessary household activities, and midday meal preparation need to be finished by 12:30-1 p.m. when the children arrive home from school. The popularity of rice dishes undeniably makes rice the preferred grain for family consumption, but the fact that rice is uniformly eaten at midday and not at other meals seems to be strongly linked to this time constraint. Ninety percent of respondents claim that rice is the easiest grain to prepare. Data also show that rice (and sauce) cooks faster than any other principal dish except toh, which requires about the same amount of time.

Women (and families) demonstrate a strong desire to diversify their consumption, but this must be accomplished within the constraints enumerated above. A program supporting commercial food processing and the marketing of processed grain products can help women overcome several constraints. The availability of processed grain products would make food preparation easier and faster, allowing women to increase the range of foods they could prepare. Such products must conform to the standards of cleanliness and hygiene that the public demands. Processed grain products would be more expensive than whole grain, but they would compete more with the rice, tubers, meat, salad, and store-bought prepackaged items which are often used to save time. If the price of processed grain products is too high, it will seriously limit effective demand, as in the case of the maize grits presently sold along city streets. It is not possible from this survey to determine to what extent taste and the time constraint respectively influence demand for coarse grains. It is obvious that overcoming the constraints of limited time and home-processing of grain products will increase demand.

## 7.2 Women as Processors of Coarse Grain for Other Households

Commercial processing of grains will hurt those women who attempt to earn income by manually dehulling and grinding grain. The situation in Bamako is different from that in Dakar, Senegal, where few households employ such women to manually dehull or grind and where few itinerant women manually dehull coarse grain to generate income. The team found little evidence that custom manual processing is an important income-generating activity in 12 Bamako neighborhoods during the period of the study (November-December 1990).

It is important to note, however, that women perform manual processing on a seasonal basis in urban areas, migrating from rural areas. The period of the study may not have coincided with this seasonal migration. Nevertheless, urban women report that few such women perform custom manual dehulling. Expanded commercial processing would not affect the other, non-urban sources of income of those few women who do provide these services, however. Commercially sold coarse grain products would reduce the demand for maids only slightly. Most maids do far more than process grain for food preparation.

## 7.3 Women as Agro-Entrepreneurs

Increased commercial grain processing will provide employment and/or income-generating activities for many women. Women predominate in many aspects of commercial food processing and preparation. Most restaurant owners and food vendors of prepared (ready-to-eat) coarse grain products are women, as are most vendors of processed and semi-processed coarse grain products (grits and flour). Twenty-seven of the 28 processors/vendors of maize grits we encountered were women. Women who sell processed coarse grain products directly or who use them as an input into enterprises that sell prepared coarse grain products would benefit from an abundant supply of uniformly processed, clean, relatively inexpensive coarse grain products.

A second group of beneficiaries would be female agro-processors. Women owned over one-third of the Bamako artisanal mills surveyed. Hence, one cannot assume that mechanical operations owned and operated by men will displace manual work for women. Female entrepreneurs and capital will emerge in response to new commercial food processing opportunities. A woman owns and heads UCODAL, one of the few important and successful semi-industrial food processing enterprises. A proposed artisanal fonio processing enterprise will employ 10 young women who have completed high school.

In all likelihood, the establishment of an active artisanal and semi-industrial food processing sector will provide more income-generating opportunities for women than will be lost among manual processors and maids. At the same time, processing food grain will benefit all women who seek to increase the quality and diversity of family consumption, but who face serious time constraints in doing so. Although a few women who manually process grain would be hurt by mechanization of coarse grain processing, most women would welcome a reduction in the drudgery of manual dehulling, washing, winnowing, and grinding.

## 7.4 Need to Monitor Employment Impacts of Technological Change and Increasing Commercialization

Despite the likely positive net effects on female employment, income, and leisure of technological change in coarse grain processing, future projects and policies affecting this activity need to be carefully analyzed for their employment implications for different groups. One group that mechanized processing might hurt is retailers who sell flour and grits; cleaner and less expensive products from mechanized processing could undercut currently retailed products of inferior quality and higher cost. This would encourage vendors who do their own processing to use the improved processing technology or to buy processed coarse grain products coming from enterprises using superior technology. The net effect on their income, after these adjustments, is difficult to estimate *ex ante*.

## 7.5 Effects of Improvements in Coarse Grain Processing and Utilization on Small- and Medium-Scale Enterprise Development

Small-scale urban entrepreneurs who sell coarse grain processed products and who run restaurants will benefit from innovations in processing and utilization. They would likely alter their product mix to reflect the range of improved and new coarse grain products available in the urban market. Rural farms as enterprises would also be favorably affected by innovations in coarse grain processing in rural areas in that less female labor would be allocated to hand-pounding of grain.

During peak periods of labor demand on the farm, women could use valuable, limited time for cropping enterprises rather than grain processing. It would also be easier to process large quantities of coarse grains that would be used to prepare meals for agricultural wage laborers and work groups.

Greater investment in semi-industrial grain processing units in rural areas would have positive local employment and income-generation effects. To the extent that processing capacity is shifted over time to production zones, urban artisanal millers and dehullers would be harmed. Initially, probably only the less efficient, less competitive urban processing units would be forced out of business. Heavy investment in rural-based, semi-industrial mills would be required to displace a large number of urban units.

If GMM or another industrial mill were to receive preferential treatment (subsidized credit, regulations working against coarse grain processing at the artisanal or semi-industrial level, etc.), urban artisanal mills could also be displaced. On the basis of the analysis in Section 6, the large-scale industrial milling of coarse grains is unlikely to emerge in a competitive marketing and processing system.

Greater demand for higher-quality coarse grain products would increase demand for cleaner, better-threshed grain. This could stimulate greater investment in mobile coarse grain threshing units, such as the Bamba thresher. In production zones with considerable marketed surplus, this could represent an attractive investment opportunity for rural entrepreneurs.

If innovations in coarse grain processing and utilization had the collective impact of expanding demand for coarse grain, small- and medium-scale grain traders would also benefit, expanding their volume and earning more money. Increased demand could also encourage greater entry into the grain trade at several stages of the marketing system: rural assembly, long-distance wholesale trading, urban semi-wholesale trading, and retailing.

# 8. KEY FINDINGS AND PROGRAM OPTIONS

## 8.1 Key Findings of the Consumption and Utilization Surveys

This section summarizes key empirical findings and the team's conclusions regarding coarse grain consumption and utilization in Mali. Key findings of the informal surveys of households in Bamako regarding coarse grain consumption are as follows:

- There is a long-term trend toward diversifying food consumption among families in Bamako. Middle and upper income households are substituting tubers, plantains, livestock products, and fish for coarse grain and rice at the evening meal and bread for coarse grain-based porridge in the morning.

- Another trend for families who can afford to purchase more expensive and processed food products is to consume foods which require less processing, preparation, and drudgery.

- In contrast to Tufts University findings of positive income elasticities of demand for coarse grains at all income levels, our informal survey findings suggest that income elasticity of demand for coarse grains, particularly sorghum, is likely to be negative for urban households in the upper 50 percent of the income distribution. Coarse grains are not, however, inferior goods for urban households in the bottom 50 percent of the income range.

- The marketing of processed coarse grain products which require less preparation is likely to be necessary to slow down the move toward dietary diversification and eventually away from consumption of coarse grains.

- Traditional coarse grain dishes such as toh have a rural and unsophisticated image; younger people in urban areas and upper income households will consume less toh over time. There may be scope, however to expand consumption of other sorghum-based dishes, particularly preparations using sorghum grits or new food products.

- Consumption of maize is limited relative to sorghum and millet in the central urban belt of Mali (stretching from Mopti to Bamako) and concentrated in households that have come from southern Mali. As a relatively unknown staple, maize does not have a particular image among most urban consumers. Hence, an increase in urban maize consumption may be possible.

## 8.2 Key Findings of the Grain Processing Surveys

This section will summarize key empirical findings and the team's conclusions regarding coarse grain processing, particularly technologies used in Bamako and other urban areas. Key findings are grouped according to level or scale of technology.

### 8.2.1 Artisanal Processing

Most of the coarse grain ground or milled in Bamako is done on a custom basis (using batch-processing) by artisanal plate mills. The plate mill is well-adapted to the tastes and preferences of Malian consumers. It produces a mixture of grits of varying size and flour; the proportions can be easily changed by adjusting the distance between the two metal grinding plates. Mechanized dehulling, using Engleberg dehullers, is far less widespread. Probably under 30 percent of the coarse grain consumed in Bamako is mechanically dehulled. Operating costs for dehullers are higher than for plate mills; dehullers cannot be operated profitably in non-electrified quartiers using diesel engines. Household maids manually dehull most of the coarse grain, while rural migrant women do some very limited and seasonal custom manual dehulling.

There is scope to improve the Engleberg dehuller used in Bamako and other towns in Mali, which removes up to 30 percent of the weight of the whole grain in dehulling. Abrasive-disk dehullers are technically superior, requiring less energy to operate and producing a superior dehulled grain that has more bran intact. The disadvantage of the abrasive-disk dehullers is that they are not manufactured in Mali, but in Senegal by SISMAR and in Botswana by RIIC. Furthermore, they require a higher initial investment than an Engleberg dehuller.

Artisanal mechanized processing is less frequently found in rural areas of Mali. Dehullers are relatively unknown outside the rice-producing areas; plate-mills running off a diesel engine are found in some villages, particularly where weekly markets are held. It is very likely, although unsubstantiated by this study, that mechanized milling is more common in wealthier rural areas with significant grain surpluses, such as CMDT zones.

### 8.2.2 Semi-Industrial Processing

Semi-industrial processing units are limited essentially to the CMDT zones. A semi-industrial unit is characterized by continuous as opposed to batch processing and grouping of a dehuller and grinder (as well as a winnower, sifter/separator and bag sealer in many cases) under one roof. In addition, the operators of the unit may take title to the grain and sell the processed product.

The CMDT experiment in CMDT's Koutiala zone uses the abrasive-disk dehuller and plate or hammer mills to produce higher-quality processed grain products than artisanal mills. The experiment has heavy subsidies, however, without which the 10 mills could probably not stay in operation in the short run. Assuming that the village associations running the mills will not have to amortize the physical plant and equipment, which FAC donated, the better-managed mills that process at least 200 metric tons of maize may prove to be viable over the longer term. This will depend in large part on marketing efforts in urban areas, including the central urban belt where maize is not an important staple in most consumers' diets.

Semi-industrial processing in rural production zones offers the following advantages:

- Generates employment and income in rural areas;
- Retains bran for livestock feeding in rural areas;
- Lowers transport costs to urban markets; and

- Releases labor for agriculture during peak periods by allowing women to process large quantities of grain (for labor groups) mechanically.

Preliminary but indicative analysis of processing, storage and transfer costs suggests that maize processed semi-industrially in CMDT zones would cost less on the Bamako market than maize processed by GMM in Koulikoro. The final products would differ, however, in that the former would not be degermed and could not be stored for periods longer than two months without significant depreciation in quality. Industrially processed maize would have a much longer shelf life.

Industrial Processing. The GMM processed maize on its industrial maize line only during a brief period in 1986 or 1987 (the GMM director could not remember which year). Unfortunately, the raw material acquired from OPAM had been in storage too long and GMM had trouble selling the final product to Bamako consumers. GMM stands ready to reactivate its maize milling operation provided the following conditions are met:

- The raw product (whole maize grain) is delivered to its mill in Koulikoro;
- The maize procurement price is relatively low (probably 50 FCFA or less at the factory gate); and
- Urban market outlets are assured.

None of these conditions can be satisfied easily in the short term, and their satisfaction would require medium-term investments in the development of a well-coordinated maize procurement and interregional transport capacity and promotional campaigns in urban areas. Hence, industrial maize processing is unlikely to be economically viable in the short run. Furthermore, it is not clear that GMM is willing to make the necessary investments, to play a key coordinating role and to promote maize consumption without outside subsidy or other preferential treatment.

## 8.3 Elements of a Strategy to Promote Expanded Coarse Grain Consumption

Based on these findings, we propose a fourfold strategy for promoting expanded coarse grain consumption in urban areas. The first element in the strategy would be to lower processing and preparation costs for sorghum, the cheapest and dominant coarse grain consumed in urban areas, particularly low-income families who consume primarily coarse grain dishes. Cheaper sorghum-based dishes would increase the real income of low-income households and expand sorghum consumption at the margin. Rice is prepared at the midday meal by lower income households who can afford it, due in large part to time constraints associated with preparing coarse grain-based dishes.[35]

Sorghum processing costs could be lowered at the same time as improvements are made in the quality of grain processed in urban areas. Testing, promoting and perhaps providing some of the financing for commercial installation of abrasive-disk dehullers in urban areas would be a key first step in such a strategy. As pointed out in Section 6, dehulling loss would be about 10 percent lower than losses associated with using Engleberg-type dehullers. This would make 14 percent more coarse grain

[35] In addition, the shift away from coarse grains to rice at the midday meal is strongly associated with rising incomes and a desire for dietary diversification.

available for a given quantity of whole grain at a 12.5 percent lower cost per unit of dehulled grain, assuming the same processing costs for each type of dehuller. The higher investment cost of abrasive-disk dehullers (relative to Engleberg-type dehullers) would offset in part this advantage, requiring dehuller owners to charge a higher custom dehulling rate per kilogram. Over time, the emergence of artisanal workshops or manufacturing firms that could produce abrasive-disk dehullers would likely lower acquisition costs and enable owners to charge a lower dehulling rate that would be similar to or cheaper than the rate of Engleberg dehullers.

The second component of a strategy to stimulate coarse grain consumption would be to continue developing novel dishes based on sorghum (and millet) that could substitute for toh in part and help forestall the shift away from sorghum among wealthier urban consumers and the young.[36] New sorghum products that would be unlike toh could respond to consumers' desire for greater dietary diversity and not carry the same stigma as toh. Developing new dishes that could be prepared quickly and cheaply from inexpensive, processed sorghum would also benefit low-income urban consumers. It would provide them with dietary diversity as well as a cheaper source of calories than rice.

A counterpoint to this strategy is that due to the rural and unsophisticated image of sorghum-based dishes, they may only be accepted by lower-income families. This would depend in large part on how much the new sorghum-based dishes differ from traditional preparations such as toh. If the new sorghum products carry the same stigma as toh, demand will likely be limited. Furthermore, if the dishes prepared from new products cost more than toh and other traditional preparations, the relatively low incomes of the target clientele will limit demand for such products. Since resources for food product development and marketing are limited, greater emphasis and funding need to be directed to processing products which are known to have a market, because they are presently consumed in significant quantities. The development of new products (such as sori) that are unfamiliar to consumers should receive secondary priority and wait until a profitable coarse grain processing sector exists and can become increasingly responsible for such development. New products will likely require more research, development, and marketing, which translates into more time and financing and better knowledge of product markets than is presently available. In addition, development of new products will be easier during periods when per capita incomes are increasing rapidly. Real per capita incomes grew at an average annual rate of 1.6% from 1965 to 1988 (World Bank, 1990).

A third component of the coarse grain promotion strategy should be to identify, adapt, develop and test maize-based dishes. Although many households in the central urban belt do not consume much maize, processed maize products (flour and grits) would contribute to increased diversification. Since maize consumption would be new in many households, it would not suffer from the stigma that sorghum has. Maize is probably the coarse grain with the highest potential for acceptability among medium and higher income families (i.e. households which have the income to buy higher quality processed products and which set urban consumption trends). Hence, the new maize dishes should be targeted to the upper half of urban households (in per capita income terms). If maize prices fell significantly due to expanded maize output during the 1990s, maize could also become the least expensive coarse grain, leading lower-income households to consume greater quantities.

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[36] The IER/SRCVO Food Laboratory has recently hired two more food technologists, who will work primarily on sorghum. USAID has provided the resources for and is clearly committed to this second component of the strategy for promoting coarse grain consumption.

Developing and promoting new maize-based dishes would complement projected expansion of maize production in southern Mali. Improved maize production technology has been developed which CMDT can effectively disseminate in southern Mali. Maize is far more responsive to fertilizer than other coarse grains under Malian farming conditions, and expanded maize culture in wetter, more fertile southern zones could lead maize to become more abundant and cheaper than sorghum. These factors seem to give processed maize products a longer-run market potential which is perhaps even greater than that of sorghum products. This potential will not be realized through a passive approach, however. Many consumers in the central urban belt are not familiar with maize products. Hence, public agencies need to assist the private sector in developing, testing, and promoting widespread dissemination of maize-based dishes that are not currently well-known in order to complement efforts to expand maize production in southern Mali.

A fourth, lower priority component of a coarse grain promotion strategy is to tap the market potential for pre-packaged millet couscous and tiny flour balls used in preparing moni. Demand for these products is particularly strong during Ramadan, when prices of millet products are reported to rise. The higher marketing margins during Ramadan would favor commercial production of such products.

## 8.4 Likely Impacts and Expected Beneficiaries of the Strategy to Promote Coarse Grain Consumption

Higher-quality and cheaper sorghum processed products could benefit low-income urban consumers. Since a high proportion of their expenditures is for food, lower-priced sorghum products would increase their real income. To the extent that purchase of processed sorghum substitutes for own household labor in food processing, poor urban women could spend more time at the margin in other income-generating activities. Where maids dehull coarse grain, their labor could also be allocated to household income-generating activities.

Introduction of improved dehulling technology in urban areas would provide income-generating opportunities for urban entrepreneurs, both male and female, who process coarse grain (millers) and prepare coarse grain-based snack food for sale on the street or coarse grain-based meals for sale at urban restaurants. Coupled with better grain cleaning as part of a dry-processing technology, widespread dehulling could benefit wholesale and retail sellers of processed or semi-processed coarse grain products. Introduction of a superior technology which produced processed grain at similar or lower cost would probably expand sales of dehulled coarse grains, which are not now common in urban areas. Widespread introduction of a superior dry-processing technology, which could produce cleaner, cheaper and more uniform grits and flour, would likely lead to expanded sales of the processed products, through market retail vendors, shops, and perhaps supermarkets.

Development of new sorghum-based dishes and maize products would benefit urban consumers who are keen to diversify their diets. Although placing a monetary value on such diversity would be hard, it would lead to greater consumer satisfaction with their diets. The successful introduction of new products would create employment opportunities for street vendors and restauranteurs. Substituting these new products for a second rice meal or for tubers at the evening meal, particularly among upper-income urban households, could expand the demand for coarse grains. At the margin, improved sorghum and maize products could substitute for bread, an expensive source of calories in urban Mali, again among wealthier households.

The processing and preparation of improved millet-based products for ready consumption during Ramadan could expand urban demand for millet, which many urban households prefer to sorghum (but

which is more expensive and difficult to process). Availability of high-quality, processed millet products (couscous and moni balls) at affordable prices could lead to expanded millet consumption during other periods of the year as well.

A key question is whether the aggregate benefits of these projected developments, even under the most optimistic scenario, would make a significant difference. The skeptics point out that rice consumption is well-established in Bamako and urban Mali, particularly at the midday meal. It is unlikely that cheaper coarse grains or new coarse grain products would substitute for rice at the midday meal. The opportunities to expand coarse grain consumption lie more at the morning and evening meals as part of an ongoing process of dietary diversification. Clearly, urban consumers are not interested in eating more toh. They may be quite willing, however, to consume more coarse grain-based processed products in the morning or evening, provided they are sufficiently differentiated from toh.

Any improvements in coarse grain processing techniques that reduce mechanized processing costs or produce a higher-quality processed grain at the same or lower cost are likely to benefit lower-income urban consumers the most. Any savings in expenditure on processed coarse grains or processing services will translate into greater real income, which can be used to buy more food. Cheaper, better-quality and readily available processing services will also enable poorer households to allocate more time to income-generating activities.

In addition to urban consumers, other beneficiaries of improved processing technology would be producers, grain traders and processors. Producers, particularly coarse grain sellers, would benefit from expanded demand for coarse grains. Grain traders' incomes would rise with expanded grain volume. Processors would also earn more on expanded grain throughput. In both cases, greater income could be used to finance investments in transport, storage, and processing equipment. These investments could generate further income streams, as well as improve the performance of the grain marketing system. Greater transport and storage capacity could be used for agricultural input distribution as well as product marketing. Higher producer revenues from coarse grain sales could be reinvested in animal traction, agro-chemical inputs, or other production improvements. This in turn could expand aggregate grain supply, which over time would lower coarse grain prices in rural and urban areas, benefitting food-insecure rural households and urban consumers. Under favorable scenarios, marginal improvements in coarse grain processing and products could help to unleash a coarse grain subsector development dynamic, with accompanying multipliers and forward and backward linkages. This would help to enhance Mali's comparative advantage in coarse grain production for its own consumption. Over the longer term, higher coarse grain productivity and reduced coarse grain prices would encourage greater use of coarse grain for livestock feed. Livestock produced under more intensive conditions (e.g. poultry, fattened sheep, and cattle) could be produced more cheaply, benefitting both producers and consumers. Increased productivity of livestock fattening for export could enhance Malian competitiveness in coastal West African markets and generate higher export revenues.

## 8.5 Specific Policy and Program Options for USAID and PRMC

This section lays out policy and program options for USAID, PRMC, and GOM consideration. It provides action alternatives to help revitalize the PRMC cereals transformation subprogram.

### 8.5.1 Major Recommendation 1: Change the Emphasis of Food Technology Research

An exciting feature of food technology research is the development of new products, or novel processing and product preparation using raw material that can capture consumers' attention and find a niche in their diets. The best example of this in Mali is the Food Technology Laboratory's efforts to produce a sorghum-based rice substitute, parboiled sorghum (or sori), in collaboration with USAID's INTSORMIL Collaborative Research Support Program (CRSP). At this point, the potential of medium and fine grits produced from parboiled sorghum as a rice substitute is unclear. Preliminary taste tests in urban households and restaurants are mildly discouraging (see BECIS, 1990), if one considers the numerous problems with the product cited in the report and the estimates of production costs.

Consider Sorghum to be an Inferior Good and Unlikely Rice Substitute. While the efforts to develop new products such as sori are laudable and imaginative, we question their basic premise. Developing a sorghum-based rice substitute is a difficult task, given the expressed preference of urban households to diversify their diets away from sorghum. In contrast to the findings of a recent analysis of urban household food consumption data (see Rogers and Lowdermilk, 1988), our informal surveys have revealed that many urban consumers view sorghum as an inferior good and that many younger people are rejecting it outright. Given the disproportionate share of the population that is under 25 years old, this perception is discouraging.[37] On the other hand, possibilities for substituting maize for rice and sorghum are greater in urban centers outside the major maize production zones, because maize is not currently an important part of urban consumers' diets and does not carry the same stigma as sorghum. Maize could be a credible alternative to rice, tubers, and plantains (which are for the most part imported), and animal protein for those middle and upper income consumers who are in the process of diversifying their diets, particularly at the evening meal.

Re-evaluate Parboiling of Sorghum in the Malian Context. The choice of parboiling as the best method for processing a sorghum-based rice substitute can also be challenged. Parboiling increases the storage life of sorghum and raises its nutritional value in that vitamin- and protein-rich nutrients from the outer layer of the sorghum kernel are diffused farther into the grain and less easily removed during dehulling. Nevertheless, parboiling increases energy costs in grain processing and is not a widely known technique in Mali. Furthermore, coarse grains are not stored for long periods in urban Mali, primarily because urban households generally can afford to buy only one bag of grain at a time for household consumption. Since this single bag is usually consumed in one month or less, the advantage of longer shelf life is not a key consideration.

Our informal survey of urban consumers has revealed that grits from non-parboiled sorghum have as much as or more potential to substitute for rice than grits from parboiled sorghum. Furthermore, urban households do not have to incur the higher energy and labor costs associated with the parboiling to prepare grits from non-parboiled sorghum.

Continue Food Technology Research on Sorghum but Focus on Grits Produced from Current Processing Techniques. Sorghum laboratory research should not be abandoned. Sorghum will continue to be the major cereal consumed by rural households and lower income urban households for

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[37] According to the World Development Report, 1990, 46.6 percent of the Malian population was 0-14 years old in 1988.

years to come. Sorghum testing should focus, however, on developing improved medium and fine grits using current processing techniques (which do not include parboiling). Our informal consumption survey shows thee types of grits offer some potential as a rice substitute, and that a well-prepared sauce with several ingredients will make a sorghum-based dish prepared with grits as palatable as a rice-based dish.

Improve Quality, Storage Life, and Attractiveness of Coarse Grain Products. Based on our informal survey findings, we recommend first that food technology research be oriented more toward increasing the quality, cleanliness, attractiveness, and storability of existing coarse grain products using known processing techniques and less toward trying to develop a sorghum-based rice substitute. Urban consumers, particularly women in middle to upper income stata, stressed the importance of clean, hygienic and high-quality grits and flour. Many of these women are probably substituting rice for coarse grains, because unprocessed coarse grains tend to be laden with foreign matter, requiring time-consuming washing, and processed coarse grains are perceived as unclean, unhygienic, and unattractively presented. Since these women usually work outside the home and have limited time to prepare food, they prefer and can afford processed grain. In the present context, these conditions tilt purchases toward polished rice.

This shift in emphasis of food technology research toward improving processing, storage, and presentation of existing coarse grain products will require more work of an agricultural engineering nature than laboratory development of new coarse grain products. As an example, current dehulling technology, featuring Engleberg-type machines, is not well-adapted to processing millet, sorghum, and maize. The Engleberg dehuller was developed for rice processing. The fact that grills (or perforated screens) surrounding the rotating cylinder deteriorate rapidly from the abrasive scraping of foreign matter is a serious disadvantage. Dehulling rates are also higher than desirable from a nutritional standpoint, resulting in removal of valuable nutrients in outer layers of the grain. In one sense, the Engleberg design is well-adapted to the urban Malian processing of coarse grains, however. In removing most of the darker outer layer of the grain, the color of the product becomes as light as possible, which satisfies the Malian preference for clean, white grits and flours over the darker, processed grain products that result from higher dehulling rates and less removal of outer layers of the grain. Reduced dehulling loss, leading to a less white processed coarse grain product, may need to be accompanied by urban extension efforts that underscore the nutritional attributes of grits and flour containing more bran.

A second example of needed but neglected research is development and introduction of simple, low-cost packaging techniques, which will be critical in promoting greater sales and consumption of coarse grain flour in urban areas. Urban women, particularly from the middle and upper classes, fear dust in the coarse grain grits and flour sold in the marketplace. This perception of contamination discourages the purchase of coarse grain products.

Develop Maize-Based Food Products. We strongly recommend that one or more Malian food technologists be trained to do applied and adaptive research on developing and introducing maize-based products in the major urban areas outside the maize production belt. Maize production is forecast to increase significantly in Mali during the next decade and into the next century (see MOA, Perspectives de la production céréalière, 1985-2100, 1986 and MOA, Schéma directeur du secteur développement rural: Premier rapport de synthèse, 1990). There seems to be little consideration of market outlets, the forms in which maize will be consumed in urban areas, and methods of integrating maize more fully into urban diets. While sorghum is likely to decline in relative importance in

Sahelian diets during the 1990s and early twenty-first century as the Sahel urbanizes and its consumers seek to diversify their diets, the importance of maize in the diet will probably increase.

It is also important to note that technologies to significantly expand sorghum (and millet) production using improved cultural practices are currently unavailable, and that significantly changing the way in which sorghum and millet are grown in Mali (e.g. introducing irrigation and far heavier agro-chemical application rates) is not economically viable under current input and output price relationships. ICRISAT and IER have not yet succeeded in developing and introducing varieties which perform much better than traditional varieties under Malian farming conditions. USAID and other donors should not abandon their support of ICRISAT and IER efforts to develop improved millet and sorghum varieties and cultural practices that will lead to higher yields, given the predominance of sorghum and millet in much of Malian agriculture and in rural and lower income urban consumption patterns. We are arguing, however, for increasing emphasis on maize processing and food technology, since maize appears to have the greatest potential for long-term expansion through economically viable intensification and continued extensification (in zones such as Bougouni).[38]

Introduce White Maize Varieties into the Bamako Market. While some of the higher-yielding varieties that will expand in production in the maize belt during the 1990s are white, it is important to note that yellow maize is sold and consumed in the key urban market of Bamako, due in large part to its local availability. It may also be due to the sharp color contrast between yellow maize grits and flour and foreign matter, permitting easy inspection of the processed product and rejection of products containing too many impurities. Food technologists need to consider how white maize will be processed and prepared and most effectively introduced to the Bamako market.

Identify Known Maize Processing and Preparation Techniques in Other Countries and Test Them in Mali. Reflecting our support for increasing emphasis in food technology research on maize, we recommend that USAID not repeat the sori experiment, even though better management and quality control over (uniformity of) sori production and presentation to test consumers might change the results at the margin. Opportunities to develop and introduce new maize products in Mali, perhaps using well-known existing technologies and products from Southern and Eastern Africa and from South and Central America, hold more promise and take on a special urgency given the forecast increases in maize production (and marketed surpluses). Relatively more resources will need to be invested in maize processing and food technology to reduce the cost of maize to consumers and to improve its quality. Such efforts could facilitate market absorption of the greater maize surpluses expected in the 1990s.

### 8.5.2 Major Recommendation 2: Strengthen the Testing, Extension, and Outreach Capability of the Food Technology Laboratory

The Food Technology Laboratory is clearly understaffed, its staff overworked, and its extension and outreach capability limited. More cereal technologists need to be trained as soon as

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[38] Even if human consumption of sorghum and millet were to decline in per capita terms, animal feed use could expand, especially if these coarse grains can be produced more cheaply per unit of output. At higher productivity levels, millet and sorghum prices could decline at the same time that farmer returns per hectare or per person-day increased.

possible. The laboratory needs at least one additional sorghum/millet technologist; USAID funding will permit hiring of two new food technologists to work principally on sorghum. One or more maize technologists could also be hired to identify known maize processing and preparation methods as well as products consumed widely in other African countries and regions of the world that could be tested in Mali.

The laboratory also needs to develop better extension and outreach capabilities, which are presently very limited. The ineffective management and quality control over sori production and testing clearly exemplify how limited extension capability can undermine the efforts of even the best laboratory. Staff need to be hired and trained to provide this capability. More importantly, they need to be fully integrated into the laboratory's work.

Strengthen Economic Analysis and Marketing Extension Capabilities in the SRCVO. One area where IER needs institutional strengthening is the economic analysis of alternative food technologies and market acceptance and potential for new food products. The Food Laboratory has collaborated with a private firm, BECIS, in producing and testing parboiled sorghum in Bamako, and the head of the laboratory has collaborated with RDTM to present new sorghum preparations on a wide scale. These are promising initiatives, but they do not substitute for in-house capacity to assess market potential and the likely economic viability of alternative products. If the Food Laboratory had this capacity, it could make better choices on how to allocate scarce research and development resources among products and processing methods. Hence, we recommend that a full-time agricultural economist or marketing specialist be assigned to the Cereals Laboratory.

### 8.5.3 Major Recommendation 3: Develop and Fund Promotional Campaigns for Specific Coarse Grain Products

Coarse grain products that are unfamiliar to urban consumers, which have been developed by particular ethnic groups in different regions of Mali or conceived in the Cereals Laboratory, are candidates for broader media dissemination. The most effective media for reaching large numbers of urban consumers are radio and television. While radio jingles and television commercials can promote specific products, they are costly to develop and diffuse. Base RDTM rates are 107,575 FCFA for a one-minute television commercial and 42,666 FCFA for a 15-second spot. To these sums, one must add taxes (15 percent IAS), a surcharge of 10 percent for commercials broadcast on Saturdays, Sundays and holidays, and unspecified technical expenses. (See Annex 6 for more detailed information on RDTM rates.) Clearly, these charges can be borne by only the largest formal sector firms with deep financial pockets. Nevertheless, the success of television advertising campaigns is undeniable, as is evident in the Maggi group's promotion of Calvé mayonnaise. Radio advertising spots are far cheaper, costing 3,750-6,250 FCFA for a 15-second message (depending on the hour of transmission) and 6,250-11,250 FCFA for a one-minute advertisement, plus a 15 percent IAS tax.

A potentially very effective dissemination medium is Ms. Amy Sow's half-hour television program, broadcast weekly on Saturday from 7:45 to 8:15 p.m. Amy Sow has achieved celebrity status for this show, where she has been demonstrating how various local dishes are prepared for over five years. The show, presented in Bambara, reaches a broad urban audience in Mali. Many women interviewed in the informal consumption survey reported watching the show and trying to prepare some of the recipes she demonstrates. New shows are broadcast for two to four weeks and repeated in the following two to four weeks, so that viewers get a second chance to watch a new dish being prepared. According to Ms. Sow, viewers flood her with letters detailing their experiences in

preparing and trying new dishes and suggesting new recipes. Ms. Sow would like to devote more attention to exploring the ethnic cuisine of different regions, but time and resources are limited.

It is also important to note that the Food Laboratory staff, particularly Mme. Haidara, has begun to collaborate with Amy Sow in introducing new sorghum recipes. This is one obvious way that the laboratory can reach a much broader audience and receive informal feedback from housewives who try out the recommended recipes. It is also far less demanding on the laboratory's limited staff and resources than formal tests of specific products, which require a high level of management and quality control to be conducted successfully.

Donor agencies could contribute in several ways to the further success of Amy Sow's program and diffusion of new dishes as part of a dietary diversification strategy. First, donors could fund personnel, travel, materials, and food preparation costs and tests for a broader program that explores ethnic dishes and creative recipes in different rural areas of Mali. The show could be literally taken on the road to highlight varied cuisine in different regions, and perhaps even neighboring countries such as Senegal, where a wider range of vegetables is used in cooking. A second strategy for promoting new food products, particularly coarse grains, would be donor-funded advertising spots for some of the new, improved coarse grain products appearing on the Malian market. An example is the packaged and processed fonio sold by UCODAL and being developed by FINISSO (with CIDA assistance).[39]

CMDT/CERECOM could also use Amy Sow's program to inform consumers about the merits of processed maize grits and flour produced by semi-industrial mills in southern Mali. The two-kilogram pack could be the subject of a specific advertising spot, while Ms. Sow could prepare one or more dishes using maize products.[40] The fine to medium white maize grits, which are used in preparing maïs à la façon du riz could be the subject of one of Ms. Sow's television shows, where this product could be compared directly with a rice dish using the same sauce. Perhaps a group of consumers could even sample and compare the two dishes during the program.

### 8.5.4 Major Recommendation 4: Promote Third Country Development Cooperation in the Transfer of Grain Processing Technology

What most strikes the outside observer in looking at urban grain processing technology in Mali is the haphazard adoption from other countries of machinery that is probably not best adapted to the Malian context and to promotion of efficient grain processing industry. The use of Engleberg-type dehullers has expanded significantly in Bamako and other towns. While the Engleberg design is suitable for processing paddy, and the thriving paddy processing industry in rice-producing areas of Mali uses Engleberg-type dehullers, the Engleberg design is far less suitable for coarse grain

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[39] The criticism that these small firms are favored or unfairly subsidized can be anticipated and offset in part by requiring, for example, that they contribute a proportion of incremental revenues following an episode that promotes their processed products (during a negotiated period) toward payment of the cost of advertising the products.

[40] One wonders why CMDT/CERECOM has not yet considered this strategy. To be fair to CMDT/CERECOM, however, we note that no processed maize products were in stock in Bamako in late 1990.

processing. As noted above, the grills that encase the rotating cylinder in Engleberg dehullers require frequent replacement and repairs, and dehulling rates are higher than desirable from a nutritional standpoint, resulting in removal of valuable nutrients in outer layers of the grain. Furthermore, the Engleberg dehuller does not degerm coarse grain. The semi-processed, dehulled grain therefore cannot be stored for long periods.

Improve Coarse Grain Dehulling Technology. While existing degerming technology is costly and suitable for only industrial milling, experiments are underway in Senegal and other African countries to develop and perfect prototype dehullers that are better suited for dehulling coarse grains than Engleberg-type machines are. IDRC has provided significant resources to support development of abrasive-disk dehullers in collaboration with local African engineers and manufacturers (see Bassey and Schmidt, 1989). These dehullers are all based on a common Canadian design, developed by the Prairie Research Laboratory (PRL) in Saskatchewan. A modified PRL-type dehuller which has been successfully introduced in Botswana, is being manufactured by the Rural Industries Innovation Centre (RIIC) in Kenya, Botswana. CMDT has purchased six of the RIIC dehullers and introduced four into its semi-industrial mills in the CMDT and ODIPAC zones. In Senegal, IDRC has provided funding for modification of the PRL design by the Institut Sénégalais de Recherches Agricoles (ISRA) in collaboration with the manufacturer, SISMAR. Five prototypes, each an improvement on the preceding one, are being tested in nine villages and one urban area (Mbengue, 1988).

Test the ISRA/SISMAR Prototype Dehuller. Both the RIIC and the ISRA/SISMAR dehullers are better suited to dehulling coarse grains than the Engleberg-type machines. The Senegalese ISRA/SISMAR dehuller should be acquired and tested by either the Division du Machinisme Agricole (DMA) or specific development projects/agencies. These dehullers could be experimentally introduced in Bamako and one or more rural settings. Donor support is needed to purchase and transport them. Donor funding could also be used to pay for consultative missions by engineers who have worked with the two dehullers and who could help set up a testing and monitoring program.[41] Funding for Malian engineers to visit ISRA and the test sites in Senegal is strongly recommended. This could be coordinated through PROCELOS (Programme régional de promotion des céréales locales au Sahel), the regional Sahelian local cereals network.

In addition to testing machinery, Malian food technologists will need to test the characteristics and acceptability of coarse grain flours and grits produced using the ISRA/SISMAR (and RIIC) dehullers and existing grinding mills. This case provides an excellent opportunity for agricultural engineers to collaborate with food technologists in developing better processing techniques and coarse grain-based food products.

IDRC's Comparative Advantage in Technology Testing and Introduction. Given IDRC's successful track record in promoting dehullers, IDRC could provide financial and technical support. Canada (IDRC in particular) has a comparative advantage in working in cereals processing technology, which raises the question of why the Canadians have not been more active in technology transfer and adaptation in Mali, given their successes elsewhere in Africa (see Bassey and Schmidt, IDRC, 1989). For DMA to play an effective role in technology development, it needs strengthening

[41] DMA could contract for the services of Hyacinthe Mbengue, head of ISRA's Post-Harvest Technology Program, in setting up a testing and monitoring program for the ISRA/SISMAR dehuller in Mali.

as an institution. Donors could provide support for staff training (both short- and long-term), purchase and transport of prototype processing equipment for testing, and the development of a far more active technology testing capability, in both the laboratory and in experimental test sites.

Develop Low-Cost, Effective Grain Cleaning Technology. The use of abrasive disk dehullers requires use of a dry process (voie sèche) for coarse grain transformation rather than the traditional wet process (voie humide). This entails a change in consumer behavior in that grain brought for dehulling should be thoroughly cleaned and dried. Currently, dry but uncleaned coarse grain is brought to Engleberg-type processors for dehulling. The excessive foreign matter in the threshed grain, such as stones, damages the perforated grills in the dehulling process. (The main reason for wetting coarse grains before manual dehulling is that it is easier to remove the pericarp.) Adopting an improved dehulling technology requires either thorough washing, cleaning, and drying of coarse grain before dehulling or use of low-cost, mechanical, transportable threshers, such as those that have been introduced into CMDT zones. These machines produce a threshed grain product that is superior to the grain threshed using traditional techniques.[42] As analyzed elsewhere (Holtzman, 1989), these mechanical threshers (the Bamba, manufactured by Bourgoin in France) are economically viable only in zones of coarse grain surplus, where commercial agriculture is well-established.

Assuming that most coarse grain will not be mechanically threshed in the short term, there is scope for developing low-cost grain-cleaning technology that would be used prior to mechanical dehulling. This would eliminate the need to wet and wash the threshed grain. Clean whole grain could also be dehulled and ground in two successive steps without intermediate washing and wetting. Hammer mills, which are used widely in Senegal, could also be introduced experimentally at the semi-industrial level. Hammer mills are more powerful and efficient than plate mills, which predominate in Mali. By changing perforated grills in a hammer mill, the coarseness or fineness of the end-product can be changed and a more uniform product achieved. The disadvantage of a hammer mill in the Malian context is that Malian consumers desire different grades of final coarse grain product from each milling run. Plate mills can be adjusted to produce different mixtures of coarse grits, fine grits, and flour.

Learn from Senegalese Artisans. Another possibility for TCDC (third country development cooperation) is to put Senegalese artisans in contact with Malian artisans. Leading Senegalese artisans, who have well-equipped workshops and who produce agricultural equipment and hammer mills, formed an association in late 1988. Malian artisans could be organized along the same lines, and representatives of such an association could visit the workshops of leading artisans in Senegal to learn how to fabricate mills and dehullers.

### 8.5.5 Major Recommendation 5: Foster a Competitive Coarse Grain Milling Industry

Clearly, the scale of maize processing has important implications for employment, equity, consumer satisfaction, and maize subsector development. Tilting the playing field to favor one or another potential competitor through preferential policies and regulations or special subsidies would essentially be a political decision. Fostering a transparent and competitive system, which allows maize to be transformed by several different sets of actors of different scale at different levels of the

[42] CMDT reports that 60 Bamba threshers have been introduced in southern Mali: 41 to associations villageoises and 19 to individual large-scale farmers.

subsystem is the recommended strategy. The issues of continued subsidization of particular transformation options, such as CMDT/CEKECOM's semi-industrial mills, and the granting of tax exoneration on imported equipment and spare parts need to be carefully reviewed to assess whether and how long these preferential instruments should remain in place.

CMDT has established 10 semi-industrial units in rural areas of southern Mali under the management of village associations. Processing coarse grain in rural production zones makes good economic sense on a number of grounds. First, value is added in rural areas, rural incomes are increased, and rural employment is generated. Second, processed rather than raw coarse grain products are transported from production zones to urban areas. Since 18-20 percent of the weight of the grain is lost during the dehulling process, transport costs are reduced. Third, the coarse grain bran remains in rural areas, where it can be used as livestock feed. The fundamental disadvantage of this technology is that maize is not effectively degermed in processing, which limits the storage life of processed maize products to two or three months.[43]

Section 6.5 compares the processing costs facing the semi-industrial mills in the CMDT zone (plus transfer costs to Koutiala and Bamako) to the estimated costs of GMM procurement of maize in Koutiala and processing in Koulikoro. It is assured that GMM would buy whole grain maize from local assemblers in Koutiala, transport it to Koulikoro for milling and packaging, and transfer it to Bamako wholesale traders for distribution. The analysis is illustrative and preliminary rather than complete and conclusive.

From this preliminary analysis, it is clear that CMDT/CERECOM benefits from transport of finished products from rural mills to the urban market of Bamako. While GMM would face higher transport costs in moving unprocessed maize from Koutiala to Koulikoro (paying to transport an additional 25 percent in weight), it would benefit from scale economies in processing. There appears to be potential for competition between semi-industrial, rural mills, and a GMM alternative maize procurement, processing, and distribution system. Rather than legislating that a particular transformation system enjoy a statutory monopoly and a protected market, the three alternative processing systems should be allowed to compete without outside subsidy.

Another alternative maize transformation system would involve a CMDT/village association and GMM collaborative agreement for at least some of the expanding maize production in southern Mali. Rural mills would be located only in production zones where a marketed maize surplus of well over 200 metric tons could be produced, which is a CMDT estimate of the minimum operating level needed to break even. In production zones where less than 200 MT could be marketed, GMM could also negotiate with AVs or CMDT to procure unprocessed maize at a set price or perhaps a price that was adjusted upward over the course of the marketing season. GMM could transport the maize to Koulikoro for processing and then supply urban centers in central-western Mali. The CMDT-established mills would supply local rural and urban markets in south-central Mali, and perhaps

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[43] In contrast to the existing coarse grain marketing and processing system, where nearly all the coarse grain transported to urban areas is undehulled, virtually all the paddy produced in Mali is dehulled prior to shipment. Investment in dehulling capacity in paddy production zones is probably due to the following factors: paddy production is more geographically concentrated, making rural processing more economically viable; and a 40 percent dehulling loss (which is double the coarse grain dehulling loss rate) provides an extra incentive for rural processing to avoid transportation of paddy to urban areas.

export maize products in some years to neighboring Côte d'Ivoire, Burkina Faso, and Ghana. The output of semi-industrial mills would be stored for short periods, if at all, and sold within two months of processing. Longer-term storage would be provided by GMM or Bamako-based wholesale traders in processed maize products. Farmers could continue to exercise the storage option if they preferred to sell their maize at open-market prices prevailing in rural production zones well after the maize harvest.

It would be very difficult implement the above system. GMM and CMDT/CERECOM are not disposed to cooperate with one another. GMM is concerned that CMDT/CERECOM, as a state company enjoying special status and privileges (such as exonerations on equipment imports), as well as considerable outside subsidy (by FAC and CFDT), would scheme to have the rules of the game written to its benefit and would receive heavy subsidies. On the other hand, CMDT/CERECOM wants to protect farmers from open-market prices that are often perceived as too low and exploitative. CMDT/CERECOM also hopes to make village associations responsible by providing semi-industrial mills that generate rural employment and income, as well as ease the workload of rural women. Furthermore, CMDT/CERECOM hopes to train the AVs (and mill staff) in effective, responsible management methods. Taking a critical view, however, it is not clear that donating the rural mills (no contribution from the AVs) and CERECOM's taking title to processed maize products (that have piled up in storage in the past and could not be easily disposed of) is the most effective way to make the village associations assume responsibility.

The potential disadvantages of a maize transformation and distribution system dominated by GMM are obvious. Centralizing wheat and coarse grain processing in one organization would give considerable market power to one firm. As part of a larger group of associated enterprises, the GMM probably has the financial resources to cross-subsidize its maize milling operations to the point where it could squeeze out less well-capitalized competitors. The employment implications for rural and urban artisanal milling and semi-industrial rural transformation could be quite negative. Finally, if GMM wished to abuse market power, it could lower maize offer prices and raise the prices of processed maize products once it squeezed out weaker competitors.

### 8.5.6 Major Recommendation 6: Reduce Proposed Tariffs on Imported Agricultural Processing Equipment and Spare Parts

The GRM proposed significant increases in duties on imported agricultural processing equipment and spare parts, to become effective in 1991. The overall tax burden on mills and dehullers was proposed to double from 11.0 percent (plus 5 FCFA/kg) to 28.0 percent, while duties on spare parts would rise from 37.1 percent to 53.0 percent. These tariffs will penalize small- and medium-scale firms which have to import machinery and spare parts that are not produced in Mali or produced at the same quality level as in other countries. It may also discourage further artisanal investment. Since semi-industrial mills in the CMDT zone are exonerated from paying import duties, they receive an important advantage relative to the artisanal millers.

### 8.5.7 Minor Recommendation: Foster Greater Dietary Diversity

Two striking findings of our household consumption surveys are the increasing diversification of urban diets in Mali, subject to an income constraint, and urban consumers' strong expressed preference for greater dietary diversity. In acknowledging this trend, our report is more than just an analysis of the coarse grain-rice substitution issue. Dietary diversification manifests itself in middle-

and high-income urban households in part through increased purchases of tuber crops, particularly during periods of plentiful supplies and low prices; tubers are often substitutes for either rice or coarse grains. Out of season, when tuber crops cost much more per kilogram than grain, most urban households buy them infrequently, typically once or twice a week to provide a change from the monotonous rice-toh regime.

A large and growing literature describes how tuber crops, especially yams, cassava, and sweet potatoes, as well as plantains, have been neglected in agricultural research and extension in most of the developing world (e.g. Pearce, 1990). In dryland agriculture, tuber crops, with the exception of yams, will typically outproduce cereals by a wide margin in calorie per hectare terms. Tuber crops, particularly yams and cassava, thrive in poor or degraded soils, resist drought, and require no agro-chemical inputs to be productive. Tuber crops are rich in carbohydrates yet deficient in protein, relative to cereals. The leaves of tuber crops are typically rich in vegetable protein, however, and can be prepared in a number of dishes.

Most consumption studies in developing countries show that demand for tuber crops, with the exception of Irish potatoes, is income inelastic. Tuber crops are generally inferior goods, particularly in countries where they provide a large proportion of total calories in the diet and over middle to upper ranges of income. In the urban Sahelian context, however, tuber crops are likely to be superior goods for most consumers over most ranges of income. Urban households express their desire to purchase more tuber crops, subject to budgetary constraints. During most of the year, tuber crops in the urban Sahel are expensive luxury goods.

Recommending expansion of tuber crop production to meet growing urban demand may seem in some respects to be a regressive agricultural research and extension strategy. Production projects in Mali focus on intensifying maize and rice culture and increasing yields through application of fertilizer and agro-chemicals. Developing some capacity to do applied agricultural research and extension on tuber crops, particularly in southern Mali, is a sensible strategy in that the willingness of urban consumers to substitute maize for rice, sorghum, and millet in their diets is likely to be limited. In addition, the GRM is advised to work closely with Côte d'Ivoire and other trading partners to reduce tariff and non-tariff barriers to trade in agricultural commodities. Coastal countries such as Côte d'Ivoire, Ghana, and Guinea have an advantage in tuber crop production relative to the Sahel, and every effort should be made to reduce trade barriers and marketing costs of interregional trade in agricultural commodities. The World Bank in particular plans to promote West African regional integration during the 1990s as part of its strategy to expand agricultural production and trade and increase rural incomes in Africa (see World Bank, 1989).

In concrete programmatic terms, donors should earmark some funds in agricultural production projects for tuber crop varietal and agronomic research. This should not be a major program thrust; rather, agricultural research and extension on tuber crops in southern Mali will help farmers diversify their own diets and sources of agricultural revenue. Depending too heavily on maize in the short to medium term has decided risks; farmgate maize prices could plummet before maize substitution for rice/other coarse grains at the margin is underway in urban areas. This could dampen farmer enthusiasm for growing maize and undermine the success of major production investments. At the margin, promoting tuber crop production could help to offset these risks.

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## ANNEX 1

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## ANNEX 2

## SUPPLEMENTARY PRICE ANALYSIS

This annex contains three sets of exhibits. Exhibits 1-4 shows the statistics and plot associated with the grand seasonal index for each of four crops: millet, sorghum, maize, rice. These indexes are generated from the Bamako retail price series, which begins in January 1982 and runs through mid-1990.

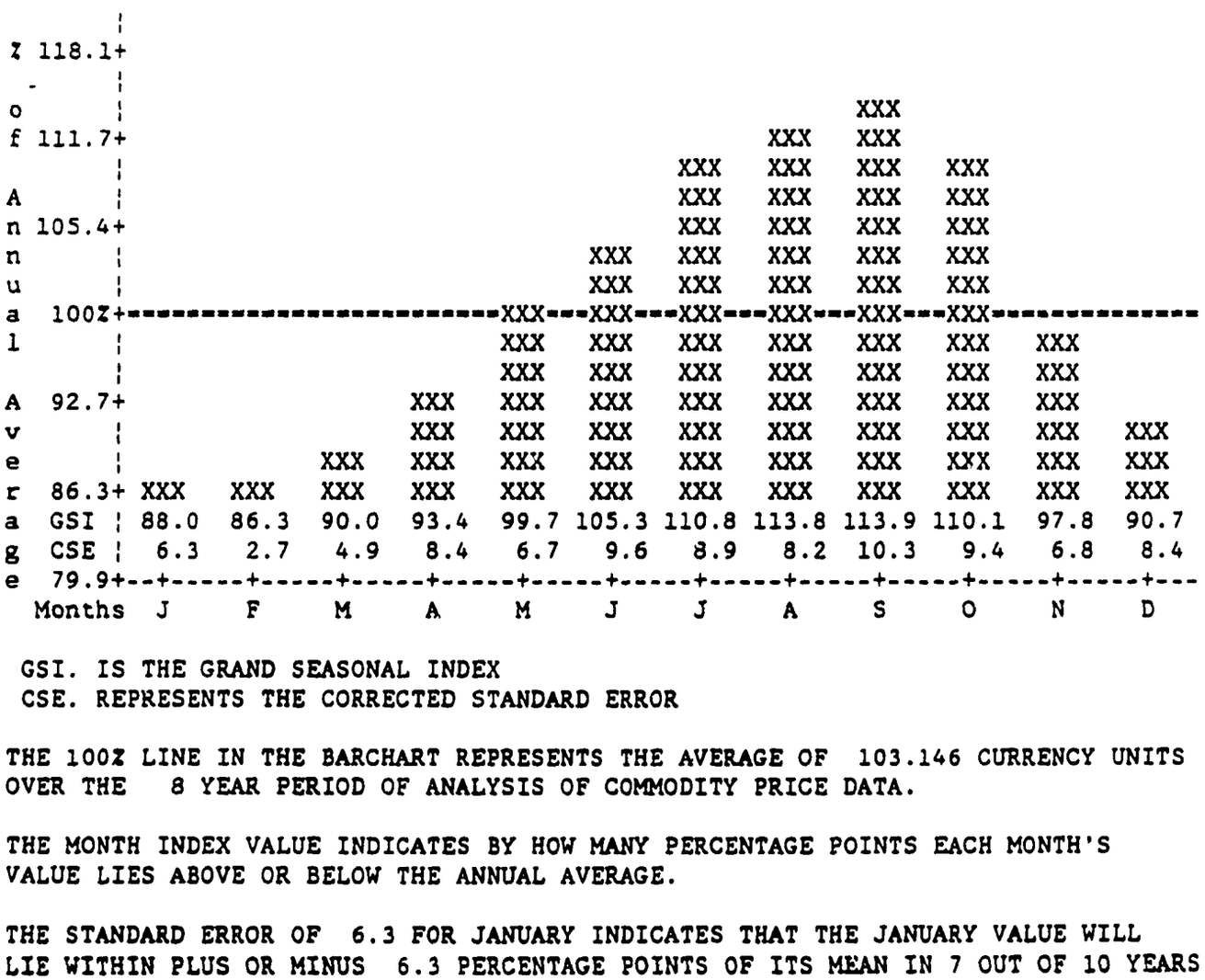
Exhibits 5-7 show the interest rate of return from storage of millet, sorghum and maize. These nominal returns (the price data are not deflated) are calculated from the Bamako retail price series. The calculations assume that the beginning of the marketing year is November, when the crop is purchased and put in storage. The returns are shown in the tables as positive or negative interest rates that would accrue over the storage period from November to the month in question.

In each case in Exhibits 8-10, there are plots of monthly unadjusted wholesale prices, adjusted wholesale prices, and rice prices. These exhibits show how adjusting for processing costs increases the effective price of each of the three coarse grains, so that coarse grain prices are comparable to rice prices. That is, coarse grains can be compared to rice in similar stages of processing; all of the cereals are ready to be cooked.

## EXHIBIT 2-1

## GRAND SESONAL INDEX FOR RETAIL MILLET PRICES IN BAMAKO, JANUARY 1982 TO MAY 1990 (EXCLUDING 1988)

| MONTH | AVERAGE SEASONAL INDEX | STANDARD ERROR | GRAND SEASONAL INDEX | CORRECTED STANDARD ERROR | GSI + CSE | GSI - CSE |
|---|---|---|---|---|---|---|
| JAN | 87.23 | 6.17 | 88.01 | 6.28 | 94.28 | 81.73 |
| FEB | 85.55 | 2.66 | 86.31 | 2.70 | 89.01 | 83.60 |
| MAR | 89.21 | 4.80 | 90.01 | 4.89 | 94.90 | 85.12 |
| APR | 92.62 | 8.28 | 93.45 | 8.42 | 101.87 | 85.02 |
| MAY | 98.87 | 6.61 | 99.75 | 6.72 | 106.47 | 93.02 |
| JUN | 104.39 | 9.41 | 105.32 | 9.57 | 114.89 | 95.74 |
| JUL | 109.86 | 8.73 | 110.84 | 8.88 | 119.72 | 101.95 |
| AUG | 112.83 | 8.06 | 113.84 | 8.21 | 122.04 | 105.63 |
| SEP | 112.87 | 10.10 | 113.87 | 10.29 | 124.16 | 103.58 |
| OCT | 109.10 | 9.21 | 110.07 | 9.38 | 119.45 | 100.70 |
| NOV | 96.99. | 6.70 | 97.85 | 6.82 | 104.67 | 91.03 |
| DEC | 89.91 | 8.23 | 90.71 | 8.38 | 99.08 | 82.33 |




GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 103.146 CURRENCY UNITS OVER THE 8 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA.

THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.

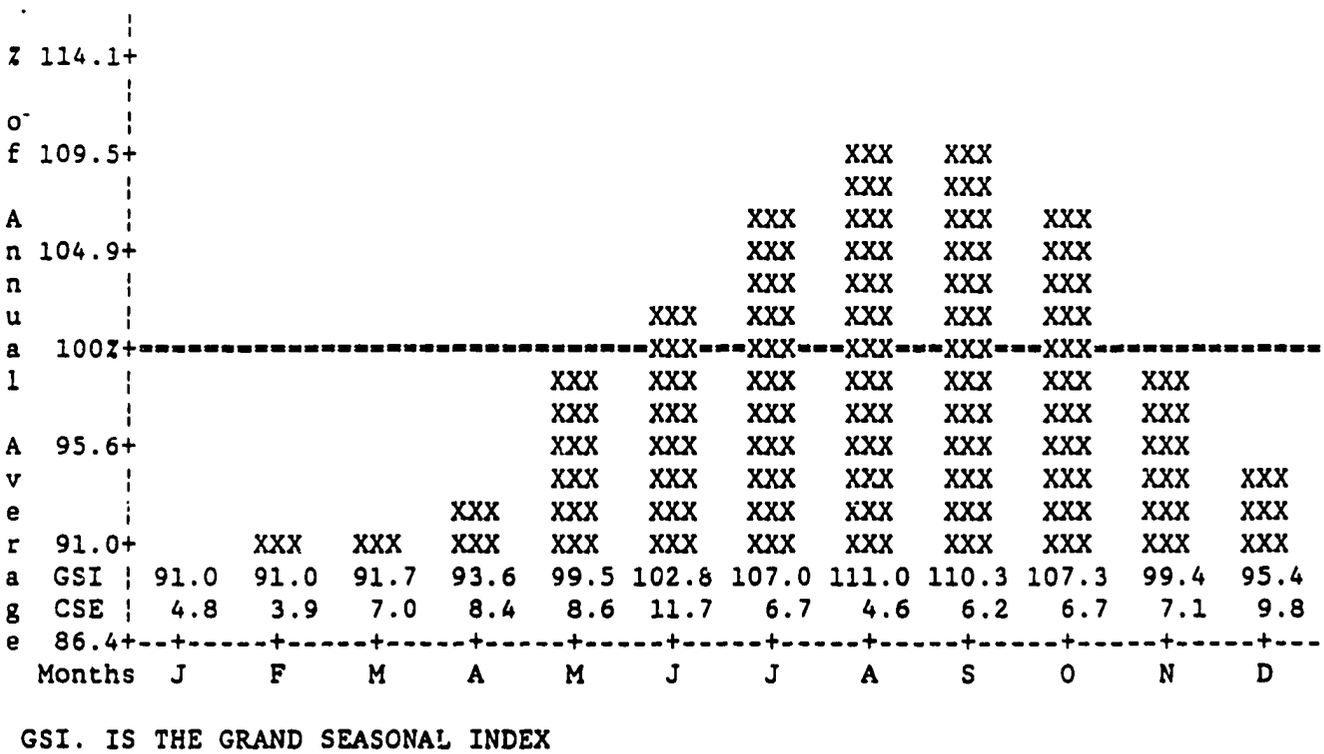
THE STANDARD ERROR OF 6.3 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 6.3 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS.

## ANNEX 2

## EXHIBIT 2-2

### GRAND SEASONAL INDEX FOR RETAIL SORGHUM PRICES IN BAMAKO, JANUARY 1982 TO MAY 1990 (EXCLUDING 1988)

| MONTH | AVERAGE SEASONAL INDEX | STANDARD ERROR | GRAND SEASONAL INDEX | CORRECTED STANDARD ERROR | GSI + CSE | GSI - CSE |
|---|---|---|---|---|---|---|
| JAN | 90.49 | 4.72 | 91.00 | 4.78 | 95.78 | 86.23 |
| FEB | 90.51 | 3.87 | 91.02 | 3.92 | 94.94 | 87.10 |
| MAR | 91.17 | 6.93 | 91.68 | 7.01 | 98.69 | 84.67 |
| APR | 93.07 | 8.32 | 93.60 | 8.41 | 102.01 | 85.19 |
| MAY | 98.93 | 8.53 | 99.49 | 8.63 | 108.12 | 90.85 |
| JUN | 102.20 | 11.53 | 102.77 | 11.66 | 114.43 | 91.12 |
| JUL | 106.38 | 6.59 | 106.99 | 6.66 | 113.65 | 100.33 |
| AUG | 110.40 | 4.57 | 111.03 | 4.62 | 115.65 | 106.41 |
| SEP | 109.67 | 6.14 | 110.29 | 6.21 | 116.50 | 104.09 |
| OCT | 106.73 | 6.62 | 107.34 | 6.69 | 114.03 | 100.64 |
| NOV | 98.86 | 6.99 | 99.42 | 7.07 | 106.49 | 92.35 |
| DEC | 94.84 | 9.65 | 95.38 | 9.76 | 105.13 | 85.62 |




GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 97.688 CURRENCY UNITS OVER THE 7 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA.

THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.

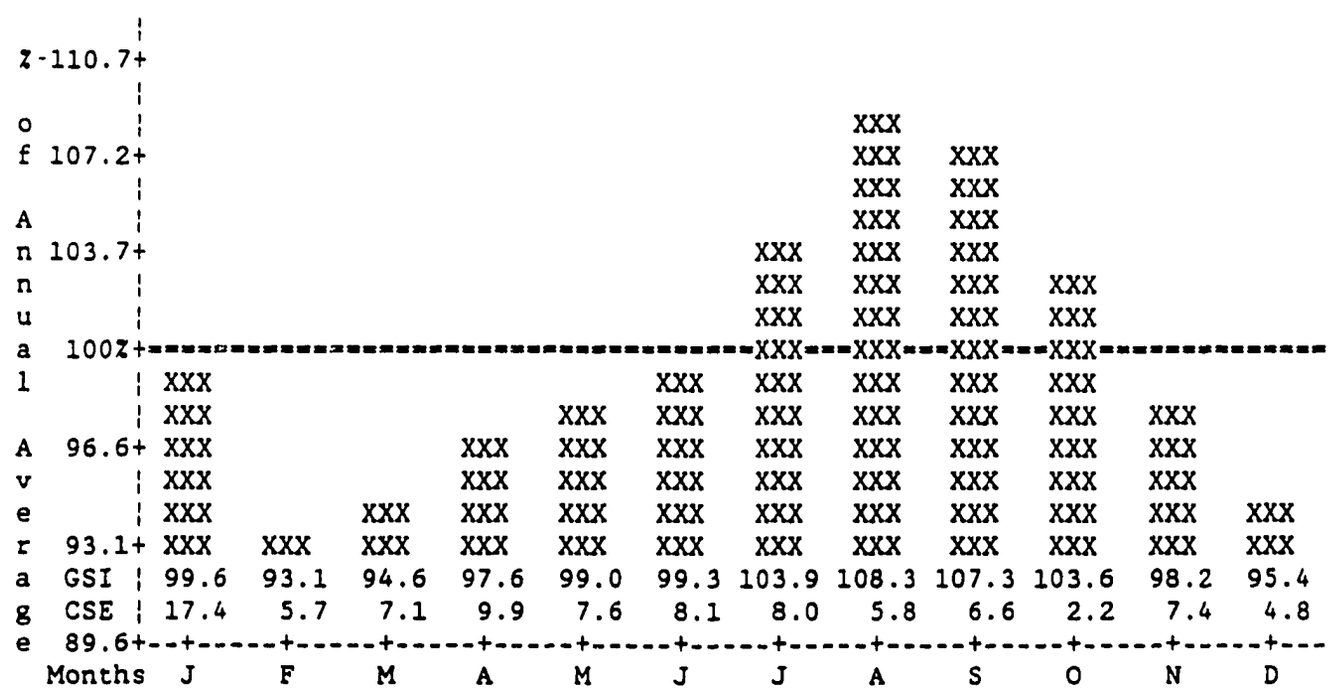
THE STANDARD ERROR OF 4.8 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 4.8 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS

## ANNEX 2

## EXHIBIT 2-3

### GRAND SEASONAL INDEX FOR RETAIL MAIZE PRICES IN BAMAKO, JANUARY TO MAY 1990 (EXCEPT 1988)

| MONTH | AVERAGE SEASONAL INDEX | STANDARD ERROR | GRAND SEASONAL INDEX | CORRECTED STANDARD ERROR | GSI + CSE | GSI - CSE |
|---|---|---|---|---|---|---|
| JAN | 99.42 | 17.31 | 99.64 | 17.39 | 117.03 | 82.25 |
| FEB | 92.93 | 5.66 | 93.14 | 5.68 | 98.82 | 87.45 |
| MAR | 94.43 | 7.10 | 94.64 | 7.13 | 101.77 | 87.50 |
| APR | 97.42 | 9.87 | 97.64 | 9.92 | 107.55 | 87.72 |
| MAY | 98.75 | 7.52 | 98.97 | 7.55 | 106.52 | 91.42 |
| JUN | 99.12 | 8.04 | 99.33 | 8.08 | 107.41 | 91.26 |
| JUL | 103.64 | 7.96 | 103.87 | 7.99 | 111.86 | 95.88 |
| AUG | 108.10 | 5.78 | 108.33 | 5.80 | 114.14 | 102.53 |
| SEP | 107.09 | 6.59 | 107.32 | 6.62 | 113.95 | 100.70 |
| OCT | 103.38 | 2.15 | 103.60 | 2.16 | 105.76 | 101.45 |
| NOV | 97.94 | 7.38 | 98.15 | 7.41 | 105.57 | 90.74 |
| DEC | 95.16 | 4.77 | 95.37 | 4.79 | 100.16 | 90.57 |




GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 87.988 CURRENCY UNITS OVER THE 8 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA. THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.

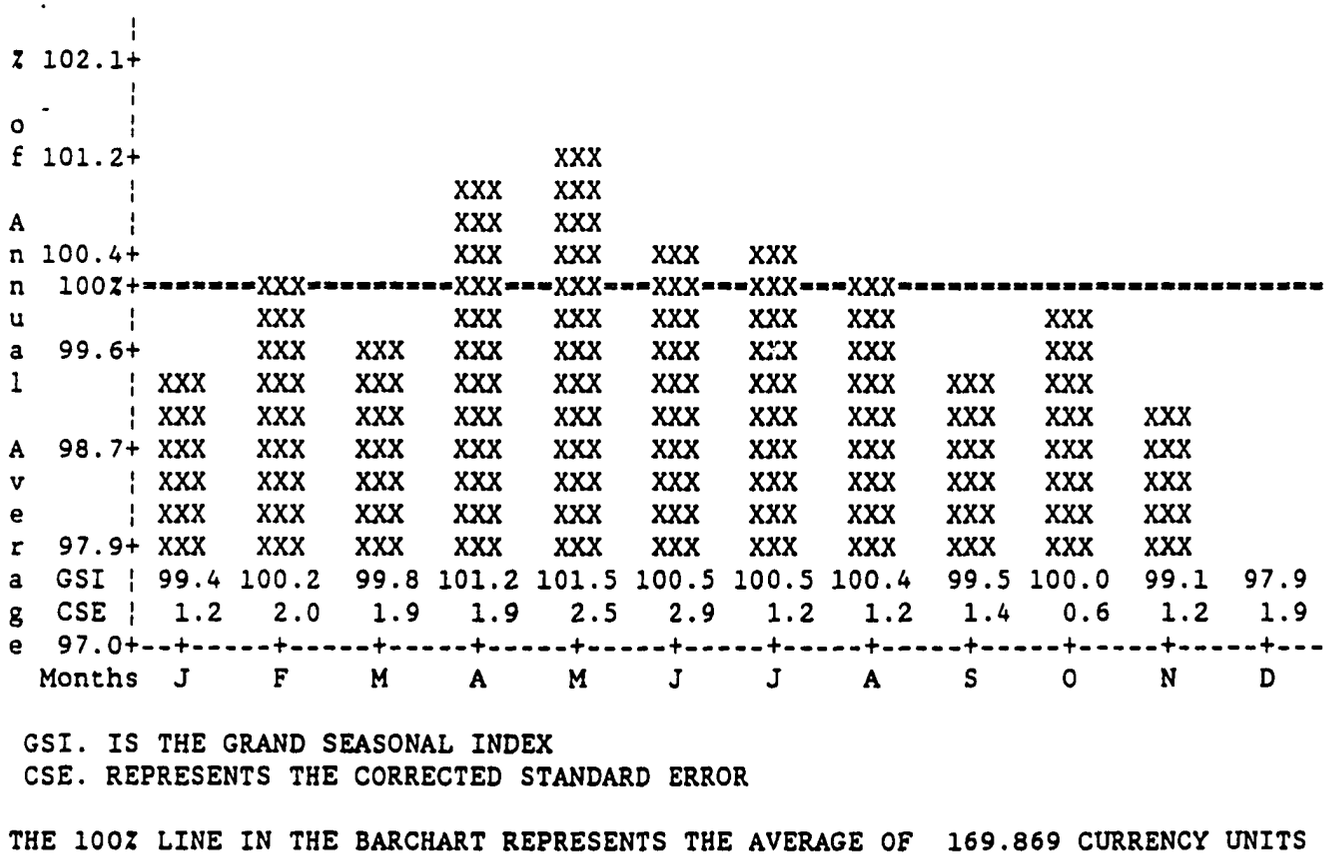
THE STANDARD ERROR OF 17.4 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 17.4 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS.

## ANNEX 2

## EXHIBIT 2-4

### GRAND SEASONAL INDEX FOR RETAIL PRICES IN BAMAKO, JANUARY 1982 TO JANUARY 1988

| MONTH | AVERAGE SEASONAL INDEX | STANDARD ERROR | GRAND SEASONAL INDEX | CORRECTED STANDARD ERROR | GSI + CSE | GSI - CSE |
|---|---|---|---|---|---|---|
| JAN | 99.14 | 1.23 | 99.38 | 1.23 | 100.61 | 98.14 |
| FEB | 99.99 | 1.97 | 100.23 | 1.98 | 102.20 | 98.25 |
| MAR | 99.54 | 1.90 | 99.77 | 1.91 | 101.68 | 97.87 |
| APR | 100.96 | 1.91 | 101.20 | 1.92 | 103.12 | 99.28 |
| MAY | 101.28 | 2.44 | 101.52 | 2.45 | 103.97 | 99.07 |
| JUN | 100.28 | 2.86 | 100.52 | 2.88 | 103.39 | 97.64 |
| JUL | 100.23 | 1.18 | 100.47 | 1.18 | 101.65 | 99.29 |
| AUG | 100.14 | 1.19 | 100.38 | 1.20 | 101.58 | 99.18 |
| SEP | 99.26 | 1.36 | 99.49 | 1.37 | 100.86 | 98.12 |
| OCT | 99.80 | 0.64 | 100.03 | 0.65 | 100.68 | 99.39 |
| NOV | 98.89 | 1.15 | 99.12 | 1.15 | 100.27 | 97.97 |
| DEC | 97.65 | 1.89 | 97.88 | 1.90 | 99.78 | 95.98 |




GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 169.869 CURRENCY UNITS OVER THE 6 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA.

THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.

THE STANDARD ERROR OF 1.2 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 1.2 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS.

## ANNEX 2

## EXHIBIT 2-5

### INTEREST RATE OF RETURN FROM STORAGE FOR MILLET IN BAMAKO (RETAIL PRICES)

| YEAR | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 0.0 | 0.0 | -2.3 | -9.2 | -4.6 | -1.1 | 10.3 | 23.0 | 24.1 | 52.9 | 56.3 | 56.3 |
| 1983 | 0.0 | -11.0 | -5.5 | -7.1 | -0.8 | 10.2 | 13.4 | 28.3 | 22.8 | 17.3 | 18.9 | 22.0 |
| 1984 | 0.0 | -8.2 | -9.0 | -4.9 | -0.8 | -1.6 | 19.7 | 22.1 | 23.0 | 26.2 | 29.5 | 20.5 |
| 1985 | 0.0 | -6.5 | -7.5 | -11.2 | -11.2 | -10.3 | -14.0 | -16.8 | -11.2 | -12.1 | -13.1 | -21.5 |
| 1986 | 0.0 | -4.8 | -15.5 | -23.8 | -28.6 | -31.0 | -22.6 | -19.0 | -8.3 | -3.6 | -3.6 | -6.0 |
| 1987 | 0.0 | 2.5 | 1.3 | | | | | | | | | |

Statistics for above Table

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.0 | -4.7 | -6.4 | -11.2 | -9.2 | -6.8 | 1.4 | 7.5 | 10.1 | 16.1 | 17.6 | 14.3 |
| S.D. | 0.0 | 5.1 | 5.8 | 7.4 | 11.6 | 15.4 | 18.5 | 23.4 | 18.2 | 25.7 | 27.5 | 29.8 |
| Low | 0.0 | -11.0 | -15.5 | -23.8 | -28.6 | -31.0 | -22.6 | -19.0 | -11.2 | -12.1 | -13.1 | -21.5 |
| High | 0.0 | 2.5 | 1.3 | -4.9 | -0.8 | 10.2 | 19.7 | 28.3 | 24.1 | 52.9 | 56.3 | 56.3 |
| Rises | 0.0 | 1.0 | 1.0 | 0.0 | 0.0 | 1.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Falls | 0.0 | 4.0 | 5.0 | 5.0 | 5.0 | 4.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |

Statistics for Last 5 Years of above Table

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.0 | -4.7 | -6.4 | -11.2 | -9.2 | -6.8 | 1.4 | 7.5 | 10.1 | 16.1 | 17.6 | 14.3 |
| S.D. | 0.0 | 5.1 | 5.8 | 7.4 | 11.6 | 15.4 | 18.5 | 23.4 | 18.2 | 25.7 | 27.5 | 29.8 |
| Low | 0.0 | -11.0 | -15.5 | -23.8 | -28.6 | -31.0 | -22.6 | -19.0 | -11.2 | -12.1 | -13.1 | -21.5 |
| High | 0.0 | 2.5 | 1.3 | -4.9 | -0.8 | 10.2 | 19.7 | 28.3 | 24.1 | 52.9 | 56.3 | 56.3 |
| Rises | 0.0 | 1.0 | 1.0 | 0.0 | 0.0 | 1.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Falls | 0.0 | 4.0 | 5.0 | 5.0 | 5.0 | 4.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |

## ANNEX 2

## EXHIBIT 2-6

## INTEREST RATE OF RETURN FROM STORAGE FOR SORGHUM IN BAMAKO (RETAIL PRICES)

| YEAR | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 1.2 | -3.7 | -6.2 | -9.9 | -7.4 | -2.5 | 12.3 | 19.8 | 19.8 | 55.6 | 60.5 | 0.0 |
| 1983 | -6.3 | -8.7 | -7.1 | -6.3 | -1.6 | 9.5 | 10.3 | 32.5 | 14.3 | 7.9 | 16.7 | 0.0 |
| 1984 | -25.2 | -39.0 | -38.2 | -30.9 | -26.8 | -29.3 | -11.4 | -19.5 | -16.3 | -13.8 | -13.0 | 0.0 |
| 1985 | -26.7 | -31.7 | -33.7 | -36.6 | -36.6 | -36.6 | -42.6 | -42.6 | -35.6 | -35.6 | -37.6 | 0.0 |
| 1986 | -1.2 | -8.5 | -22.0 | -24.4 | -31.7 | -31.7 | -25.6 | -22.0 | -11.0 | -2.4 | -6.1 | 0.0 |
| 1987 | 0.0 | 2.6 | -7.7 | | | | | | | | | |

Statistics for above Table

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | -9.7 | -14.9 | -19.1 | -21.6 | -20.8 | -18.1 | -11.4 | -6.3 | -5.8 | 2.3 | 4.1 | 0.0 |
| S.D. | 12.9 | 16.6 | 14.3 | 13.1 | 15.4 | 20.4 | 23.5 | 31.3 | 22.8 | 33.9 | 37.0 | 0.0 |
| Low | -26.7 | -39.0 | -38.2 | -36.6 | -36.6 | -36.6 | -42.6 | -42.6 | -35.6 | -35.6 | -37.6 | 0.0 |
| High | 1.2 | 2.6 | -6.2 | -6.3 | -1.6 | 9.5 | 12.3 | 32.5 | 19.8 | 55.6 | 60.5 | 0.0 |
| Rises | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 |
| Falls | 4.0 | 5.0 | 6.0 | 5.0 | 5.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 0.0 |

Statistics for Last 5 Years of above Table

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | -9.7 | -14.9 | -19.1 | -21.6 | -20.8 | -18.1 | -11.4 | -6.3 | -5.8 | 2.3 | 4.1 | 0.0 |
| S.D. | 12.9 | 16.6 | 14.3 | 13.1 | 15.4 | 20.4 | 23.5 | 31.3 | 22.8 | 33.9 | 37.0 | 0.0 |
| Low | -26.7 | -39.0 | -38.2 | -36.6 | -36.6 | -36.6 | -42.6 | -42.6 | -35.6 | -35.6 | -37.6 | 0.0 |
| High | 1.2 | 2.6 | -6.2 | -6.3 | -1.6 | 9.5 | 12.3 | 32.5 | 19.8 | 55.6 | 60.5 | 0.0 |
| Rises | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 0.0 |
| Falls | 4.0 | 5.0 | 6.0 | 5.0 | 5.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 0.0 |

## ANNEX 2

## EXHIBIT 2-7

### INTEREST RATE OF RETURN FROM STORAGE FOR MAIZE IN BAMAKO (RETAIL PRICES)

| YEAR | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 0.0 | 4.5 | 1.5 | 3.0 | 4.5 | 9.1 | 18.2 | 31.8 | 19.7 | 45.5 | 59.1 | 60.6 |
| 1983 | 0.0 | -1.8 | 1.8 | 2.7 | 9.1 | 20.9 | 18.2 | 10.0 | 11.8 | 10.0 | 8.2 | 10.9 |
| 1984 | 0.0 | -1.8 | -10.9 | -6.4 | -0.9 | 4.5 | 10.0 | 12.7 | 11.8 | 14.5 | 11.8 | -2.7 |
| 1985 | 0.0 | -2.3 | 1.1 | 1.1 | 3.4 | 0.0 | -10.2 | -11.4 | -4.5 | 0.0 | 2.3 | -12.5 |
| 1986 | 0.0 | -5.4 | -16.2 | -25.7 | -25.7 | -27.0 | -20.3 | -23.0 | -5.4 | 6.8 | -2.7 | -1.4 |
| 1987 | 0.0 | -4.2 | 45.1 | | | | | | | | | |

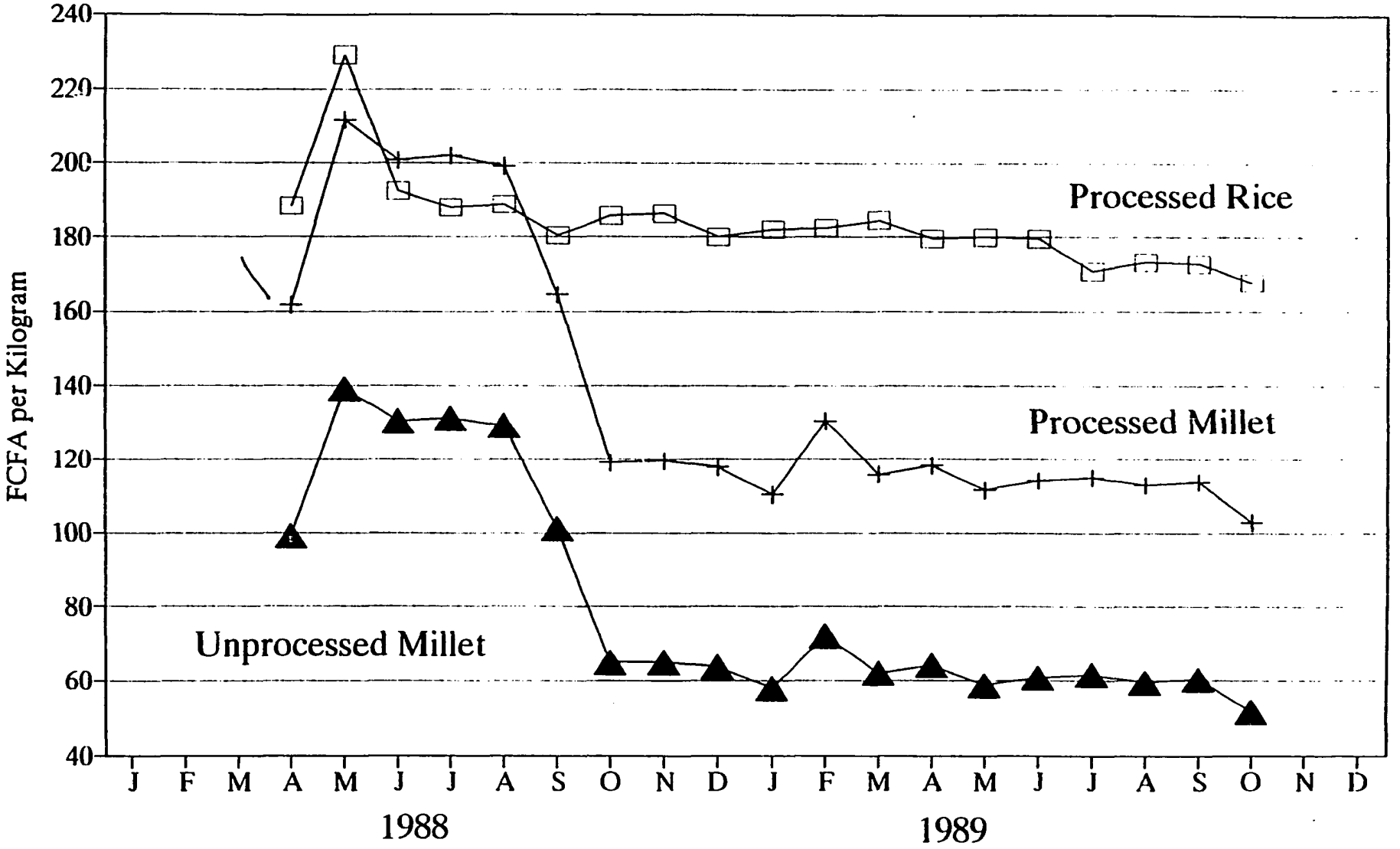
Statistics for above Table

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.0 | -1.8 | 3.7 | -5.0 | -1.9 | 1.5 | 3.2 | 4.0 | 6.7 | 15.4 | 15.7 | 11.0 |
| S.D. | 0.0 | 3.4 | 21.6 | 12.2 | 13.8 | 17.7 | 17.5 | 21.5 | 11.1 | 17.6 | 24.9 | 29.0 |
| Low | 0.0 | -5.4 | -16.2 | -25.7 | -25.7 | -27.0 | -20.3 | -23.0 | -5.4 | 0.0 | -2.7 | -12.5 |
| High | 0.0 | 4.5 | 45.1 | 3.0 | 9.1 | 20.9 | 18.2 | 31.8 | 19.7 | 45.5 | 59.1 | 60.6 |
| Rises | 0.0 | 1.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | 4.0 | 2.0 |
| Falls | 0.0 | 5.0 | 2.0 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 2.0 | 0.0 | 1.0 | 3.0 |

Statistics for Last 5 Years of above Table

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.0 | -1.8 | 3.7 | -5.0 | -1.9 | 1.5 | 3.2 | 4.0 | 6.7 | 15.4 | 15.7 | 11.0 |
| S.D. | 0.0 | 3.4 | 21.6 | 12.2 | 13.8 | 17.7 | 17.5 | 21.5 | 11.1 | 17.6 | 24.9 | 29.0 |
| Low | 0.0 | -5.4 | -16.2 | -25.7 | -25.7 | -27.0 | -20.3 | -23.0 | -5.4 | 0.0 | -2.7 | -12.5 |
| High | 0.0 | 4.5 | 45.1 | 3.0 | 9.1 | 20.9 | 18.2 | 31.8 | 19.7 | 45.5 | 59.1 | 60.6 |
| Rises | 0.0 | 1.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | 4.0 | 2.0 |
| Falls | 0.0 | 5.0 | 2.0 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 2.0 | 0.0 | 1.0 | 3.0 |

# WHOLESALE PRICES IN BAMAKO: RICE - MILLET COMPARISON

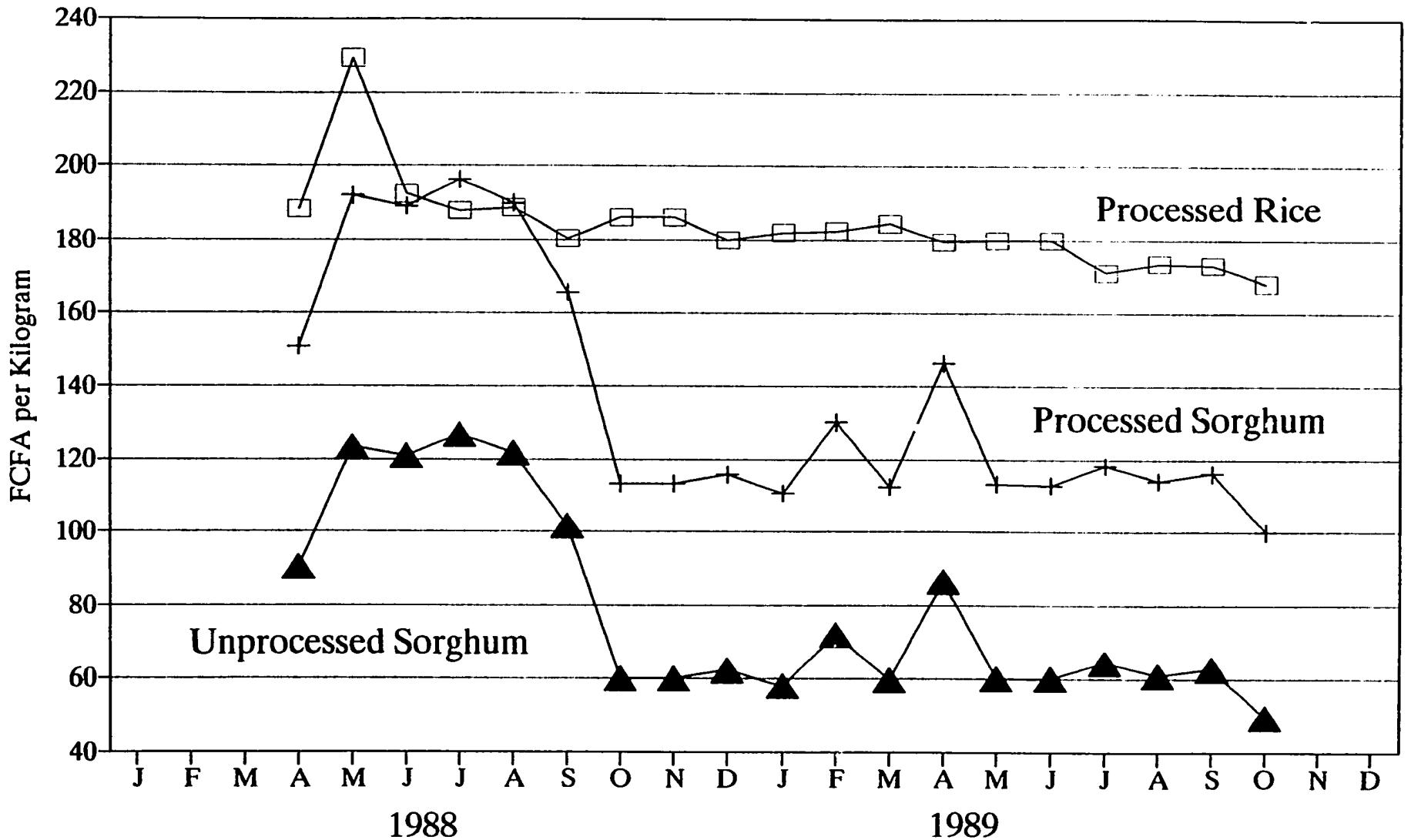



Note: Prices for processed millet were estimated by adjusting for dehulling losses and adding processing costs to wholesale market prices. to wholesale market prices.

Source: Michigan State University, Department of Agricultural Economics, Food Security in Africa Program

ANNEX 2, EXHIBIT 9

# WHOLESALE PRICES IN BAMAKO: RICE - SORGHUM COMPARISON

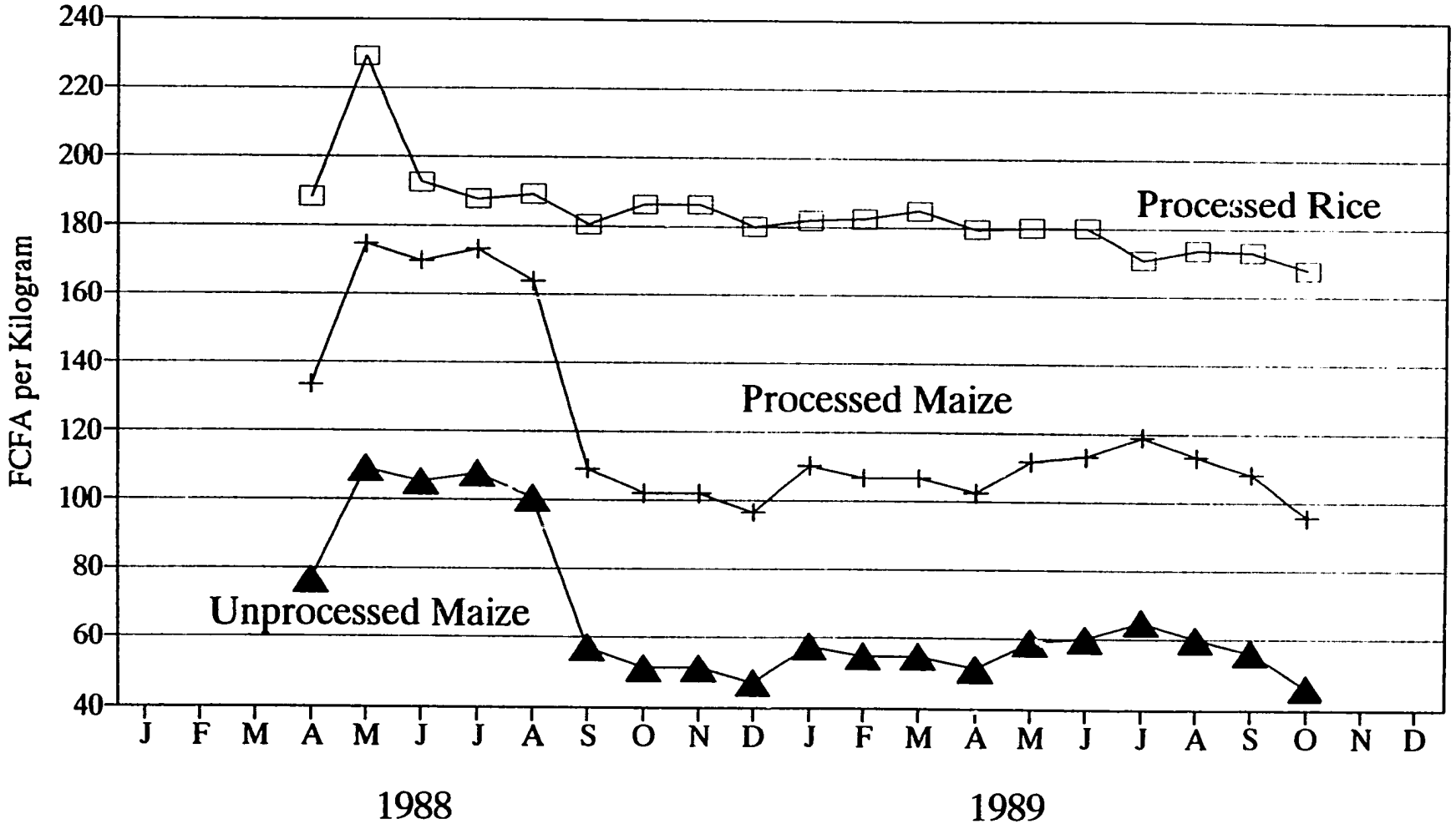



Note: Prices for processed sorghum were estimated by adjusting for dehulling losses and adding processing costs to wholesale market prices.

Source: Michigan State University, Department of Agricultural Economics, Food Security in Africa Program

ANNEX 2, EXHIBIT 10

# WHOLESALE PRICES IN BAMAKO: RICE - MAIZE COMPARISON




Note: Prices for processed maize were estimated by adjusting for dehulling losses and adding processing costs to wholesale prices.

Source: Michigan State University, Department of Agricultural Economics, Food Security in Africa Program

## ANNEX 3

## INFORMAL INTERVIEW GUIDELINES (IN FRENCH)

### Guide d'Enquête Informelle: Ménages Urbains

Quartier
Nom de la Femme
Sa région d'origine et ethnie

Nom du Chef de Famille
Son Age et son travail
Région d'origine et ethnie

Nombre d'années installés à Bamako
(Religion)

Taille/Composition de Famille/Ménage
Est-ce qu'il y a une bonne?

LES PLATS PREPARES

1. Qu'est-ce que vous mangez le matin?

   Combien de fois par semaine?
   A base de quelle céréale? Toujours ou à quelles saisons?
   Est-ce qu'il y a quelque chose de spécial le dimanche?

2. Quels sont les plats que vous préparez pour le repas de midi?

   Combien de fois par semaine?
   A base de quelle céréale? Toujours ou à quelles saisons? Quelle est la quantité de riz que vous préparez?
   Est-ce qu'il y a quelque chose de spécial le dimanche?

3. Quelles sont les sauces que vous préparez avec ces différents plats?

   Riz
   Toh
   Couscous, etc.

4. Quels sont les plats que vous préparez le soir?

   Combien de fois par semaine?
   A base de quelle céréale? Toujours ou à quelles saisons?
   Est-ce qu'il y a quelque chose de spécial le dimanche?

5. Est-ce que vous préparez d'autres plats à base de:

| | |
|---|---|
| petit mil | pain |
| sorgho (gros mil) | plantain |
| maïs | igname |
| riz | manioc |
| fonio | patate |

viande
poisson
salade/légume
bouillie

pomme de terre
niébé
voandzou

Quels plats? Combien de fois par semaine?

6. Quelles sont les sauces que vous préparez avec ces différents plats que vous préparez le soir?

7. De quelle quantité de viande avez-vous besoin pour faire une bonne sauce? De poisson?

   Combien de fois par semaine préparez-vous la sauce avec la viande, avec le poisson?

8. Combien dépensez-vous pour les condiments chaque jour? (Est-ce que le prix de la viande est inclus?) Combien pour le bois?

9. Préparez-vous des plats spéciaux pour les enfants? Lesquels?

10. Quels sont les plats spéciaux que vous préparez pour les fêtes?

11. Quels sont les plats que vous préparez pour le carême?

12. Est-ce que certains membres de la famille mangent en dehors du ménage? Qu'est-ce qu'ils font? Est-ce que les enfants achètent des goûters à l'école?

13. Hier, qu'est-ce que vous avez préparé pour le matin, le midi et le soir?

## ACHATS, UTILISATIONS DES MACHINES

14. Où vous procurez-vous vos céréales? (marché, village, coop)
    En vrac ou une fois par semaine?

15. Pourriez-vous estimer combien de mois par année vous mangez du sorgho, petit mil, maïs?

16. Comment décortiquez-vous vos céréales? Manuellement ou par machine? En vrac ou hebdomadairement? Quelle quantité et à quel prix?

17. Comment faite-vous moudre vos céréales? Manuellement ou avec une machine? En vrac ou quotidiennement? Quelle quantité et à quel prix?

18. Est-ce qu'il y a des femmes dans le quartier qui préparent les céréales manuellement? Pour quels plats? Est-ce que cela est commun? Quel est leur prix de préparation? Est-ce qu'elles deviennent de plus en plus ou de moins en moins nombreuses?

## COMPARAISONS

19. Pourriez-vous comparer les céréales suivantes:
    riz, gros mil, petit mil, maïs, fonio; laquelle est la plus facile à préparer? Faites une liste qui commence avec la plus facile et qui termine avec la plus difficile.

20. Pourriez-vous comparer les différents plats du point de vue temps de cuisson? Faites une liste qui commence avec le plus rapide et qui termine avec le plus lent. (toh, couscous, riz, moni, seri, brisures de riz, brisures de fonio) Combien de temps est-ce qu'il faut pour la cuisson de chaque plat?

21. Est-ce que vous achetez ou employez des produits transformés comme:

céréale déjà décortiquée
brisures de maïs
brisures de sorgho à façon de riz
brisures de sorgho à façon de fonio
farine du marché
riz étuvé
pâtes alimentaires
couscous arabe
bonne foutou

22. Préférez-vous les brisures de sorgho préparées comme le riz ou comme le fonio?

23. Est-ce qu'il y a des produits (surtout produits transformés) que vous aimeriez trouver au marché et qui n'existent pas maintenant ou qui ne sont pas de bonne qualité?

24. Qu'est-ce qui peut aider les citoyens à varier les plats qu'ils mangent? Quelles sont les actions qui peuvent être menées pour les aider à diversifier leurs plats?

## Guide d'Enquête Informelle: Meuniers

Ville/village
Quartier
Nom de l'opérateur
Nom du gérant

Années d'opération
Inventaire d'équipement: engin, moulin à meules ou broyeur, décortiqueur, autre:

| Type | Marque | Année Fabricat. | Année Achat | Coût d'Achat | Emploi Actuel? |
|---|---|---|---|---|---|

Autres coûts d'investissement: bâtiment ou hangar, magasin, balance, équipement d'emballage, autre:

Services rendus:

Traitement à façon pour les clients particuliers? Poids ou rendement typique de céréales traitées par client?

Traitement continuel pour emballage/vente aux ménages? aux acheteurs institutionnels?

Mouture, ou décorticage plus mouture?

Coûts pour la mouture et le décorticage des céréales par kilogramme de céréales traitées?

| Céréale | Opération | Coût/kg. | Gardez le son? |
|---|---|---|---|

Prix de produits traités et vendus à l'unité:

Quantités transformées par mois (ou jour ou semaine)

| Période | Durée | Céréale | Quantités | Revenus |
|---|---|---|---|---|
| Post-récolte | | | | |
| Saison sèche | | | | |
| Début hivernale | | | | |
| Saison pluviale | | | | |

Les quantités traitées et les clients ont-ils augmenté pendant les années récentes? Pourquoi?

Coûts de fonctionnement (indiquez la période de référence)

| Catégorie | Subcatégorie | Frais | Période ou autre Référence |
|---|---|---|---|
| Electricité | | | |
| Essence/Gasoil | | | |
| Vidange | | | |
| Graissage | | | |
| Main-d'oeuvre | | | |
| Réparation | (pièces de rechange) | | |
| | tamis | | |
| | convois | | |
| Impôts/taxes | patente | | |
| | taxe municipale | | |
| | autre | | |
| Loyer | | | |

Possibilités d'investissement et d'expansion? d'autres unités de traitement? intégration verticale (achat des céréales pour traitement et vente; autres débouchés tels que les restaurants)?

Autres entreprises (sources de revenus) du gérant?

Contraintes majeures et suggestions pour les enlever.

Y a-t-il trop/assez/peu de moulins dans cette ville/quartier?

Disponibilité des pièces de rechange? des mécaniciens?

Fournissez-vous des céréales traitées ou traitez-vous des quantités importantes de céréales pour certains clients?
En dehors des céréales, quels autres produits agricoles traitez-vous? (arachide, niébé, autre)

ANNEX 4

# HOUSEHOLD CONSUMPTION SURVEY: SUMMARY FINDINGS

| HOUSEHOLD INFORMATION | | CONDIMENT EXPENSE | | RICE CONSUMPTION | | RICE CONSUMPTION BY MEAL NUMBER OF DAYS PER WEEK | | | | COARSE GRAIN CONSUMPTION | | C.G. CONSUMPTION BY MEAL NUMBER OF DAYS PER WEEK | | | | GRAIN PURCHASE | | GRAIN PROVID BY VILLAGE (GIFTS) | | DEHULLING PRACTICES | | | | | MILLING PRACTICES | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Household by Quarter | Number of Persons | CFA/Day | CFA/Day Per Capita | Kg/ Day | Kg/Day Per Capita | Morning | Noon | Evening | Evening Dessert | Kg/Day | Kg/Day Per Capita | Morning | Noon | Evening | Evening Dessert | Magnitude | Location | Type | Kgs. | Method | Frequency | Kgs. | Cost (FCFA) | FCF Kg. | Method | Frequency | Kgs. | Cost (FCFA) | FCFA/ Kg. |
| Sabalibougou | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 3 | modest | > 50 | no | | 3 | 3.5 | 3.5 | | 1.0 | 0.33 | 5 | 3.5 | 3.5 | 2 | daily | market | sorghum | 100 | manual | 3 days | 1.0 | | | machine | 3 days | 2.0 | 40 | 20.0 |
| 2 | 20 | 1,000 | 50 | 7 | 0.35 | 0 | 7 | 0 | | 5.0 | 0.25 | 7 | 0 | 6 | | 100 kgs | market | rice sorghum | 300 | maid | daily | 5.0 | | | machine | daily | 4.0 | 50 | 12.5 |
| 3 | 27 | modest | > 50 | 4 | 0.15 | 0 | 7 | 0 | | 4.0 | 0.15 | 7 | 0 | 7 | | 100 kgs | market | | | maid | daily | 4.0 | | | machine | daily | 4.0 | 40 | 10.0 |
| 4 | 41 | 1,250 | 30 | 0 | | 0 | 0 | 0 | | 10.0 | 0.24 | 7 | 7 | 7 | | 100 kgs | market | sorghum | 400 | manual | daily | 10.0 | | | manual | daily | | | |
| 5 | 12 | 100 | 8 | 0 | | 0 | 0 | 0 | | 2.0 | 0.17 | 7 | 7 | 7 | | daily | market | | | manual | daily | 2.0 | | | manual | daily | | | |
| Badala SEMA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 5 | high | >150 | 1.5 | 0.30 | 0 | 6.5 | 0 | | 0.0 | | 0 | 0 | 0 | | 100 kgs | boutique | | | machine | same day | | | | machine | same day | | | |
| 7 | 10 | high | >150 | 1.5 | 0.15 | 0 | 6.5 | 0 | | no | | 7 | 0 | 0.1 | 3 | 100 kgs | boutique | | | machine | same day | | | | machine | same day | | | |
| 8 | 11 | 750 | 68 | 4 | 0.36 | 4 | 4 | 4 | | 2.0 | 0.18 | 3 | 3 | 3 | 5 | 100 kgs | boutique | | | machine | monthly | 50.0 | 500 | 10.0 | machine | daily | 2.0 | 25 | 12.5 |
| 9 | 18 | 5,000 | 278 | 5 | 0.28 | 0 | 6 | 0 | | 2.0 | 0.11 | 3.5 | 0 | 2 | 7 | 100 kgs | boutique | | | maid | daily | 2.0 | | | machine | daily | 2.0 | 0 | 0.0 |
| 10 | 9 | high | >150 | 1.5 | 0.17 | 0 | 6.5 | 0 | 2 | 1.0 | 0.11 | 0 | 0 | 0.2 | 5 | 100 kgs | boutique | | | machine | monthly | 50.0 | 500 | 10.0 | machine | daily | 1.0 | 10 | 10.0 |
| Djikoroni Para | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | 12 | 500 | 42 | 3 | 0.25 | 0 | 5 | 0 | | 3.0 | 0.25 | 7 | 2 | 7 | | 50 kgs | boutique | sorghum | 700 | manual | daily | 3.0 | | | machine | daily | 3.0 | 30 | 10.0 |
| 12 | 9 | 150 | 17 | 1.5 | 0.17 | 1 | 5.5 | 1 | | 2.0 | 0.22 | 6 | 1.5 | 6 | 2 | daily | market | | | manual | daily | 2.0 | | | machine | daily | 2.0 | 30 | 15.0 |
| 13 | 12 | low | < 50 | 3 | 0.25 | 0 | 4 | 2 | | 3.5 | 0.29 | 7 | 3 | 5 | | daily | market | | | manual | daily | 3.5 | | | machine | daily | 3.5 | 30 | 8.6 |
| 14 | 11 | 1,250 | 114 | 3.5 | 0.32 | 0 | 6.5 | 0 | | 3.5 | 0.32 | 7 | 0 | 4 | 2 | 100 kgs | market | | | machine | daily | 3.5 | 70 | 20.0 | machine | daily | 3.5 | 70 | 20.0 |
| 15 | 8 | 500 | 63 | 3 | 0.38 | 0 | 5.5 | 5.5 | | 2 | 0.25 | 3 | 1.5 | 1.5 | 7 | 100 kgs | market | maize | 200 | manual | 2-3 days | 5 | | | machine | 2-3 days | 5 | 50 | 10.0 |
| Lafiabougou | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | 11 | 500 | 45 | no | | 0 | 3 | 0 | | 5 | 0.45 | 5 | 4 | 5 | | 100 kgs | coop | | | maid | daily | 5.0 | | | machine | daily | 5 | 50 | 10.0 |
| 17 | 10 | 1,000 | 100 | 2 | 0.20 | 0 | 5 | 0 | | 2 | 0.20 | 7 | 0 | 4 | | 100 kgs | coop | | | maid | daily | 2.0 | | | machine | daily | 2 | 25 | 12.5 |
| 18 | 16 | 1,000 | 63 | 2.5 | 0.16 | 1 | 6 | 0 | | 2.0 | 0.13 | 6 | 0 | 5 | 1 | 100 kgs | coop | | | maid | daily | 2.0 | | | machine | daily | | | |
| 19 | 10 | modest | > 50 | no | | 0 | 5 | 5 | | 25.0 gatele | no | 7 | 2 | 2 | | 50 kgs | coop | | | machine | 2 days | 50 | 500 | 10.0 | machine | daily | 22 | | |
| 20 | 5 | v. low | < 50 | 0 | | 0 | 0 | 0 | | no | no | 7 | 7 | 7 | | daily | market | | | manual | daily | | | | manual | daily | | | |
| N'Tomikorobougou | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | 21 | 1,000 | 48 | 5 | 0.24 | 0 | 7 | 1 | | 4 | 0.19 | 7 | 0 | 6 | | 100 kgs | coop | maize | no | manual | daily | 4.0 | | | machine | daily | 4.0 | 40 | 10.0 |
| 22 | 5 | modest | > 50 | 2 | 0.40 | 0 | 4 | 3 | | 2 | 0.40 | 7 | 3 | 3 | | 50 kgs | | yes | no | machine | weekly | 2.0 | | | machine | daily | 2 | 50 | 25.0 |
| 23 | 40 | 2,500 | 63 | 7 | 0.18 | 0 | 6.5 | 0 | | 5.5 | 0.14 | 7 | 0 | 7 | | 100 kgs | boutique | | | maid | daily | 5.5 | | | machine | daily | 5.5 | 50-100 | |
| 24 | 16 | 500 | 31 | 4.5 | 0.28 | 0 | 2 | 2 | | 5.0 | 0.31 | 7 | 5 | 5 | 7 | 100 kgs | varies | | | maid | daily | 5.0 | | | machine | daily | 5.0 | 75 | 15.0 |

# HOUSEHOLD CONSUMPTION SURVEY: SUMMARY FINDINGS

| HOUSEHOLD INFORMATION | | CONDIMENT EXPENSE | | RICE CONSUMPTION | | RICE CONSUMPTION BY MEAL NUMBER OF DAYS PER WEEK | | | | COARSE GRAIN CONSUMPTION | | C.G. CONSUMPTION BY MEAL NUMBER OF DAYS PER WEEK | | | | GRAIN PURCHASE | | GRAIN PROVIDED BY VILLAGE (GIFTS) | | DEHULLING PRACTICES | | | | | MILLING PRACTICES | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Household by Quarter | Number of Persons | CFA/Day | CFA/Day Per Capita | Kg/Day | Kg/Day Per Capita | Morning | Noon | Evening | Evening Dessert | Kg./Day | Kg./Day Per Capita | Morning | Noon | Evening | Evening Dessert | Magnitude | Location | Type | Kgs. | Method | Frequency | Kgs. | Cost (FCFA) | FCF Kg. | Method | Frequency | Kgs. | Cost (FCFA) | FCFA/Kg. |
| 25 | 4 | 750<br>modest | 47<br>> 50 | 2 | 0.50 | 0 | 4 | 0 | | 2.0 | 0.50 | 6 | 3 | 7 | | varies | market | | | manual | daily | 2.0 | | | machine | daily | 2.0 | 30 | 15.0 |
| Bazzalo-Coura | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | 10 | 500 | 50 | 2 | 0.20 | 0 | 3 | 2 | | 2.0 | 0.20 | 7 | 4 | 3 | 7 | 100 kgs | market | | | machine | weekly | 100 | 1000 | 10.0 | machine | daily | 12 | 125 | 10.4 |
| 27 | 40 | modest | > 50 | 7 | 0.18 | 0 | 6 | 0 | 3 | 7 | 0.16 | 6 | 0 | 6 | 4 | 100 kgs | market | yes | na | machine | daily | 7 | 60 | 8.6 | machine | daily | 7 | 60 | 8.6 |
| 28 | 40 | 1,000 | 25 | 5 | 0.13 | 0.5 | 4 | 0 | | 8 | 0.20 | 6.5 | 0.5 | 7 | yes | 50 kgs | market | | | mixed machine | daily | 8 | 110 | 13.8 | machine | daily | 8 | 110 | 13.8 |
| 29 | 17 | 1,500<br>1,500 | 38<br>88 | 5 | 0.29 | 0 | 7 | 0 | | 4.5 | 0.26 | 6 | 0 | 6 | | 100 kgs | market | | | machine | monthly | 100 | 1000 | 10.0 | machine | daily | 4.5 | 60 | 13.3 |
| 30 | 26 | 2,000 | 77 | 6 | 0.23 | 1.5 | 5.5 | 0 | 1.5 | 6.0 | 0.23 | 5.5 | 1 | 6 | 5.5 | 100 kgs | coop | maize | na | mixed | daily | 6.0 | | | machine | daily | 6.0 | 40 | 6.7 |
| Sogonito | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | 6 | 200 | 33 | 2 | 0.33 | 0 | 3 | 3 | | 2.0 | 0.33 | 7 | 4 | 4 | yes | 100 kgs | boutique | | | machine | monthly | 100 | 1000 | 10.0 | machine | daily | 2.0 | 25 | 12.5 |
| 32* | 31 | 500<br>1,000 | 83<br>32 | 6.5 | 0.21 | 0 | 7 | 0 | | 7 | 0.23 | 6 | 0 | 7 | 2 | 100 kgs | boutique | | | machine | daily | 7 | 100 | 14.3 | machine | daily | 7 | 55 | 7.9 |
| 33 | 7 | 1,000 | 143 | 2 | 0.29 | 0 | 5 | 0 | | 3 | 0.43 | 0 | 1 | 0 | 3 | 50 kgs | market | | | mixed | daily | 3 | | | machine | daily | 3 | 30 | 10.0 |
| 34** | 10 | noon only<br>500 | 50 | 5 | 0.50 | 0 | 5 | 4 | | 4.0 | 0.40 | 6 | 2 | 2 | | 50 kgs | boutique | maize | 100 | manual | daily | 4.0 | | | machine | daily | 4.0 | 45 | 11.3 |
| 35 | 8 | 500 | 63 | 2 | 0.25 | 0 | 6 | 6 | | 3.0 | 0.38 | 6.5 | 1 | 1 | 5 | 100 kgs | boutique | millet | na | machine | monthly | 100 | 1000 | 10.0 | machine | daily | 3.0 | 30 | 10.0 |
| Faladje-SEMA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | 11 | 2,000 | 182 | 3 | 0.27 | 0 | 6 | 0 | 2 | 3.0 | 0.27 | 6 | 0 | 2 | 5 | 100 kgs | market | | | mixed | daily | 3.0 | | | machine | daily | 3.0 | 30 | 10.0 |
| 37 | 12 | 1,500 | 125 | 2 | 0.17 | 0 | 6.5 | 0 | 1 | 3 | 0.25 | 6 | 0 | 3 | 1 | 100 kgs | coop | | | mixed | daily | 3 | | | machine | daily | 3 | 40 | 13.3 |
| 38 | 10 | 1,000 | 100 | 2 | 0.20 | 0 | 6.5 | 0 | 0.5 | 2 | 0.20 | 1 | 0 | 3 | 0.5 | 50 kgs | work | | | mixed | daily | 2 | | | machine | daily | 2 | 25 | 12.5 |
| 39 | 5 | 1,000 | 200 | 1.5 | 0.30 | 0 | 5 | 0 | | 1.5 | 0.30 | 0 | 1 | 1 | 7 | 50 kgs | boutique | | | mixed | daily | 1.5 | | | machine | daily | 1.5 | 15 | 10.0 |
| 40 | 6 | 300<br>500 | 50<br>83 | 4 | 0.67 | 3 | 4 | 4 | | 4.5 | 0.75 | 4 | 4 | 4 | | varies | marche | millet<br>sorghum | 300<br>300 | manual | daily | 4.5 | | | machine | daily | 4.5 | 25 | 5.6 |
| Niaréla | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41 | 11 | 1,500 | 136 | 4 | 0.36 | 0 | 5 | 0 | | 5.0 | 0.45 | 6 | 2 | 4 | 3.5 | 100 kgs | coop | | | mixed | daily | 5.0 | | | machine | daily | 5.0 | 45 | 9.0 |
| 42 | 9 | 2,500 | 278 | 3 | 0.33 | 0 | 5.5 | 0 | | 3 | 0.33 | 0 | 0 | 2 | 7 | 100 kgs | market | | | mixed | daily | 3 | | | machine | daily | 3 | 25 | 8.3 |
| 43 | 6 | 3,000 | 500 | 2 | 0.33 | 0 | 5 | 0 | | 2 | 0.33 | 7 | 0 | 0 | 7 | 50 kgs | boutique | | | maize<br>machine | monthly<br>monthly | 50<br>50 | 500<br>500 | 10.0<br>10.0 | machine | daily | 2 | 25 | 12.5 |
| 44 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Quinzambougou | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | 8 | 1,000 | 125 | 2 | 0.25 | 0 | 4.5 | 1 | | 2.0 | 0.25 | 1 | 0 | 2 | 2 | 50 kgs | work | millet<br>sorghum | 200<br>100 | mixed | same day | 2.0 | | | machine | same day | 2.0 | 30 | 15.0 |
| 47** | 35 | 1,000 | 29 | 4 | 0.11 | 0 | 3 | 0 | 1 | 6 | 0.17 | 7 | 4 | 7 | 6 | 100 kgs | boutique | | | mixed | daily | 6 | | | machine | daily | 6 | 50 | 8.3 |

# HOUSEHOLD CONSUMPTION SURVEY: SUMMARY FINDINGS

| HOUSEHOLD INFORMATION | | CONDIMENT EXPENSE | | RICE CONSUMPTION | | RICE CONSUMPTION BY MEAL NUMBER OF DAYS PER WEEK | | | | COARSE GRAIN CONSUMPTION | | C.G. CONSUMPTION BY MEAL NUMBER OF DAYS PER WEEK | | | | GRAIN PURCHASE | | GRAIN PROVID BY VILLAGE (GIFTS) | | DEHULLING PRACTICES | | | | | MILLING PRACTICES | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Household by Quartier | Number of Persons | CFA/Day | CFA/Day Per Capita | Kg./ Day | Kg./Day Per Capita | Morning | Noon | Evening | Evening Dessert | Kg./Day | Kg./Day Per Capita | Morning | Noon | Evening | Evening Dessert | Magnitude | Location | Type | Kgs. | Method | Frequency | Kgs. | Cost (FCFA) | FCF Kg. | Method | Frequency | Kgs. | Cost (FCFA) | FCFA/ Kg. |
| 48 | 7 | 1,500 | 214 | na | | 0 | 4 | 0 | 4 | na | | 0 | 0 | 0 | 0 | 50 kgs | boutique | fonio | 200 | machine | monthly | 50 | 500 | 10.0 | machine | monthly | 50 | 500 | 10.0 |
| 49 | 6 | 500 | 83 | 2 | 0.33 | 0 | 2 | 2 | | 4.0 | 0.67 | 7 | 5 | 5 | 2 | daily | market | | | chauffeur maid | daily | | | | chauffeur machine | daily | 4.0 | 30 | 7.5 |
| 50 | 12 | 750 | 63 | 4 | 0.33 | 0 | 4 | 0 | | 8.0 | 0.67 | 7 | 3 | 5 | 1 | 100 kgs | work | yes | 200 | maid | daily | 8.0 | | | machine | daily | 8.0 | 60 | 7.5 |
| Korafins | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 51 | 12 | 1,500 | 125 | 4 | 0.33 | 0 | 6 | 0.5 | | 5.5 | 0.46 | 7 | 0 | 5 | 1 | 50 kgs | work | | | maid | daily | 5.5 | | | machine | daily | 5.5 | 30 | 5.5 |
| 52 | 6 | 500 | 83 | 1.5 | 0.25 | 0 | 6 | 0 | | 2 | 0.33 | 7 | 1 | 0 | 7 | 100 kgs | work | | | maid | daily | 2 | | | machine | daily | 15 | | |
| 53 | 5 | 750 | 150 | 1.5 | 0.30 | 1 | 6.5 | 2 | 1.5 | na | | 0 | 0 | 1 | 1.5 | 50 kgs | market | | | machine | monthly | 50 | 500 | 10.0 | machine | monthly | 50 | 500 | 10.0 |
| 54 | 8 | 2,500 | 313 | 2.5 | 0.31 | 0 | parboiled 5 | 0 | | 4.0 | 0.50 | 7 | 0 | 2 | [illegible] | 50 kgs | market | | | maize maid | same day | 4.0 | | | machine | same day | 4.0 | 25 | 6.3 |
| 55 | 16 | 1,500 | 94 | 6 | 0.38 | 0 | parboiled 6.5 | 0.5 | 0.5 | 7.0 | 0.44 | 1 | 0 | 4.5 | 0.5 | 100 kgs | boutique | | | maid | daily | 7.0 | | | machine | daily | 7.0 | 70 | 10.0 |
| Banconi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 56 | 15 | 1,000 | 67 | 3 | 0.20 | 0 | 7 | 0 | | 4.0 | 0.27 | 7 | 0 | 5 | 2 | varies | work market | | | maid | daily | 4.0 | | | machine | daily | 4.0 | 60 | 15.0 |
| 57 | 11 | 1,500 | 136 | 4 | 0.36 | 0 | 5.5 | 0 | | 5.5 | 0.50 | 7 | 0.5 | 5 | 3 | 100 kgs | market | sorghum | 100 | maid | daily | 5.5 | | | machine | daily | 5.5 | 60 | 10.9 |
| 58 | 4 | 300 | 75 | 0.5 | 0.13 | 0 | 2 | 2 | | 1 | 0.25 | 3 | 5 | 5 | 1 | daily | market | | | manual | daily | 1 | | | machine | daily | 1 | 10 | 10.0 |
| 59 | 6 | 500 | 83 | 3 | 0.50 | 0 | 3 | 3 | | 3.0 | 0.50 | 6 | 3 | 3 | | 50 kgs | work market | maize | 200 | manual | daily | 3.9 | | | machine | daily | 3.0 | 30 | 10.0 |
| 60 | 7 | 500<br>750 | 71<br>107 | 2 | 0.29 | 0 | 3 | 0 | | 4.5 | 0.64 | 7 | 4 | 7 | 2 | 100 kgs | coop | rice<br>millet | 600<br>600 | maid | daily | 4.5 | | | machine | daily | 4.5 | 45 | 10.0 |

## ANNEX 5

## COMMENT PREPARER CERTAINS DES PLATS LES PLUS COURANTS A BASE DE CEREALES LOCALES*

1. Moni

Peut se faire avec toutes les céréales. Mettre de l'eau dans la marmite et poser sur le feu. Tamiser la farine avec le mugu tèmè[44]. Retamiser avec le nilon tèmè. Mettre un peu de farine de côté qui servira de renfort pour les boules. Prendre la farine restante et mélanger avec un peu d'eau, faire des petites boules. Bien battre en ajoutant un peu de farine de temps en temps jusqu'à ce qu'elles deviennent dures et résistantes. Une fois l'eau bouillie, mettre les boules par portion dans la marmite en remuant régulièrement. Laisser cuire un peu. Ajouter du citron ou du jus de tamarin ou encore du vinaigre avec une pincée de sel. Quelques 5 minutes plus tard, ajouter du sucre, ensuite du lait caillé ou de la crème maturée selon les disponibilités.

2. Seri

Peut se faire avec toutes les céréales. Mettre de l'eau dans la marmite et poser sur le feu. Nettoyer et laver la céréale. Mettre la céréale dans l'eau bouillante. Laisser cuire. Ajouter une pincée de sel (si l'on veut). Ajouter du sucre et du lait caillé ou de la crème maturée.

3. Degué

Avec le petit mil. Former des boules plus petites que pour le moni ou de la même épaisseur. Mettre dans le couscoussier et poser sur la marmite contenant de l'eau bouillante. Laisser cuire pendant 15 à 20 minutes à la vapeur. Ajouter avec du sel, sucre vanillé, féfé, kafiné, fleur d'orange, et piment (si l'on veut). Enlever de la vapeur, ajouter du beurre et laisser refroidir. Mélanger le sucre avec de l'eau et ajouter du lait.

4. Lakha

On le fait exclusivement avec le petit mil. Mettre de l'eau dans la marmite et poser sur le feu. Tamiser la farine avec le nilon tèmè. Mettre la farine dans l'eau bouillante et laisser cuire. Ajouter du sucre, et ensuite du lait.

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*Cette section a été rédigée par Madame Fanta Mantchiny Diarra et revue par John Licthe.

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[44] tèmè = tamis. Le mugu tèmè donne une granulation moyennement fine. Le nilon tèmè donne une granulation très fine. Le basi tèmè donne une granulation plus grande.

5. Riz

Mettre de l'eau dans une marmite et poser sur le feu. Laisser bouillir. Ajouter un peu de margarine, ou à défaut un peu d'huile, et un peu de sel. Mettre le riz, fermer et laisser cuire à peu près 45 minutes.

6. Sauce Pâte d'Arachide

Mettre de l'huile dans la marmite et poser sur le feu. Couper la viande en petits morceaux, laver et mettre dans l'huile. Remuer, ajouter du sel et laisser cuire un peu. Ajouter ail, oignon, et poivre, remuer. Ajouter les
autres condiments: pâte d'arachide, tomate, soumbala, poisson séché, cube maggi, féfé, aubergine, courge et piment. Laisser cuire pendant 1 heure de temps. Quelques minutes plus tard, ajouter un peu de gombo frais ou du gombo séché.

7. Sauce Pâte d'Arachide et Feuilles Vertes

Acheter les feuilles vertes, les laver et les couper. Mettre sur le feu une marmite contenant de l'eau. Couper la viande en petits morceaux, laver et mettre dans la marmite. Ajouter les feuilles coupées. Fermer et faire cuire pendant 5 minutes. Mettre la pâte d'arachide en la remuant. Ajouter selon votre goût: un peu de poisson séché, soumbala, sel tomate et cube maggi. Couvrir à moitié pour que la pâte d'arachide ne colle pas au fond de la marmite. 15 minutes plus tard ajouter un peu de gombo en poudre, laisser cuire à petit feu doux, avec le couvercle incliné.

8. Sauce Tomate (Soupe Djabadji)

Mettre la marmite sur le feu et mettre de l'huile dans la marmite. Couper la viande en morceaux, laver et mettre dans l'huile. Remuer, ajouter du sel et laisser cuire un peu. Ajouter ail, oignon, et poivre; remuer. Ajouter une tomate fraîche, laisser cuire jusqu'à ce que l'eau s'évapore, et puis ajouter du concentré de tomate. Mettre de l'eau, la quantité qu'il faut (pour la quantité de sauce et épaisseur désirée). Ajouter tous les autres ingrédients: carotte, aubergine, cube maggi, féfé, choux pomme, courge, et si l'on veut poisson séché et macaronis. Fermer et laisser cuire 1 heure. A la fin de la cuisson ajouter, gombo frais ou poudre et piment.

9. Sauce Gombo frais (SOUPE KANDJAN)

Poser la marmite sur le feu et mettre 0,5 litre d'huile de palme. Couper la viande en morceaux, laver et mettre dans l'huile. Remuer, ajouter du sel, tomate fraîche et oignon. Laisser cuire un peu, puis ajouter du concentré de tomate. Laisser cuire jusqu'à ce que l'eau s'évapore. Mettre la quantité d'eau qu'il faut. Ajouter ail, poivre, féfé, poisson séché, soumbala, cube maggi, piment, aubergine plus le gombo coupé. Laisser cuire pendant 1 heure de temps.

10. Sauce Fakoyé

Vanner la quantité de feuilles de fakoyé. Mélanger le fakoyé avec du beurre de karité ou de l'huile d'arachide. Poser une marmite contenant une quantité d'eau sur le feu. Couper la viande, laver et mettre dans la marmite. Ajouter les autres ingrédients: soumbala, kabé, mafé djé, cube maggi, oignon, poisson séché, aubergine, piment poivre, sel et féfé. Couvrir et laisser cuire pendant

10 minutes environ. Ajouter le fakoyé en remuant pour décoller le fond de la marmite. Laisser cuire sur le feu. 15 minutes plus tard, baisser un peu le feu et laisser cuire à feu doux. A la fin de cuisson, ajouter du beurre de vache si possible.

11. Sauce Sagasaga

Bien laver les feuilles de patate et les couper. Poser la marmite sur le feu, mettre de l'huile de palme. Couper la viande en morceaux, laver, et mettre dans l'huile. Ajouter du sel, tomate fraîche, oignon, cube maggi. Laisser cuire pendant un bon moment. Mettre un peu d'eau. Ajouter du poivre, féfé, piment, poisson séché et feuilles de patate. Remuer. Couvrir et laisser cuire pendant 1 heure. Mettre enfin du gombo frais.

12. Sauce Yassa

Couper 5 kg d'oignon et assaisonner avec vinaigre, sel, cube maggi, poivre, ail écrasé, huile et laisser de côté. Couper le poulet en morceaux, bien laver, assaisonner et puis griller. Après avoir fini de griller, mettre le poulet dans une marmite avec 0,5 litre d'huile. Ajouter les autres ingrédients: carotte coupée, piment, ail, sel, poivre, choux, pomme de terre, poivron, et cube maggi. Mettre la quantité d'eau nécessaire. Laisser cuire jusqu'à ce que l'eau s'évapore. Ajouter maintenant les oignons bien assaisonnés. Fermer et laisser cuire pendant 1 heure de temps.

13. Sauce Domada

Couper la viande en morceaux et puis laver. Poser la marmite sur le feu et mettre de l'huile. Mettre la viande dans l'huile et ajouter du sel, tomate fraîche, concentré de tomate, et oignon. Mettre la quantité d'eau nécessaire. Ajouter poisson séché, cube maggi, ail, féfé, piment et une demi bouteille de vinaigre. Laisser cuire pendant 1 heure de temps et puis après mettre un peu de farine ou du gombo frais ou de la poudre de gombo.

14. Sauce Cari

Couper la viande en morceaux, laver. Poser la marmite sur le feu, mettre de l'huile et ensuite la viande. Ajouter sel, poivre, ail, poudre de cari, oignon, et cube maggi. Mettre la quantité d'eau qu'il faut. Ajouter les autres légumes: carotte coupée, navet, choux, piment, haricot vert, aubergine, pomme de terre, poivron, ou petits pois. Fermer et laisser cuire pendant 1 heure de temps.

15. Tö

Tamiser la quantité de farine nécessaire avec le mugu tèmè. Poser la marmite sur le feu contenant de l'eau et laisser bouillir. Mettre un peu de farine de côté. Prendre le reste de la farine en ajoutant de l'eau tiède et un peu de potasse. Mettre ce mélange dans la marmite en remuant. Fermer avec un couvercle et laisser cuire 5 à 10 minutes. Bien battre le mélange en ajoutant de temps en temps des petites quantités de la farine gardée à sèche. Continuer jusqu'à ce que le mélange soit dur. Couvrir et laisser cuire à petit feu.

16. Sauce Tomate

Voir numéro 8. Même procédure, mais souvent avec moins de produits maraîchers.

17. Sauce Gombo Frais

Acheter le gombo frais au marché en quantité suffisante. Laver, découper en petites tranches fines, et, si possible, l'écraser. Mettre la marmite sur le feu contenant un peu d'eau. Mettre du gombo frais, laisser cuire pendant 5 minutes en ajoutant un peu de potasse pour que les gombos se cuisent sans que la sauce ne se verse sur le feu. Ajouter du poisson séché ou du poisson fumé en poudre. Ensuite ajouter soumbala, cube maggi, et sel. 10 minutes plus tard réduiser le feu et laisser cuire à petit feu.

18. Sauce Gombo Séché

Piler le gombo séché en poudre. Mettre sur le feu la marmite contenant la quantité d'eau nécessaire. Ajouter du poisson fumé pilé en poudre, du sel et un cube maggi. Mettre la tomate et la viande (hâchée si possible). Après 5 minutes de cuisson, ajouter la poudre de gombo en la remuant pour que ça ne forme pas de grumeaux. Laisser cuire pendant 20 minutes.

19. Sauce Feuilles de Baobab

Enlever les feuilles jusqu'à la quantité de sauce désirée. Les piler jusqu'à ce qu'elles donnent une boule gluante. Mettre sur le feu la marmite contenant de l'eau. Mettre la boule en remuant. Ajouter du poisson séché ou du poisson fumé pilé, un peu de sel, du piment, un cube maggi, et un peu de potasse. Laisser cuire 5 à 10 minutes sans couvrir. Après 20 minutes de cuisson, la sauce est prête.

20. Couscous

Tamiser la farine avec le mugu tèmè. Mélanger la farine avec un peu d'eau pour former des boules très, très fines. Retamiser la farine avec le basi tèmè. Mettre la marmite sur le feu contenant la quantité d'eau désirée. Mettre la farine tamisée dans le couscoussier et poser sur la marmite. Couvrir le couscoussier. Faire cuire à la vapeur 5 minutes. Enlever la farine, la mettre dans une calebasse en écrasant les boules de farine. Remettre le couscous dans le couscoussier et laisser cuire 5 minutes de plus. Répéter à deux reprises. A la troisième reprise, ajouter un peu de poudre de baobab et reprendre la cuisson. 10 minutes plus tard enlever le couscous du couscoussier et le mettre au frais en remuant afin que ça ne forme pas de grumeaux.

21. Sauce Pâte d'Arachide

Poser la marmite contenant de l'eau sur le feu. Découper la viande en morceaux, laver et mettre la viande dans la marmite. Ajouter une tomate fraîche et couvrir avec un couvercle jusqu'à ébullition. Ajouter la pâte d'arachide en remuant et ajouter le sel, poisson séché, cube maggi, et haricots. Laisser cuire en goûtant de temps en temps pour déterminer s'il y a assez de sel.

22. Sauce Farine d'Arachide et Feuilles

Mettre de l'eau dans la marmite et poser sur le feu. Couper la viande en petits morceaux, laver et mettre dans la marmite. Ajouter les feuilles, mettre le couvercle et laisser bouillir. Quelques minutes plus tard, ajouter la farine d'arachide en remuant afin de décoller l'arachide du fond de la marmite. Ajouter les autre condiments: tomate, poisson séché, cube maggi, et sel. Laisser cuire pendant 1 heure de temps.

23. Sauce Tomate

Même procédure que le numéro 8. La sauce pour le couscous est souvent moins riche que pour le riz mais le couscous demande plus de sauce pour la même quantité de tö.

24. Yinyinkini = Brisure Sorgho Façon Riz

Bien laver et nettoyer une quantité de brisures. Mettre la marmite contenant de l'eau sur le feu jusqu'à ébullition. Mettre la brisure en remuant pour que ça ne donne pas de grumeaux. Ajouter un peu de sel et fermer. 10 minutes plus tard vérifier si la quantité d'eau est suffisante pour la cuisson et laisser cuire à petit feu.

Sauces

Le yinyinkini est employé avec les mêmes sauces que le riz. Souvent les familles soumises à des contraintes financières substituent le yinyinkini au riz. Ces familles avec des ressources limitées peuvent utiliser moins d'ingrédients que pour les sauces de riz.

25. Foyo = Couscous de Fonio

Utiliser le fonio décortiqué (plutôt que de la farine) bien lavé. Mettre le foyo dans le couscoussier et poser sur la marmite contenant une certaine quantité d'eau. Faire cuire à la vapeur 4 fois pendant 5 à 10 minutes. Remuer entre chaque passage de cuisson pour que le fonio ne colle pas.

Sauces

Les sauces employées avec le foyo sont souvent les mêmes que celles utilisées avec le riz. Les sauces: pâte d'arachide et tomate sont les plus communes. La granulation fine du fonio demande plus de sauce que pour la même quantité de riz. Le foyo est souvent préparé comme plat spécial pour le dimanche et l'on peut utiliser plus de viande qu'à la normale.

26. Laro

Piler de l'arachide, tamiser pour avoir de la poudre fine. Très bien laver le fonio. Poser la marmite sur le feu et mettre de l'eau pour bouillir. Ajouter la viande hachée, poisson séché, sel, piment, feuille d'osseille, et la tomate fraîche. Laisser cuire. Ajouter la poudre d'arachide et le fonio. Remuer et fermer, laisser cuire pendant 1 heure.

27. Lafiri

Bien laver le fonio. Mettre de l'eau dans la marmite et poser sur le feu jusqu'à ébullition. Mettre le sel, piment, aubergine, gombo frais et cube maggi dans la marmite, laisser cuire pendant 30 minutes. Ajouter le fonio, laisser cuire pendant 30 minutes. Mettre le soumbala au milieu du fonio, fermer et laisser cuire à feu doux pendant 15 minutes. La cuisson terminée, ajouter l'huile de palme.

Sauce

On peut préparer une sauce de viande à côté pour bien augmenter le goût: Poser la marmite sur le feu et mettre de l'huile. Hâcher la viande et mettre dans l'huile. Ajouter tomate, sel, poivre, féfé, oignon, et cube maggi. Laisser cuire jusqu'à ce que l'eau de la cuisson s'évapore. Arroser le lafiri avec la sauce.

28. Djouga

Utiliser 1 kg de fonio pour 2 kg d'arachides. Piler le fonio et vanner. Laver plusieurs fois. Mettre dans un linge propre pour l'égoutter. Mettre de l'eau dans une marmite et poser sur le feu. Poser le couscoussier sur la marmite et mettre l'arachide dedans pour faire passer à la vapeur pendant 10 à 15 minutes. Enlever l'arachide du couscoussier et piler pour avoir de la poudre. Mettre le fonio dans le même couscoussier. Donc la cuisson prend 15 à 20 minutes. Mélanger la poudre d'arachide cuite avec un peu de potasse et ajouter le fonio. Renouveler la cuisson en fermant le couscoussier avec un couvercle hermétiquement fermé jusqu'au moment du dîner. Mettre de côté une sauce de poudre de gombo pour assaisonnement.
Ingrédients: aubergine et piment selon le goût.

29. Ragoût d'Igname

Eplucher l'igname, le couper en morceaux et le laver. Poser la marmite sur le feu et mettre un peu d'huile. Couper la viande, laver et mettre dans l'huile. Ajouter un peu d'oignon, sel et tomate fraîche. Remuer et laisser cuire un peu, puis ajouter du concentré de tomate. Ajouter de l'eau, poivre, cube maggi et ail. Enfin, mettre l'igname. Fermer et laisser cuire 30 minutes.

30. Foutou d'Igname

Laver et couper l'igname, mettre dans une marmite contenant de l'eau et du sel et faire bouillir. Une fois que l'igname est bien cuit, piler dans un mortier et faire une pâte. Former la pâte en boules. Fermer les boulettes dans un récipient propre.

Sauce

Poser la marmite sur le feu et mettre de l'huile. Couper la viande en morceaux, laver et mettre dans l'huile. Ajouter de la tomate fraîche, sel, du concentré de tomate et oignon. Remuer et laisser cuire quelques minutes. Ajouter de l'eau, piment, sel, poivre, ail et cube maggi. Fermer et laisser cuire pendant 30 minutes. Servir les boulettes d'ignames et la sauce dans des bols différents. Tremper les morceaux de foutou dans la sauce en mangeant.

31. Tö de Manioc

Voir numéro 15. Souvent préparé avec une mélange de farine de manioc et de la farine de fonio.

Soupe de Poisson

Poser la marmite sur le feu et mettre un peu d'huile. Couper le poisson en morceaux et laver. Mettre une tomate fraîche, oignon, sel, et du concentré de tomate dans la marmite, remuer, et laisser cuire un peu. Ajouter de l'eau, cube maggi, poivre ail et féfé. Fermer et laisser cuire 30 minutes. Ajouter les morceaux de poisson et laisser cuire 15 minutes.

32. Atcheké

Mettre l'atcheké (manioc, granulation fine) dans un récipient, arroser avec de l'eau et laisser pendant 15 minutes. Faire frire le poisson. Prendre 5 gros oignons, laver et couper. Ecraser le piment avec d'ail, poivre, cube maggi et sel. Remuer l'atcheké avec du sel, huile, vinaigre les oignons coupés et le piment écrasé. Laisser cuire pendant 30 minutes. Servir avec les poissons frits.

33. Pâte Alimentaire

Poser la marmite sur le feu, et mettre un peu d'huile dans la marmite. Couper la viande en morceaux, laver et mettre dans l'huile. Remuer, ajouter du sel et laisser cuire un peu. Ajouter une tomate fraîche, concentré de tomate et oignon. Laisser cuire jusqu'à ce que l'eau s'évapore. Mettre de l'eau et ajouter du poivre, ail et cube maggi. Fermer et laisser cuire 30 minutes ou jusqu'à ce que la viande soit bien cuite. Faire bouillir les macaronis avec un peu de sel. Ajouter les macaronis à la viande et remuer. Chauffer l'ensemble encore pendant 5 minutes.

34. Couscous Arabe

Mettre le couscous dans un bol. Mettre un peu d'huile dans le couscous et remuer. Arroser le couscous avec de l'eau et mettre dans le couscoussier. Poser le couscoussier sur une marmite contenant de l'eau bouillante. Laisser cuire à la vapeur pendant 15 à 20 minutes.

Sauce

Poser la marmite sur le feu et mettre un peu d'huile. Couper la viande, laver et mettre dans l'huile. Ajouter du sel et oignon. Remuer et laisser cuire un peu. Ajouter une tomate fraîche et du concentré de tomate et laisser cuire jusqu'à ce que l'eau s'évapore. Ajouter de l'eau, poivre, ail et cube maggi. Fermer et laisser cuire pendant 30 minutes.

35. Niougoubala yelin

Tamiser la farine avec le mugu tèmè. Mélanger la farine avec un peu d'eau pour former des boules très très fines. Retamiser la farine avec le basi tèmè. Mettre la marmite contenant une certaine quantité d'eau sur le feu et faire bouillir. Mettre la farine tamisée dans le couscoussier et poser sur la marmite. Après 5 minutes enlever la farine et mettre dans une calebasse en écrasant les boules de farine. Remettre le couscous dans le couscoussier à deux reprises. Découper les feuilles

d'arachide en petites tranches fines. Laver et égoutter les feuilles. Mélanger les feuilles avec un peu de potasse. Mettre un peu de couscous au fond du couscoussier, ajouter les feuilles d'arachide en les recouvrant avec le restant du couscous. Fermer le couscoussier avec un couvercle hermétiquement fermé. Laisser cuire pendant 30 minutes, mais de temps en temps, vérifier si les feuilles sont cuites. Enlever le couscous, mettre dans une calebasse et assaisonner avec de la poudre de sel, du beurre de karité et un cube maggi écrasé.

36. Ouidjila

Découper la viande en gros morceaux et laver. Mettre une quantité d'huile dans une marmite et laisser chauffer sur le feu. Mettre la viande dans l'huile, ajouter quelques tranches d'oignon , du sel et de l'eau. Fermer avec un couvercle et laisser cuire 5 à 10 minutes. Ajouter poivre, féfé, tomate fraîche, concentré de tomate, kabé, mafé djé et des oignons non découpés. Fermer et laisser cuire à feu doux.

## ANNEX 6

## RDTM RADIO AND TELEVISION ADVERTISING RATES

MINISTERE DE L'INFORMATION
ET DES TELECOMMUNICATIONS

-:-:-:-:-:-:-:-:-

AGENCE MALIENNE DE PRESSE
ET DE PUBLICITE (AMAP)

-:-:-:-:-:-:-:-

DIVISION PUBLICITE

Tél : 22-57-67

-:-:-:-:-:-:-:-

REPUBLIQUE DU MALI

Un Peuple - Un But - Une Foi

-:-:-:-:-:-:-:-

-:- TARIF DE PUBLICITE TELEVISION -:-

Pour compter du 2 Janvier 1990 Tarif de Publicité TV : en francs CFA hors taxes

| HORAIRES | 15" | 20" | 25" | 30" | 35" | 40" | 45" | 50" | 55" | 60" |
|---|---|---|---|---|---|---|---|---|---|---|
| 19 heures 55 à 20 heures 00<br>20 heures 30 à 20 heures 40 | 42 666 | 47 402 | 52 138 | 56 875 | 66 515 | 76 155 | 85 800 | 93 058 | 100 316 | 107 575 |

N.B. : A ce tarif il convient d'ajouter taxes TL 15% (LIS) + 10% les Samedis, Dimanches et jours fériés, les frais techniques

Réalisation Film : A la charge du client sur Devis

Emissions de 5 minutes : Interviews, reportages etc ..... 250 000 F CFA

Annonces Spectacles : 92 000 F CFA

Matériels nécessaires : Film de 16m/m son optique (couleur) PAL Video 13 pour VPR
2 B - Video 3/4 de Pouce UMATIC

Délai de Diffusion : Elément à remettre à l'AMAP 3 semaines avant Programmation non compris examen par la commission de Censure

Publicité en faveur des Produits Pharmaceutiques : avec visa

Interdiction : Tabac - Alcool

N. B. : Degressif de 25% sur la diffusion pour les Produits Nationaux "Consommer Malien" A compter du 1er Octobre 1987

Bamako, le 2 Janvier 1990

MINISTERE DE L'INFORMATION
ET DES TELECOMMUNICATIONS
==========
AGENCE MALIENNE DE PRESSE
ET DE PUBLICITE (AMAP)
==========
DIVISION - PUBLICITE

REPUBLIQUE DU MALI
UN PEUPLE - UN BUT - UNE FOI
==========

-:- TARIFS DES MESSAGES PUBLICITE RADIO -:-
(F CFA)
Pour compter du 1er Janvier 1987

| | PREMIERE TRANCHE | DEUXIEME TRANCHE | TROISIEME TRANCHE |
|---|---|---|---|
| SEMAINE | 6H 00 à 6H 30<br>13H 00 à 13H 30<br>18H 00 à 18H 30 | 7H 30 à 8H 00<br>13H 00 à 14H 30<br>21H 15 à 24H 00 | 6H 30 à 7H 10<br>14H 30 à 17H 30<br>19H 00 à 20H 30 |
| SAMEDI, DIMANCHE ET JOURS FERIES | | | 8H à 12H 30<br>13H 30 à 17H 30<br>18H 00 à 19H 30<br>19H 40 à 21H 00 |
| MESSAGE JUSQU'A 15 SECONDES | 3 750 F CFA | 5 000 F CFA | 6 250 F CFA |
| MESSAGE DE 15 A 30 SECONDES | 4 065 F CFA | 5 940 F CFA | 7 190 F CFA |
| MESSAGE DE 30 A 45 SECONDES | 5 000 F CFA | 7 500 F CFA | 8 750 F CFA |
| EMISSION DE 45 A 60 | 5 625 F CFA | 8 750 F CFA | 10 000 F CFA |
| EMISSION DE 60 A 90 DONT 60 DE PUBLICITE | 6 250 F CFA | 10 000 F CFA | 11 250 F CFA |
| EMISSION DE 2 A 3MN DONT 1MN DE PUBLICITE | 10 000 F CFA | 15 000 F CFA | 16 250 F CFA |

PRIX FORFAITAIRE POUR LES ORGANISATIONS DEMOCRATIQUES : 3 750 F CFA la diffusion
TAXE : I.A.S. 15°/o en plus

Bamako, le 13 / 11 / 1986

ANNEX 7

# INTSORMIL UTILIZATION ACTIVITIES IN MALI

Dr. Lloyd W. Rooney, Texas A&M University

## Program Thrusts and Achievements

Varietal Development and Evaluation: The food technology laboratory since its inception was designed to work very closely with the breeding and improvement programs especially on sorghum and millet. The laboratory identified the major food systems in which sorghum and millet were consumed in Mali and adjacent countries. A strategy for developing sorghum varieties with acceptable and improved processing quality was evolved. Mali was the first country in Africa to integrate food technology into a crop improvement program on a practical workable basis. This was done through a combination of INTSORMIL and ICRISAT bilateral efforts. Over a period of several years, methods for evaluation of sorghum were developed and essential factors affecting sorghum quality were determined. Most of these findings were very important to international sorghum improvement efforts and are in fact the basis for current evaluations of sorghum quality in many areas of the world.

Some of these accomplishments were:

1. Development of a mini tô test to evaluate the texture of thick porridges.
2. The need for thick pericarp sorghums because of their ease of pericarp removal during pounding.
3. The need for hard endosperm sorghums for good decortication ease and good tô quality.
4. The effect of head bugs and moulds on grain deterioration and loss of food quality.
5. The fact that poor tô taste was in fact poor texture and had little to do with actual taste.
6. The development and release of Malisor sorghum lines with processing quality of clearly defined quality.
7. Malisor 7 is the only improved variety in west Africa that has some resistance to the headbugs. It is a very hard grain with a thick pericarp and hard endosperm, tan plant color with excellent milling characteristics and tô properties.
8. Pearl millets with different kernel characteristics were milled and processed into various products. A major problem with millet was the very poor milling yields obtained with the souna millets that have long slender kernels which break into pieces during decortication. The best milling kernels have spherical or circular kernels.
9. Millet with thick pericarps were observed to have in general better milling properties.
10. The properties of pearl millet varieties did not differ significantly in tô properties other than milling yields.

## Food Processing and Product Development

The laboratory has conducted cooking trials to produce sorghum or millet based foods in the laboratory and in villages and in urban areas. These trails have involved cooperative efforts of several agencies over the years. Some of the major accomplishments are:

1. Weaning Foods - Blends of cowpea with millet and sorghum were formulated to produce porridges with increased nutritional value for infants. These trials were conducted in several villages by feeding young children. Brochures in Bambara and French describing the process for millet and cowpeas were printed and used in extension programs. The technology was applicable to the village level. Peanuts were used in some formulations.
2. Composite flour products - Various blends of sorghum millet flours with wheat flours were baked into cookies, breads and other products to demonstrate the potential uses of sorghum and millet flours.
3. Dried flours for tô - A method to produce flour for porridge that can be stored for several weeks has promise. The grain is soaked in alkali, sun dried and milled. The flour has some tolerance to insects during storage and does not go rancid. It has been tried in some village trials but is not commercially used to my knowledge.
4. Parboiling of sorghum and millet - The process has been adapted to Malian conditions but has not been tried extensively except in a large trial in Bamako which was plagued by problems of inadequate supervision to produce a good quality product. The results considering some of the problems were quite encouraging.

   The process is energy intensive but a recent modification requires only soaking followed by one boiling. This procedure produces increased breakage of the sorghum but the broken kernels of grain are highly desirable as a substitute for couscous, riz au gras, and other dishes.

   Millet is promising for parboiling because of its enhances stability. The mousy aroma that develops in milled millet is controlled by parboiling apparently because an enzyme is inactivated by the heat.

5. Decorticated sorghum - Grits and meal from sorghum can be cooked as rice-like products if parboiling is unacceptable. The major problem is the poor shelf stability and slimy texture that is undesirable to some consumers.

**Technical Assistance to Mali:**

1. Training: Two Malian scientists were provided short term training in laboratory procedures and analysis.
2. A Malian student completed a Master of Science degree in Food Science and Technology and returned to Mali.
3. Since 1979, Lloyd W. Rooney, Professor, Food Science and Technology has spent two weeks per year in Mali with significant time spent on Malian activities in the USA.
4. Procedures used in Mali were developed first in United States and transferred to Mali through INTSORMIL and ICRISAT.
5. Laboratory analysis to support the Malian lab has been done since 1979.
6. Laboratory equipment was bought, shipped, installed and demonstrated in Mali. A number of donors have supplied pieces of equipment including Canada and France primarily because of our efforts in INTSORMIL and ICRISAT.
7. The laboratory was designed and built jointly with ICRISAT-Mali.

**Resources Committed to the Food Technology Lab:**

The financial support given to the laboratory from INTSORMIL has been very modest over the years. The program has been provided with adequate support to function collaboratively with the crop improvement programs, but there hasn't been funding for efforts to do a great deal of village trials including nutritional and marketing research. Limitations of budgets and personnel have been a major constraint.