
Chapter 15

An assessment of sorghum and millet in Mali and implications for competitive and inclusive value chains*

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1. Introduction

Sorghum and millet are strategic crops for food security in much of the Sahel. Over half of the farming population grow sorghum and millet crops, which together account for 5-7 percent of all full time jobs in the country. Sorghum and millet also contribute 5 percent to the gross domestic product and account for about 15 percent of consumption shares (in monetary terms) in Mali.

These crops are highly adapted to the low rainfall and light soil types that prevail in the Sahel. Yet yields have remained very low, and output is significantly below its potential. Lack of policy support, not better technologies, are the prime reasons. In Mali, like much of the Sahel, sorghum and millet value chain remain relatively underdeveloped, weakly integrated, and only a small share (30 percent) of production is marketed despite a significantly larger urban demand.

This chapter examines the sorghum and millet value chain in the Mali case and draws conclusions and recommendations for rebuilding the sorghum and millet value chain potential. The same conclusions are largely applicable to other countries of the Sahel, given the large similarity in the overall development status of these two critical staple food crops.

The chapter is divided into four sections. The first one examines the characteristics and drivers of demand for sorghum and millet value-chain products. Section two focuses on the key impediments along the value-chain (input markets, production, processing, and marketing). Section three review policy, trade and institutional aspects relating to sorghum and millet value chains. The last section concludes.

2. Demand drivers for sorghum and millet

2.1 Urbanization and income distribution changes

In West Africa, population growth has increasingly shifted from rural into urban areas over recent decades. Between 1980 and 2010, urban populations grew 4.5 percent annually, compared with 1.8 percent in rural areas. This trend is expected to continue between 2011 and 2050, with urban population growth projected at 3.7 percent per year, compared with only 0.5 percent in rural areas (UNFPA 2010). By 2020, just over half of the people residing in West Africa are projected to live in urban areas (193 million) and urbanization is expected to reach 67 percent by 2050 (UNFPA 2010).

Urbanization is not limited to primary cities. There is an equally rapid expansion in the number of new smaller cities of 10 000 or more inhabitants, primarily along major axes and in the periphery of larger metropolitan neighborhoods (Denis *et al.* 2008).

Urbanization is also driving changes in consumption habits through: (1) increasing demand for prepared food and for convenient, ready-to-cook and ready-to-eat food products (e.g. rice, wheat, sorghum and maize flours), particularly for urban women who have less time to prepare meals; and (2) increasing consumption of food and meals outside of the home (i.e. "street consumption"). These evolving changes are creating an increasingly segmented urban market comprised of many recently-arrived, low-income consumers with evolving "urban" tastes and a nascent urban middle class. The increasing number of urban poor will require large quantities of cheap food, including both staple foods and lower quality imported food. Over the last 20 years, evidence shows that urban consumers have gradually substituted

regionally-produced coarse grains with imported rice and wheat (Singare *et al.* 1999). At the same time, a growing urban middle class creates additional demand for a diversified basket of higher value and processed goods, with preferences for high-quality imported products (FARM 2008).

Income growth and distribution of purchasing power (including poverty patterns and income distribution) are also powerful drivers that shape the structure and evolution of food demand. In Mali, between 1990 and 2001, GDP grew by 4.4 percent on average (2.2 percent for GDP per capita) (World Bank Development Indicators). According to estimates of poverty headcount ratios expressed in purchasing power parities, more than half of the entire regional population in West Africa lives on less than US\$1.25 per day and three-quarters have less than US\$2.00 per day at their disposal. Poverty is relatively higher in Sahelian countries such as Mali and Burkina Faso, but cotton areas generally exhibit lower rates.

Growing populations have contributed to a strong expansion of the regional market for food products. The value of total regional consumption of food staples (including farmers' own consumption) has been estimated at US\$20 billion, more than three times the value of West African international exports and 50 times the value of intraregional trade captured by official statistics (Hazell and Diao, 2005, cited in ReSAKKS, 2008).

2.2 Consumption of sorghum and millet

Because of urbanization and increasing evidence on growing rural urban income disparities, most of this market growth has taken place in urban areas. According to estimates from the international agricultural research center for development (*Centre International de Recherche Agronomique pour le Développement* – CIRAD), almost all wheat, two-thirds of rice and more than 40 percent of roots and tubers available in the region are consumed in urban areas. Even in the case of typical rural staples such as millet and sorghum, approximately 20 percent is consumed in towns and cities. The total value of food transacted in the markets of eight West African capitals is considerably larger than the value of agricultural export revenues achieved by these countries. According to projected future demographic trends, the growth of the domestic food market will continue to take place mainly in urban areas. In addition, there will be growth in the demand for semi-industrial and industrial processed food and non-food products, which can stimulate the local agricultural sector if value-chain development effectively takes place.

The rapid rate of urbanization has driven demand in urban markets for imported food staples, and this has fostered import dependency, while rural markets have continued to be served with domestic production such as sorghum and millet. New marketing strategies could make local production more accessible to central markets and meet the needs of urban consumers.

In Mali, food demand for cereals amounted to 2.6 million tonnes in 2008 (including maize, sorghum and millet), in addition to a growing feed market demand for the poultry industry (around 50 000 tonnes of maize per year).² There is a clear consumption substitution from millet-sorghum and maize toward rice and wheat in Mali. The three main cereals (maize, sorghum and millet) represent 70 percent of consumers' cereal needs. While the growing poultry sector is targeting maize, new marketing strategies for millet and sorghum are also developing and would contribute to the growth of these crops value chains. Key drivers supporting the development of sorghum and millet value chain include meeting consumers' preferences and quality requirements.

² Poultry being produced in modern industrial farms amounts to 1,5 million heads in Mali (most of which for eggs), which calls for additional demand of 50,000 tons of processed maize (could be partially mixed with processed sorghum).

Diverse consumption studies and budget consumption surveys provide some insights into the possible future size and structure of food demand by extrapolating observed differences in food consumption between population groups and income strata.

Evidence suggests that there are no inferior goods in the Sahel; as incomes grow, households' immediate concern is to increase quantities consumed. In this way, consumption preferences of rich and poor are similar (Camara 2004). An analysis of budget consumption surveys from Ghana, Mali and Senegal conducted during 1998 and 2001 revealed that notwithstanding changes in the structure and composition of food demand, absolute consumption levels of all food items tend to increase with rising incomes. This is evidenced by large expenditure gaps between the five income quintiles of households within each country. In Mali, both rural and urban households in the highest quintile spent more on millet (including processed) than households in all the other four lower quintiles. In Senegal, the average person in the richest household quintile spent almost three times more on sorghum and millet than the average household in the poorest income group. This empirical data point towards a significant growth in demand for all food staples if population and income growth continues as expected.

Poor households spend a high share of their food expenditures on basic foodstuffs such as coarse grains, roots and tubers (ReSAKSS 2008). When real household incomes rise and households satisfy their demand for basic staples, they will tend to gradually diversify towards consumption of non-staple commodities (Singare *et al.* 1999). As incomes rise in West Africa, households have tended to gradually spend a larger share of their disposable income on rice and wheat (ReSAKSS 2008). This preference for wheat and rice has become common in both poor and rich households. But products that are more adapted to the preferences of urban consumers and those that are processed from dry cereals can compete with rice and wheat (Boughton and Reardon 1997). Specific marketing strategies (such as the ones promoted by INTSORMIL - International Research Consortium on Sorghum and Millet) along with easier access to urban markets (e.g. decreased transaction, transport and marketing costs) offer a strong alternative for import substitution to rice and wheat.

Dietary diversification in urban areas, including increased consumption of meat, dairy products occurs when these non-staple foods are available and prices are low (Camara 2004). With further income increases, most of the incremental income is spent on livestock products, while the amount spent on grains also increases. This is in line with international experience and suggests high income elasticities for livestock products, whereas higher-value cereals play an intermediate role (ReSAKSS 2008). In other words, the relatively high income elasticities for food suggest that in the initial stages of growth, the demand for food will continue to grow rapidly, especially for vegetables and animal products. But this will also affect millet-sorghum and maize to the same extent, as a result of the potential linkages between livestock and cereal value chains. Therefore, demand for dry cereals might increase the most in response to marketing development, scaled-up processing and improved circulation of market and consumers' information between the upstream and downstream parts of the value chain.

The overall pattern is that demand growth for dry cereals is huge provided that processing is sufficiently stimulated for key value-chain outlets such as prepared food, animal feeding (poultry), breweries and blended flour for pastries and restaurants.

In this context, national and regional public and private actors will be challenged to address many key issues including:

- driving down the real price of food to consumers (a major determinant of wage rates, real incomes and food security in poor countries) as an input into sustained economic growth and employment in the rest of the economy;

- stimulating the growth of small-scale, peri-urban/urban processors with convenient value-added products;
- providing an enabling environment for large-scale processing industries in key sectors (e.g. rice, vegetable oil and dry cereals) to compete with food imports; and
- introducing and harmonizing adequate regional norms and standards for high quality, safe, traceable agricultural and food products.

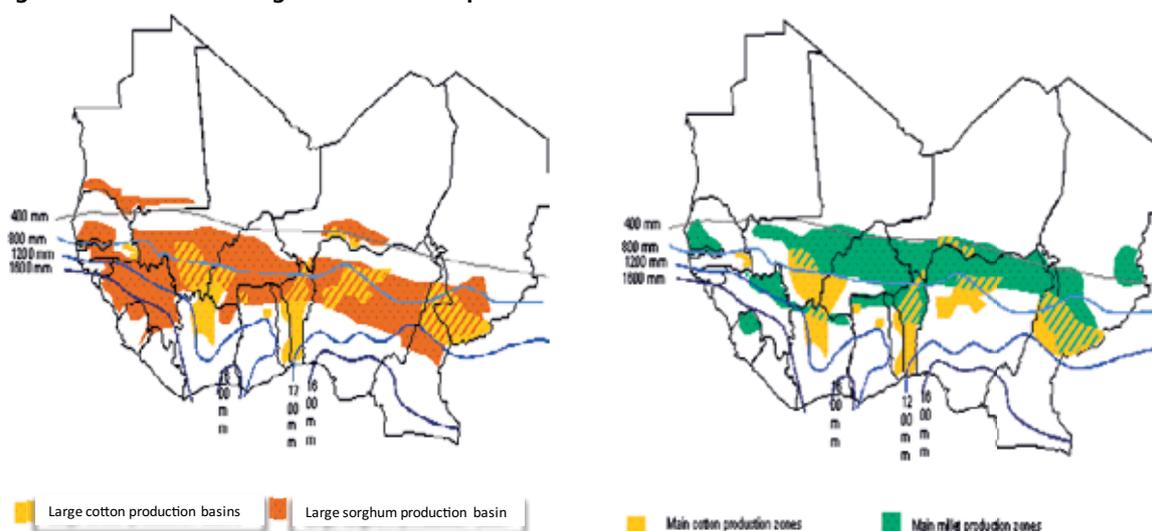
These challenges are especially applicable to dry cereals in Sahelian countries like Mali where enhanced productivity and closer food market integration can affect food prices and agricultural growth in positive ways. The next sections reviews the characteristics and the environment of the millet-sorghum value chain in Mali before looking at policy and operational interventions which are susceptible to spur value-chain development.

3. Sorghum and millet value chains: status, constraints, and opportunities

3.1 Production

Sorghum and millet are grown in the cotton-cereal production basins of Mali and belong to traditional cotton-cereal farming systems. In semi-arid West Africa, cereals (millet, sorghum and maize) tend to be grown in rotation systems with cotton. Sorghum is more closely tied in rotations with cotton than millet which is more tolerant to drought and can be found farther north than sorghum or maize (figure 1).

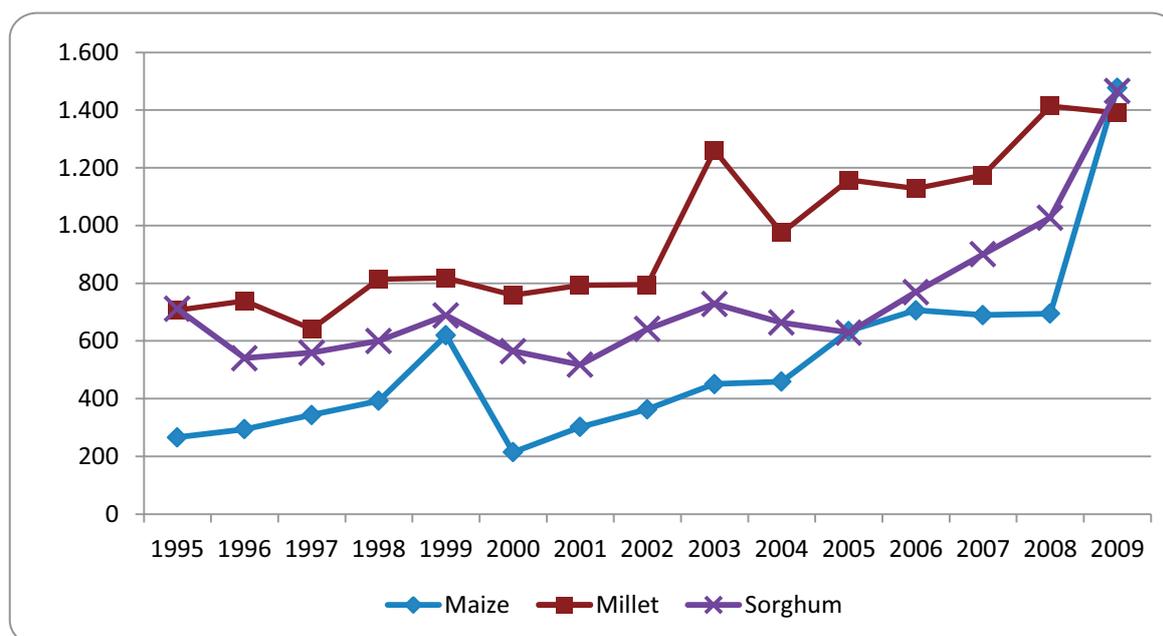
Figure 1. Location of sorghum and millet production basins in West Africa



Source: Atlas de l'Afrique (2000), SWAC (2007)

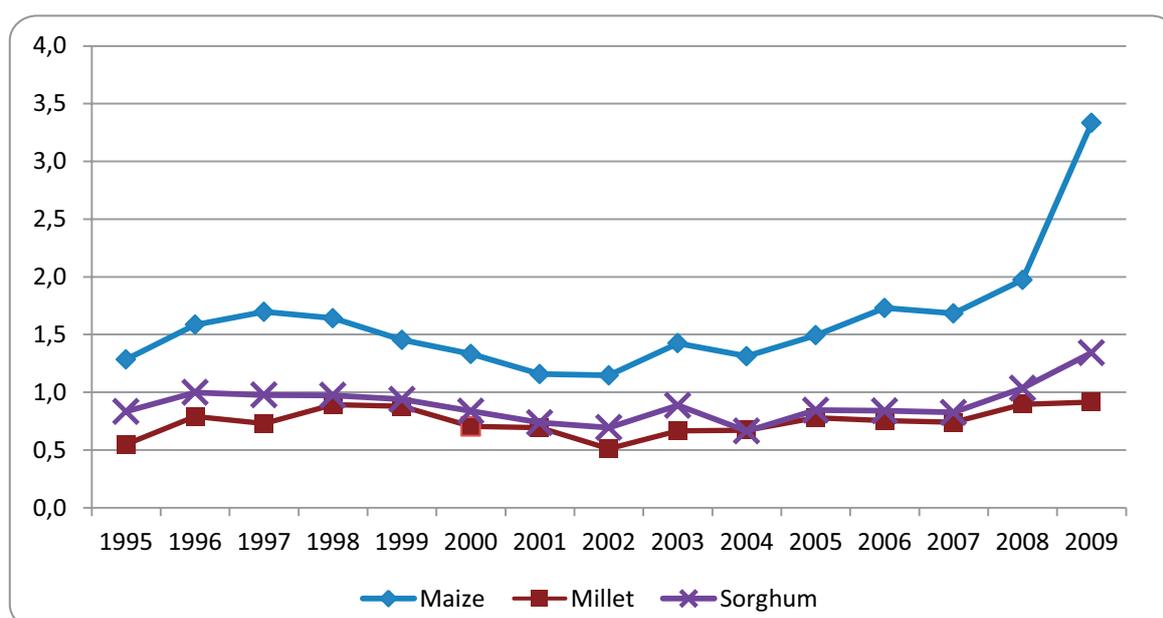
Both sorghum and millet production in Mali have been stagnant during much of the 1990s and began only trending upwards as areas for these crops increased at the expense of cotton (figure 2). There is no significant change in yields for these crops for the last 20 years. Low average sorghum and millet yields (between 0.5 and 1 tonne per ha) (figure 3) is symptomatic of the total neglect shown for these crops despite the existence of improved varieties and management techniques that can easily double or triple average yields. Microeconomic constraints for technology adoption, market failures, and the lack of public and private resources for more professional extension services are the main drivers.

Figure 2. Cereal production patterns in Mali in tonnes



Source: FAOstat (2011)

Figure 3. Crop productivity patterns in Mali hg/ha



Source: FAOstat (2011)

3.2 Input markets

The persistent low yields of sorghum and millet are primarily due to the lack of input use and the continued practice of traditional and minimum input production techniques. Producers face difficulties in accessing inputs due to liquidity constraints and a lack of accessible credit because of low yields, high weather and market risks and high variability in surplus production. This is especially true for cereals grown outside cotton areas where producers could use provided cotton inputs to benefit cereals. Even in the case of cotton, reforms have led to a reduction and rationing of input credit together with a rise in input prices and better control and monitoring of repayment issues. All of which made access to inputs more difficult.

Because of the limited marketability of sorghum and millet and lack of value chain linkages with agro-industry, sorghum and millet usually do not have access to interlinked agreements such as outgrower schemes nor under contract farming that would facilitate input access. Typically microfinance institutions (e.g. village banks and producer organizations (POs)) are very limited and do not meet the required needs.

Another key step in the development of sorghum and millet value chain is the presence of a thriving seed development program. Currently the seed market remain severely underdeveloped where few certified seeds are sold to farmers in local markets, and most farmers relying on one another or themselves for seed (Diakit  2006). The dominant source of certified seed is the national seed service. Certified seed is multiplied by contracted farmers and seed producer groups, and supplied to farmers through farmers' associations, development organizations, and extension services. The informal sector supplies farmers with non-certified seed directly and indirectly through village grain markets. There is no consensus about whether it is lack of effective demand or supply that constrains farmer use of certified sorghum and millet seed, but researchers generally conclude that the process of certifying seed is too lengthy, some mechanism must be established for production and trade of locally-adapted landraces, and Mali's highly structured farmers' associations could play an even stronger role in testing and promoting demand for certified seed. Recommendations have included the use of small packs and seed auctions where market infrastructure is sparse, and in more commercialized areas, involvement of agro-input dealers, shopkeepers and traders. Still, estimated adoption rates for improved millet (under 10 percent of crop area) and sorghum seed (under 20 percent of crop area) could be as high as can be expected in this challenging natural environment and institutional context (Diakit  *et al.* 2008).

Overcoming the perennial credit constraint for smallholders

Alternative finance and credit options are urgently needed. This includes microfinance institutions or involvement of village rural or development banks to step in to fill the void as they are more aware of rural farmers' specific needs. Further, new arrangements could also be applied to input providers and producers (e.g. barter schemes).

Poorly functioning input and credit markets are the result of high transaction costs, repayment problems due to asymmetric information and low technical support. Such roles could be fulfilled by extension services and more rural infrastructure investments (both hard - e.g. roads/electricity - and soft - e.g. market information services) but they lack the necessary funding following the state retreat in the aftermath of structural adjustments.

Alternative finance schemes have emerged in recent years to fill the credit gap. Interesting examples in the region are provided by the tight relationship between farmers' organizations and newly established rural

microfinance institutions (e.g. the Kafo Jiginew in Mali). These institutions have helped farmers obtain a bank account (the “*bancarisation*”), secure their savings and access credit for productive investments and input needs. Cotton farmers in Mali can now access input credit or equipment credit out of cotton firms’ outgrower schemes.

For cereals, an interesting approach comes from cereal banks that have allowed better access to input credit, more remunerative output prices (with economies of scale and better bargaining ability over traders or millers), stabilization of local prices through inventory credit, more mutual learning, collective processing and sometimes self-marketing of miscellaneous products from the farms.

Box 1. Warrantage as a viable instrument for credit facilitation

Inventory credit is often set up by a NGO which arranges a commercial credit facility between a newly formed cooperative and a lender. After harvest, the borrower deposits its grain under predetermined quality standards in a community storage facility. A quality control committee then supervises storage treatment and the issued certificate is presented to the lender. Then the loan is granted to the cooperative, pegged at 75 percent of the prevailing harvest time market price. Managers monitor market prices, quality of stored products and market supply to determine the best time to release the stocks on the market. Sales are used to pay back the loan with interest of 30 percent, storage costs and the net proceeds given to the farmer. The use of inventory credit (i.e. *warrantage*) has been shown to be an effective market and institutional arrangement that can facilitate farmers’ access to credit. Under *warrantage* farmers can sell their products later in the season and retain ownership of their harvested crops. *Warrantage* is also a way to improve communication and linkages with other stakeholders of the emerging value chain.

Analyzing constraints to adoption of improved technologies

Many studies have examined the causes of the lack of input uptake by sorghum and millet producers. Ahmed, Sanders and Nell (2001) reviewed the technology introduction experiences in Sub-Saharan Africa and witnessed few successful cases. Under the prevailing growing conditions, earlier cultivars that better resist droughts do not exhibit higher yields. Hence, better seed technologies have to be combined with higher organic and inorganic input use and irrigation schemes (such as the Gezira scheme in Sudan for the HD-1 variety). The low intensification of agriculture in the Sahel generally results in low, but significant, returns on variety creation, except for some cases³ with low rates of adoption.

Vitale and Sanders (2005) document the case of Mali, where new cultivars have been associated with animal traction and ridging, thus enabling water retention. The adoption of these cultivars together with mechanization was rapid, while fertilizers and ridging were not because of strong liquidity constraints and a lack of access to capital (i.e. a low-performing informal rural finance sector and low involvement of the formal sector).

Abdoulaye and Sanders (2005) identify the basic determinants of fertilizer use in Niger (but which are easily applicable to the case of sorghum and millet in Mali) with two stages of improvement: (1) moving from manure to classic inorganic fertilization; and (2) moving to micro-fertilization and side-dressing techniques. Controlling

³ See for example, the successful introduction of S-35 in Cameroon.

for the value-to-cost ratio for millet (price incentives), the authors show that learning and experience foster technological adoption according to risk-aversion and liquidity constraints. Demonstration trials have helped farmers turn to modern techniques. Incentives are poor for sorghum and millet because of low value-to-cost ratios, while they are high for maize, rice and cotton. The study also showed that constraints on incentives arise from high marketing margins and transaction costs while capacities are lowered by poor infrastructures and a lack of human capital (capacity constraints). Fertilizer use was also found to be covariant with roads and rainfall. The study concluded with a strong recommendation linking technology development with better extension services, quality control to foster fertilizer use on higher-value crops, and reduce risk for lower-value ones.

In a follow up study, Abdoulaye and Sanders (2006) show that adoption of improved fertilizer techniques can be fostered under different options. In the case of millet, they use the marketing strategies developed by the INTSORMIL project to raise the profitability of millet production and incentives for fertilizer use. However, without a clear policy framework that enables farmers to make profit during adverse years (when prices partly recover production losses), new incentives are unsustainable and investment in technical change remains unsecured. Indeed, assuming lexicographic preferences of farmers (with income and subsistence objectives), the marketing strategies of INTSORMIL that aim to reduce between- and within- year price variability – namely, the widespread use of inventory credit ⁴ and agro-processing of millet – would foster the introduction of technology. But this could be sustainable only if there is a change in public policy with a reduction in cereal export bans in adverse years that would dramatically increase farmers' revenues.

Box 2. INTSORMIL Project and improved sorghum and millet technologies

A breeding research program for sorghum and millet has been carried out through the International Research Consortium on Sorghum and Millet (INTSORMIL) programme – one of the most visible programs dedicated to sorghum and millet in the region. The successful program INTSORMIL enabled the development of a number of early cultivars as well as new improved techniques such as improved water-retention (i.e. organic fertilizers with manure or compost).

Beside technology development and testing production technique, the INTSORMIL project also seeks to foster technology transfer to producers to obtain clean millet and grain sorghum of good quality. This has been led by the food industry's increased demand for steamed millet in yoghurt, couscous, arraw, degue, sankal and thiackri, and the rising demand for poultry and poultry feed with sorghum. Sorghum is toxin-free, which is an advantage over maize for poultry feeding. A key component is to expand the links between producers and processors.

Marketing strategies intended to increase technology adoption become profitable only when there is sufficient market demand. Market alternatives have to be clearly elucidated under the pattern of local, regional and international demand. For instance, technology introduction is clearly demand-driven for cotton and, to a lesser extent, for maize and some niche crops, such as green beans, flowers and pigeon peas. Irrigated rice in Mali does not experience any problems with price collapses because of strong market integration and internal organizational arrangements; the production benefit is either from export, parastatal arrangements or local markets. Hence, market integration is very important since it can help secure production and ensure technology adoption.

⁴ Inventory credit is believed to have a within-year smoothing effect in the mid-term (i.e. 10 years) if it is widespread among farmers. Otherwise, it helps farmers benefit from higher grain prices later after harvest.

According to Vitale and Sanders (2005), the yield frontier is further from actual productivity levels for sorghum/millet than for maize or rice. Input use is not incentivized because of low prices, political bias against food crops and poor marketing performances and opportunities, sustained by discriminatory policies. Hence, allocation of inputs is inefficient because of distortive policies, and this is also combined with technical inefficiency because of low adoption rates of existing technologies.

3.3 Processing

Apart from milling, there is little processing for sorghum and millet. However, there has been new attention to the potential of millet and sorghum production in the Sahel recently. Some studies have shown that new marketing strategies (such as processed sorghum, animal feed or already-prepared millet meals) could be profitable and that there could be in turn an increase in farm productivity. The industrial poultry sector for broilers is not fully developed in Mali⁵, most production of broilers is artisanal.

Recently, there has been some development in agro-processing, especially around Bamako, with the emergence of small and medium enterprises (SMEs) many of which are run by women. Women play an important role in the small scale semi-industrial processing of cereals notably sorghum and millet based food products. Women are very active in various production-related capacities and income-generating activities in horticulture, bakeries, food processing, grocery, and more recently they have been involved in the promotion of millet and sorghum through marketing and processing. Among the processed food showing up in the market we find flours, broken grains, semolina and other by-products like fodder, straw and chaff. These are supplying urban markets like Bamako, but also Koutiala, Sikasso, Ségou, Mopti and Kayes. These are the first sorghum and millet derived food products that can play an important role in fostering demand-driven growth in the sorghum and millet value chain⁶.

There are three main problems with the quality of the raw material originating from sorghum-millet, in descending order: (1) a low degree of cleanliness; (2) heterogeneity in grains; and (3) unstable/insufficient quality. For traditional processors, problems of grain quality are even more important than their heterogeneity. A high percentage of impurities can be attributed to a lack of appropriate post-harvest handling techniques in storage and conservation as well as to a lack of quality certification systems in domestic markets.

Consistent product quality is necessary to develop customer loyalty. One of the main difficulties for processing is to reproduce similar quality over time, since quality is affected by a lack of established standards and non-standardized processing techniques, such as a lack of control about choice of ingredients, the heterogeneity in raw material and a lack of measuring instruments (e.g. pH-meters, scales).

⁵ The exception is the commercial poultry farm SODOUF, with 3 000 reproducing hens and capacity for more than 45 000 incubating eggs (but no slaughterhouse).

⁶ Dry cereals are consumed in many products and by-products, especially in rural areas. Traditional meals can be adapted to the urban background, provided constraints to processing and marketing are addressed. The most consumed form is the cooked paste. The cereal, whether hulled or not, is milled and the flour is cooked and consumed as a paste with sauce. Sorghum whole flour can be fermented and consumed as a paste or boiled. Tô, a paste of hulled cereals, is the traditional meal in Sahelian countries, especially in Burkina Faso and Mali. Other meals, such as grits, are prepared by steam cooking hulled cereals and are consumed as couscous or as a mush. Flour can be rolled, cooked and consumed as a couscous (semolina), and maize and sorghum can be germinated and floured into alcoholic and non-alcoholic beverages (i.e. lactic or alcoholic fermentations).

Fermented food products is a major consideration in consumers' tastes in major cities in West Africa. In Bamako, but even more in Cotonou (Benin) or Abidjan (Côte d'Ivoire), 30 to 45 percent of cereal products are fermented and 85 percent of those are produced by artisanal processors. Cereals, however, do not include essential amino acids such as lysine. Although fermentation is the most cost-saving technique to increase cereal value, final quality varies significantly as a result of nutritional value, taste and other functional qualities of cereal products and uncontrolled natural fermentations. But natural fermentation is widely used in the observed marketed products (e.g. tchoukoutou, kenkey and dolo). Establishing controlled fermentation processes is thus a key challenge for small and medium agri-businesses (SMAs). Diverse tastes, smells and colours are important for promoting the consumption of local products, and this can be addressed by designing new products to promote new consumption habits. Marketing specialists and sociologists can collaborate to study new products that will better respond to consumers' preferences for convenience, conservation and safety while still remaining competitive.

Box 3. A public-private partnership to develop biofortified sorghum for West Africa – Is it the best solution to food security in the Sahel?

The African Biofortified Sorghum (ABS) Initiative is a Private-Public Partnership that aims to improve the nutritional value of sorghum by enhancing the content of some essential nutrients (like zinc and iron) known to be deficient in this crop. The potential benefit for the West African population is enormous given the reliance on over 100 million of people on sorghum as a staple food crop, especially in the Sahel. The project has made substantial investments in R&D to develop new varieties with increased zinc and iron content and improved protein digestibility (not easily altered by cooking).

The partnership has initially involved the Bill and Melinda Gates Foundation for financing, the Kenyan NGO Harvest for managing and for leading the consortium, and the Pioneer seed company for seed development, technology transfer, and capacity building. Moreover, the initiative is expanding its scope with the support from Pioneer and the Howard Buffet Research Foundation to improve the content of Vitamin A as well as expand the consortium members (African universities and governments, and private industry), develop seed production and product dissemination through both farmer and commercial systems, and foster enterprise-driven product delivery through food and beverage processed products.

Yet the ultimate success and sustainability of the initiative hinges on resolving a number of potentially serious obstacles. There is first the acceptance of transgenic products- an issue that is still much contested at global level. Second the difficult task of ensuring strong biosafety safeguards in an environment known for weak regulatory enforcement. Another concern is how accessible such improved varieties will be to small scale producers who typically face difficult odds in accessing credit or inputs (fertilizer- or improved seeds) to improve their productivity. Access to credit is conditioned in part by reliable marketable surplus which is linked to high average yields. Yet these conditions are often not met by sorghum producers currently. Faced with this situation, the question is whether it would be better off for food security and population nutrition to double yields, generate marketable surplus and hence more income to buy more food, or go through the route of fortified seeds which may not be easily accessible to small farmers because of cause or lack of availability- at least at the scale required to make a difference within the region.

3.4 Marketing

Most sorghum and millet production units are small family farms subject to capital and assets constraints. These staple crops are largely self-consumed with only about 30 percent of production marketed in local and urban markets. Storage is mostly used for producers' own use, rather than for market. To address cash needs, farmers sell even in years where there is no surplus. Farmers are forced to sell at harvest to pay-off their debts or family obligations.

Marketing channels for sorghum and millet are varied and include direct sales to final buyers, sales to retail markets; sales to wholesale markets or to urban traders (often at fixed prices) or to visiting traders in the village. To get rapid payment, sales can also proceed through marketing relationships with small or large-scale mills. Commercial mills are a possible outlet, but farmers need to deliver large quantities and organize transport to get higher returns than if they sell to visiting traders. Furthermore, farmers need to ensure that their production meets quality requirements, which is another source of risk.

Beyond the farm gate, market coordination for cereal commercialization occurs through sales contracts between local traders and wholesalers in central markets (RURALSTRUC Mali 2008). More than 50 percent of wholesalers use written contracts with their customers, but they use oral contracts with their providers (e.g. local traders and collectors) because there is greater trust and fewer security problems. This is because most wholesalers use their own personal networks for purchases, while they contract with many different retailers and also institutional buyers on the sales side. For dry cereals (maize, sorghum and millet), most wholesalers (about 70 percent) and retailers (67 percent) have their own network of collectors (OMA 2008).

Quality standards and enforcement along the sorghum and millet value chains is highly uneven. At the production stage, quality enhancing techniques (i.e. varietal purity, post harvest techniques) are rarely practiced. Product quality (grain size, uniformity of products, purity, taste and odor standards, and water composition) seems to be handled mostly by buyers, especially industrial large scale or institutional buyers (World Food Program, or state agencies). But in general, quality assurance is not yet developed in local or even urban markets, giving the final consumer the task of upgrading the quality of the purchased cereal crops. This is a serious hindrance to the development of sorghum and millet value chain and a significant demand-suppressing factor.

Standardization and certification are necessary to promote the development of downstream sorghum-millet value chains. Standard setting should aim to satisfy international norms (e.g., aflatoxin) of production and sales. Several studies have pointed out numerous constraints which have to do with a lack of norms, information, training and communication. Compliance with quality standards requires time, human resources, capital, physical investments and the involvement of all direct and indirect stakeholders in the value chain. Capacity-building is essential in the areas of standardization, quality control and promotion of agricultural and agri-food products. Quality improvements (e.g. by using mechanical threshers to decrease the rate of impurities) in raw millet and sorghum enable producers to meet higher quality standards and thus set higher prices and enhance their profitability. An enabling business and market environment is essential for promoting high quality standards.

Distribution of margins among the main stakeholders always leaves a constant share for farmers, but the producers' share has decreased somewhat since 2005. The margins for intermediate actors between producers and consumers (e.g. traders, processors and retailers) have constantly increased; this can be attributed to marketing costs (e.g. transportation and credit rates) which have remained high.

Sorghum value chain can develop much further because of more rural demand, fewer required inputs, less costly processing and better suitability for the animal feeding industry. In Mali, given the high production potential for sorghum and millet, one potential market strategy is to increase capacities and market functioning in the sorghum commodity chain

In Mali, there are three phases in the commercialization and marketing of sorghum-millet throughout the year: from May to August, provision is slowing down and may stop; from September to November, there is a slow and careful revival of supply; and from December to April, there is a continuation/consolidation of supply/provision operations. The same timing roughly applies to maize (plus or minus one month in between each period).

Heads/chiefs of networks finance cereal purchases through their collectors/traders. They reach agreement with them about cereal quality and price levels at which purchases can be carried out in local markets (primary supply markets). Those prices are retained if and only if there is no competition among traders' networks or importers from neighbouring countries. Prices in local rural markets are influenced by the degree of competition between traders and marketing networks and by the relative weight of cereal demand. But in the largest rural markets (i.e. regional ones), opportunities for purchases from institutional actors (e.g. non-governmental organizations (NGOs), like the Food Products' Directorate (*Office des Produits Alimentaires du Mali* – OPAM) and the World Food Programme (WFP) or possible export outlets are key determinants of price formation. In general though, the influence of wholesalers is well-established on the market, through possible limited competition, personal networks and collusion.

Box 4. Cereal fairs (bourses aux céréales)

Cereal fairs bring together all major cereal stakeholders (e.g. POs, wholesalers, traders, technical partners, processors, transporters). This event is an opportunity for them to network by enabling the emergence of business relationships between given production areas and processing units. It is also an opportunity for wholesalers to gather information about the level of inventories, supplies and demands. Cereal fairs are of increasing interest and are known to all value-chain stakeholders.

Cereal fairs are organized by *Afrique Verte* network and APCAM (*Association Professionnelle des Chambres d'Agriculture du Mali* – *The Professional Association of the Chambers of Agriculture of Mali*). The success of the cereal fairs at local level prompted interest at scaling it up at country level. The scaling up initiative is co-organized by *Afrique Verte*, APCAM, the Union of Cooperatives (Faso Jigi), and Sasakawa Global 2000, a non-governmental programme.

The main advantages of such an approach lie in the concentration of supply and demand over a short period and more transparency in market transactions. Cereal fairs also offer opportunities for business contracts and more equitable prices and standardization of marketed products. Attendance by institutional operators contributes to stabilize markets. This approach also serves as a means to better record market prices and feed into market information services.

Transactions recorded during the fair of Ségou reached 12,000 tonnes in 2009 and 15,200 tonnes in 2010. Altogether, this amounts to 2-3 percent of all marketed production over the agricultural campaign. This has not had a significant influence on national prices, greater participation from public institutions could change this.

Box 4. Cereal fairs (bourses aux céréales - Cont.)

The fair consists of three main phases: (i) pre-fair organization at the local level in order to stimulate grouped marketing and collective supply from POs in order to increase their negotiation/bargaining power; (ii) preparation of the event which involves much promotion and advertising; and (iii) holding the fair with the participation of POs which hold large inventories, wholesalers, cereal transporters, public institutions (e.g. Office des Produits Vivriers du Niger, WFP) and official representatives and other involved organizations.

The fair lasts from two to three days. The first day is for disseminating information about the output realization of the campaign and for the stakeholders to observe one another and compare their bargaining power. Possible prices and quantities are discussed, but not decided upon. The following days lead to contracts and purchases between stakeholders, with POs providing the supply and other stakeholders, including cereal banks, formulating demand. While not mandatory, those contracts are recorded by *Afrique Verte* and overseen until their final execution.

4. Policies and initiatives for competitive and inclusive sorghum and millet value chains

4.1 Cereal market liberalization and renewed policy support

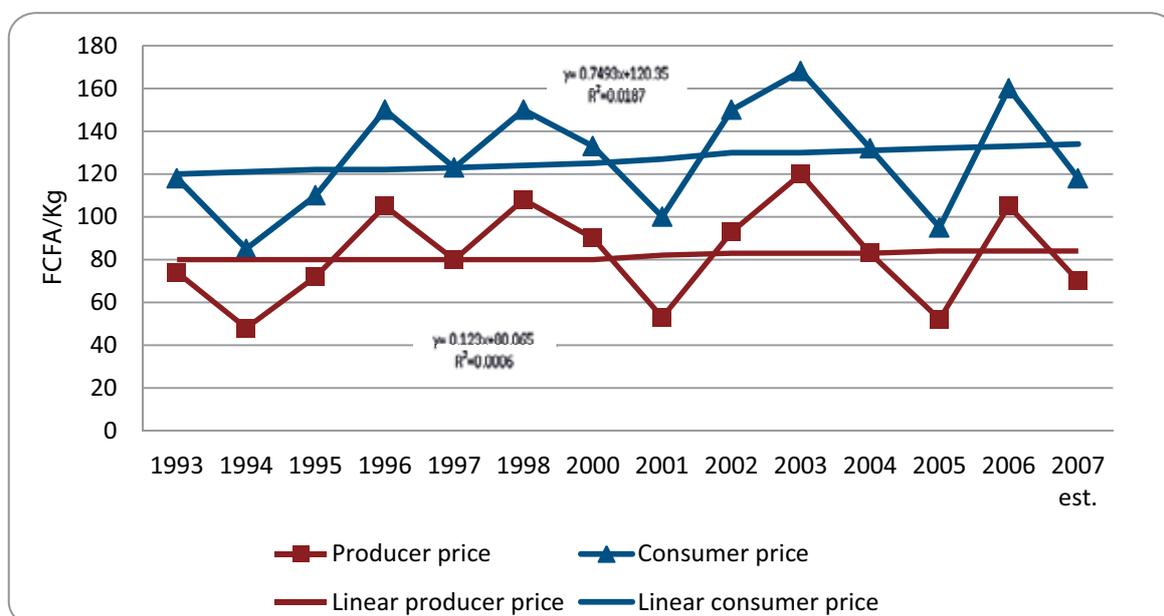
Cereal markets in Mali have been liberalized since the 1990's with the dismantlement of former parastatal marketing boards and cereal *caisses de stabilisation* (stabilization funds). With liberalization, private actors entered the cereal marketing, including large and medium size wholesalers, several of which were operating illegally before reform. Legalization of private traders which improved (private) storage infrastructure and helped reduce transaction costs for grain purchases. However, entry was still constrained by trade risks and a lack of working capital and the persistence of ineffective regulatory institutions to enforce contracts (See Staatz *et al.* 1989 for more details).

Following cereal market liberalization in Mali, prices exhibited on average a slow decrease from 1986 to 1999 (as evaluated from the impact of the *Programme de Restructuration des Marchés Céréalières* (Revamping Cereal Markets Programme - PRMC), both in nominal and real terms (Dembélé *et al.* 1999), but have since exhibited high interannual variability, without any significantly detectable trend. Figure 4 shows producers' and consumers' sorghum prices in the country while figure 5 shows producers' and consumers' sorghum prices along the Koutiala-Bamako axis. Co-movement between producer and consumer prices is clearly evident from the two series, with the producers' price accounting for a roughly constant share of the consumers' price in Bamako.

Gross margins fluctuate from year to year, according to product types and geographic areas. In general, margins are lower in high production concentration zone (due to more competition and scale economies) and much higher in landlocked ones with low production. Since the devaluation of the *CFA Franc* (*Communauté Financière Africaine- African Financial Community*) in 1994, overall competitiveness

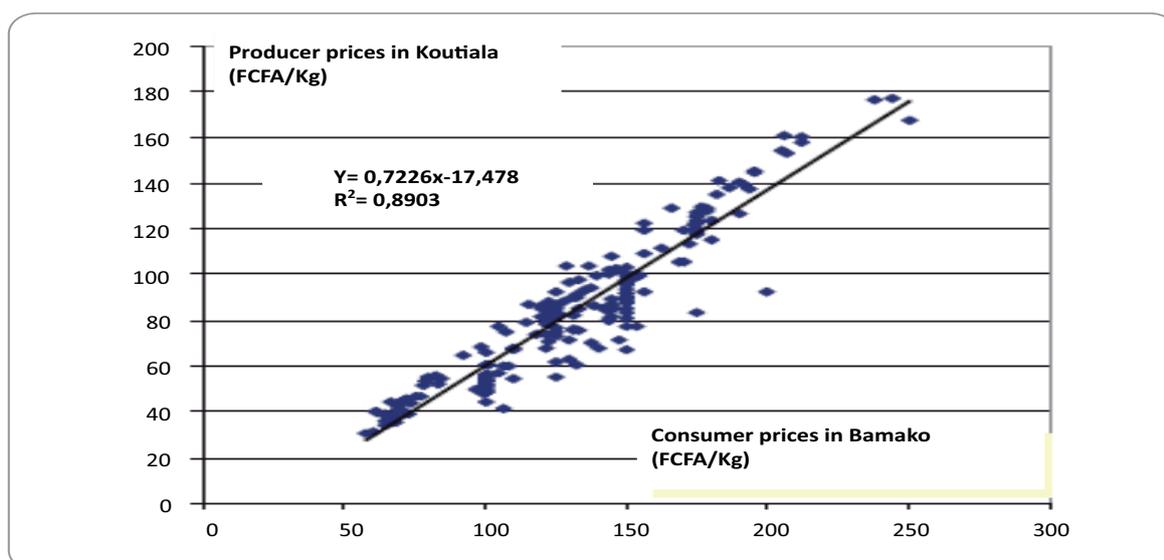
of “dry cereals” (i.e. maize, sorghum and millet) has improved in local and regional markets⁶ in Mali following liberalization. Demand from neighbouring countries and processing units have scaled up in both countries (Diakit , 2006).

Figure 4. Average monthly real sorghum prices FCFA/Kg, 1993-2007 (Base: 2000)



Source: RURALSTRUC Mali (2008) from OMA database and GDP deflator

Figure 5. Empirical relationship between producer and consumer monthly sorghum prices, in current FCFA/Kg value, 1993-2007



Source: RURALSTRUC Mali (2008) from OMA database

⁶Diakit , L. 2006, p.136 : « Following devaluation, the observation is that producers earn positive margins despite increase transport costs. This was made possible thanks to the competitive gains of national cereal products». See also K b  *et al.* 2005.

There are also seasonal price variations which are not shown in Figures 4 and 5. These have to do with variations of supply (mostly correlated with agricultural weather conditions) and availability, as well as with the state of inventories and storage. Cereal prices follow a similar intra-annual pattern every season: they begin at low levels at harvest and then increase, reaching maximum values during the lean period and collapsing during harvests. This pattern is attributable to climatic factors and low levels of storage among producers. Storage made by traders and wholesalers increases marketing costs and leads to increasing prices over the season (together with a decrease in supply). Hence, cereal prices can be multiplied four-fold over the agricultural season.

Most of the price fluctuations can be attributed to the drivers affecting production uncertainty (e.g. weather and other agricultural inputs), rather than to the functioning of liberalized cereal markets, according to several studies (see RURALSTRUC, 2008). However, some peculiarities of grain markets do play a role, such as narrow markets and significant transaction costs. Those factors have limited the liberalization process' impacts on price stabilization, given the fact that incentives for storage and conservation have not worked well. Even if cereal bank projects have been conducted in several villages, their aim has been to improve local food availability rather than better downstream development of the value chains. The latter would be essential to induce more incentives for storage and processing, and in turn, induce price stabilization (see the *Initiative Mil-Sorgho* (IMS) project in Mali for downstream development promotion). However, the Mali Cereal Marketing Support Program (*Programme d'appui à la Commercialisation des Céréales au Mali* – PACCEM) project has produced interesting results that need to be carefully characterized and scaled up.

4.2 Trans-border trade and the necessity to remove its barriers

Another source of demand growth for Mali sorghum and millet is the expansion of transborder trade through the removal of trade barriers. Potential exports of high quality sorghum and millet exist for Niger and Senegal from Mali. High transaction costs, risks and uncertainty continue to hinder greater trade possibilities in cereals in the region. A USAID study (CARANA corporation, 2011), shows that 57 percent of final market price is represented by transport and logistics costs (for sorghum and millet on the Sikasso-Dakar corridor, and for millet on the Koutiala-Bobo-Ouagadougou one). Moreover, approximately 33 percent of end market price is represented by "extra costs", or those costs considered as unjustified, inefficient or too expensive when compared with an optimized scenario. The main drivers of these high transport and logistics costs are found to be inadequate farm logistics and market logistics equipment and processes, as well as expensive and inefficient transport services. The USAID study also finds that cross-border flows of millet and sorghum are constrained by these high costs, and thus dependent on sufficiently high price differentials between regional markets to sustain traders' profit margins.

However, the potential exists to remove many of the inefficiencies and extra costs in the value chain system, improve economic incentives to trade, and increase regional price arbitrage. A number of interventions would be required to reduce trade costs including a uniform and transparent quality certification measures, open and accessible market information (including price, supply, quality requirements and other trade requirements), better provision of extension services, and enhanced producers' capacity for group marketing.

At the regional level, the guiding agricultural development strategy is the Economic Community of West Africa Agricultural Policies (ECOWAP) which derives from the CAADP framework, initiated since 2003 as part of the New Economic Partnership for African Development (NEPAD). The ECOWAP aims

to achieve economic integration including harmonizing trade policies to facilitate the circulation of commodity products and inputs within the ECOWAS region.

Transport costs are a real challenge, notably for landlocked countries such as Mali. This is related to trade issues. While domestic markets seem rather integrated (according to estimations performed by Araujo Bonjean *et al.* (2008) on price gaps between and among central and local markets) for millet, there does not seem to be regional integration, which points towards a transborder effect. Hence, there are specific transaction costs imputable to transborder trade, which are also a strong impediment to intraregional trade and the spatial efficiency of markets. Those problems are tackled in more detail in the following subsection.

Cereals have a low value/weight ratio, often resulting in high transport costs. They also exhibit significant price variability at the producers' gate because of low market integration between surplus and deficit periods. This is also the result of well-known short-run low supply and demand elasticity. Hence, the transport cost component of cereal marketing is often substantial, which limits further market integration and increases transaction costs.

Two main barriers to intraregional trade can be identified about market integration (and the lack thereof) in West Africa. The first one relates to costly transportation and high transaction costs, and the second arises from inconsistencies in trade policies (e.g. export bans for food security purposes that do not allow performing producers to benefit from remunerative prices) and non-tariff trade barriers.

Another avenue for further integration is the establishment of regional market information systems. The Market Information Systems and Traders' Organizations in West Africa (MISTOWA) project (FAO, 2007) is one of the main tools for the ECOWAS region to generate and disseminate market information. Under this program, market information is generated for use by trade partners to enhance production, handling, credit, trade and value-generating services such as processing, packaging or quality control.

4.3 Critical role of producer organizations as a market agency

Enhancing the sorghum and millet value chain competitiveness and insuring greater smallholder inclusiveness necessarily requires strong and functional producer organizations capable to liaise between producers and market. POs can play a critical role in helping farmers coordinate their marketing strategies and enhance farmers' participation in the market. In Mali, several producers' federations are being established or are repositioning themselves to become more market-oriented and to focus their efforts on providing economic services to their members. Many producer organizations specialize in marketing cereal, including rice.

Since the end of the PRMC, POs' financing of cereal marketing through the national agricultural development bank (BND – *Banque Nationale de Développement Agricole*) has been severely curtailed. Private banks lending to producer organizations including many risk-reducing measures including requiring a minimum of three years' experience in marketing, physical collateral under village collective responsibility and an annual 12 percent interest rate. These requirements are often too prohibitive for small scale farmers or their organizations.

In many cases, access to credit by POs can only occur through a combination of internal saving and external credit. This presupposes fully functioning producer organizations with a strong internal coordination and high managerial capacity. In the Koutiala region, POs have developed internal saving

and credit systems often working with the microfinance institution Kafo Jiguineu. An example of successful producer organization using the combination of savings and credit to assist its members access to input and carry out collective marketing is given by ULPC (*Union Locale des Producteurs de Céréales de Dioïla* - Local union of cereal producers), which represents around 1700 producers of cereals and legumes, 25 percent of them being women. The union provides its members with fertilizers and pesticides from its own funds and recoups the costs from farmers after harvest who pay in kind using a reference price which is calculated based on the average price in three villages, plus a premium. ULPC also borrows from banks (30 FCFA million (60,000 USD) in 2011) to purchase cereals from member cooperatives and managed grouped cereal sales and give higher prices to supplying producers, who also benefit from improved yields thanks to access to inputs and in-kind credit.

A number of factors account for the success of ULPC high level of internal coordination, managerial capacity and technical competency, which ensures the organizations access to credit from banks. Moreover, UPLC forged a fruitful direct collaboration with national and internal agri-research institutions resulting in a better alignment of research to farmers' needs.

Another successful case is Faso Jigi, a producer cooperative, established to carry out grouped purchases of inputs marketing of cereals on behalf of producer groups. At the beginning of the campaign, Faso Jigi offers a fixed base price for cereals (millet, sorghum or maize). In early June each year, it pays to the producers 60 percent of the base price for quantities it commits to deliver, which allows producers to finance their agricultural inputs, plowing and possibly hiring labor. After harvest, Faso Jigi pays the remaining 40 percent of the fixed price to producers after deliveries, but it deducts interest on the payment made in the first phase.

Management committees of each participating producer organization are responsible for collecting output production and for storage in village banks. The committees are also in charge of the transport towards secondary and central markets (e.g. Bla, Niono and Ségou). Collective supplies are marketed to local retailers and processors, and Faso Jigi also contracts directly with some of them. Faso Jigi also develops new marketing options and market valorization, as well as marketing channels in order to offer farmers price premiums. Grouped marketing ensures stable and remunerating incomes to farmers, which are spread over three periods each year, with possible bonuses. Faso Jigi marketed around 1,000 tonnes of millet, sorghum and maize in the last agricultural campaigns, in addition to large quantities of rice, shallots and onions.

Many other collective action organizations had positive outcomes, which shows the potential to scale-up production and marketing, as well as processing, within the millet-sorghum value chain.

4.4 Toward a strategy for competitive and inclusive sorghum and millet value chains

The following summarizes the structure of the millet/sorghum value-chain in much of West Africa and is quoted from the USAID study (Mamadou 2010):

- Value chain actors have limited market incentives—generally a result of governments' control of input markets and food aid programs—to invest in commercial millet/sorghum production, large-scale processing, and supply chain management practices.
- Growth in millet/sorghum processed products, although currently a small percentage of total consumption or sales of millet/sorghum has the greatest potential to transform the value chain and infuse inter-relations between actors with incentives for long-term, win-win cooperation.
- Unstable policy environment, notably the unofficial restrictions on cross-border trade in cereals that

are a component of governments' policies of self-sufficiency in food security items, prevents a more efficient and vibrant flow of information and cereals between surplus and deficit areas as they occur across the region.

- Weak organizational capacity among producers and other value chain actors limits the potential for improving trade relationships beyond being based on price-based, bulk sales to more transparent, cooperative long-term trade relations.
- High transport and logistics costs due to corruption and roadway checkpoint delays.

The sorghum-millet which is the basis for staple food in rural households in Mali can be a viable alternative to rice and wheat for urban consumers. But a number of constraints limits its competitiveness and impede the development of sorghum and millet value chains. Like most semi-developed value chains, sorghum and millet exhibit weak processing and packing activities while market is beset by large seasonal price variations that can be daunting and imputable to large variations in supply, quality availability and lack of storage. However, there is ample room for improving marketing using new information technologies.

One advantage for dry cereals is that their production relies on an efficient use of local resources (e.g. labour and capital) (Faire-Dupaigre *et al.* 2006). Intensification of poultry and other short-cycle livestock production systems would also spur demand-driven growth. But most intensive production takes place in coastal cities where imported maize, rice and wheat or animal feeding competes with the cereals that are produced inland, such as sorghum and millet. Therefore, uniform trade policies and unrestricted regional trade and investment would be critical to unlock the potential of these staple value chains including sorghum and millet.

More transparent information on cereal markets would pave the way for more efficient markets. First, assessing national harvested quantities is difficult, in spite of performing agricultural surveys. A more daunting challenge is evaluating inventories, particularly farmers' inventories. As a result, there is great uncertainty about available quantities on the market (i.e. those marketed or possibly to be marketed), not to mention the influence of external markets and margins achieved by speculation.

Sorghum has a potential to meet greater food demand in rural and urban markets as well as the burgeoning feed market. Important prerequisites include improving farmers input access to boost yields, building up the required agro-processing infrastructure, and enhancing value chain linkages. A number of initiatives are being promoted to secure greater integration of sorghum and miller producers into value chains. One important instrument to improve market linkages is the use of producer-processor contracts. A typical example of such contracts is the outgrower scheme allowing participating farmers to supply breweries under contracts with sorghum. The pilot project funded under the Common Fund for Commodities (CFC) is applied in Ghana and Sierra Leone and its outcomes are also applicable to Mali. The basic objective of the project is to substitute imported cereals (such as barley) by locally-produced sorghum. Under the pilot project, the out-grower scheme turned sorghum production into a cash crop serving an established agro-processor. The success of the program necessitated private-led investment in warehousing, purchasing, treatment, storage and supply of sorghum. Under the program, new farming technologies have been introduced and are being implemented. Local and foreign varieties are being tested for adaptation as high yielding industrial sorghum (Deters, 2011).

Policy support is critical to reverse the long standing neglect toward staple crops in general and sorghum and millet in particular among the major crops grown in Mali. It is clear that private investments and a more actively engaged agro-industry in the cereal value chains can only occur under a favorable policy environment. Following the food crisis of 2007-08, Mali has recalibrated its rural development strategy

to include cereals more forcefully. Mali's Rural Development Strategy or SDDR (*Schéma directeur du développement rural*) has placed cereals, including sorghum and millet as among the priority areas, as part of the new policy framework for poverty reduction⁷. However, a review of the public expenditures patterns show that the practices still carry a serious anti-cereal and anti-sorghum/millet bias. Much of the agricultural and rural public investments devoted to cereals went mostly to rice with little to dry cereals like maize, sorghum and millet. More needs to be done to translate the objectives stated in the SDDR into reality.

5. Conclusion and policy recommendations

Sorghum and millet are two of the most critically important food security crops in the Sahel (15 countries comprising the CILSS group stretching from Senegal to Chad). Their adaptability to light soils and lower rainfall make them highly suitable when other crops are not feasible. Over 50 percent of the Sahel population depends on sorghum and millet as the primary food source. Yet owing to policy neglect (much of it due to bias toward commodities for exports or toward urban consumers needs) and the resulting lack of incentives, these crops are typically grown with little or no inputs and produce low yields, compounded by lower fertility soils. Consequently, these crops remain largely subsistence crops with limited surplus to market and lower market penetration compared to maize or rice. As a result, sorghum and millet value chains remain under-developed with little processing apart from small scale milling.

A detailed analysis of the sorghum and millet value chains in Mali helped identify the key constraints along the value chain and pointed to specific recommendations to rebuild these two critical staple food value chains. A coherent sorghum and millet policy and investment programme would target the following priorities:

- (i) Create the required market, price and credit incentives needed to increase adoption of improved technologies by farmers and to improve yields;
- (ii) Promote higher marketable surplus by subsidizing investments in producer-run storage facilities to improve marketing and introduce supply and price risk-management schemes;
- (iii) Provide subsidized credit and investments for small- and medium-sized agriprocessing units through public-private partnerships in agriprocessing mills (which use sorghum and millet in animal feed, as well as processed and semi-processed food and beverage products);
- (iv) Encourage demand for sorghum and millet food products by strengthening food quality control measures and supporting improved quality packaging through subsidized investments; and
- (v) Support the emergence of strong and market-oriented producer organizations for sorghum and millet by funding training and capacity based on need, and by subsidizing investments in storage and encouraging public-private partnerships involving producer organizations, finance institutions, and agriprocessors.

⁷ Note: this chapter was written before the political turmoil that befell Mali and the instability that followed since April 2012.

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