

Demand for Millet Processed Products in Mali and Burkina Faso

Ababacar Ndoye,¹ Botorou Ouendeba,² and John H. Sanders³

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Abstract

Cereals pass from staples to processed foods and feeds with economic growth. The demand for cereals and tubers substantially declines with economic growth as high value products including animal products, fruits and vegetables become much more important in the diet. However, for the short run (next five years) rapid population growth is expected to be the principal factor maintaining demand growth. Moreover, as the prices for the processed traditional millet products are reduced 30% from their present high levels, the increased consumption by lower and middle income consumers would double the demand growth for these processed products over the next five years.

On the farm technological change enables a reduction in costs per output unit and therefore prices can decline with many farmers still making money. However, with a too rapid price decline farmers are discouraged from making the investments and increased expenditures necessary for the added inputs associated with technological change. Moreover, the substantial rainfall variation in the Sahel combined with the lack of secondary markets can lead to price collapses in good rainfall years. Therefore, an important component of introducing new technology for millet and sorghum is developing the secondary markets. The primary market is the unprocessed threshed grains. The secondary market reduces or avoids these price collapses.

We are investigating the actual and the potential growth of two of these secondary markets, millet food processing and the use of sorghum in animal feed. In this paper we are focusing on the first with the provision that there is some substitution of sorghum for millet especially in poor rainfall years but a general preference for millet over sorghum in the urban areas of the Sahel.⁴

In spite of the small size of the millet food processor sectors in the urban areas in both Burkina and Mali relative to the extent of millet food production in these countries there has been substantial investment by donors in machinery and hygiene training.⁵ So this sector has evolved and produces high quality products for the diaspora of people from the Sahel in Europe and the US, for high income domestic consumers, and for special occasions for middle and lower income consumers in Mali. For this sector to evolve rapidly millet food processors need to reduce costs so that they can obtain increased consumption from low and middle income consumers. Secondly, expansion of the number of farmers'

¹ Former Director General of "Institut de Technologie Alimentaire" Dakar - Sénégal , Member of the National Academy of Science and Techniques (ANSTS) , B.P.4344 Dakar - Sénégal

² Director of the 3N program in Niger, Niamey, Niger

³ Professor of Agricultural Economics, Purdue University, West Lafayette IN, 47906 jsander1@purdue.edu

⁴ With the substantial increases in maize yields during the last two decades with new technologies many consumers are shifting to the lower cost maize for their "tô".

⁵ This sector predominantly includes female entrepreneurs and substantial local female employment.

associations producing clean millet can enable a reduction in the number of stages in the marketing process and thereby reduce costs and prices.⁶

So we document the potential for these two sources of cost reduction and then estimate how much this could facilitate the growth of this millet processing sector. Then we compare the effects of these price declines with the effects of population and income growth over the next five to ten years. There are substantial income, nutritional, and health benefits to low income consumers from the evolution of this secondary market as they increase access to lower cost processed millet products. Moreover, the shift from disk mills to hammer mills would have important health effects on consumers by reducing or eliminating the metal residues in the millet flour. Finally, on the horizon is a potential major shift in this demand from bakers for millet flour with the availability of technology improvement for increased millet flour shelf life.

In the conclusions we review the various measure to facilitate this evolution of the millet food processing sector in the Sahel.

Introduction

The objective of this report is to estimate the present and the potential impacts that this sector can have on the demand for millet in Mali and Burkina Faso. We will first consider the importance of millet products in the diet and then summarize the present state of this sector. An important determinant of the growth of the millet processor sector is the increasing availability of clean millet. An increased supply of clean millet with the evolution of the farmers' organizations can lead to both reduced purchase costs and to a consolidation of the market structure with farmers and processors receiving larger shares of the marketing margin. More efficient firms and improved market structures can result in cost and price decreases. These price declines can enable market expansion, increase the demand for millet, and thereby raise farmers' and processors' incomes. A quantitative section will estimate the effect of the price reducing changes on demand growth expected from the cost reductions made possible from technological and marketing changes. Moreover, the demand analysis will include the effects of income and population growth. The conclusions outline the strategy to obtain these gains in the production and marketing system. A final section proposes some measures to achieve this objective of reducing the costs in the systems enabling price declines and thereby increasing the ability to compete with rice and neighborhood women buying less processed millet and having it processed locally.

Millet Consumption in the Neighborhoods

Millet is not only a basic cereal staple it is also made into a series of other products for which there is substantial demand in Burkina Faso and Mali. So here we review the millet consumption pattern in the neighborhoods for three income classes. Rather than going into a full consumer survey we interviewed the millet processors about consumption patterns in their neighborhoods. They should know present consumption trends because their sales depend upon this.

⁶ Note that this consolidation of the marketing sector would also enable farmers through the farmers' associations to obtain a larger share of the marketing margin with further incentives for increased technology use. But there would be some contesting between processors (or wholesalers) and the farmers' associations over these reduced costs in the marketing process.

The low income sector eats millet products 1 to 3 times per day (see Table A-1). But it was estimated that only one-half of the low income households in the sample could buy these processed products. There are also a range of other products made from millet that people eat occasionally. So this occasional consumption of other millet products and the preferences that people have for the processed products, such as various kinds of grumeaux, degue and couscous (see product descriptions in A-2), indicates a strong potential demand as incomes increase. To facilitate this demand growth the processors need clean millet.

Demand for Clean Millet

Mali

Millet processing requires an increasing supply of clean millet. Consumers want clean millet without sand, dirt, or rocks. Dirty millet results from cutting the heads and putting them on the ground, threshing on the ground,⁷ or deliberate activities to adulterate the grain. Processors want clean millet to protect their machines, to save time and expense in the cleaning operation, and to maintain their reputations for producing a quality product.

In Mali and Burkina there is a focus on the demand for higher quality millet cereal and this is changing the marketing system. The sector of processed millet is still small⁸ but is having a role in these changes. Moreover, there is an important evolution in the demand for processed millet, traditional products. Presently these products are marketed principally for high income consumers especially the diaspora in France and the US. Also in the neighborhood (“quartiers”) there is a demand for these products for special occasions.

Now in 2014 in Bamako, there is a focus on buying a higher quality product (fewer impurities) and processors are willing to pay a price premium, over 20 cfa/kg. Even the merchants (“commerçants”) interviewed expressed concern about a quality product and one merchant noted that he gave refunds to his processor buyer for the impurities she separated out in the cleaning process.

Moreover, in the rest of the value chain for millet marketing there are adjustments reflecting the greater appreciation of quality of the millet supply. For example, one of the collectors for Misola (infant nutrition firm) and OPAM (Office des Produits Agricoles du Mali-the national grain storage program to moderate the price swings of the staples) has been providing new sacks and riding in the trucks transporting the grain to prevent the theft and adulteration often occurring in the transportation process.⁹

⁷ The traditional activity of mortar and pestle can also keep the millet clean. But as production and productivity increases the women doing this operation get overwhelmed and there have been shifts as in the Segou region to threshing by running over the millet with trucks or tractors.

⁸ Of the 28 firms interviewed they were only processing 797 tons of millet. Adding in the infant food maker (Misola) and the food aid buyer for the United Nations, (PAM), gives another 10,492 tons (Ndoye, Ouendeba, and Sanders, April 2015, pp.2,14-16). The sector is very small compared with the 1.4 million tons of millet produced annually in Mali (Jazayeri, 2014, p. 16). From this total supply 20 percent (280,000 tons of millet) is marketed to urban areas (Jazayeri, 2014, p. 2). But only 3.7% of the millet entering the urban market is passing through these millet processors and that is also including infant food and the relief food purchases.

⁹ In another illustration of the importance of preventing adulteration and theft in the transportation process we note the example of Thiare, Senegal where the farmers’ association always sends a farmer to accompany the truck

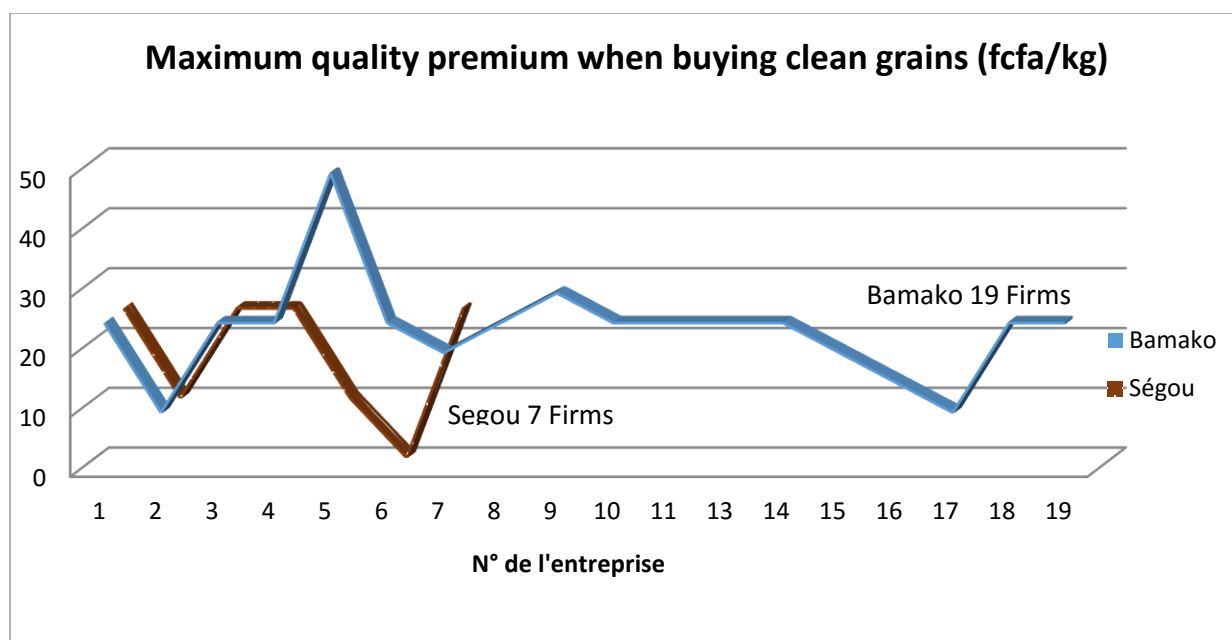


Figure 1. Premium prices (fcfa) per kg paid for cleaner millet by Bamako and Segou millet processors

Source: Field interviews September 2014

Burkina Faso

In Burkina Faso the millet processing sector is much smaller and less developed than in Mali. The enterprises are almost entirely of the local neighborhood variety.¹⁰ The concept of clean seed is known in the farmers' associations and by the processors. However, it is much more expensive for the millet food processors to obtain clean millet than in Mali. The principal hypothesis for the difference is the failure to introduce new millet technologies in the principal production zones of millet in Burkina in contrast with the rapid introduction of this technology in the principal millet production zones of Mali.¹¹ Without an increased marketed surplus there is little clean millet available hence higher prices for it. Moreover, the lack of the clean millet means that the market structure still stays more complicated with a lower share of the marketing margin for farmers. In Burkina Faso the collectors had an important role in aggregating sufficient quantities of clean millet for the processors (see the market structure section

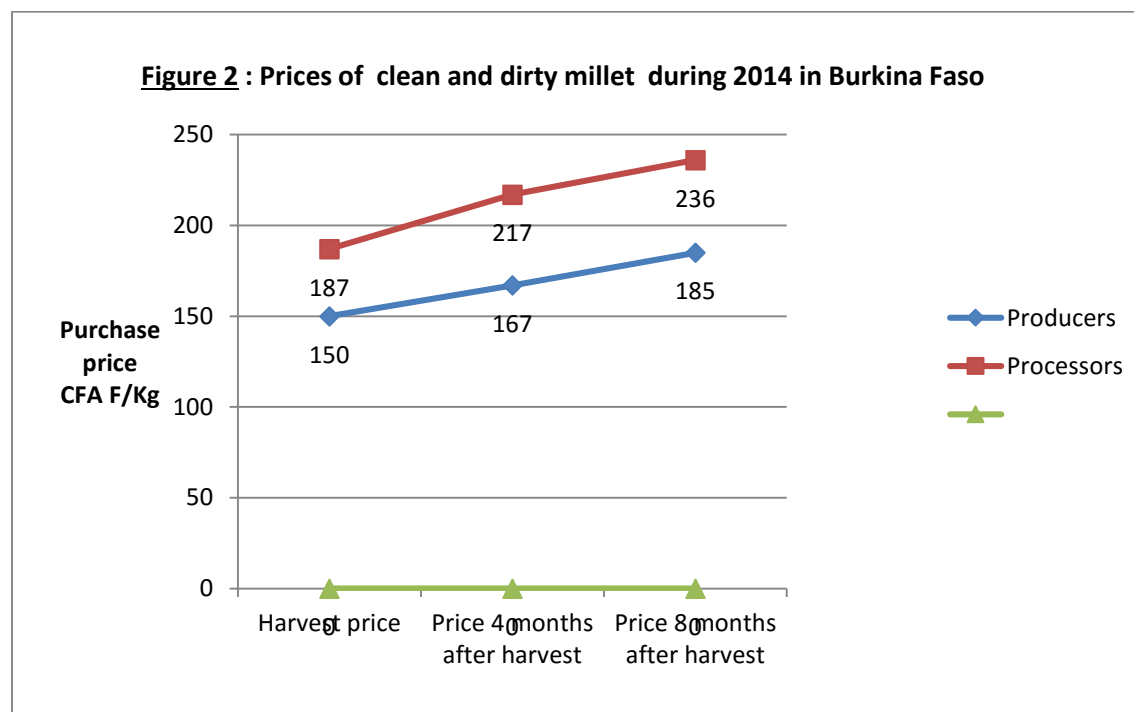
to Dakar with their clean sorghum to prevent both. This farmers' association is a leader in both modernizing the production and building marketing ties with the food processors. They have regular sales of 20 tons/month of millet to the food processors' association of Dakar.

¹⁰ See the Mali country paper (#1) on millet processing for a separation of types of firms.

¹¹ In Segou and Mopti, Mali an intermediate height millet was combined with two to three sacks of inorganic fertilizer to obtain yields 400 to 600 kg/ha higher than local cultivars. This was combined with various marketing techniques of the farmers' associations. These included storage and later sales, selling in larger quantities to later stages of the marketing chain, getting a price premium for clean cereal. In Burkina the same tall cultivars with little or no inorganic fertilizer do not give an increased marketed surplus.

below). Improvements in the agricultural technology are expected to drive changes in the marketing and in the processing sector.

If we compare the price processors had to pay to get clean millet with the price in the villages for ordinary millet (Figure 2), we get a price premium similar to what the processors in Mali had to pay to the farmers' association to get clean millet. This price premium was generally in the 15 to 25 cfa/kg range in Mali. In contrast in Burkina Faso half the millet processors bought either from collectors or other merchants in the marketing chain. So the price processors had to pay for quality ranged from 37cfa/kg at harvest to 50 cfa/kg four months later and 51 cfa/kg eight months later.



^a Mean prices for the clean millet were from 17 firms. The prices for the dirty millet bought in the village were obtained from eight firms.

Source: unpublished field data from the interviews

Competition for the Millet Processors:

What are the products that the millet food processors need to compete with? There are two sources of competition for the millet processors. First millet products have to compete with other cereals and secondly they have to compete with consumers buying the unprocessed millet and making the processed products themselves using neighborhood dehullers and millers.

The lowest cost cereal staple is the broken rice at around 300 cfa/kg in both countries (Figures 3 and 4). All millet products begin with the flour including the basic dishes of most of the rural population, "tô", and "bouillie", a thick porridge for a breakfast cereal. Note that the millet flour presently retails at about 2 and 1/2 times the price of rice in both countries.

Figure 3. Average retail prices of broken rice and millet products in Bamako, Mali, 2014

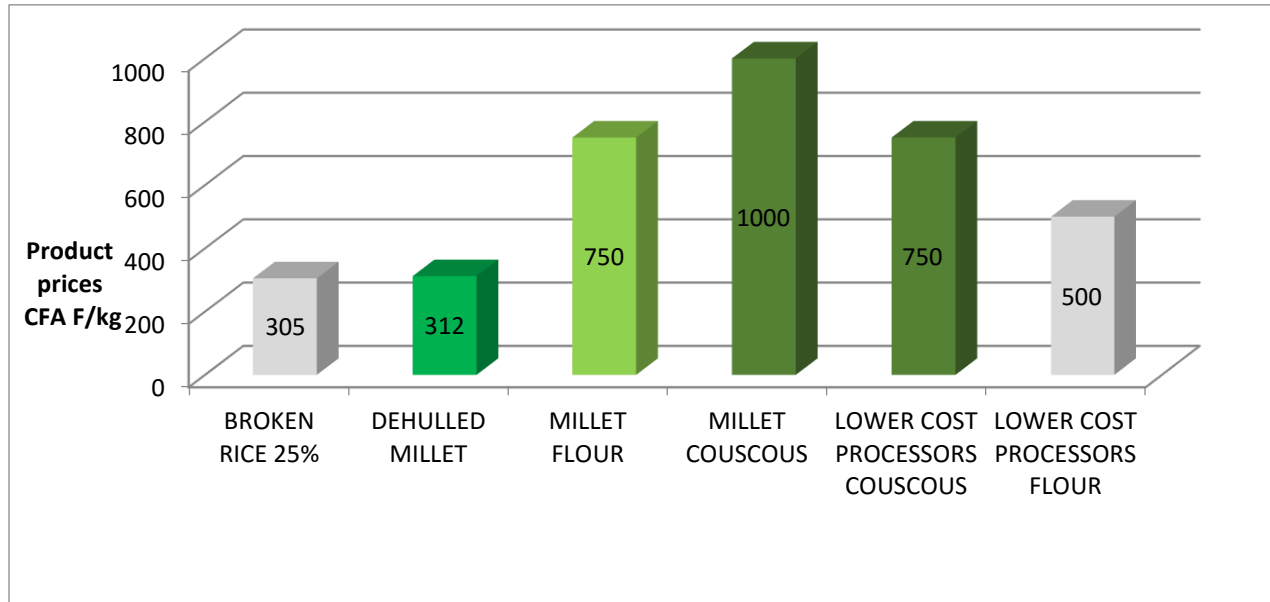
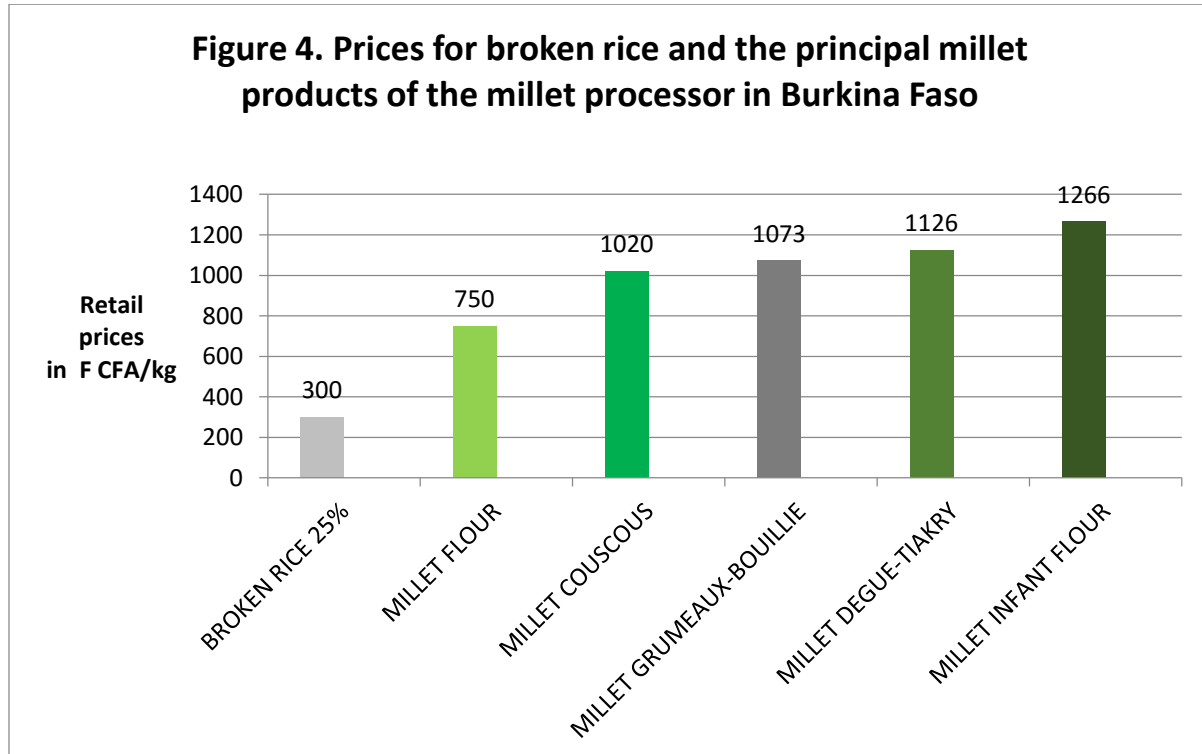


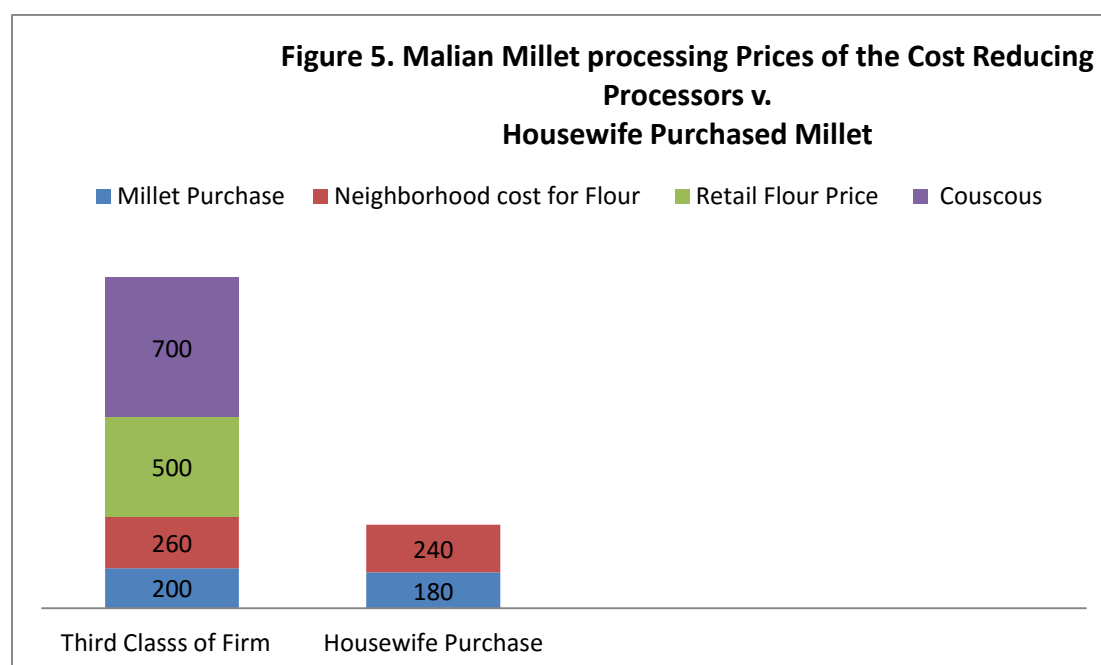
Figure 4. Prices for broken rice and the principal millet products of the millet processor in Burkina Faso



Hence, substantial price decreases are necessary to move millet processed products from a higher income and special occasion products to capture more of the regular market for low and middle income

consumers. But note that in Mali some of the millet processors have been able to reduce their costs of production by 1/3 for millet flour and 25% for couscous. In Burkina Faso we did not observe this type of cost savings, nor did we observe a sub sector of processors trying to produce at lower costs for the domestic market in Burkina Faso.

Millet processors also have to compete with the households buying the raw millet. Households can buy and process (dehull and mill) millet into flour for about the same price as the broken rice. Again there is the comparison of 500 cfa/kg for the flour in Mali produced by the lower cost processors but still 750 cfa/kg in Burkina Faso (Figures 5 and 6). Hence, it is clear why there are few purchases of millet products by low and medium income consumers. These techniques for cost savings in Mali can be followed by other processors in both Mali and Burkina Faso. Nevertheless, the millet flour price is still double that of the housewife, who purchases the raw millet and has it processed in the neighborhood. So we need to search for further cost reduction when we consider the market structures. First let's look in detail at where the cost savings come from.



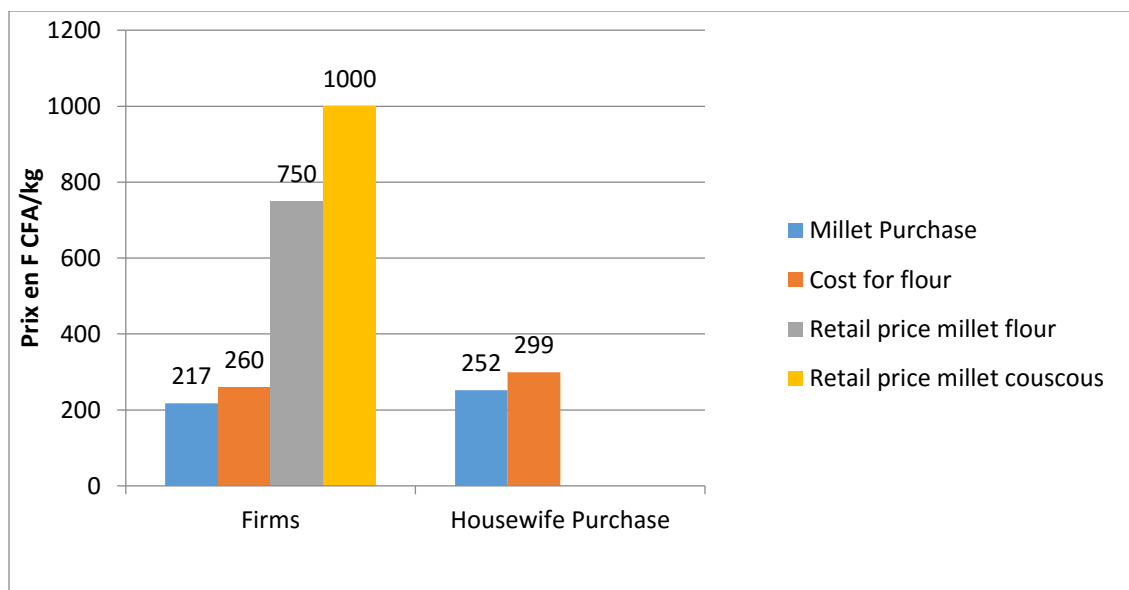


Figure 6. Burkina Millet Processors' Prices Competing with Household Buying the Raw Millet and Processing it Themselves

Cost Reductions and Market Structures:

Here we consider first the method used by these Low Cost Processors in Mali to reduce their costs and prices (Ndoye et al. 2014 for the Mali background paper). Then we give an example of the potential cost savings from changes in the market structure.

Mali has a small group of low cost processors producing for the domestic market and often furnishing the neighborhood processors with the dehulled millet. These processors are able to do this with the greater availability of clean millet and the recognition of the need to reduce costs to be competitive with broken rice and with households doing their own purchases

In Segou a new machine has been introduced that can handle 30 tons/day so it offers the potential of providing millet processors with very clean and uniform millet in large quantities (Picture 1). Note the rocks and other debris separated by this machine (Picture 2). The extent and the size of the



Picture 1: The cleaning machine in Segou, 2014



Picture 2. Debris from the cleaning operation, Segou. 2014

rocks indicates the other problem of reducing impurities when the collectors or farmers adulterate the millet. Cleaner millet from the farmers' association sold for 125 cfa/kg (interviews with processors from Segou, Sept 2014). This wholesaler with the cleaning machine paid his collectors 175 cfa/kg for clearly adulterated millet). A saving of 50 cfa/kg could have been partially passed on to processors and then partially passed on to consumers. This is the type of market structure reform that needs to be accelerated to attain the second cost savings in the system by removing the number of stages of marketing and enabling the farmers' associations and processors to share parts of these marketing .

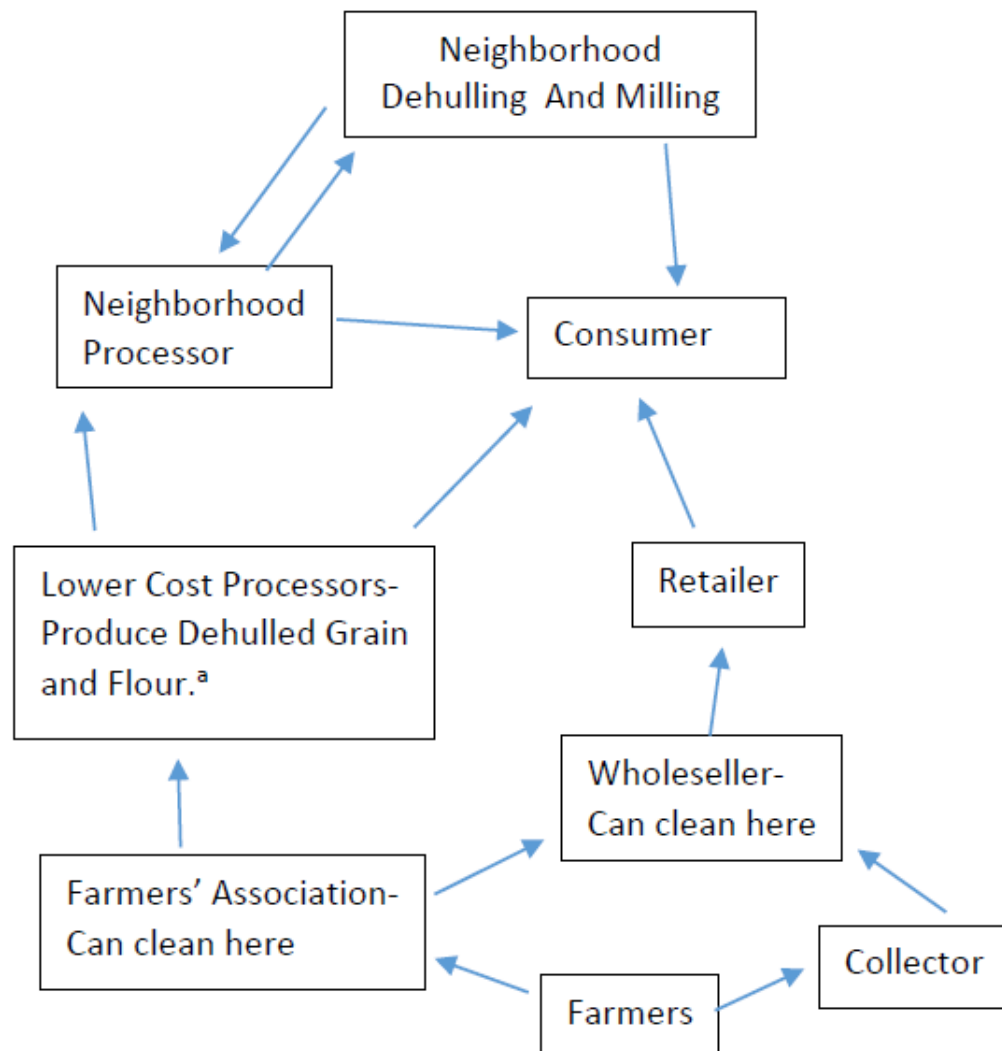
Thus the second cost reducing factor is the simplification of the marketing process. The marketing process has been Farmers to Collectors to Wholesalers to Processors or to Retailers and then to Final Consumers (adapted from Jayazeri, 2014,). With the development of Farmers Associations introducing new millet technologies, aggregating the cereal into large volumes and cleaning it, the skipping of at least both collectors and regional markets and selling directly to the wholesalers is the natural evolution of the market structure (for evidence of this process in Mopti and Segou see Sanders et. al., 2015, pp. 8-10). The biggest gains though are when the millet food processors buy directly from the farmers' associations. Then the wholesaler can also be avoided. This requires that the processors expand more rapidly to take advantage of higher millet yields and greater supplies of clean millet. Moreover, the farmers associations will need to assure the buyers for the processors of the quality of their clean millet (see Recommendations).

In summary the new marketing system can be Farmers' Associations to either Wholesalers, who perform critical functions of cleaning on a large scale or the clean millet can be provided by the farmers associations directly to processors. So the marketing structure in Mali has various options.

The small sector of the Lower Cost Producers in Mali for the domestic market has been able to expand by taking advantage of the increasing availability of clean millet. The high prices paid by the wholesaler with the cleaning machine for the adulterated millet shows the potential for further gains from improving the quality of the millet received. With the increasing importance of the farmers' associations in providing clean millet the role of the collectors will be decreased. This will enable cost savings for the processors and higher prices for farmers in the farmers' associations. Obviously there will be competition over these gains from the cleaning and the market consolidation process.

In Burkina Faso the market structure is very similar except for the absence of the low cost processors and a much larger role for the collectors due to the lower supplies of clean millet. Some of the retail merchants even became collectors going to the village markets as farmers sell small quantities during the year.¹²

Figure 7. Present Structure of Millet Marketing in Mali

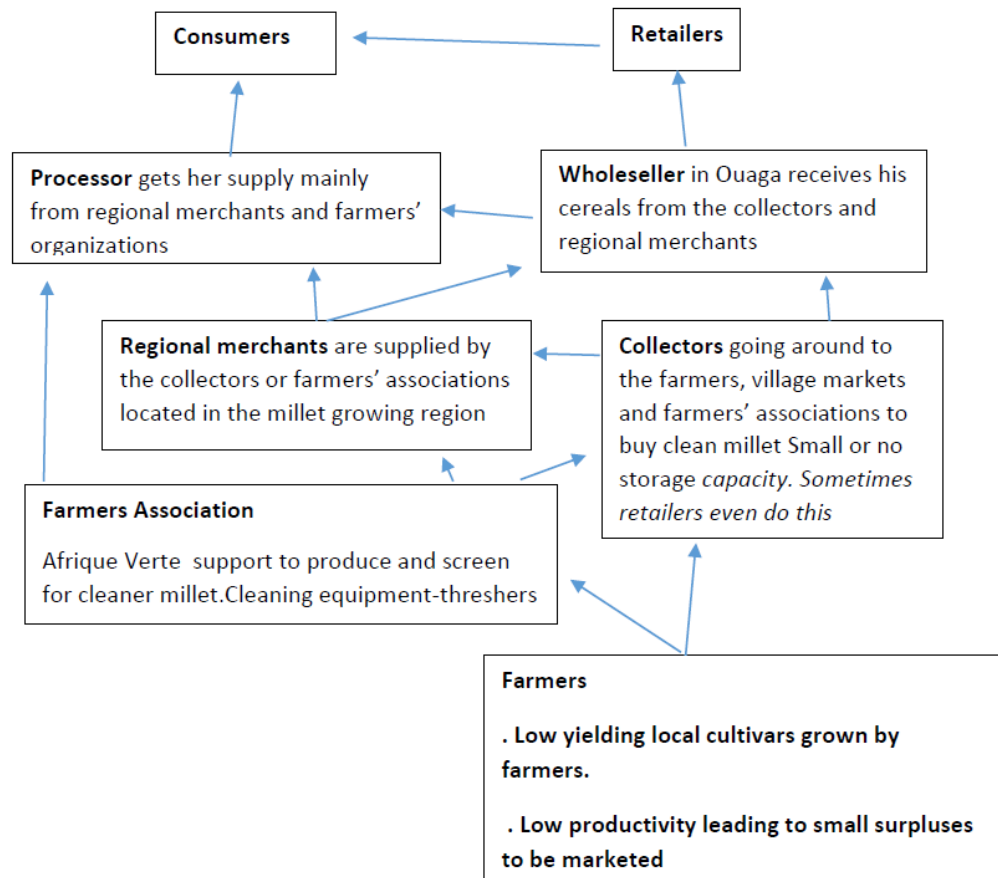


¹² Farmers use their stored millet and sorghum as a checking account taking small quantities to local markets to exchange in order to finance the household purchases.

With the failure of clean millet supplies to expand more rapidly in Burkina Faso it is not surprising that there are no low cost processors emerging. The fundamental difference is the failure to introduce productivity increasing measures (moderate levels of inorganic fertilizers and fertilizer responsive millet cultivars) for millet at the farm level, which would produce a larger market surplus. The failure to increase farm level productivity results in a more elaborate market structure with a greater dependence upon collectors to search for and aggregate small quantities of clean millet (Figure 8). Farmers' organizations aggregating larger quantities of clean millet can sell directly to the processors. But both farm organizations (some exceptions) and processors were reported to have little investment in storage facilities as compared with Mali.

The upper part of Figure 8 of consumers illustrates the choice of buying from retailers the dirty grains and processing them in the neighborhood or purchasing the cleaner more finished millet products from the neighborhood merchant. The neighborhood consumers can opt for the cleaner millet of the neighborhood processors but neighborhood processors also use the same disk mills. As processors obtain more and cheaper millet some will shift to more efficient milling equipment, which reduce or eliminate the metal residues.

Figure 8. Current millet market structure in Burkina Faso with collectors playing a key role in aggregating larger quantities



One large food processor in Burkina has begun specializing in producing maize flour with a hammer mill and he promises to begin producing millet flour on a large scale for bakeries and school feeding programs as part of the World Bank program, WAP. He could provide the same role of cost reducing processor as is being performed by several processors in Mali.

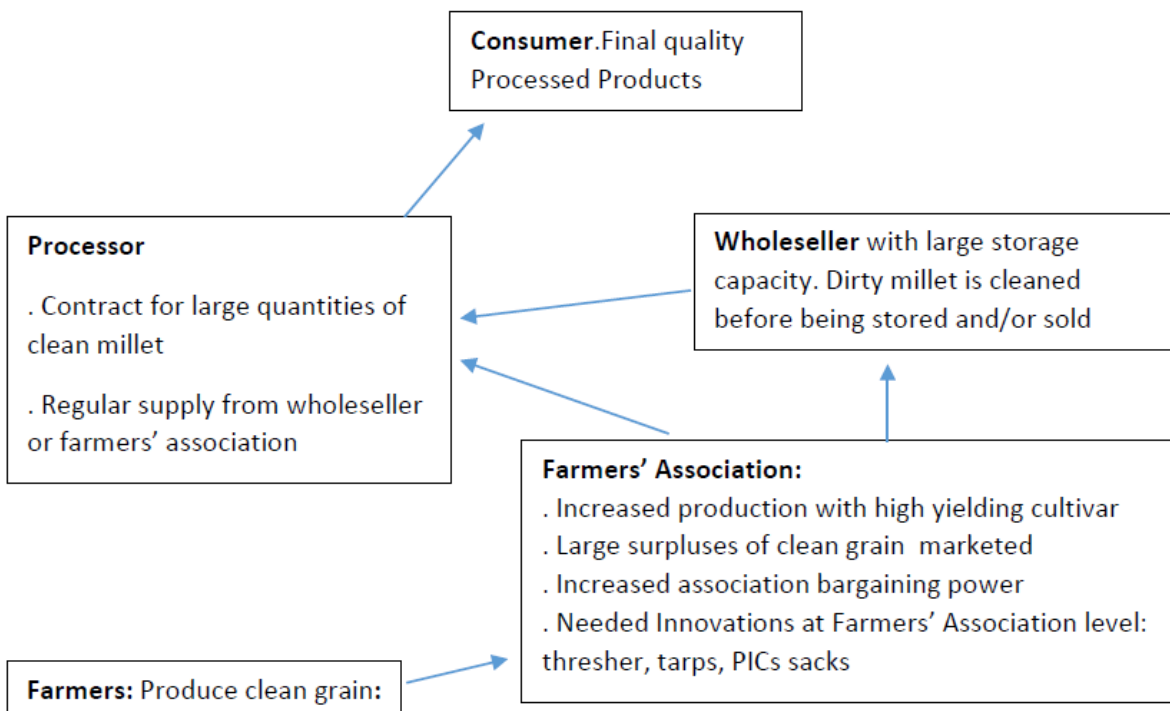
Figure 9 shows the potential emerging market structure with increasing farm level productivity. With technology introduction farmers have more to sell and farmers' associations can produce more clean grain. Farmers Associations also do some of the cleaning plus training in production on keeping the cereal clean. Then the Farmers' Associations can sell the clean grain directly to the processors for

the premium price. The Farmers' Associations can also sell clean cereal to the wholesalers, who have contracts with the processors for clean cereal.

Note that in this market evolution case the role of the collector and the regional market is taken over by the farmers' associations (Figure 9). As in Mali some wholesalers will invest in new cleaning operations and then sell this clean millet to the processor or retailer. The big change will be when some of the processors become lower cost processors. At this point the neighborhood customers will have access to millet flour from 350 to 400 cfa/kg of flour. This flour will be cleaner and without metal residues as it will be milled with hammer mills.

The cost reduction and the quality of the flour and the other products made from it will increase the substitution of the neighborhood processors' products for the home made products. Many lower and middle class women can shift from previously buying the unprocessed millet and having it dehulled and milled in the neighborhood to the processors' products. This flour and other products from the low cost processors is cleaner and without metal debris. It can be elaborated into final products of grumeau (monikuru) and degue (tiakry) or sold as flour. *The new sector of lower cost processors will need to invest in the better mills and to get their costs down. But in we have shown that some processors are already reducing their costs by 30% with access to increased supplies of clean millet and we estimated that with the on-going changes in market structure another 30% price decrease would be possible. How quickly this will happen is another important question (see Recommendations after the Conclusions).*

Figure 9. Future improved millet market structure with strong farmers' associations producing large quantities of clean millet grain.



Improved Millet Flour as Key

All millet products, “tô”, “bouillie”, couscous, are made from flour. There is a serious shelf life problem from the weevils that infest the flour.¹³ Normal shelf life of flour not well dried is 24 to 72 hours in the neighborhood processing of women. In the low cost firms a thorough washing and drying of the dehulled grain before milling is undertaken often with bleach to eliminate contamination in handling the raw material. The washing and drying would not be expected to remove all the eggs. Even a very small number of eggs of the weevils would then find an excellent environment to expand rapidly and with the short life cycle of the weevil would then cause problems. Three months would then be a good estimate of the flour being relatively insect free (A. Ndoye, correspondence, Feb 2015).

There is now a machine, the entoleter, that with centrifugal motion can destroy all forms of insect life including eggs. With the entoleter, neither washing nor drying are necessary and the shelf life is prolonged indefinitely, depending on the handling of the flour.¹⁴ Freedom from insect infestation during storage can be ensured only if flour is free from insect life when put into bags. The entoleter helps to extend shelf life of flour by killing larvae in it with a fast rotating rotor pin. It is used between

¹³ It is also necessary to control the moisture content of the flour to avoid molds and oxidative rancidity. Also preventing contamination from bacteria is important. But the chronic and difficult problem is the insect one.

¹⁴ The dehulling process has to be contaminant free for this cleaning process to be successful.

production and storage as well as between storage and packaging of flour. The expected shelf life of entoleted normal flour packed in paper bags and stored in cool and dry condition is 2-3 years

Millet food processors from Senegal have already been buying this machine and processors from Mali have been looking at various potential suppliers (A. Ndoye, written communication, Feb 18, 2015). This entoleter is an important step in the handling of millet flour potentially benefiting substantially not only the millet processors focused on in this paper but also the bakeries. With longer lasting flour the processors can supply flour to the bakeries as the basis for cakes, cookies and even bread made from composite millet/wheat flour. In Senegal this type of bread is already common in some bakeries, known as “pain riche.” But an improvement in the shelf life of the flour is expected to make a substantial difference for the introduction of this flour to bakeries and to other processors of millet products (A. Ndoye, written communication, Feb 18, 2015).

Demand growth for millet processed products

The per capita demand for the millet in these processed products¹⁵ is a function of the millet price, and per capita income growth (1).

$$\frac{C}{N} = \alpha P^{-n} \left(\frac{Y}{N}\right)^{\epsilon} \quad (1)$$

$$\frac{(\partial C/\partial t)/C}{(\partial N/\partial t)/N} = -n \frac{\partial P/\partial t}{P} + \epsilon \frac{\partial(Y/N)/\partial t}{Y/N} \quad (2)$$

$$\frac{\partial C/\partial t}{C} = -n \frac{\partial P/\partial t}{P} + \epsilon \frac{\partial(Y/N)/\partial t}{Y/N} + (\partial N/\partial t)/N \quad (3)$$

Taking the log and then the derivatives with respect to time gives (2). On the left hand side (2) is the growth rate of the per capita demand for millet food products. The first term on the right hand side is the contribution to this demand growth from the declining prices. The second term is the effect of per capita income growth on the demand for millet per capita. Then converting this from millet per capital demand growth to total demand growth for millet in these finished products gives Equation (3). The third term in (3) is then the effect of population growth. The price elasticity of demand for millet products is n . ϵ is the income elasticity of demand for millet products.

A 30% price reduction has a big effect on the demand growth for millet products even larger than the high population growth rate (Table 1). Transformed millet products have higher price and income elasticities than those for unprocessed¹⁶ millet. Our annual demand growth for millet products of results in an estimate of 71% growth over the five years. If there are no price decreases, demand growth is cut almost in half. Using IFPRI estimates (Nelson et al., 2013; also see Balarabe and Chikwendu, 2011 for estimates for northern Nigeria) of the price and income elasticities for *unprocessed* millet reduces the growth rate to 7.2% and the increase in demand over the period to 54%. Even with a rather extreme assumption of no difference between unprocessed millet and these transformed millet

¹⁵ We did not include here the possible structural shift of a large expansion of the demand by bakeries if the millet flour can attain these long shelf lives.

¹⁶ Neighborhood women buy threshed millet and then have it dehulled and milled in the neighborhoods with disk mills. The hammer mills in contrast with the disk mills do not have metal on metal contact.

products, this is still a substantial increase in demand. For the ten year estimates and the 60% price decrease the annual demand growth is a respectable 8.6% with a 128% increase over the decade.

Table 1. Estimating Demand Growth for Millet Products over the Next Five and Ten Years in Mali and Burkina Faso.

Name	Characteristics	Price Effect	Economic Growth Effect	Population Effect	Annual effect on growth of consumer demand	Percentage Increase in consumer demand in five (ten) years
Best Bet Estimate (5 years)	Our price and income elasticities (-0.8 and 0.6); 30% price reduction over five years	4.3%	1.8%	3.0%	9.0%	71%%
Lower Consumer preferences for millet(five years)	IFPRI price and Income elasticities (-0.58 and 0.354)	3.2 %	1.15%	3.0%	7.2%	54%
Best Bet (10 years) ^b	More real price decrease (60 %) but otherwise same assumptions as Five Year Best Bet	3.8 %	1.8 %	3.0 %	8.6%	128%

Notes: Price Effects. In the Mali millet food processing report (2015) and earlier here we showed the effect of the larger cost reducing firms in reducing prices by 30% for flour and couscous. Over a longer ten year period we think that another 30% reduction would occur as the market structures change. Population growth. Burkina Faso is growing at 2.9% and Mali at 3.1% (World Development Report 2014, p. 296). We used 3% here. Per capital economic growth. Burkina is growing at 6.9% annually and Mali with the war, a coup, and continuing stagnation at -0.44% (World Development Report 2014, p. 296). Adjusting both for expected long term normal growth at 3%. Price elasticity of demand. “Bouillie” and “to” are basic staples but there are a series of other products from millet that people like but that have been high priced from the processors. With lower prices and economic growth there would be substantial expansion of demand for these combined products. Hence, our price elasticity of demand was -0.8 as compared with the unprocessed millet estimate of IFPRI of -0.58. Note that IFPRI estimates are for millet and our estimates are for the processed, convenient but traditional food products made from millet. Hence we would expect higher elasticities than for millet. We have been fairly conservative in estimating the differences. Income elasticity. We used 0.6 rather than the IFPRI estimate of 0.354 for the same reason as above.

Conclusions:

Based upon surveys in Mali and Burkina Faso in the fall of 2014 the millet processing sectors are still very small activities given the extent of millet (and sorghum) production in these countries.

Presently, the millet processing sectors produce quality products and many processors are highly mechanized. However, their products are high cost compared with alternative cereals and neighborhood processing by housewives. Therefore sales are concentrated for higher income individuals, including in Mali exporting to the higher income (as compared with Malians) diaspora, and for special occasions for middle and lower income classes in Mali. By increasing the efficiency of processing and consolidating the market structure with less middle men between the farmers' associations and the processors millet product costs can be substantially decreased. The keys are a cheaper production of millet flour as the basic component of all millet products, the further development of farmers' organizations, and a unified buying system by the processors of the clean millet. These changes would then reduce the marketing margins paid by the processors and increase the share of the marketing margin received by the farmers' associations.

Secondly, as with cowpeas before the introduction of the PICs sacks a principal barrier to increased production of millet flour has been its short time of storage due to the inability to control the weevils. The entoleter give long term control and changes the whole industry by making the millet flour the most important finished product, reducing its cost and enabling a long shelf life.

Greater availability of clean millet and of longer shelf life flour will enable cost reduction in the market structure and demand expansion for the flour accelerating the growth of the market for processed millet. In the next section, Recommendations, strategies for both countries to accomplish this process of reducing product costs by first 30% and then another 30% are laid out in more detail. Mali is the leader in this process having already substantially increased millet yields in the principal supplying region and now evolving a small sector of high quality processors. Several of the larger processors are now reducing costs for selling to a wider domestic market. The market consolidation, by eliminating many of the collectors and even some of the next stages of regional merchants¹⁷ has the potential to reduce the costs another 30%.

Using these price reduction estimates combined with population and economic growth we estimate the effects on demand for millet transformed products. The regional effects will be in those regions producing for processors especially the Segou and Mopti regions. There will be income effects for the small farmers in these regions, for the urban processors and for urban consumers especially low income ones. An important additional benefit for low income consumers will be the shift from disk to hammer mills thereby eliminating the metal residues in the flour milled in the neighborhoods.¹⁸ This combination of potential benefits to low income farmers, processors and consumers makes them especially interesting for further developmental activities to facilitate these changes.

These changes will become relevant to Burkina once they increase productivity of the millet system. Higher yields with inorganic fertilizers and fertilizer responsive cultivars will expand the supply of millet with more production surplus to sell. Then further promotion of clean millet, the emergence of low cost processors, and the availability of longer shelf life millet flour will enable the Burkina millet processors to follow the same growth path as in Mali.

Recommendations:

¹⁷ And even some of the wholesaler activity with direct sales of the Farmers' Associations to the Processors.

¹⁸ Anon., 2002, p. 24.

1. As the Farmers' Associations have increased productivity and produced clean cereals the growth of the processors' capacity to purchase and integrate this increased supply of clean millet has not accompanied the progress in the Farmers' Associations. The processors joining together in an association would enable group buying and thereby facilitate the contacts of many processors with the associations. The Farmers' Associations need a price premium for the higher quality millet. The Farmers' Associations need to take responsibility for quality control and sell their clean millet in marked bags indicating the origin by Association and farmer. Then the processors association could easily take collective action against poor suppliers. There would be a rapid response in quality control by the Farmers' Associations and farmers.
2. As the productivity of millet increases the demands on women's time become too much for the traditional mortar and pestle technique. This technique does result in very clean millet and Mopti is known for this millet quality. In Segou as millet yields were increased farmers switched to running over the millet on the ground with tractors or other vehicles and quickly acquired a reputation for dirty millet and a market price discount for inferior quality (dirty millet). A principal innovation for value added is to switch to methods to produce clean millet. and to demand a price premium for the clean millet especially when selling to the millet food processors. One innovation was to put tarps ("bache") on the ground to reduce the dirt and pebbles picked up with this rolling over technique.¹⁹ Unfortunately, the tarps soon develop holes and need to be replaced. PAM introduced screens for farmers to use especially when putting the cereal into bags in the storage facilities of the Farmers' Associations. Ultimately the Farmers' Associations will need to have their own threshing machines or to have a local farmers with these machines. Many threshing machines have been tried in Mali. With group ownership they break down very quickly as there is a tendency to let all the members use the machine. Unfortunately, then no one controls the abuse of a member introducing dirty cereal and damaging the machine. So more serious than financing the machine has been the management and maintenance of these machines.
3. A principal constraint on the sales of millet flour has been its short shelf life. Weevils can be a devastating storage pest and are very difficult to control with the conventional washing and drying methods. However, there is a machine available that destroys the weevils and their eggs, the entoleter. This machine offers the potential to open up new markets and products, ie bakeries and composite flour for bread. This type of bread is already marketed in some bakeries in Dakar ("pain riche"). Some investments in entoleters could accelerate this process and turn flour into the principal product of these food processors. Low cost entoleters are available from India and China.

¹⁹ Farmers cutting the heads at harvest also need to avoid then putting them on the ground but should put them on the stalks.

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Table A-1. Consumption of Millet Products in the Neighborhoods of Burkina Faso

No. (Reference No.)	Principal Products	No. of times per day consume products of the neighborhood processor	No. of times/day consume millet products bouille and tô ^a	Other millet Products; frequency of consumption
1. (3)	G, D,C,F, Gnon	Low Income 1 Medium Income 1 High Income 1	3 1 1/week	Couscous 2/week C 2/week; Degue 1/month; Zoum-Koum 1/one to two months
2 (4)	G,D,F,C	Low Income 1 Medium Income 1 High Income 1	3 2 1	Couscous 1/day Couscous 1/week Couscous 1/week
3 (6)	G,D,C	Low Income Medium Income 1 High Income 1	2 to 3/day (to) 1/day (to) 2 to 3/week	

3 (7)	G,D	Low Income Medium Income 1/ 1 to 2 days High Income	3/ day 2 to 3/week 2 to 3/week	Degue 1/two weeks Degue 1/week Degue 1/day
4 (8)	G, D,C	Low Income Medium Income 1 High Income	Bouillie 1/day 2 to 3/week 1/week	
5 (9)	G, D,C, B	Low Income Medium Income 2 High Income 2	2to 3/day 2/day 1/day	Zoum-Koum 1/week 1 to 2/week 1/month
6 (10)	Dehulled millet; G, B	Low Income 1 Medium Income 1 High Income 1	2/ day 2/day 1/week	Degue 1/day 1/week 1/ day
7 (11)	D,G,C	Low Income 1 Medium Income 1 High Income 1	3/day 2/week 1/month	Gnon, Couscous 1/week 1/ month
8 (13)	F, Zoom-kom	Low Income 2 Medium Income 2 High Income 2	1/ day 1/day 1/ day	Boire-boire, couscous 1/ month 1/week 1/month
9 (15)	G, D,B	Low Income 2 Medium Income 2 High Income	1/ day 3/week	Gnon1/day 3/week 1/month
10 (16)	G,D,C	Low Income 1 Medium Income 1 High Income 1	2/day 2/ day 1/day	Couscous, Zoum-Koum 1/month 1/month 1/week
11 (17)	G,D, cookies	Low Income 1 ^b Medium Income 1 High Income 1	1/ day 2 to 3/ day 2 to 3/day	Zoum-Koum,others 1/day 1/day 2/ week
12 (18)	G,D,C,B	Low Income ^c Medium Income 1 High Income 1	3/day 1/day 2/month	Couscous 1/month 1/ month 1/month
13 (19)	G,D,C,B	Low Income ^d Medium Income 1 High Income 1	1/day ^e 1/day ^e 1/day ^e	Zoum-Koum

- a. "Tô" often made from maize because the flour is cheaper but millet is expected to regain some of this market if millet flour price can be reduced.
- b. Low income sector buys more at Ramadan(respondent).
- c. Low income sector buys less due to high costs of the products (respondent).
- d. Low income consumers prefer to buy the bouillie sold on the street in this neighborhood (respondent)
- e. If add in the "tô" from maize, this would double the traditional dishes

G: Grumeaux; D: Degue; C:Couscous;B: Bassie; F:Millet flour

Source: Field interviews

A-2. Definition of Millet Products in Mali and Burkina Faso Surveys

Tô : Is a thick porridge from cereal (maize, millet or sorghum) flours eaten with stew of meat or fish; process: boil water; add flour and stir slowly until you get thick paste.

Gnon: prepared with millet flour, powder of cowpea leaves and spices. The mixture is then steam cooked.

Bassi or Sweet Couscous. Process: a mixture of fine flours of millet and peanut is granulated, steam cooked, addition of sugar and the product is dried then packaged and labeled for marketing.

Zoom-koom : Is a non steamed product. Millet grain milled into very thin flour; add water; stir to get a millet beverage widely used in Burkina Faso.

Grumeaux or Monikuru séché or Bouillie: is a non steam cooked granulated flour; large granules used to make a thick porridge consumed morning and evening. Process: Screen to get thin flour; add water and hand granulate (large granules). Sun dry and do packaging.

Tiakri or Degue: This product is widely used for dinner by some communities in Mali, Burkina and Senegal. Process: wash the decorticated millet grain; add spices and aromas then grind and screen; add water and agglomerate the flour into small granules then steam cook ; screen for the second time then sundry. Packaging in plastic bags for marketing.

Couscous sec: The millet couscous is eaten with milk or stew. The flour is first screened; put small quantity of water and agglomerate; second screening; steam cook; break the large granules to get the desired size; steam cook for a second time; break the large granules and screen; sun dry and package in plastic bags.

Segoudégué: is a spicy granulated flour used to make thin porridge. Consumed any time during the day. Process: wash the decorticated millet; grind and screen the flour; add spices; add water and agglomerate into small granules; dry and pack.

Farine infantile: infant food enriched with peanut and soybeans and supplemented with vitamins and minerals; distributed in regions where malnutrition is chronic. This infant food is often sold in pharmacies. Process: Wash the non decorticated millet; dry and roast the grains ;add roasted peanut and soybeans ; mix and mill; screen the product and package in 100, 250 and 500 g bags.

Bénédegue : enriched flour with sesame ; flour used to make thin porridge consumed by the family (infant and adults). Process: wash the decorticated millet; clean the sesame; roast millet and sesame grains; mill the mixed grains and add spices; for marketing package in plastic bags (500 to 1000 g/bag).

Boire-Boire; Probably the same as ***Mougou Dji***: Millet drink made from millet flour, water and milk