USAID-KAVES VALUE CHAIN ANALYSES

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KENYA AGRICULTURAL VALUE CHAIN ENTERPRISES PROJECT (KAVES)

VALUE CHAIN ANALYSES

June 2013

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1. EXECUTIVE SUMMARY

The goal of the Kenya Agricultural Value Chain Enterprises (USAID-KAVES) project is to increase the productivity and incomes of smallholders and other actors along the maize, dairy and horticulture value chains, thereby enhancing food security and improving nutrition. In order to select the target crops and products for maximum impact, the project conducted value chain analyses from the period of January 16 to May 15, 2013.

The scope of the study reflects the key elements of income generation, productivity, food security, and nutrition for smallholder farmers. It analyzes production and marketing trends, prices, value accumulation, and the role of participants in the value chains for dairy and twelve potential crops produced by smallholders in 22 counties prioritized for support under the United States government's Feed the Future initiative led by United States Agency for International Development (USAID).

The crops included in the study are maize, Irish potato, sweet potato, banana, sorghum, pulses, groundnut, cassava, French beans, mango, passion fruit and avocado. The focus areas for smallholder production comprise 16 counties within the Western high rainfall region (HR1) of Kenya (Kisumu, Siaya, Homabay, Kisii, Nyamira, Bomet, Kericho, Nandi, Uasin-Gishu, Elgeyo-Marakwet, Bungoma, Busia, Vihiga, Kakamega, Migori, and Trans Nzoia) and 6 counties in southern semi-arid regions (SA2) of Eastern and Coast Provinces (Meru, Tharaka-Nithi, Machakos, Kitui, Makueni, and Taita-Taveta).

The methodology combined a desk review of relevant reports and studies with analysis of primary data, as well as information collected from field interviews and a questionnaire-based survey of farmers, traders, processors and other value chain participants.

The report focuses on yields, costs of production, gross margins and net household income that smallholders can obtain from dairy cows and each of the fourteen crops studied. It also estimates the proportion of average price at retail level that the farmer receives and the value added by each value chain actor.

Target products are recommended for each county based on five criteria: market demand; competitive advantage of smallholder producers based on potential gross margins and market prices; current production statistics and trends; potential contribution to income for farm households with up to five acres of productive land; level of investment required to start up or increase production; and potential contribution to household food and nutritional needs (Table 1).

Target interventions are recommended for each county based on five criteria: potential to increase cumulative value and margins throughout the value chain; potential to increase net household income, including the value of home consumption for smallholder households; impact on productivity; scalability and impact on total production; and the time and investment required for the intervention to be successful relative to the net income increase and number of farmers benefiting.

Markets are strong for all the products reviewed but for successful smallholder commercialization and new income generation, farmers need to become more aware of market opportunities and trading companies need to adapt their business models to work on a long-term basis with smallholder farmers

Smallholder farmers generally receive a fair share of the final price achieved at retail level. The highest "value chain equity" is over 80 percent achieved by growing sorghum and groundnut for which farm gate prices are high, markets are very local and low volume, post-harvest value addition is minimal and trader margins small. However, for maize and milk, the two highest volume products, average farm gate prices are relatively high at 49 percent and 36 percent of the final price going back to the producer. Based on this, increases in productivity at farm level will have the most significant impact on smallholder income for most crops and products reviewed.

Grower equity for Irish potato is disproportionately low compared with other crops, at 13 percent of retail price, and this may be a reason why smallholder production has not developed. If the high postharvest margins are validated, interventions are needed at marketing level to provide incentives for smallholders to invest in seed and other inputs that would increase their productivity.

Gross margins are high at more than 60 percent return on direct costs for all products except dry beans and Irish potato. Some crops such as cassava and groundnut give high gross margins at current prices but these are unlikely to be maintained if production increases significantly (Table 31). More market analysis is needed to establish competitiveness of these staple crops at current gross margins if volumes increase before major investments are made in these crops

Dairy farming is a good way for enterprising smallholders to build their asset base and generate year-round income. The major constraint facing smallholder dairy milk producers is lack of credit to purchase cows with high genetic potential. Access to a complete package of technical assistance and credit is required for expansion of smallholder dairy production in the USAID-KAVES target counties

At present, French beans for export have the more commercial potential than any other crop that smallholders can grow competitively. Farmers can obtain 2-3 crops per year at a gross margin per crop of Ksh 60,000 per acre for each crop. Kenya is a market leader and exporters claim that they can handle at least 50 percent more product if it is grown under traceable and compliant smallholder systems. The Kenya Horticulture Competitiveness Project (USAID-KHCP) is supporting initiatives on smallholder traceability systems but has no significant intervention to scale up production. USAID-KAVES should make a major joint investment with export companies to scale up production of French beans in both HR1 and SA2 regions.

Passion fruit is the highest earning crop grown by smallholders but requires a high capital investment that prevents many smallholders from planting or expanding despite the strong market. USAID-KAVES should work with credit agencies to develop financial products that are accessible by smallholder passion fruit growers

Tree crops such as mango and avocado also provide high annual returns but require investment and long start-up period of five years. There are signs that the local market for mango is becoming saturated at the same time as new trees are coming into production. Recommendations by USAID-KHDP, Fresh Produce Exporters Association of Kenya (FPEAK), and other projects for a major initiative to increase production of mango and passion fruit concentrate from Kenyan fruit should be implemented after review of previous reports and discussions with commercial partners in the processing industry

Overall, mixed farming systems that include a combination of staples, horticultural crops, and dairy farming will produce the highest increase in net income. For staple crops, smallholders gain the highest contribution to net income from home consumption. As sellers of surplus maize, sorghum, and pulses, they lose competitive advantage because of the high postharvest costs of aggregation and quality control. Mixed farming systems are essential for small-scale farmers with less than one hectare of land to make a significant contribution to their income from commercial agriculture

If farmers double their current yields, which in many cases can be achieved, without financial risk, by simply adopting good agricultural practices, it is estimated that they can increase their net income per acre, by up to Ksh 60,000. This can be increased further by good farmers who are able to access credit. For smallholders to achieve this level of income from small areas of land they need to farm intensively and include at least one high value horticultural crop or three dairy cows in their farming system

Overall, mixed farming systems that include a combination of staples, horticultural crops, and dairy farming will produce the highest increase in net income. For staple crops, smallholders gain the highest contribution to net income from home consumption. As sellers of surplus maize, sorghum and pulses, they lose competitive advantage because of the high postharvest costs of aggregation and quality control.

Table 1. Recommended Crops and Products per County

County	Primary Products	Secondary Products
Kisumu	Dairy, French beans, sorghum	Passion fruit
Siaya	Maize, bananas, passion fruit	Pulses, cassava, sorghum
Homa Bay	Dairy, groundnuts, pulses	Sorghum, cassava,
Kisii	Dairy, banana, maize	French beans
Nyamira	Dairy, Bananas and French beans	Maize, passion fruit
Bomet	Dairy, Irish potato, maize	Avocado, passion fruit
Kericho	Maize, dairy, French beans	Passion fruit, Irish potato
Nandi	Maize, dairy, French beans	Irish potato
Uasin Guishu	Maize, dairy, passion fruit	French beans, Irish potato
Marakwet	Maize, dairy, mango	Irish potato, banana
Bungoma	Maize, dairy, French beans	Pulses, sorghum, cassava
Busia	Dairy, groundnut, banana	Passion fruit, pulses, sorghum
Vihiga	Dairy, banana, French beans	Avocado, passion fruit
Kakamega	Maize, Dairy, French beans	Pulses, cassava, avocado
Migori	Dairy, French beans, passion fruit	Maize, groundnut, pulses
Trans Nzoia	Maize, dairy, French beans	Irish potato, pulses
Meru	Irish potato, banana, passion fruit	French beans, maize, dairy, pulses
Tharaka-Nithi	Banana, sorghum, pulses	Dairy, Irish potato
Machakos	Dairy, pulses, mango	French beans, cassava, sorghum
Kitui	Pulses, mango, passion fruit	Sorghum, dairy, cassava
Makueni	Pulses, mango, passion fruit	Dairy, sorghum, French beans
Taita-Taveta	Dairy, banana, French beans	Maize, passion fruit

2. INTRODUCTION

This study was conducted during the period January 16 to July 1, 2013 to provide a basis for selection of target crops and products, and to recommend interventions for USAID-KAVES that is scheduled to run for five years through January 15, 2018. The goal of USAID-KAVES is to increase the productivity and incomes of smallholders and other actors along the maize, dairy, and horticulture value chains, thereby enhancing food security and improving nutrition.

The scope of the study reflects the key elements of income generation, productivity, food security and nutrition for smallholder farmers. It analyzes production and marketing trends, prices, value accumulation and the role of participants in the value chains for dairy and fourteen potential crops produced by smallholders in 22 counties prioritized for support under the United States government's Feed the Future initiative, led by USAID.

The crops included in the study are maize, Irish potato, sweet potato, banana, sorghum, dry beans, green gram, pigeon pea, groundnut, cassava, French beans, mango, passion fruit and avocado. The focus areas for smallholder production comprise 16 counties within the Western high rainfall region (HR1) of Kenya (Kisumu, Siaya, Homabay, Kisii, Nyamira, Bomet, Kericho, Nandi, Uasin-Gishu, Elgeyo-Marakwet, Bungoma, Busia, Vihiga, Kakamega, Migori, and Trans Nzoia) and 6 counties in southern semi-arid regions (SA2) of Eastern and Coast Provinces (Meru, Tharaka-Nithi, Machakos, Kitui, Makueni, and Taita-Taveta).

The report is a synthesis of relevant information from previous reports combined with survey data from value chain actors collected specifically for this study. Unlike previous reports we have reviewed, it covers a comprehensive list of crops grown by small-scale farmers in Kenya and focuses specifically on quantifying their costs of production, potential for improvements in productivity, market opportunities, gross margins and interventions that will have maximum impact on smallholder incomes.

3. METHODOLOGY

The methodology for the study combined a desk review of relevant reports and studies, as well as analysis of primary data and information collected from field interviews and a questionnaire-based survey of farmers, traders, processors, and other value chain participants.

Based on this primary and secondary data a quantified value chain profile was built up for each product that includes the following components in each section:

- Analysis of annual production trends based mainly on the Ministry of Agriculture (MoA) data validated from other sources and including regional county level analysis where possible
- A value chain map and brief comments on the roles and relative importance of each category of value chain participant
- An analysis of value chain equity distribution including smallholder current and potential crop budgets, gross margins, value accumulation along the value chain and distribution of revenue generated.
- Recommendations for USAID-KAVES interventions to upgrade the value chain

Target products are recommended for each county based on five criteria: market demand; competitive advantage of smallholder producers based on potential gross margins and market prices; current production statistics and trends; potential contribution to income for farm households with up to five acres of productive land; level of investment required to start up or increase production; and potential contribution to household food and nutritional needs.

Target interventions are recommended for each county based on five criteria: potential to increase cumulative value and margins throughout the value chain; potential to increase net household income, including the value of home consumption, for smallholder households; impact on productivity; scalability and impact on total production; the time and investment required for the intervention to be successful relative to the net income increase and number of farmers benefiting.

A final section is provided summarizing overall conclusions and, where applicable, key recommendations for cross-cutting and specific interventions that should be considered by the project.

4. PRODUCTS

4.1 MILK/DAIRY PRODUCTS

4.1.1 Background

The dairy industry has grown in recent years to become both a lucrative source of income for enterprising smallholders with limited land available for crop production, and as a key factor in national food security and nutrition. It is the highest value industry within the agricultural sector, with an estimated 2012 farm-gate value of over Ksh 162 billion ($1.9 billion), compared to Ksh 89.9 billion ($1 billion) for export horticulture. The industry has grown at a rate of 3 to 4 percent annually (Kenya Dairy Master Plan 2010-2030, MOLD) and its continued growth is a key factor in attaining the agricultural development goals of Vision 2030. Currently, the dairy industry is dominated by smallholders who produce more 80 percent of the domestic milk. A high proportion of commercial production is concentrated in central and northern Rift Valley areas but small-scale dairy farming is increasingly being taken up by farmers in other areas.

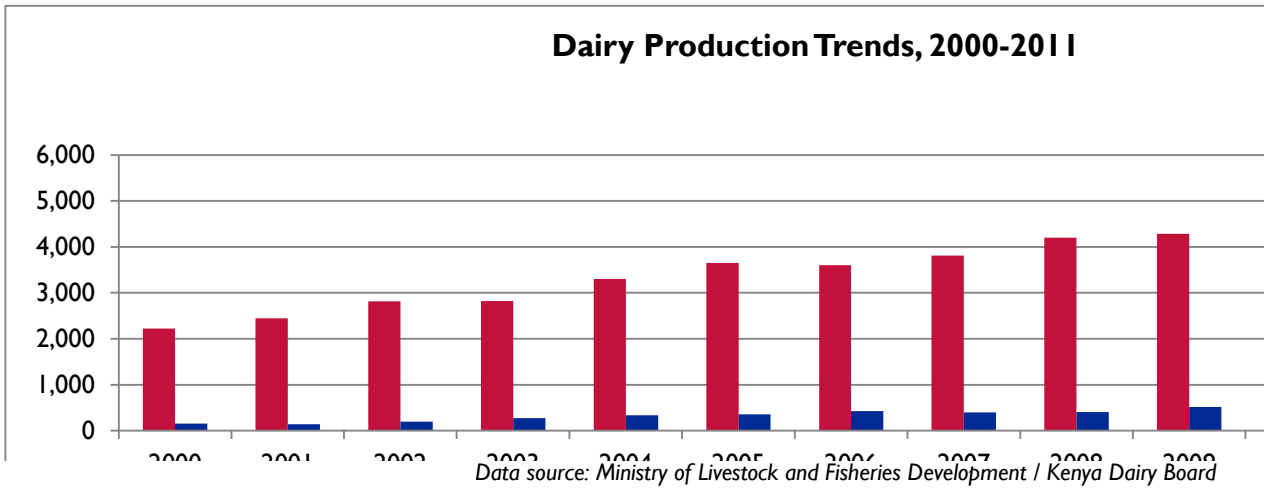
The milk marketing system has been successful in providing milk in the quantities necessary to supply growing rural and urban consumers, but it is characterized by low compliance with safety and quality standards, a diffuse market structure consisting of many small-scale marketing agents, low-value products limited in diversity, and weak participation of producers in policy formulation. Annual increases in milk production have come from increasing the size of herds rather than raising productivity levels per dairy cow. The industry supports an estimated 1.8 million rural households, out of which 250,000 are in USAID-KAVES target counties, which are not historically considered as commercial dairy regions.

4.1.2 Production Trends

Figure 1 shows that cow milk production doubled in the last 10 years, from 2.22 billion metric tons in 2000 to 4.65 billion metric tons in 2011. This growth is attributed to several factors including:

- Adoption of better animal husbandry practices by smallholders and improvement of breeds through increased use of Artificial Insemination (AI).
- Increased access to markets and improved producer prices. In 2011, based on average milk prices, the dairy industry had an estimated value of Ksh 125 billion up from Ksh 100 billion in 2007. The average farm-gate price in May 2013 was Ksh 32.4 per liter, up from Ksh 20 per liter in 2007 (Kenya Dairy Board).
- Introduction of "zero-grazing systems" and use of concentrates and alternative feedstuffs that allowed smallholders, particularly in central Kenya, to increase herd size without the need for additional land.

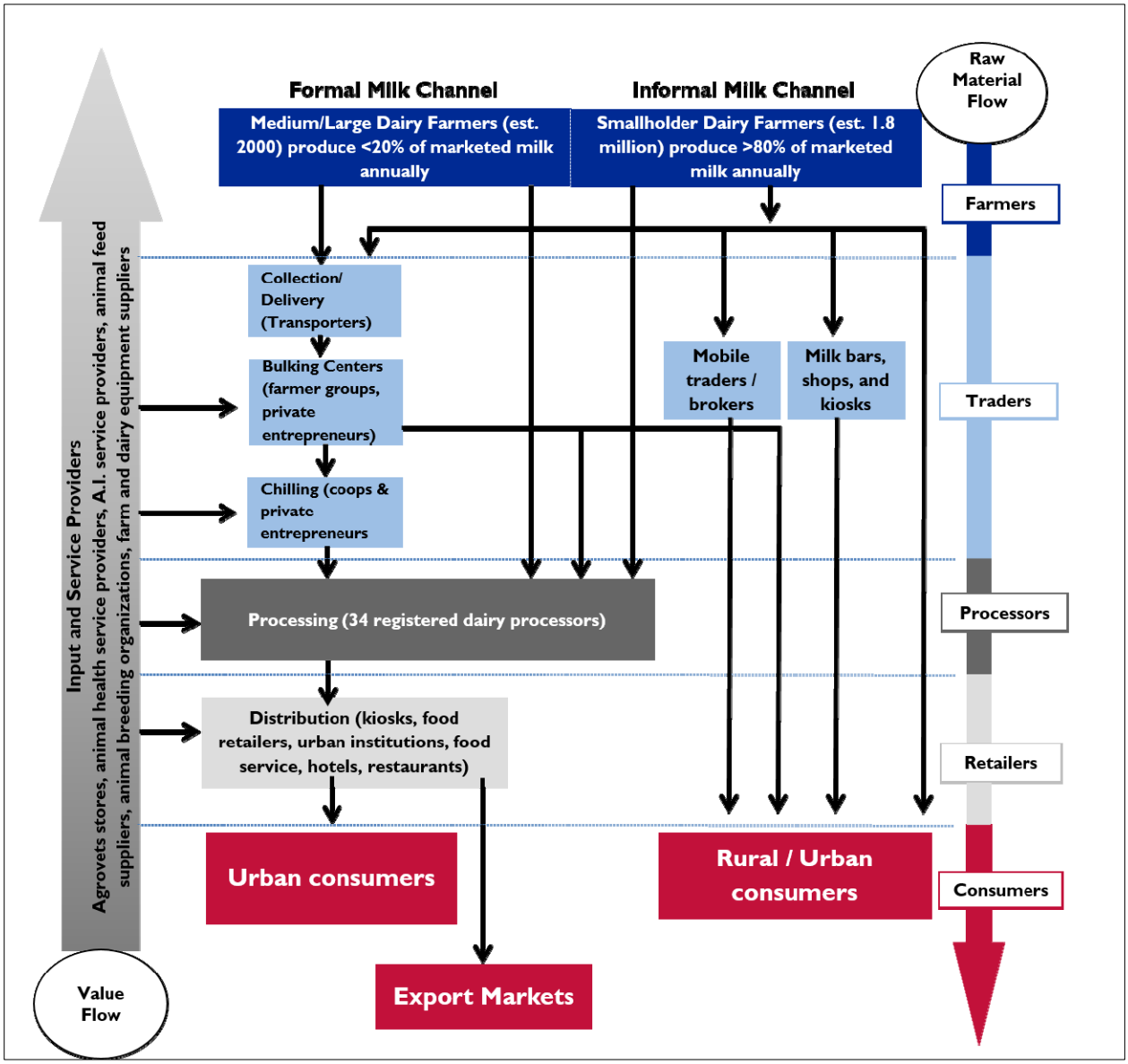
Figure 1: Dairy Production Trends, 2000-2011



4.1.3 Value Chain Actors

Relationships between the key participants in dairy production and marketing are shown below in Figure 2. Supply of milk and dairy products to the end consumer emanates from two channels: industrial dairies supplying pasteurized milk, and dairy products; and farmers, hawkers and traders selling raw milk. Processors currently sell pasteurized milk to formal retailers for about Ksh 70 -80 per liter who then retail it for Ksh 80 -90 per liter. Milk bars and retailers are retailing raw milk at Ksh 40 -50 per liter. The supply of processed milk has increased significantly by 255 percent over the past ten years, from 152 million liters in 2000 to 540 million liters in 2011 in Figure 1. This shows an average annual growth rate of above 20 percent (current milk prices).

Figure 2: The Dairy Value Chain Map



Source: Adapted from GATES EADD project and other sources

The key actors for both small-medium and large-scale farmers are: inputs suppliers, technical service providers, traders, bulking enterprises, transporters, processors and retailers. Rural households and low income urban consumers generally buy via a short value chain from local farmers selling to small-scale traders with minimal processing. Middle income urban consumers are increasingly served by large scale processors who receive, pasteurize and package milk from commercial farmers, mainly located in rift valley and central Kenya.

Producers

There are an estimated 1.8 million smallholder dairy farmers with 1-5 cows, who supply more than 80 percent of all milk consumed in the country. They sell their milk either directly or through local traders and milk bars to rural and low income urban consumers or to large processors, directly or through their dairy cooperatives. There are an estimated 2,000 medium and large-scale farms, producing at least 100

liters per day. The majority of these are located within 50 kilometers of urban centers. Only Nandi and Uasin-Gishu amongst the USAID-KAVES target counties, have significant numbers of these large scale dairy producers. Major challenges facing smallholder producers, especially those in USAID-KAVES target counties include very low productivity due to low use of yield enhancing technologies like AI, nutritious feed, and veterinary services.

Input suppliers

They include agrovets stores, animal health service providers, AI service providers, animal feed suppliers, animal breeding organizations, farm and dairy equipment suppliers. Within the USAID-KAVES counties these input suppliers are either non-existent, or have minimal capacity to effectively provide appropriate services to farmers because they lack access to finances or lack the technical expertise needed to sustainably provide the respective service they supply to farmers resulting to low milk productivity.

Traders/Transporters

Traders/transporters are the main post-farm dairy value players in most USAID-KAVES counties. They buy milk directly from the farmers or farmer cooperatives and sell it directly to consumers through licensed milk bars or in some cases to the processor. A major challenge at this point in the value chain is food safety and quality assurance. Reliable quality testing is virtually non-existent for the portion supplied directly to consumers or to milk bars/hotels/shops by these traders .The equipment used for handling and transportation on milk by most traders does not satisfy the minimum food safety standards as required by the industry regulators including the Kenya Dairy Board (KDB), Kenya Bureau of Standards (KEBS), and the Ministry of Public health.

Collection /bulking and chilling enterprises

According to the dairy industry code of hygienic practice, milk requires to be refrigerated within two hours of harvesting if not processed to avoid quality deterioration. Since chilling tanks are expensive and require substantial milk volumes, smallholder dairy farmers can only market their milk successfully when they come together in viable groups, to bulk their milk not only to afford these and other investments in equipment and infrastructure but also for price negotiation. There are more than 1,000 functional primary dairy cooperative societies, self-help groups and dairy companies mainly concentrated in the Rift Valley and Central Kenya and some parts of eastern region.

Bulking and chilling of milk is an essential step for quality improvement of smallholder dairy commercialization in USAID-KAVES target counties. Most cooperatives also own milk bars where they sell their members' milk directly to the consumer at prices which are higher than prices offered processors but also good value for the consumers.

Processors

There are 42 registered dairy processors in the country. About twenty five of these are actively producing a wide range of products including fresh milk, yoghurts, ghee, cheese, and milk powder. Besides the processors, there are 128 registered mini-dairies and 173 cottage industries. Most of the farmers in the USAID-KAVES Rift Valley counties and some counties in Eastern region supply milk to these processors. Processors do not collect milk from the other target counties due to the associated logistics costs and price competition from fresh milk traders in those counties where production is scattered and limited, causing prices to be generally higher. Postharvest upgrade interventions are needed in all counties to raise the efficiency of bulking operations, improve quality standards and invest in cottage processing of niche products including traditional foods derived from milk.

Retailers

Processed dairy products are retailed by supermarkets, stores, and kiosks in all urban centers. The distribution system between the processor and retailer is well developed and the only challenge

currently is the state of road infrastructure. Introduction of direct milk dispensing machines in supermarkets and shopping malls is providing larger dairy cooperatives with an opportunity to compete with processors for this segment of the fresh milk market.

Service providers

Providers of finance, accounting and business development skills, insurance, quality testing/certification, and research play a critical role in the development of the dairy value chain. Linkages to these providers and the capacity to engage with them is lacking for most of the smallholder dairy farmers in USAID-KAVES target counties.

Policy

Dairy policy and regulations are mainly implemented through the KDB. Hitherto, most KDB action have tended to protect the interests of large scale processors who supply less than 20 percent of the dairy market as shown in Figure 2 above. The Board has therefore banned milk hawking citing public healthy safety concerns arising from sell of raw milk directly to consumers. Despite this policy, the Board has licensed over 4,000 traders who sell raw milk through milk bars. However, in a circular issued by KDB in January 2013, the traders were required to only trade in processed milk. Most of the traders in the USAID-KAVES target counties sell raw milk. This policy is therefore a major hindrance to dairy development in these counties unless measures are put in place to address the quality and safety concerns raised by the Board.

4.1.4 Smallholder Productivity and Value Accumulation

Table 2 gives a summary of farm budgets from a basic non-adopting farmer to a more improved adopting farmer with same herd size under current prices of inputs and milk. the basic farmer, who is the typical farmer in most USAID-KAVES counties, will normally keep cross breeds of Friesian, feed his/her animals by grazing, and limited cut folder, use limited veterinary services only when necessary, breed using a bull and get a calf every eighteen months to two years. Because of this low technology adoption base, the yields for the basic farmer are normally below six liters/cow/day. Note that the basic farmers make no profits from the sale of milk but overall will realize some profits from the sale of calf and cull cows as shown in Annex 11 (Dairy Farm Budget).

On the other hand, if the farmer adopts higher quality pure breeds and AI, supplements fodder feeding techniques with minerals concentrates, and addresses animal health concerns in a timely manner, he/she will not only increase yields fourfold but will reduce calving intervals to a calf a year. The improved farmer starts makes significantly higher profits from the sale of both milk and higher quality in-calf heifer.

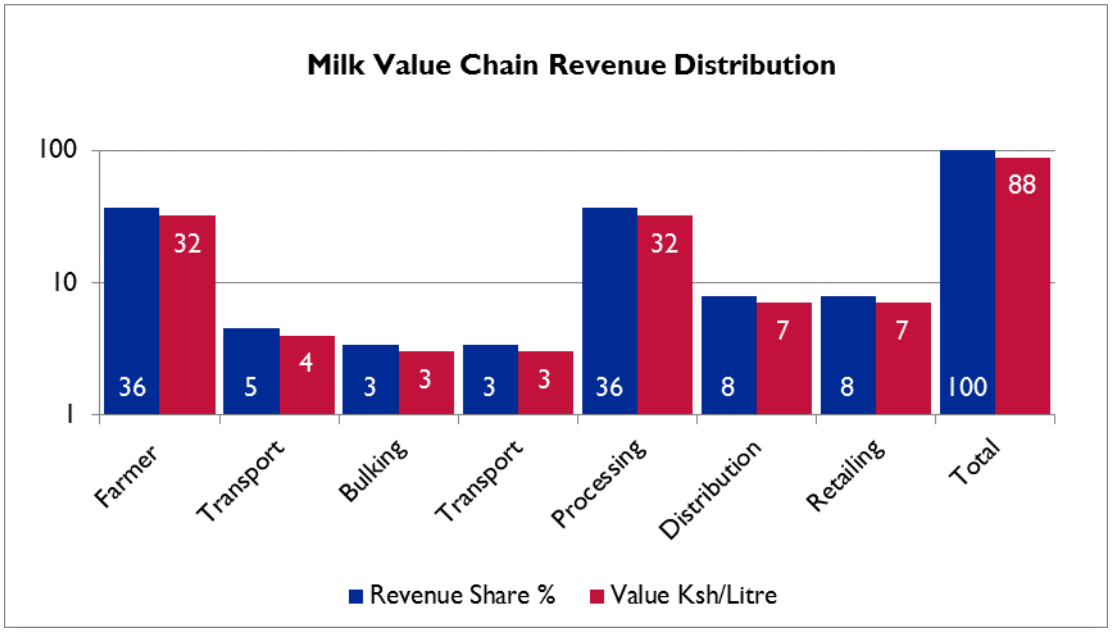
Table 2: Incomes achieved by Dairy Smallholders using Basic and Improved Systems

Farming Practices	BASIC	IMPROVED
REVENUE (1,000 lts/pa)	KSh	KSh
Milk sales	145,600	674,506
Calf and cull-cow sales	97,808	179,506
Manure sales	-	24,500
Milk consumed	21,900	21,900
Manure used at home	31,500	98,000
Total Gross Revenue	**296,808**	**998,412**
PRODUCTION COSTS		
Annual pasture crops	-	695
Bought feed and water	74,780	123,740
Recurrent veterinary	40,660	57,300
Selling expenses	7,072	38,543
Reproduction	6,000	8,000
Overheads, hygiene, depreciations	33,579	76,457
Hired labor	60,000	62,000
Total Gross Revenue	**222,091**	**366,736**
PROFIT		
Total cost per liter of milk produced	36	17
Total gross profit from milk	(26,462)	400,678
Total net profit from milk	(54,591)	329,670
Total net profit from milk, calves, culls	**74,717**	**631,677**

Source: Template adapted from World Bank commodity competitiveness analysis study, 2006

The overall value accumulation of the value chain is presented below in Figure 3 based on 2013 formal market figures obtained from various trade sources. On average, smallholder milk producers receive 36 percent of the final retail value of processed milk. As described above, the non-adopting basic dairy farmers in USAID-KAVES regions will not make any margin under in this price scenario. It is, however, important to note that farmers in the target zone receive prices that are way above these. An adopting farmer receives an average gross margin of 59.4 percent. The gross margin for this adopting farmer increases to 76.4 percent if he/she sells to the informal milk trader as is common in the target regions.

Figure 3: Milk Value Accumulation

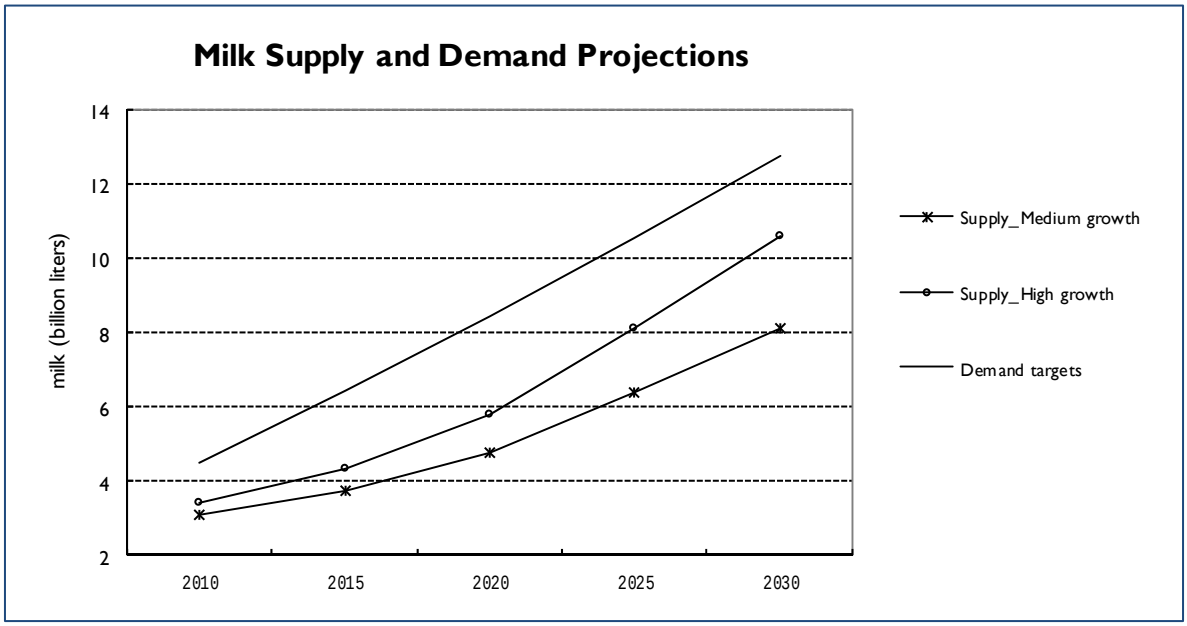


Source: Adapted from IFC Dairy Sector Value Chain Study 2007 and the Dairy Value chain Competitive Report, 2008.

4.1.5 Market Potential

According to the recently developed national dairy master plan, Kenya's domestic milk supply at a medium growth rate of (3.5 percent) and high growth rate of (4.2 percent) suggest that demand will continue to outstrip supply by 31.8 to 43.5 percent for medium growth rate and 16.8 to 32.8 percent for high growth rate (Figure 4). In order to satisfy this growing demand for dairy products and perhaps achieve the World Health Organization's recommended 220 liters per capita milk consumption by 2030, strategic actions to more than double milk productivity are necessary.

Figure 4: The demand and supply milk balance projections from 2010 to 2030



Source: The Kenya National Dairy Master Plan 2011

Milk production volumes are projected to grow to 8-10 billion liters by 2020 versus a milk demand of about 12 billion liters. Key factors that are likely to increase demand for milk and milk products in Kenya include: high population growth, improvement in household incomes, rural-urban migration, Regional export markets, growing consumer awareness and demand for high nutritional foods, expanding retail and supermarket networks and easing distribution of dairy products

The estimated market for milk in sub-Saharan Africa is 35 million metric tons, a large percentage are imports from outside the continent, indicating significant export potential. Dairy products with potential include powder milk, cheese and butter. Within the Common Market for Eastern and Southern Africa (COMESA), and East African Community (EAC), the demand is estimated at 14 million metric tons while supply is only 12 million tons. Most supply is from Europe, Australia, New Zealand, and the United States (U.S.). Total imports to this region are $ 362 million, out of which only 7 percent is from the region. Customers want high end dairy products-milk powder, cheese, and butter. Overall, Kenya has not penetrated export markets significantly despite having the largest production volumes outside South Africa.

4.1.6 Upgrading the Dairy Value Chain

Smallholders produce an estimated 80 percent of Kenya's milk but with very low productivity. Milk quality is generally poor due to unhygienic milking and handling practices and under-developed "cold chains" from farm to processor. Husbandry skills are low, cost of production at farm level is high, and adoption of technologies is low, often constrained by lack of finance. Combined with high processing and packaging costs, consumers are faced with a high cost, often low quality product. Investment in the sector is constrained in part by the weather-based fluctuation of the industry and the unstable relationship between processors and milk producers caused by the fluctuation of supply. A high procurement cost for processors and instability in the marketplace stifle investment, innovation, productivity and profitability on both sides, and creates uncertainty and conflict. The past few years have seen a rapid concentration in the processing sector to five major processors. The only price premium processors pay is for chilled milk and high volumes, so producers do not receive any benefit for achieving higher fat content, while the processors benefit from producing value added products such as cheese, ghee, and butter.

Based on the factors described above, USAID-KAVES is proposing to focus on the following interventions to upgrade the value chain in target counties:

- Improve feed and fodder quantity and quality for increased productivity, including fodder preservation to address the milk supply fluctuation
- Increase access to finance and credit for dairy farmers and cooperatives that adopt good practices and want to expand
- Improve milk quality leading to lower processing costs, longer shelf life, increased production of value added dairy products, and increased exports
- Improve availability, quality and affordability of extension services, including AI animal health, and inputs at the farm level collection and bulking centers
- Increase the capacity of farmer organizations through acquisition of required management and extension skills
- Promote inclusive business models thus encouraging processors to invest in the supply chain for improved productivity.

4.2 MAIZE

4.2.1 Background

Maize is Kenya's main staple food crop, providing daily food caloric uptake to most urban and rural households. According to MoA statistics, 2.1million hectares of maize were planted in 2012 and 98 percent of the estimated 3.5 million smallscale farmers across the country include it in their farming system (Tegemeo Institute, 2009). Maize consumption is estimated at 98 kilograms per person per year (Kirimi et al, 2009), most predominantly in the form of maize flour to make *ugali*, boiled with other products such as dry beans and vegetables to make *githeri* or *nyoyo* (a mixture of maize and beans meal), or eaten off the cob as roasted whole "green maize." It accounts for nearly 20 per cent of total food expenditures among the poorest of urban households, and any factor that threatens maize production becomes a national food security issue (Muyanga et al. 2005).

Depending on crop performance and the demand-supply situation in each year, smallholder households often retain over 50 percent of the harvest for home consumption and sell the rest for household cash income, as required, over a 3-6 month period. Losses in storage are relatively high, sometimes reaching 30 percent according to Food and Agriculture Organization (FAO) figures but probably in the10-15 per cent range for most farmers based on the USAID-KAVES Value Chain 2013 (KVC) survey. Medium and large scale producers sell most of their crop immediately after harvest, often to the National Cereals and Produce Board *(*NCPB), and retain small quantities for consumption and animal feed.

4.2.2 Production Trends

Up until the early 1990s, Kenya was generally self-sufficient in maize, with production frequently exceeding domestic consumption thereby generating surpluses for export. National production decreased at an average compound growth rate of around 1 percent between 1990 and 2003 and, since 2006, the country has experienced regular deficits with serious shortages in 2008 and 2009 as in Figures 5 and 6.

According to official estimates, about 70 percent of domestic production of maize comes from smallscale farmers producing under rain-fed systems. This means that climatic conditions are the main determining factor underlying the variability and seasonality of production. Land fragmentation is also becoming a factor that limits production and precludes the majority of households from participating as sellers in grain markets.

Figure 5: National Maize Production

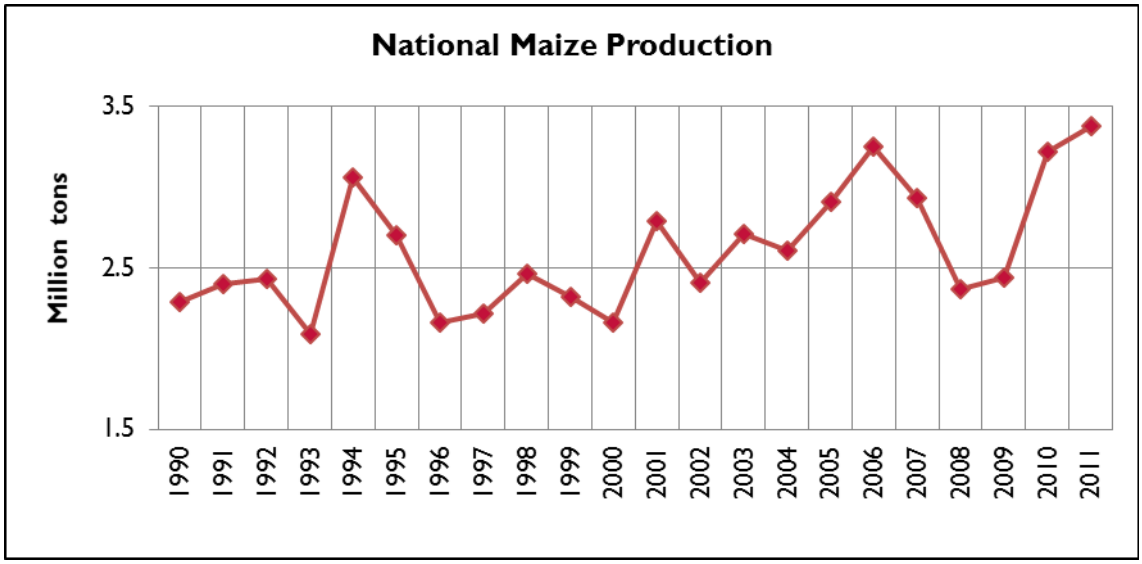
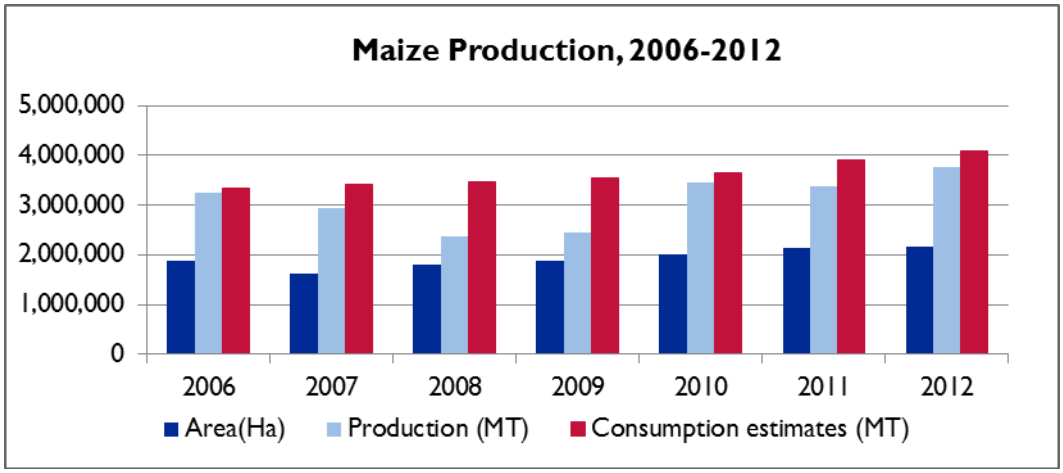


Figure 6: Maize Production Trends and Demand, 2006-2012

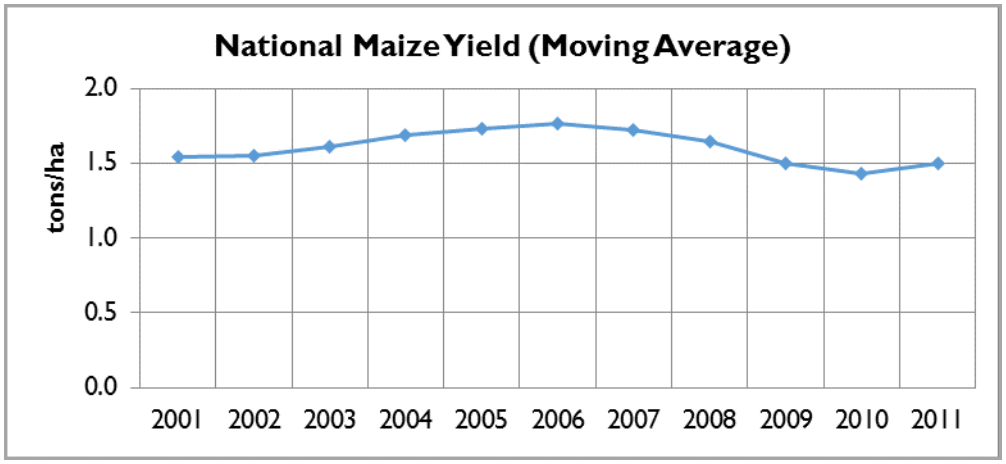


Source: Ministry of Agriculture

Inflows from regional and international sources, mainly white maize from South Africa and Uganda have bridged the supply gap and generally been available at below the cost of locally grown maize. The failure of Kenyan farmers to raise production to meet increased domestic demand is due to a combination of factors:

- Low utilization of fertilizers and improved seeds to compensate for soil nutrient depletion and changes in rainfall patterns in some areas. This has resulted in a decline in average yields from 2.2 metric tons per hectare in 1990s to 1.6 metric tons in 2003 and further down to 1.5 metric tons in 2011 as shown in Figure 7.
- Slowing down of annual growth rate in cultivated area primarily due to increased population leading to land fragmentation and competition from other land uses.
- The insecurity and price instability caused by the abrupt liberalization of maize marketing in the 1993 production season.
- The increasing cost of inputs, particularly fertilizer.

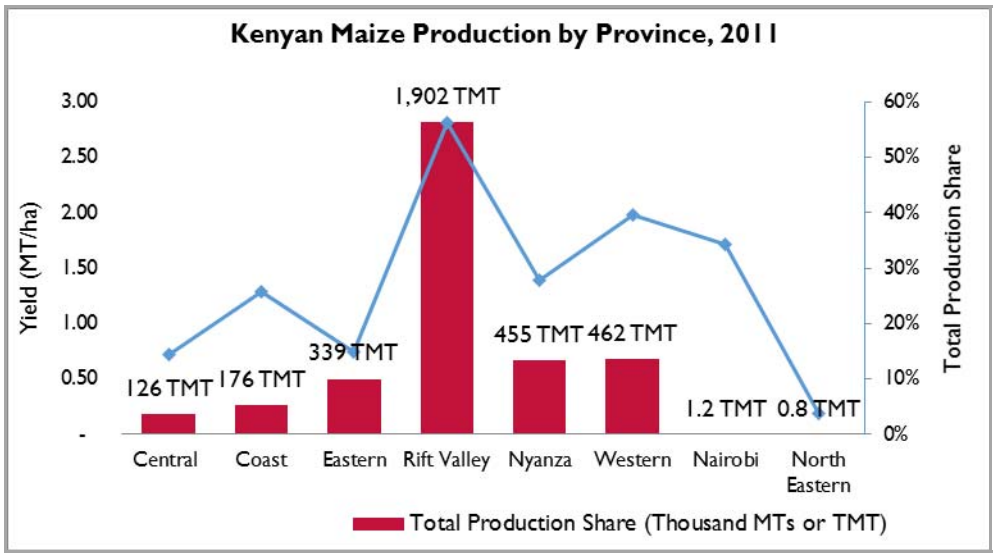
Figure 7: National Maize Yield (Moving Average)



Source: Ministry of Agriculture

Since 2009, both yield and production increased marginally and this trend is likely to be maintained into 2013 due to favorable weather, strong prices, and increased availability and use of government subsidized fertilizer. However, as the land holdings of rural households gradually decrease in size, the relatively low value of maize makes it increasingly uncompetitive as a cash crop.

Figure 8: Kenyan Maize Production by Province, 2011



Source: Ministry of Agriculture

Despite the low value of maize it will remain a crucial crop in the foreseeable future for farmers participating in USAID-KAVES commercialization interventions, both for household food consumption, and as a supplementary income source. Although many of the 22 target USAID-KAVES counties have marginal conditions for maize production, some counties in rift valley, eastern, and western regions have production areas that contribute significantly to nation maize supply (see Figure 8 above).

4.2.3 Value Chain Actors

The maize industry is highly diversified at all levels from production through trading, processing and distribution. This means that raising value chain efficiencies has a high multiplier effect on incomes, estimated at 3.9 dollars generated for every new dollar of maize sold. Producers are large, medium, and small-scale farmers across the whole country. Similarly there are small-scale traders and millers operating at village level, through medium-size businesses to large-scale companies serving major urban centers. In addition to household consumers, institutions, especially schools and hospitals, offer markets for all grades of maize and flour. Service provision to the industry employs thousands including manual workers in transportation and distribution, skilled workers in equipment supply and maintenance and trained professionals in the inputs supply companies, government agencies and research institutions.

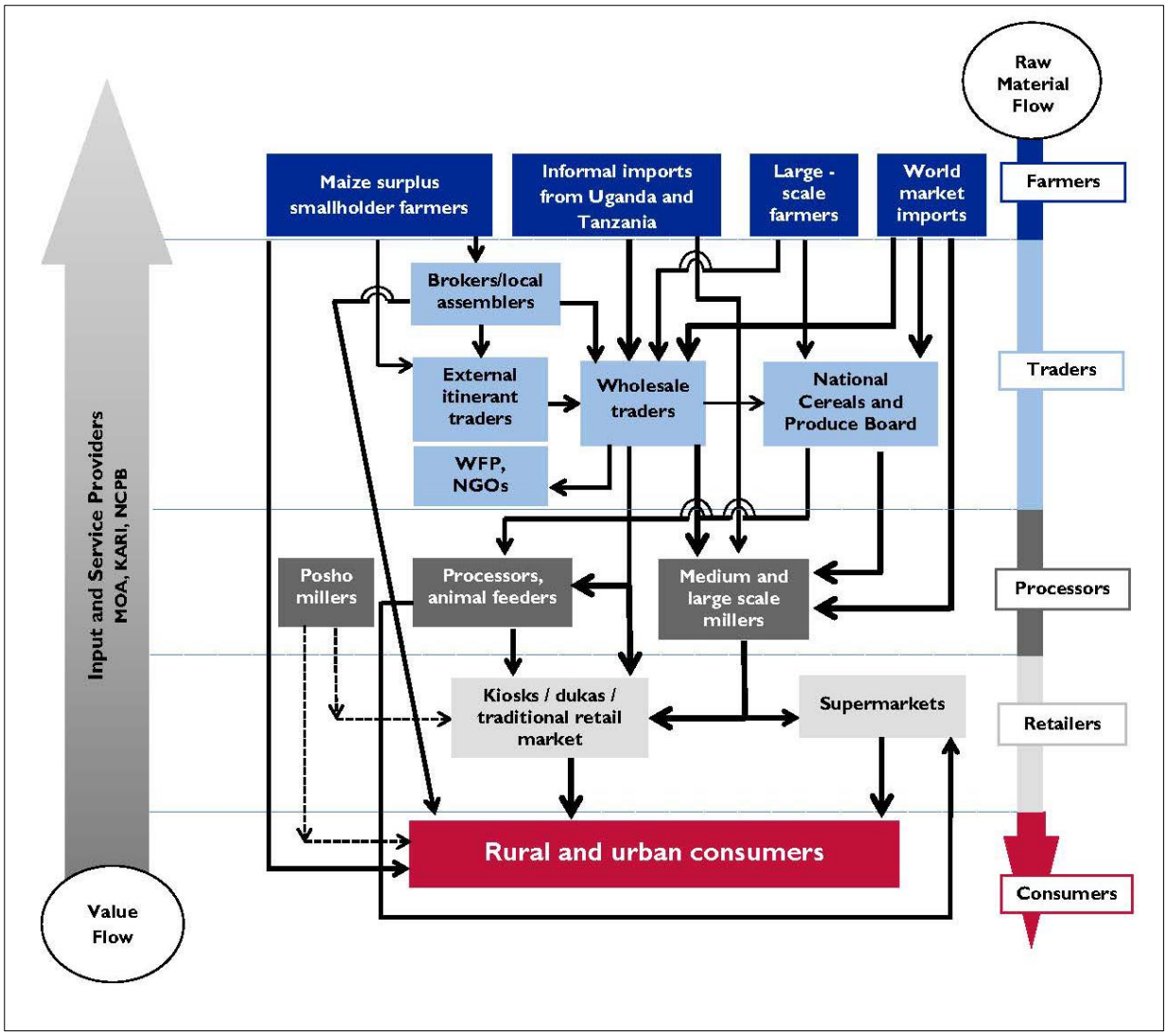
There are complex interactions of the players along the value chain with costs and value moving in both directions. For instance a farmer buys fertilizer and maize seeds from NCPB, sells his dry maize to the same organization during the harvesting season, and three months later buys maize back for home consumption, usually at a higher price. There are two main channels of distribution: trade in whole maize grain that involves only two or three transactions before reaching the final consumer; and trade in processed maize products, primarily flour for human consumption and to a lesser extent animal feed products, that involves a wide range of actors (Figure 9).

Production:

An estimated 3.5 million smallholders with farms of less than two acres account for 70 percent of all maize planted. The balance of 30 percent is grown by 2-3,000 medium and large farmers with larger areas of land planted under maize for marketing. Yields vary widely but average smallholder yields are estimated to be 6-8 bags (630 kilos) per acre compared with 12-14 bags (1,170 kilos) obtained by larger-scale commercial growers. Because of these low yields, farmers are generally net buyers of maize, selling for cash and buying back when stored household supplies run out. Maize "surpluses" are sold in small amounts to village traders, often less than 10 kilograms per lot, when cash is needed. Small-scale farmers rarely combine their crop for aggregation, collective sales or transportation.

The need for cash and limited household storage capacity forces many farmers to sell immediately after harvesting and drying to avoid losses, causing sharp seasonal fluctuations in maize prices.

Figure 9: The Maize Value Chain Map



Source: Adopted from Tegemeo Institute 'a farm gate-to-consumer value chain Analysis of Kenya's maize marketing system.

Traders

Most smallholders sell in small lots to rural-based traders who collect, assemble, bulk, and deliver to retail market traders, larger traders/companies and millers. Since margins are low and credit unavailable for most traders, they store maize for very short periods before release to the next buyer.

They also lack suitable storage facilities to store maize safely for longer periods and profit from selling when prices rise. Competition is strong within counties among Smallscale assemblers whose turnover depends on day-to-day cash availability.

Maize brokers buy from rural traders on behalf of national wholesalers and other large buyers, including millers, often consolidating produce from hundreds of village level assemblers. Sorting and grading takes place mainly at this level, incurring significant handling costs and requiring space, facilities and equipment.

In maize deficit areas there are also dis-assemblers who purchase larger quantities from wholesalers and others, breaking them down into smaller lots for sale to kiosks and small shops. Small and medium scale traders handle 45-60 percent of marketed produce, the large traders and NCPB handle 20-22 percent

while millers handle directly about 25 percent. The large trading companies and most large scale farmers sell directly to NCPB, national or international relief organizations or millers.

Maize and maize flour is still bought daily by the majority of rural Kenyans, from roadside kiosks, market stalls, small shops and supermarkets, or directly from growers with surpluses. These retailers operate at low margins of 5-10 percent depending on the source of their stock and the transport costs incurred.

Millers

Maize is milled into flour by a wide range of processors operating at all levels. More than10,000 millers convert grain to flour at village level using low-cost hammer mills. They either charge a small fee to customers consuming their home grown maize or buy maize and sell flour in small quantities. Medium scale enterprises operate in urban areas, with processing capacity ranging from as low as 100 kilograms per day to as much as 7 metric tons. Some of these enterprises have basic equipment for packing and distribution of 2-kilogram bags to local retailers and many of them are members of the United Grain Millers and Farmers Association (UGMFA). At national processing and distribution level there more than a hundred large-scale millers. These are represented by the Cereal Millers Association (CMA) - a trade association with strong lobbying powers, currently representing the interests of 109 members.

Service providers

Farmers access production services ranging from inputs supply (seeds, fertilizers, and chemicals) to extension and financial services from many sources. The services are either provided at a direct cost or as embedded services within the transactional cost incurred between farmers, traders, input suppliers or other commercial players.

Input suppliers

Small agro-dealers and stockists are the primary source of inputs for smallholder farmers and their numbers have increased substantially over the last decade from 8,000 to 10,000 nationwide. This has resulted in better access to primary inputs for farmers although average distances for farmers to the nearest seed or fertilizer supplier remains high in certain districts. The stockists also provide extension advice to farmers whenever they sell their products and the training and subsequent registration of stockists by the Kenya Plant Health Inspectorate Services (KEPHIS) has given them more confidence to provide this embedded service.

Many farmers still plant their own saved seed, or acquire seed directly from other farmers in their community. Certified seed from registered companies is readily available, with 90 percent locally produced and the balance imported. KEPHIS certifies and regulates seed production of domestically produced seed and provides permits for seed imports. There are about 35 active registered seed companies of which 14 (nine of them local) are engaged in the maize seed business, offering about 50 different varieties. These companies are all members of Seed Trade Association of Kenya (STAK).

Major players are the Kenya Seed Company (KSC) which has approximately 87 percent of national market share; Western Seed Company (WSC) with 3.5 percent; Faida Seeds with 3 percent and the balance sold by East Africa Seed Co., Freshco Seed, Farmchem, Pannar Seed, Hortitech, Monsanto, and the Kenya Agricultural Research Institute (KARI) Seed Unit.

Fertilizer use by maize farmers is still low nationally and depends on the size of farm and the maize growing season. According to the MoA, 90-98 percent of the farmers in Western and Central highlands apply fertilizers compared with only 30-55 percent in the Eastern and Western lowlands. Even for farmers utilizing fertilizers, application rates vary widely in terms of efficacy due to high soil acidity, non-specific application methods and cultivation systems that do not optimize uptake of nutrients. Other reasons given by farmers for low fertilizer application include distance to agro-input stockists, perceived high prices, lack of knowledge in customized fertilizer use, and large-sized packs that they cannot afford.

Fertilizer importers distribute directly to large farmers and retailers/stockists, and through wholesalers/distributors who sell on to stockists/agrovets. The largest importers and traders are represented by the Fertilizers Association of Kenya (FAK). Commercial imports are dominated by Yara East Africa and MEA Limited with market shares of 50 and 25 percent, respectively. Other farm chemicals - pesticides, herbicides, and fungicides - are widely available through stockists. All leading manufacturers are represented in Kenya.

Research, development, and technology transfer

Maize seeds planted vary from local landraces to composites and hybrids. Local landraces are poor yielding but have the great advantage of being suited to the local conditions. KARI has supported maize crop development and has released over 215 varieties of maize which are suited to various agro-ecological zones and are not only tolerant to drought conditions but also can withstand *striga* pressure especially in western Kenya regions. KARI is presently the main player in research and technology transfer for maize and is working very closely with other organizations with interests in seeds (CIMMYT, KEPHIS, and others) and the seed companies. MoA has also continued to support farmers through extension services on good agricultural practices including transfer of agronomic techniques that lead to increased yields. However, adoption of high quality seeds, new varieties and improved technologies has been slow.

Financial services

Access to credit facilities from input suppliers, micro financing institutions with savings and lending products, leasing, capital investing has limited smallholder farmers' ability to finance maize production. Commercial banks' lending to agriculture is limited to a few large-scale farmers while the government's Agricultural Finance Corporation which provides both individual and group loans to farmers, has high default rates. Microfinance institutions have not penetrated the smallholder agriculture sector nor designed appropriate financial products for producers, however, this is improving with savings and credit co-operative and other institutions offering a wider range of suitable loan products. Some input suppliers/stockists provide credit to small farmers based on long-term relationships, and some contract buyers also provide inputs on credit (deducting the price of the inputs from the sales price paid to the farmer upon delivery of product). A crop insurance, Kilimo Salama (safe farming), a program for Small-scale maize growers, began in 2010, and shows promise, but coverage area and utilization remain low. However, returns on maize are generally too low for farmers with small areas of land to obtain production credit (see below).

Infrastructure

The scarcity of efficient, low-medium scale on-farm and market level storage and bulking facilities is a major constraint in the current handling system. Poor storage at these levels results in both financial losses and food wastage caused by high levels of aflatoxins and other types of spoilage. The net result is that farmers and first-level traders sell immediately after harvest, creating gluts and bringing down prices. The NCPB has large scale facilities but these are not accessible at any reasonable cost to smallholder producers with marketable surpluses. Neither will the proposed warehouse receipts system provide storage services to small-scale farmers in the foreseeable future. Investment and technical interventions in farmer organization and low-cost storage at household, association and village level would have immediate impact on prices, food availability and incomes for smallholders.

4.2.3 Maize Value Accumulation

Maize production contributes to the income of almost all smallholders targeted by USAID-KAVES. Tables 3 and 4 illustrate current average returns from maize and the potential earnings if basic improvements are adopted in their production systems. A more detailed breakdown is given in Annex 11 (Maize Budget per acre). In determining the direct costs of production, current costs of labor, fertilizers, seeds, gunny

bags, chemicals were used. Average 2012 farm gate prices were applied for both inputs and outputs. The market value of dry maize grain was the only factor considered for this analysis; however other outputs, mainly sales of green maize, use of stover for animal feed, and utilization of organic matter for mulch and compost, contribute indirectly to overall profitability of Small-scale farming enterprises.

Land preparation, fertilizers, and labor are the major costs in both systems. At the prevailing low input and output level, the producer makes a negative margin of around Ksh 2,000 per acre when family labor is costed (Table 3) compared to a positive gross margin of Ksh 33,000 for a farmer who adopts better practices (Table 4).

Table 3: Maize Production Budget – Current Practices

Typical Maize Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	5,500	29.6	Manual or oxen
Seed	1,800	9.7	Saved
Fertilizer	0	0.0	
Agrochemicals	450	2.4	Storage fungicide only
Labor	10,000	53.9	Hired cost, h/h return higher on family labor
Bags, sisal	800	4.3	
Transport	0	0.0	
Total direct costs	18,550	100.0	
Yield - Kg	540		
Production cost/kg	34		
Price - KSh/kg	31		
Sales value	16,740		
Gross Margin	**-1,810**		

Source: Ministry of Agriculture

Interventions to obtain the marked improvement between the two production systems involve little risk to the farmer and rely primarily on availability of cash or credit for inputs and adoption of good agricultural practices. Focusing on intensive production from smaller areas is a basic principle that farmers will be encouraged to adopt in order to reduce labor costs, increase yields and release land for other productive activities. Specific practices necessary for this intensification include:

- Use of improved technologies including certified seed of climate-specific varieties.
- Planting on time.
- Use of herbicides.
- Increased use and precision application of fertilizers.
- Optimum plant population.
- Crop protection against field pests.
- Use of labor saving technologies for harvesting and drying.

The transformation from subsistence to commercial production that occurs when these practices are adopted is shown in Table 4 below. With efficient use of certified seed, fertilizers and chemicals, production increases from 900 to 2,700 Kg and a positive gross margin of over Ksh 30,000 can be achieved.

The significance of these changes at production level in terms of increasing smallholder incomes is illustrated clearly in the value accumulation chart shown in Figure 12 which shows the increase in value

of maize at each stage as it moves through the whole value chain. The farm gate value when it moves from farmer to trader accounts for 49 percent of the "equity" in the final product – usually a two kilogram bag of flour.

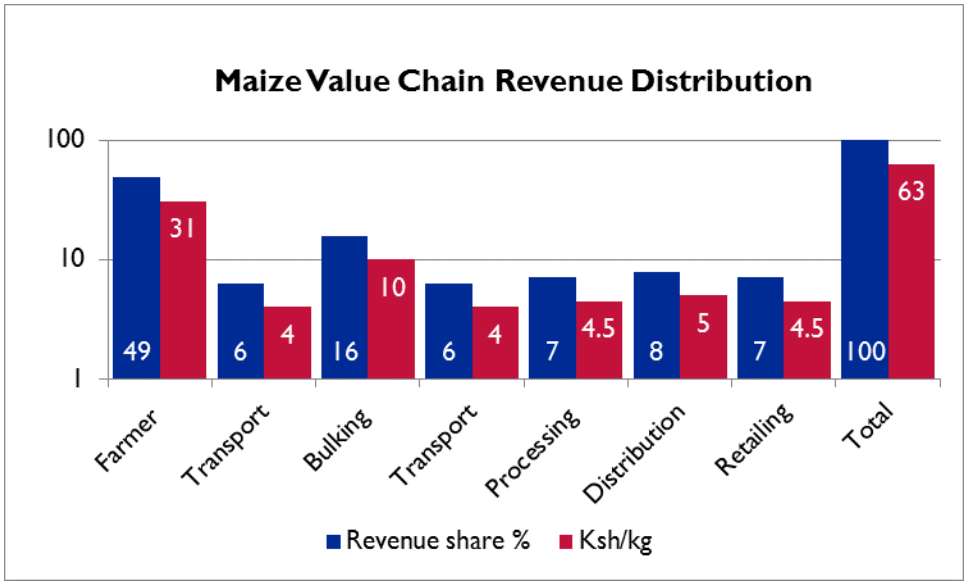
Table 4: Maize Production Budget - Efficient

Efficient Maize Production Budget per Acre			
Activity/Input	**Cost/Value KSh**	**Percent**	**Note**
Land preparation	5,500	14.9	
Seed	1,800	4.9	
Fertilizer	7,000	37.9	
Agrochemicals	1,650	4.5	Herbicide, storage
Labor	10,150	27.5	Hired cost, h/h return higher on family labor
Bags, sisal	2,300	6.2	
Transport	1,500	4.1	
Total direct costs	29,900	100.0	
Yield - Kg	2,250		
Production cost/kg	16		
Price - KSh/kg	31		
Sales value	69,750		
Gross Margin	**39,850**		

Source: Ministry of Agriculture

It is clear from Figure 10 that the main driver of the end-market price is the farm-gate price which is the largest cost component in production, trading, processing, wholesaling and retailing of maize into meal and flour. Reduction in production costs per kilogram translates directly into increase margin and income for the farmer. Reduction in costs at the first bulking or aggregation level also has the potential to increase farm gate prices, accounting for 20 percent of added value. Value increases and margins beyond that are relatively low and cost reductions at processing and distribution stages will have little effect on farm gate returns per farmer. Interventions by USAID-KAVES that increase productivity and reduce the primary traders' costs of accumulation and storage at village level will therefore have the maximum impact on smallholder income.

Figure 10: Maize Value Accumulation

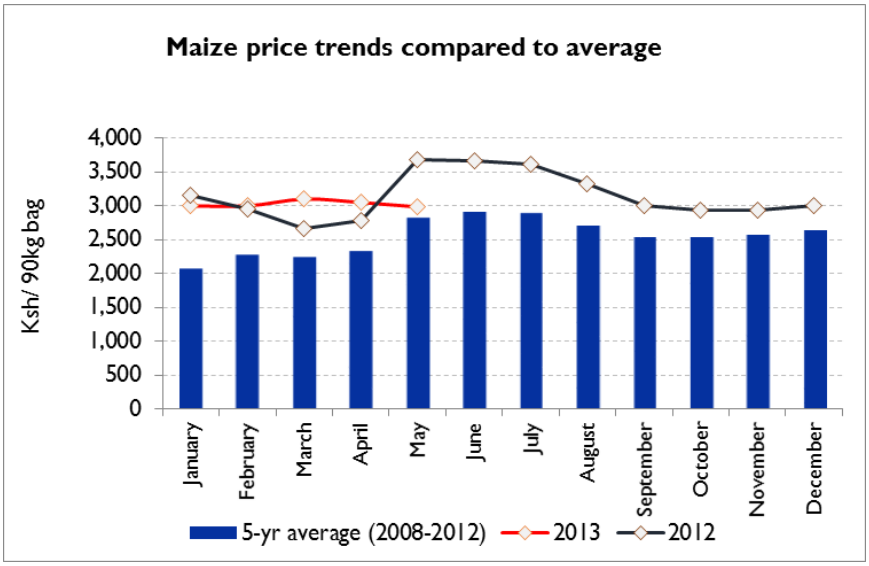


Source: Ministry of Agriculture

4.2.5 Market Potential

The domestic demand for maize has consistently exceeded supply in recent years as shown in Figure 6. In 2012, the MoA estimated national maize production of 41.8 million 90-kg bags against the demand of 45.6 million bags. Inefficient postharvest handling also impacts negatively on the total volume of maize reaching markets, estimated at only about 15-25 percent of total production. Shortfalls have been met with both formal and informal imports from Uganda, South Africa and other sources in the past. As the population and economy grow, demand will increase for human consumption and animal feed for the expanding dairy, poultry and pig industries. The market opportunity for smallholders is therefore not in question. The issue to be addressed is the competitiveness of their production systems or, in agronomic terms, the cost of production relative to the price at which white maize can be imported and distributed (the "import parity price"). Yellow maize can often be purchased slightly cheaper on world markets but this is not an option for the Kenyan consumer.

Figure 11: Maize Price Trends Compared to Average



Source: MoA

The cost of production analysis given above in Table 4 indicates that efficient smallholders can produce maize for Ksh15-20 per kilogram, less than 40 percent of the local market price in recent years (Figure 11). Although production at this price is competitive, the surpluses generated by farmers are sold through fragmented sales in small amounts in the village to traders and the cost of aggregation is high. The variability in quality between farmers also increases downstream processing and marketing costs. More efficient aggregation by well-organized farmer groups working with traders can have an immediate impact on margins and incomes at village level. The annual variability in maize prices shown in Figure 11 also illustrates the potential benefits of improved storage systems to both increase average farm gate returns and stabilize consumer prices.

4.2.6 Upgrading the Maize Value Chain

In principle, maize production efficiency is not related to scale and smallholder farmers are able to achieve high yields and margins if they adopt good agricultural practices and have access to inputs. The main comparative disadvantages of smallholders are low yields currently being achieved and high cost of product collection and marketing incurred by traders buying from them. Smallholder households also suffer economic losses related to home consumption caused directly by crop deterioration during storage.

USAID-KAVES will focus on three areas of intervention that will increase net household incomes from maize production and marketing:

Productivity

- Increasing maize productivity and reducing costs of production through training and technical assistance to raise the number of farmers using good agricultural practices.
- Increase and diversify access to cash and credit for inputs especially fertilizer. Reduce fertilizer costs through improving linkages between smallholder groups and input stockists.
- Greater use of improved technologies including certified seed of climate-specific varieties, herbicides and precision application of fertilizer.
- Adoption of labor saving technologies such as minimum tillage for production, harvesting and drying.

Aggregation of surplus production

- Supporting formation of farmer groups for collective marketing.
- Brokering new investments in storage facilities and handling/grading equipment by first stage assemblers who buy directly from the smallholders.
- Sourcing seasonal finance for traders to improve their capacity to absorb surplus production.

Improving storage performance and reducing postharvest losses

- Source commercial finance for on-farm storage to reduce grain losses.
- Demonstrate financial benefits of new storage technologies such as low-cost metal silos.
- Increase incentives for investment in commercial storage especially for small-medium scale traders.

4.3 IRISH POTATO

4.3.1 Background

Irish potato is the second most important food crop after maize in Kenya. The Irish Potato has a high protein to carbohydrates ratio and can provide the recommended daily allowance of vitamin C. In view of this, Irish potato is considered strategic in reducing hunger and malnutrition (George O. Abong et al., 2010). Irish Potato is mainly cultivated by smallholder farmers in the high altitude areas (1500-3000 meters above sea level) where Kenya's main staple food (maize) has no comparative advantage (Kirumba et al., 2004). There are approximately 500,000 growers in the country, cultivating108,000 hectares, with an annual production of over 1 million tons in two growing seasons (Maingi, Krain and Koome, 2009). The annual production of the crop is worth about Ksh 5 billion at farm gate prices and more than Ksh 10 billion at consumer prices. The industry indirectly employs about 2.5 million as market agents, transporters, processors, vendors, retailers and exporters.

The demand for Irish potato in Kenya outstrips supply – a fact that has partly been attributed to low productivity and changes in consumption habits. The current total Irish Potato production is estimated at 2.9 MT annually. Meru, Nyandarua, Bungoma, Nakuru, and Keiyo Marakwet counties account for 85 percent of the total Irish potato production (Horticulture Validated Report, 2012). Statistics on demand for Irish Potato is scanty; however, three quarters of the urban households consume Irish potato regularly, on average 5 Kg per adult per month (Potato Value Chain Report, 2012). Comparatively, Kenya produces 5-10 tons of Irish potato ha^{-1} while Egypt and South Africa are at 26 and 36 tons of potato ha^{-1}, respectively. The low potato productivity in Kenya is associated with a number of factors that include inadequate quality planting material, poor agronomic practices, and prevalence of pest and diseases. It is estimated that up to 11 percent decline in potato yields among smallholder farmers is recorded annually due to a combination of these factors (Proceedings of Potato Round Table Meeting, 2012).

There is increasing demand for Irish Potato in urban centers due to changes in consumption habits. Up to 65 percent of the Irish potato supplied to urban centers is processed into chips in fast food restaurants and hotels. In addition, processing of crisps has also become a major commercial activity in urban centers due to high demand of crisps (George O. Abong *et al*., 2010; ECAPAPA, *et al*., 2005; Kirumba *et al*, 2004). In view of the demand, Irish potato industry is increasingly becoming an important source of income and employment. The Irish potato industry employs more than 3 million people through direct and indirect linkages, and generates an income of up to Ksh 50 billion annually (Potato Value Chain Report, 2012).

In a bid to enhance the performance of the Irish Potato value chain, the Government has developed Irish potato master plan to facilitate coordinated interventions with a view of addressing challenges in the industry. In addition, the Government through the MoA has embarked on seed potato multiplication program through rehabilitation of the micro-propagation laboratory at KARI in Tigoni; potato seed screening; and seed potato multiplication on 700 acres Asante farm. These efforts are geared towards increasing usage of quality planting material to 10 percent from the current less than 5 percent of the smallholder famers (Proceedings of Potato Round Table Meeting, 2012). Potato production is heavily reliant on pesticides. The combined cost of potato seeds, pesticides and land preparation makes the potato production one of the most expensive food crops. This is largely compensated by the high yields and good returns that can be achieved. Irish potato enterprise is very profitable for a family that produces on at least one acre of land; the enterprise relies entirely on the bi-modal rainfall pattern with most farmers practicing rain-fed production.

Irish potato production is a gender-balanced enterprise with women labor utilized more in planting, grading and sorting while men labor is utilized in land preparation. The enterprise is a good rural employer.

4.3.2 Production Trends

The area under Irish Potato production increased by 18 percent from 120,754 hectares in 2006 to 143,000 in 2012; during the same period, productivity declined by 10 percent from 22.3 metric tons per hectare in 2006 to 20.3 metric tons in 2012 (Figure 12). The slight increase in area under production is partly attributed to the fact that production in Kenya is limited to areas above 1500 meters above sea level due to lack of planting material suitable for low altitude areas. The decline in productivity is associated with a number of factors that include low use of quality planting material, poor agronomic practices, and prevalence of pest and diseases. It is estimated that up to 11 percent decline in Irish Potato yields among smallholder farmers is recorded annually due to a combination of these factors (HCDA Statistics; Potato Value Chain Report, 2012).

Figure 12: Area (Ha) under cultivation and production (MT) of Irish Potato between 2006 and 2012

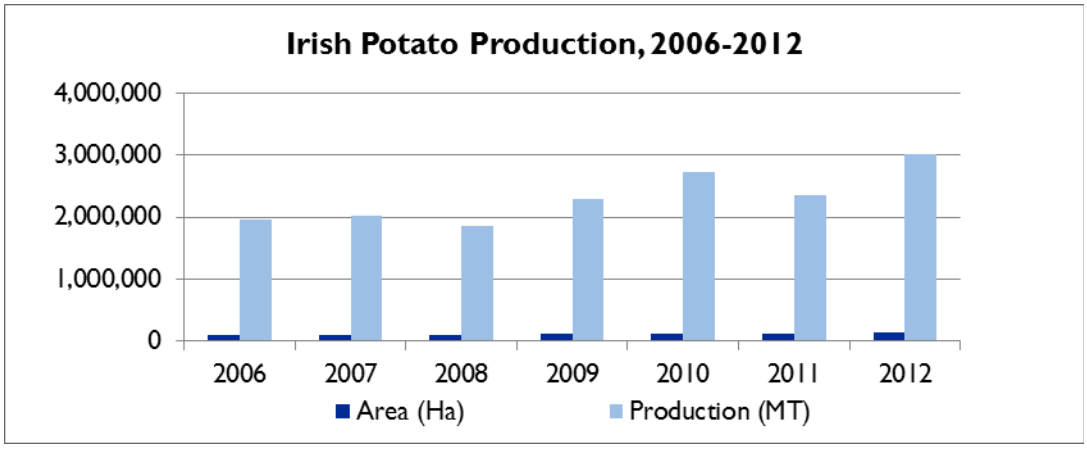


Table 5 shows the distribution of potato production across the country in 2011 as reported by the MoA. The three USAID-KAVES target counties of Meru, Elgeyo-Marakwet, and Bomet account for 24.8 percent of national production. Average yields vary widely with reported yields in Meru (14.9 MT/Ha) about half of those in Bomet (29.8 MT/Ha) and Elgeyo-Marakwet slightly higher than Meru at 19.2 metric tons per hectare. However, Elgeyo-Marakwet is the highest volume producer of the three at 290,151 metric tons, equivalent to12.3 percent of national production, followed by Meru at 186,538 metric tons (7.9 percent), and Bomet at 109,840 metric tons (4.6 percent).

Table 5: Production of Irish Potatoes in Selected Counties, 2011

County	Production		Yield	
	Area (Ha)	Quantity (MT)	MT/Ha	Value (Million Ksh)
Nyandarua	30,577	983,050	32.1	12,205
Nakuru	16,804	270,986	16.1	7,738
Meru	12,500	186,538	14.9	4,465
Kiambu	10,092	92,710	9.2	3,339
Elgeyo-Marakwet	15,097	290,151	19.2	3,297
Bomet	3,680	109,840	29.8	2,862
Narok	7,808	106,000	13.6	1,942
Nyeri	6,404	94,721	14.8	1,490
Total	**123,390**	**2,365,263**		**40,902**

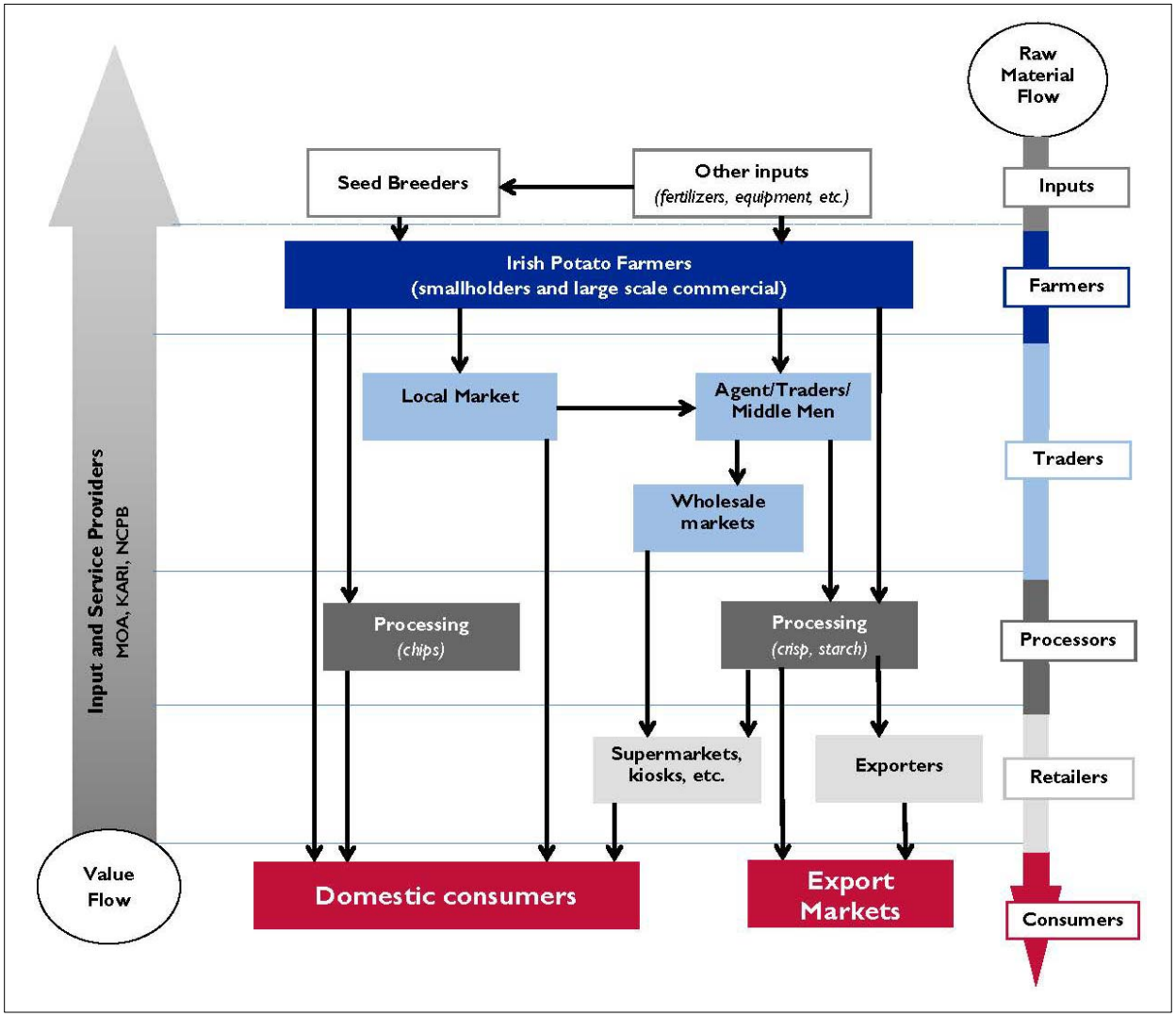
4.3.3 Value Chain Actors

The interaction of multiple actors in the value chain is shown in Figure 13. It is a complex chain with key stakeholders involved both pre-planting (breeders and seed traders) and postharvest (processors). Potato is a high response crop that is traded globally and to produce competitively growers must apply inputs at optimal levels.

Producers

Irish Potato is mainly cultivated by smallholder farmers who produce 2-3 crops per year, each season being about four months long. There is significant variation in economic efficiency among farmers. In major potato producing counties such as Nyandarua, economic efficiency indices ranged from 12.3 to 66.1 percent with a mean economic efficiency of 39.1 percent which implies considerable production inefficiency. By operating at full economic efficiency levels, on average, the smallholder farmers would be able to reduce their costs by 42.4 percent. Studies indicate that the level of education of the household head, experience, number of extension visits, and access to credit are significant variables for improving the level of economic efficiency (D. O. Nyagaka, G. A. Obare1 and W. Nguyo, 2009).

Figure 13: Irish Potato Value Chain Map



Source: MoA

Input suppliers

Irish potato production requires high input investment. The national production is far below the potential, largely due to limited use of certified seeds, low application of fertilizers and other organic amendments, and low use of fungicides and other production chemicals (Jane Muthoni & D. O. Nyamongo, 2009). It is estimated that less than two percent of smallholders use quality planting material a fact that has been attributed to inadequate supply of certified seeds (Kaguongo et al., 2008). Rapid decline in soil fertility is a major constraint in Irish potato production among smallholder farmers (Kiiya et al., 2006). Smallholder farmers apply fertilizer below the recommended rate of (90 kgN/ha + 230 P2O5/ha) (Kaguongo et al., 2008). In addition, continuous use of DAP without soil testing in inherently acidic soils has increased soil acidity thus further limiting production (Kamoni, 2009).

Bacterial wilt caused by a fungus known as *Ralstonia solanacearum* regarded as a disease of economic importance in potato production causing losses ranging between 30 and 70 percent at altitudes ranging 1800-2800 meters (Otipa et al., 2003). High cost of inputs especially seeds; fungicides and fertilizers greatly limit the production of Irish potatoes in Kenya (Kaguongo et al., 2008). Seed costs contribute a

significant 42 percent of the total production costs (Kirumba et al., 2004). Financing proper inputs, a cold chain and long life product processing can greatly stabilize the sub-sector and benefit farmers getting as low as 26.9 percent of final consumer price (Oiko Credit, 2010).

Processors

Potato is mainly processed into crisps and chips. Other potato processed products include long- life fries, pringles and potato flour (Riungu, 2007). Processing of potato flour, starch, weaning food and wine is yet to be commercially exploited. The main potato processors such as Midlands, Deepa, Norda, and Njoro Canners are operating at 40 percent capacity due to lack of consistent supply of good quality tubers. Inconsistence in supply of raw material is attributed to reliance on rain-fed production system and inadequate storage facilities (Oiko Credit, 2010).

Dutch Robijn and *Kerr's Pink* are the only two potato varieties suitable for crisp processing available to local processors; while *Roslin Tana*, *Dutch Robyn* and, and *Nyaro* are the popular varieties for chip processing (A. M. Walingo et al, 1997). However, most potato processing varieties (Tigoni, Sangi, and Desiree) are low yielding and very susceptible to pest and diseases (Potato Value Chain Report, 2012).

Infrastructure

The Agriculture Development Cooperation (ADC) Molo station undertakes production of pre and basic potato seed, and potato mini-tubers. In addition, ADC has 19 potato cold stores with a total capacity of 100 metric tons. The construction of the cold storage facility was done in 1985 with the support of the Dutch government. In addition, the government has equipped the potato tissue culture laboratories, constructed greenhouses for potato seed screening, and procured for the Cooperation 700 acres of land in Molo for seed potato multiplication. Other government infrastructure established to promote seed production include micro-propagation laboratory at KARI in Tigoni. However, production of adequate quality seed and optimal utilization of the storage facilities remains a challenge a fact that has been attributed to lack of private sector involvement (MoA, 2012).

Regulatory framework

The MoA provides extension services and leadership in formulating policy, legal and regulatory framework. Notable potato policy, legal and regulatory framework developed in the recent past by the Ministry include: Legal Notice No. 44, the crop production and livestock (seed and ware potato production and marketing standards) rules, 2005; and the Seed Potato Master Plan (2010). In addition, Legal Notice No. 113 provides the maximum weight for a bag of potato for sale as 110kg, Ministry of Local Government (Adoptive by-laws) (Agricultural Produce) (Standard Weight of Packages) Order, 2008. In spite of the existing framework, enforcement remains a challenge due to lack of standards and appropriate institutionalization of the laws for effective enforcement (MoA, 2012).

4.3.4 Irish Potato Value Accumulation

The crop budget for a typical smallholder farmer is summarized in Table 6 and in more detail in Annex 11 (Irish Potato Budget). It assumes a conservative yield figure of 8 metric tons per acre and an average farm gate price of Ksh 30 per kilogram. The return per acre is $187,100 when all labor is costed at market rates. If all or part of the manual work is done by family members, the return per household will increase to as much as Ksh 216,000 per acre for each crop cycle.

Table 6: Irish Potato Production Budget

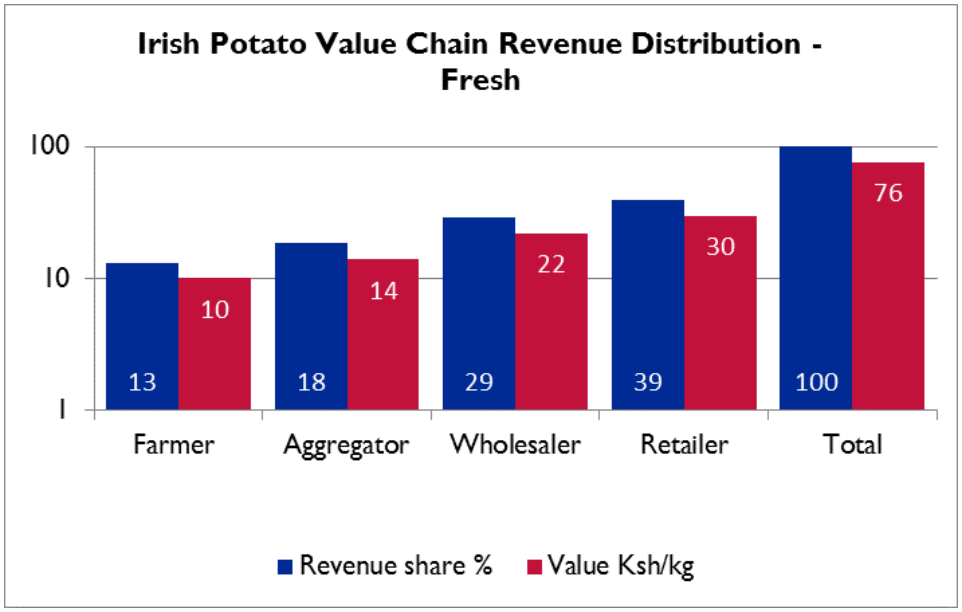
Irish Potato Production Budget per Acre			
Activity/Input	Cost/value Ksh	Percent	Note
Seed	24000	44.1	Assumes purchase of clean potato seeds
Fertilizer	12688	23.3	DAP and foliar
Agrochemicals	5256	9.6	Mainly fungicide
Labor	12000	22.0	Hired labor cost, h/h earnings higher if family labor used
other	539.44	1.0	
Total direct costs	54483.44	100.0	
Yield – kg/acre	7600		Low, can increase with adoption of GAPs.
Production	7.17		Does not include indirect costs
Price - KSh/kg	10		
Sales value	76000		High return on labor and investment
Gross Margin	**21,516.56**		

Considering a family that affords 450 person day (PD) in a year (300 from husband and 150 from the wife); it has the capacity to cultivate 2.25 acres since 1 acre requires 100 PD per season, and a year has 2 seasons. Their income for a calendar year would therefore be Ksh 570,748.5 (126,833x 2 seasons x 2.25 acres).

If the family has 5 members (2 adults, 2 children and 1 dependent), all relying on the income for livelihood all year round (365 days), their individual daily income would be Ksh 347. This basic income is adequate for survival and is far much higher than the considered international poverty threshold of USD 1 per day or Ksh 83. Such a family would therefore not be considered poor and one can safely conclude that the Irish potato enterprise is well capable of contributing very positively to the household's income.

Secondly with respect to employment creation it is evident from the data that potato cultivation needs a lot of labor which often cannot be supplied by the family and thus gives rise to rural employment opportunities (Maingi, Krain and Koome, 2009).

Figure 14: Irish Potato Value Chain Cost/Value Accumulation – Fresh

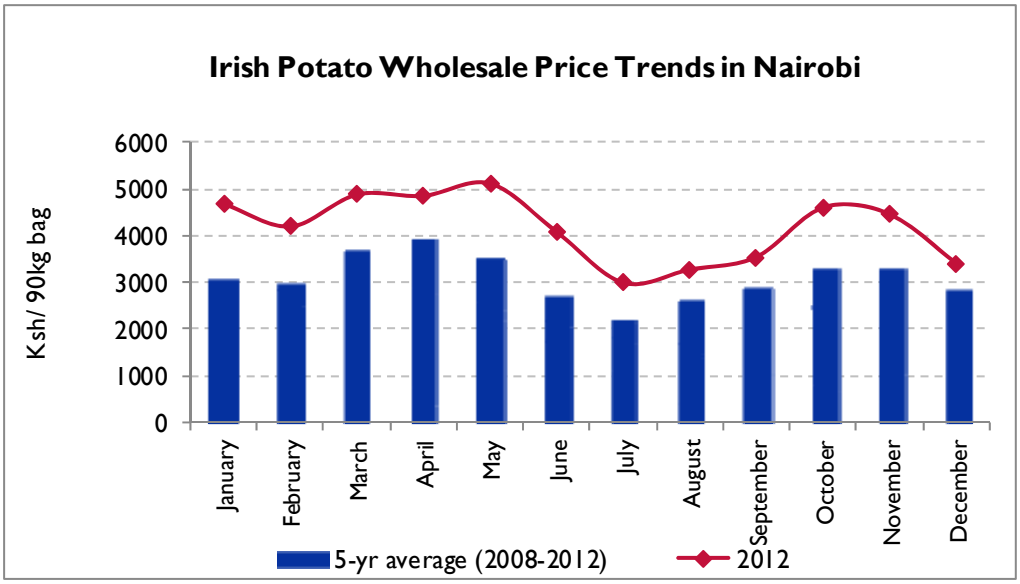


The value accumulation from grower through intermediary traders to final consumer is shown in Figure 14. At current costs and prices, the producer receives 30 percent of the final retail value and a gross margin of 130 percent per kilo on production costs. Processors buy at wholesale prices or less where they have contracts with farmers to supply large quantities.

4.3.5 Market Potential

Figure 15 shows the monthly variation in wholesale prices at Nairobi. There is increasing demand for potato which is attributed to changes in consumption habits, mainly in urban centers, where chips have become more popular part of the diet. Restaurants, hotels and canteens that process chips are major markets for potato. In addition, processing of crisps has also become a major commercial activity in urban centers due to high demand of crisps.

Figure 15: Irish Potato Wholesale Price Trends in Nairobi



Demand for crisps is validated by crisp imports and increase in number of processors; there 84 potato crisps processors in Kenya with 24 of the processor being around Nairobi. The main potato processors such as Midlands, Deepa, and Norda are currently not operating at full capacity throughout the year due to lack of consistent supply of enough good quality tubers. A study by George O. Abong *et al.* (2010) indicates that three quarters of the urban households consume potatoes regularly, on average 5 Kg per adult per month. Other form of value additions with potential to increasing demand is use of potato in preparing weaning food.

4.3.6 Upgrading the Irish Potato Value Chain

The following interventions are necessary in up grading the Irish Potato value chain:

- Improve smallholder's access to quality and effective extension service on improved agronomic and management practices in order to improve on economic efficiency in potato production.
- Increase access to input credit to facilitate use of optimal and quality inputs to enhance productivity for the smallholder farmers.
- Increase production of suitable varieties and expanding production under irrigation to guarantee optimal utilization of the current processing capacity.

- Increasing accessibility to soil testing to facilities use of fertilizer based on crop requirement and to mitigate declining productivity associated with increased soil acidity due to excessive use of fertilizer.
- The Government should provide a conducive environment for private sector investment in potato seed production and storage system.
- The Government and the industry should develop standards on sorting, grading, and packaging of ware potato; and appropriately institutionalize enforcement mandate of the laws.

4.4 SWEET POTATO

4.4.1 Background

Sweet potato is the third most important root/tuber crop in Kenya in terms of production after Irish potato and cassava and is the world's seventh major food crop after maize, wheat, rice, Irish potato, barley and cassava (Gichuki, et al., 2003). Sweet potato is grown for its edible roots which are high in dietary energy (Woolfe, 1992), and is an important food security crop for many Kenyans whose staple diet is based on cereals, particularly maize; however, it is increasingly being produced for commercial purposes. Its cultivation in many parts of the country is enhanced by the ability to adapt to a wide range of climatic conditions including the semi-arid areas. Farmers depend on rain-fed production and therefore harvested at the same time (after the rain season), leading to a surplus soon after harvest and shortage in the dry season.

Sweet potato is mainly consumed fresh; as boiled, roasted, fried, creamed or baked in their skins (Tewe et al., 2003) with little processing being undertaken. They are easily combined with both sweet and savory dishes and are mostly grown on small scale in compound gardens. Some households boil and mash with other foods while the leaves and vines are used as animal feed. Sweet potato is also increasingly becoming an important cash crop for smallholder farmers, especially in areas that have been devastated by the cassava mosaic virus and Promotion of Private Sector Development in Agriculture (PSDA) studies in Nyanza / Western region have shown that sweet potatoes have a great potential for income generation which is even higher than for maize, Kenya's number one food crop. The study also revealed that farmers who follow recommended farming practices can earn up to Ksh 62,000 per hectare from sweet potato cultivation while those who do not might earn less than Ksh 5,000.

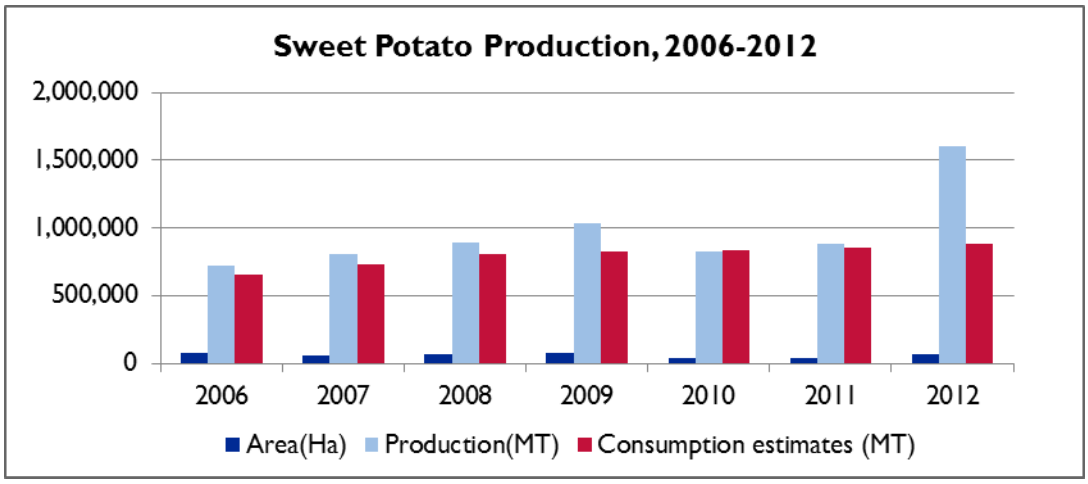
In addition, the ability of sweet potato to establish ground cover very fast enables suppression of weeds such as striga, control of soil erosion and maintenance of soil fertility. Therefore, it is an attractive crop for Kenya's farming systems. Sweet potato production is concentrated in western Kenya (including Kakamega, Bungoma, Busia, Homa Bay, Rachuonyo, Migori and Kisii districts) (Gichuki, et al., 2003). It is also grown at the Coast and Central Province (Gichuki, et al., 2003).

4.4.2 Production Trends

In 2011, the total hectares under this crop were 42,640 producing 880,210 tons with marginal changes in hectares from year to year (MoA/Horticultural Final Draft Report, 2012). There have been fluctuations in the area planted with sweet potato from between 2002 and 2011. The tuber production registered increased levels to hit 1,607,304 tons in 2012 from 823,389 tons in 2010 with the area under the crop also increasing marginally to register 77,821 hectares in 2009, from 62,786 hectares in 2008. Production has therefore almost doubled by 2012 since 2010 as shown in Figure 16.

The consumption of the staple has also steadily on the increase; however, the levels have been below the production. The yields levels have of the sweet potato in Kenya are 9.5 tons per hectare, far below the global levels of 15 tons per hectare despite the potential yield of the crop being as high as 30 tons per hectare.

Figure 16: Sweet Potato Production Trends, 2006-2012



Data Source: Ministry of Agriculture

4.4.3 Value Chain Actors

Figure 17 represents the mapping structure of how the sweet potato value chain is organized in Kenya. There are several levels in the value chain from inputs suppliers to the end users who are mainly the consumers. The various players offer different roles to ensure that the value chain is functional and that the end user gets the product.

Production

There are 400,000 smallholder farmers growing the sweet potato and 2 million households benefiting from it. Farmers are the main producers of sweet potato roots and are also involved in micro-processing of sweet potato roots at household level. In addition, farmers provide farm labor on the cultivation and postharvest operations. The farmers depend on rain for production and therefore all produce at the same time (after the rain season), leading to a surplus of sweet potatoes after the harvest and shortages during the dry season.

Sweet potato production is faced with problems that include access to quality planting materials, low level of adoption of available improved varieties and other technologies that lead to low yields and volumes for the market. Producers also disorganized and operate in a highly segmented market. Producers sell fresh or processed sweet potatoes to traders or other farmers experiencing food shortages. They also sell directly to consumers.

Marketing

Traders and vendors are both informal and formal buying sweet potato either as fresh roots or processed. Vendors buy sweet potatoes from producers and sell them to consumers. They are relatively few in number, and are not organized into any kind of professional organizations and collect fresh roots or processed products on behalf of the wholesalers and established end market retailers. They buy their sweet potatoes directly from farmers and purchase roughly a week's worth of fresh sweet potato at a time. They also sometimes engage in processing at the market to extend the product's shelf life.

Retailers sell sweet potato to consumers in both urban and rural areas. They generally work at urban markets, village centers, and on road sides and procure their ware from large-scale traders, and farmer.

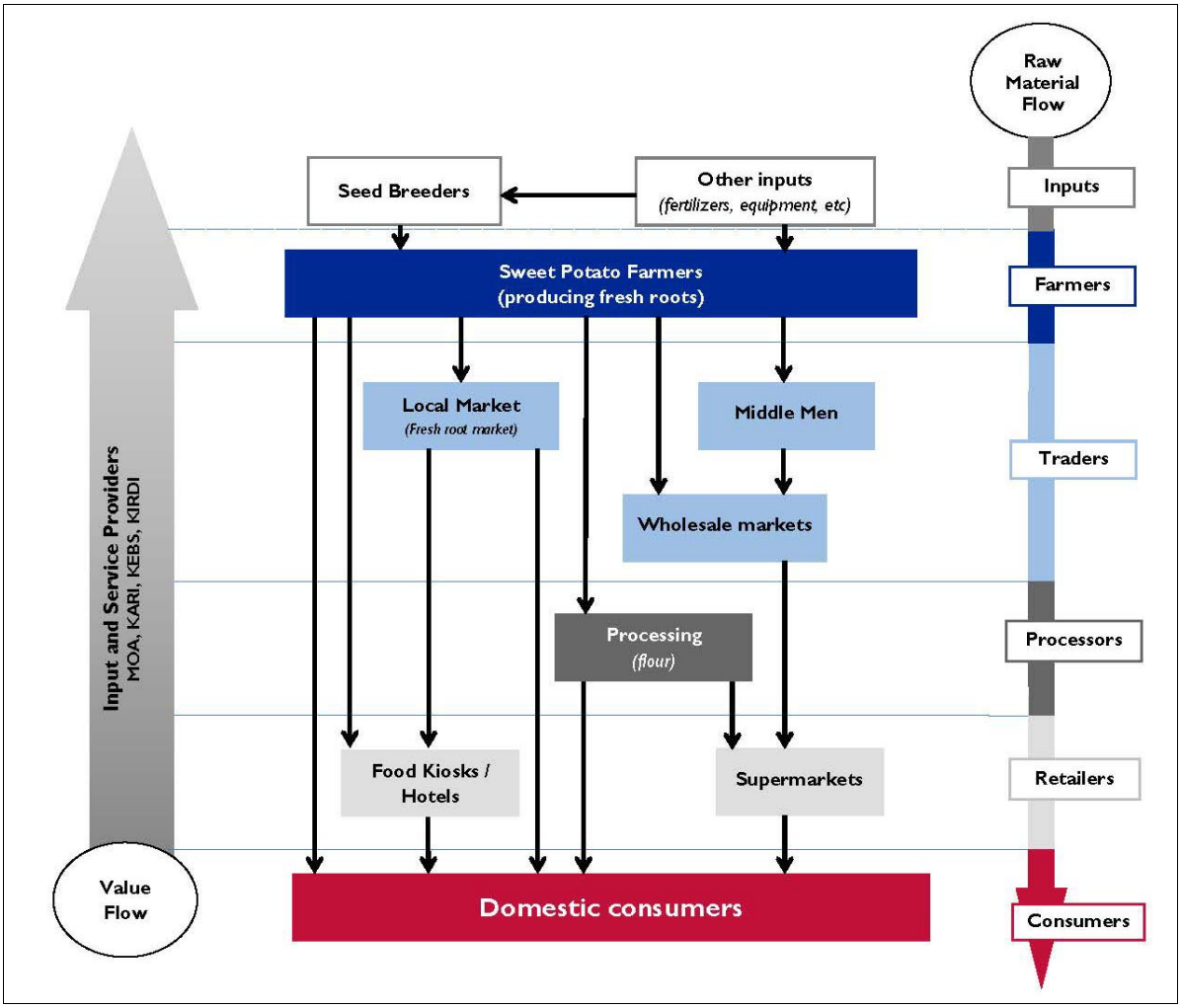
Sweet potato processing is limited to very few cottage industries set at household or group level. The cottage industries process sweet potato into chips for human consumption. Consumers generally

purchase sweet potatoes from local markets, although they also purchase directly from producers. These are the end user of the sweet potato products.

Services Provision

Transporters play a key role in transporting sweet potato vines, fresh roots and processed products. Others include very specialized organizations like KARI (research), MoA (extension), Kenya Bureau of Standards (KEBS) (standards and regulation) and KIRDI (industrial research, processing). Along with these are the business services providers like stockists who sell the inputs and also provider extension advice to farmers.

Figure 17: Sweet Potato Value Chain Map



Source: MoA, 2010

Infrastructure

Sweet potatoes are a food crop which can not only contribute to farm incomes for the smallholder famers but also help in reducing the pressure on maize as the main staple. Being a perishable crop, and the fact that it is cultivated under rain-fed conditions, sweet potatoes postharvest handling and storage infrastructure are inadequate. The need for organizing the trade at farmer and trader level to ensure volumes is also of concern.

4.4.4 Sweet Potato Value Accumulation

Tables 7 and 8 below show the crop budgets for typical and upgraded smallholder sweet potato growers. In the typical production, farmers practice production for their own consumption and usually use their retained vines for planting material with no practice of the recommended agronomic knowledge like making of ridges, weeding, planting on time and observing plant population leading to low yields of 2,750 Kg/acre and a negligible gross margin. If family labor is employed, there is a net return to the household of Ksh 12,000.

Table 7: Sweet Potato Production Budget

Typical Sweet Potato Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	5,500	27.6	Oxen
Seed	1,000	5.0	Clean vines
Fertilizer	0	0.0	None used
Agrochemicals	0	0.0	None used
Gunny bags	1,800	9.0	
Labor	11,615	58.3	Planting, weeding, harvesting (main cost)
Total direct costs	19,915	100.0	
Yield - kg	2,750		
Production cost/kg	7.2		
Price - KSh/kg	7.3		
Sales value	20,075		
Gross Margin	**160**		

If farmers plant clean vines, maintain an optimum plant population, cultivate on ridges, apply fertilizer and keep weeds under control efficiently, yield can double to more than six metric ton per hectare, giving a gross margin of Ksh 17,360 per acre or Ksh 30,000 per acre of household income if family labor is employed. The major costs incurred by farmers in both cases are labor (for weeding, processing, harvesting) and land preparation.

Table 8: Sweet Potato Production Budget - Efficient

Efficient Sweet Potato Production Budget per Acre			
Activity/Input	**Cost/Value KSh**	**Percent**	**Note**
Land preparation	7,500	28.0	Oxen
Seed	2,500	9.3	Bought seed
Fertilizer	0	0.0	None used
Agrochemicals	0	0.0	Actellic
Gunny bags + transport	3,600	13.4	
Labor	13,200	49.3	Planting, weeding, harvesting, threshing
Total direct costs	26,800	100.0	
Yield - kg	6,050	180	
Production cost/kg	4.4		
Price - KSh/kg	7		
Sales value	44,165		
Gross Margin	**17,365**		

Figure 18 and Table 9 shows the value accumulation for the fresh market sweet potato from Kisii as validated by the assessment. The price build up from Kisii to Nairobi, wholesale and retail markets is more by costs involved along the way which include transportation costs, communication, and other road levies rather than due to value addition. Sweet potato market is disorganized and dominated by brokers and rarely store or bulk the produce.

Figure 18: Sweet Potato Value Accumulation

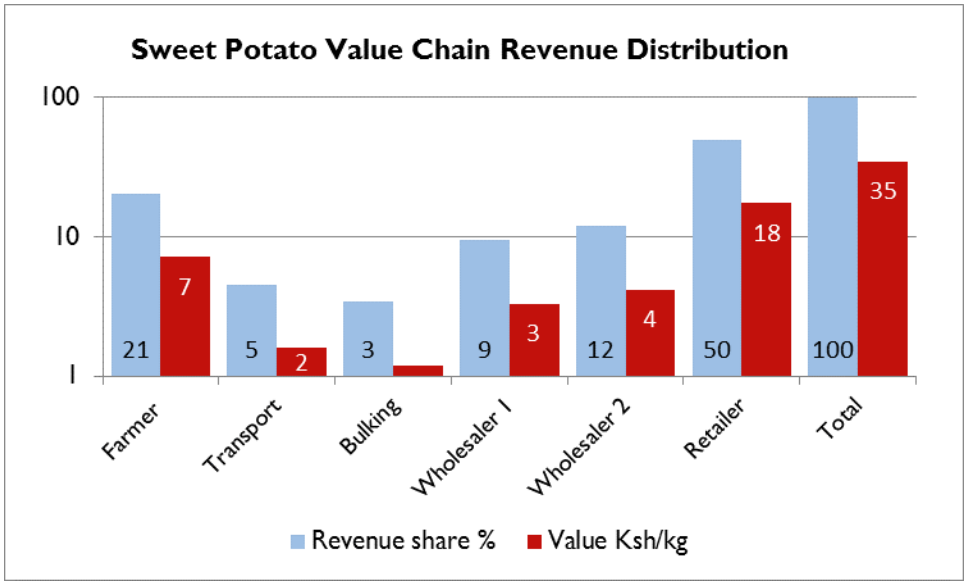


Table 9: Sweet potato price build-up, Kisii - Nairobi

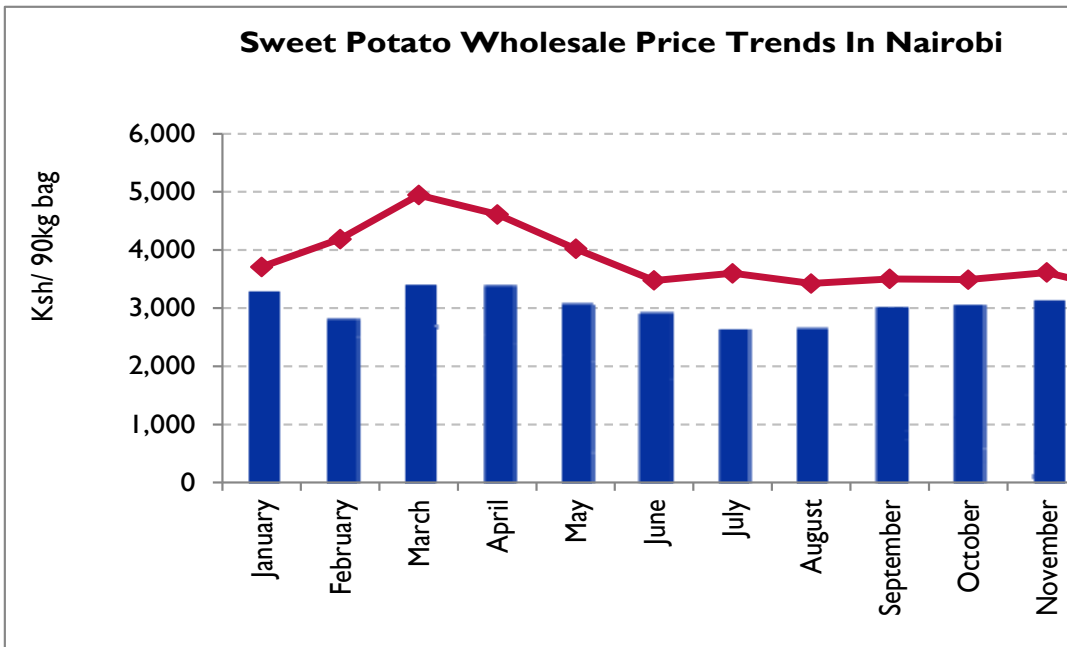
Level	Ksh/bag	Price per Kg
Farm gate	600-650	7.2
Roadside assembly	800	8.80
Kisii wholesale	800-900	10
Nairobi wholesale	1,200	13.3
Nairobi 2nd wholesale	1,350 to 1,800	15-20
Nairobi retail	2,700 to 3,600	30-40

The price of sweet potatoes in the country varies greatly throughout the year, due to variations in the availability and quality of sweet potatoes in the market. Prices are low in the main harvesting season (May through July), when the supply of sweet potatoes is highest, and higher in the off-season. Figure 19 shows price variability during the year from market information collected in Nairobi.

4.4.5 Market Potential

The market update released by USAID-KHCP and the MoA shows that national sweet potato output increased from 400,000 metric tons in 2010 to 690,000 metric tons in 2011, a 72 percent rise. Yield per acre increased by 60 percent, and there was also a 26 percent rise in the national crop area, from 45,000 hectares in 2010 to 57,000 hectares in 2011.

Figure 19: Sweet Potato Wholesale Price Trends in Nairobi



Marketing of sweet potato is limited to informal commodity markets in Nairobi, Kisumu, and Eldoret. The Gikomba market, on the eastern side of Nairobi's Central Business District, currently handles the highest volume of sweet potatoes of any market, selling an estimated 29,000 tons in 2011 valued at USD10million at current exchange rates. Although yellow and orange-fleshed sweet potato varieties have been promoted heavily by donor-funded projects and government's agencies, they have not been taken up by consumers. Growers and traders report problems in marketing these types because of flavor,

texture, and cooking properties. Increased production of sweet potato of all types has also brought down prices and made it a difficult crop to market profitably in 2013.

4.4.6 Upgrading the Sweet Potato Value Chain

The low sweet potato yields are due to several constraints that include the lack of suitable planting materials, sweet potato weevils, disease, and the seasonal nature of product. There are also limited storage options, damage from handling, and underdeveloped markets. Despite these challenges, sweet potatoes will increasingly play an important role in household food consumption, nutrition, food security, and income for the growing urban population.

The above limitations are surmountable through:

1. Adoption of improved high yielding sweet potato varieties in partnerships with Ministries of Agriculture, Research institutions and private sector extension service providers for identification and promotion of improved superior sweet potato varieties.
2. Encourage sweet potatoes commodity bulking, quality control, collective marketing and supply chain management for fresh roots and value-added products.
3. Expanding the range of sweet-potato products through processing technologies.
4. Address the postharvest challenges bedeviling sweet potato farmers through extending the storage conditions.

4.5 BANANA

4.5.1 Background

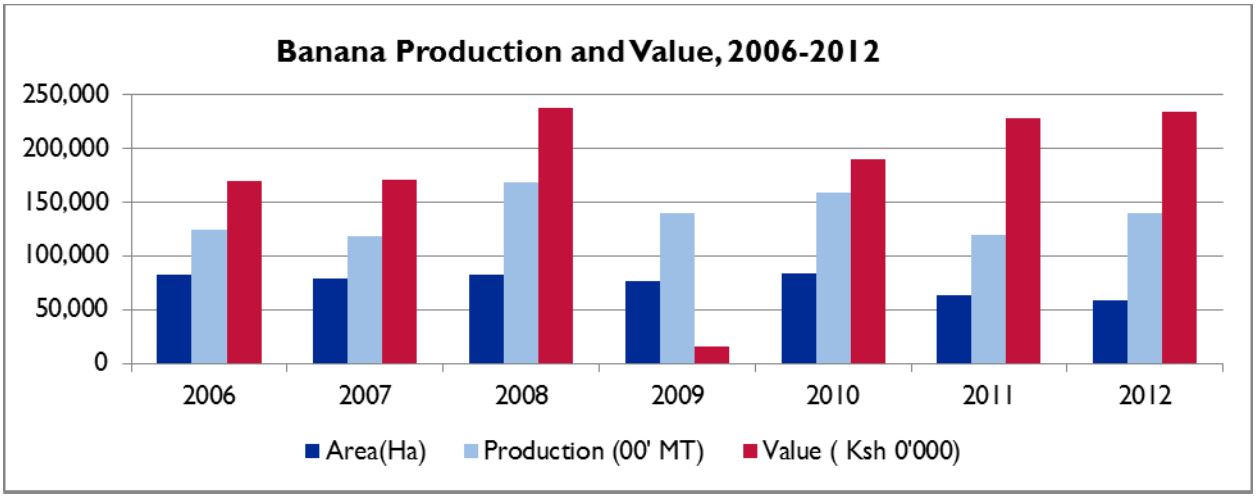
Banana is Kenya's most important fruit on the domestic market and is produced exclusively by smallholders. It is widely consumed across the whole country and contributes significantly to the incomes and household food budgets of many rural families. It is used both for cooking and desert and it is the most affordable fruit both in rural and urban households. Both green and ripe bananas are raw materials for various processed products that are gaining in popularity. Banana plants are perennial and fruit production is year-round with seasonal peaks, which is a bonus for families relying on banana as an income source. Production is mainly under rain fed conditions, although irrigation is intermittently practiced in some eastern counties including Machakos and Meru. Quality and shelf life of ripe fruit is variable with only a very small percentage of fruit being well handled postharvest and ripened under controlled conditions.

4.5.2 Production Trends

According to MoA statistics, national production of bananas has not increased significantly in recent years, and has declined over the past decade, despite increase in market demand (Figure 20). This decline has contributed to food insecurity and reduced employment income in banana producing areas. Production was static at around 1.25 million tons in 2009-2010 and dropped by 4 percent in 2011 to 1.20 million tons. This was attributed to a number of problems, primarily crop infestation with pests and diseases, including Panama disease (causing plant die-back), sigatoka (leaf spotting), weevils and nematode complexes. Traditional cultural practices of exchanging banana suckers from one farm to another in the same area have been a major factor in spreading pathogens and reducing yields. High postharvest losses caused by bulk handling of bunches also reduce the quantity and quality of bananas reaching the market by up to 25 percent.

In 2011, bananas constituted 37.6 percent of the total value of fruit produced and 11.1 percent of the total value of domestic horticulture. The area under bananas cultivation has remained steady over the last 10 years. Production data includes both cooking and dessert bananas but it is estimated that about 60 percent of production is cooking varieties.

Figure 20: Banana Production and Value Trends 2006-2012



Source: Ministry of Agriculture

The major banana production counties in Kenya are shown in the Table 10 below. The leading counties in banana production are: Meru, Kisii, Kiambu, Murang'a, Tharaka-Nithi, Kirinyaga in that order (Table 10). The main varieties grown are Grand Naine, Williams, Cavendish, Gross Mitchel, Uganda Green and Ng'ombe. This predominance of production in central Kenya reflects greater access to technology rather than comparative advantage in climate and soils. Given the higher humidity, year-round rainfall patterns and heavy soils, counties in Western and Nyanza provinces have great potential to increase banana production in the future. Kisii has traditionally been a source of green cooking banana but production has declined in recent years due to banana xanthomonas disease retarding growth and causing die-back of mother plants.

Table 10: Production Data of Bananas per County in 2010-2011

	2010			2011		
County	**Area (Ha)**	**Qty (MT)**	**Value (Ksh)**	**Area (Ha)**	**Qty (MT)**	**Value (Ksh)**
Meru	5,027	124,793	2,672,676,160	5,843	150,485	4,334,285,680
Kisii	4,573	101,540	1,669,809,520	4,942	112,152	2,631,428,560
Kiambu	2,978	50,286	2,692,723,840	3,434	49,973	2,534,285,680
Murang'a	5,188	91,973	1,359,809,520	5,583	95,397	1,798,095,200
Tharaka-Nithi	14,516	180,696	1,617,942,880	15,248	179,644	1,791,428,560
Kirinyaga	4,089	140,195	1,385,714,320	4,224	181,920	1,526,666,640
Embu	4,327	228,785	1,122,600,000	4,438	130,509	1,360,000,000
Nyamira	2,112	42,245	1,013,066,640	2,151	43,051	1,079,047,600
Taita Taveta	2,427	66,501	895,561,920	660	12,251	979,047,600
County Totals	**61,345**	**1,253,494**	**17,571,438,080**	**63,289**	**1,197,988**	**21,694,285,714**

Source: MoA/HCDA, 2011

4.5.3 Value Chain Actors

Figure 21 shows the banana value chain, mapping the links between input suppliers, producers, marketing agents, processors, retailers and consumers. Linkages to primary public and private-sector research, extension, policy and institutional organizations are also shown.

Farmers

Production is predominantly by smallholders with less than an acre of bananas but, with the availability of tissue cultured plants for up-scaling quickly, strong market demand and high margins, successful growers are expanding their farms to as much as 30 acres. Many farmers, especially in central Kenya and Meru, are organized in groups with direct linkages to traders who collect full truck loads from bulking centers to reduce transport costs and reduce handling damage.

Different banana varieties are grown depending on the end customers being served. "Kampala" (Gros Michel) and the small "apple" (ndiizi) are popular niche varieties that sell for a premium price but Cavendish varieties produce the highest yields and are coming to dominate the dessert banana market. In the western regions cooking varieties Matooke and Mbidde are popular and are traded in commercial quantities across the country.

Input suppliers

To achieve high yields, banana growers need disease and nematode free plants or suckers each year for replanting. They have traditionally planted vegetative suckers obtained through the "informal" sector including farmers' own suckers or acquired from other farmers in their community. This has tended to increase levels of nematodes and other pests and diseases and have a negative effect on yields. In recent years disease-free banana plants have become available derived from tissue-cultured sterile plantlets. These are accessible through the formal sector including KARI, and a few established commercial nurseries. The Jomo Kenyatta University of Agriculture and Technology (JKUAT) produces plantlets in its own laboratory and Aberdare Technologies Ltd (ATL) imports its plantlets from laboratories in South Africa and Israel.

Banana is a labor-intensive crop requiring continuous re-planting, plant pruning and weeding. Farmers obtain their farm implements from hardware shops in the local towns. The most commonly purchased implements included *pangas* (for harvesting) and *jembes* (for digging and weeding), and are available in the local shops. Deteriorating quality of farm implements and the high cost of good quality tools are cited by farmers and hardware shops as a constraint since they must be replaced regularly.

Fertilizers are widely available from local hardware stores but are used only in limited amounts by banana farmers. Many apply only compost and animal manure. Since banana is a high demand crop with specific requirements for phosphate, nitrate and potassium at different growth stages, this means that most farmers are generally only achieving a fraction of potential yields. Agrochemicals – nematicides, insecticides and fungicides are also available from local agro-vet shops but are not generally used by banana farmers. This means that nematode infestation and leaf spot diseases depress yields. Farmers complain that the high costs of agrochemicals and lack of access to credit prevents them from managing pests and diseases effectively.

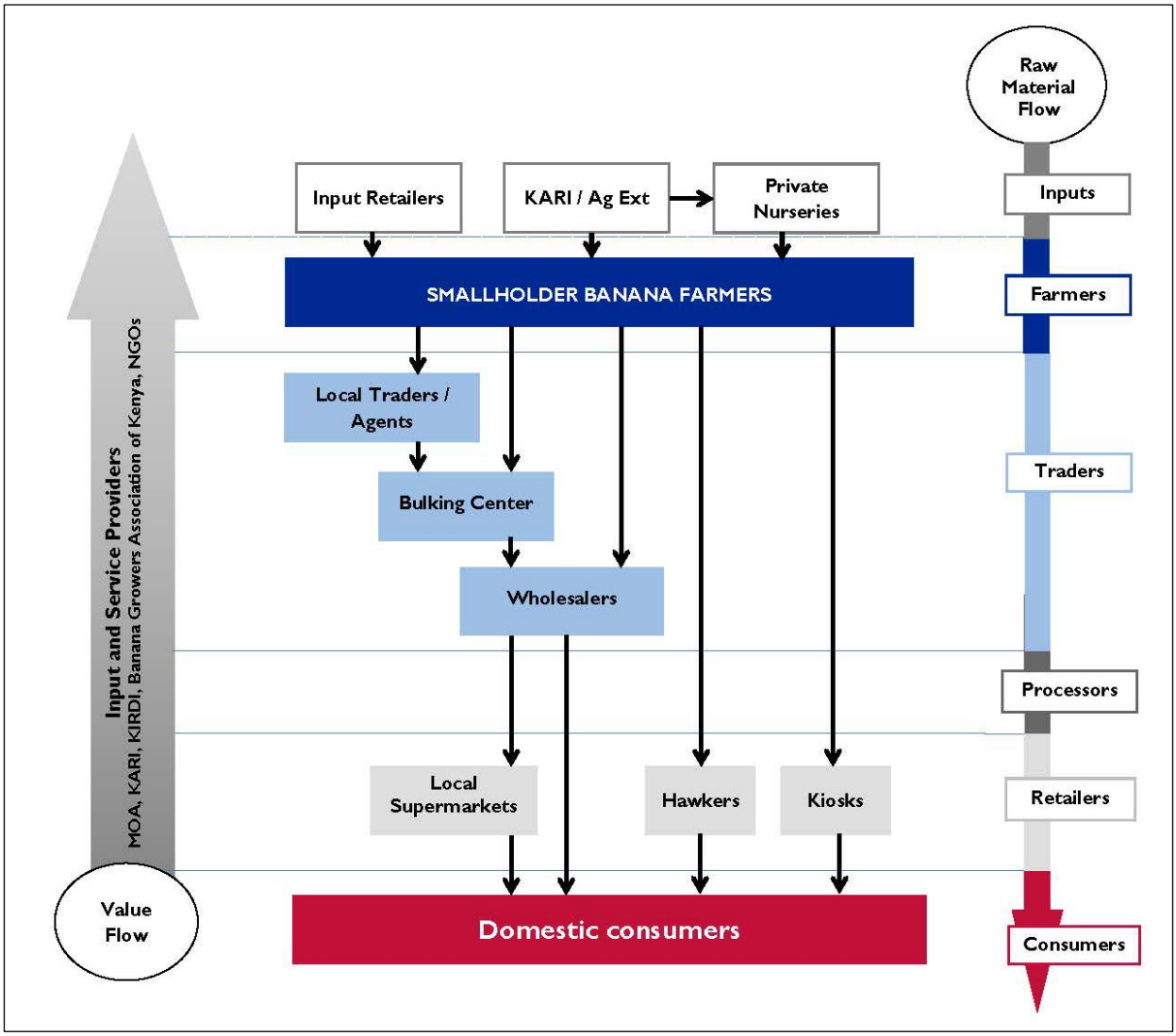
Traders

Local assemblers buy at farm gate and provide market access for small producers selling onto middlemen/brokers and sometimes directly to the wholesalers. Middlemen/brokers supply to the wholesalers who in turn sell to retail outlets and institutions (schools, hospitals, etc.). Wholesalers also purchase directly from the small-scale and limited large-scale producers. Within the banana marketing chain there are up to four intermediaries between the buyer and the consumer, which sometimes leads to handling inefficiencies and reduces prices paid to farmers. Increasing direct contracts between distributors and farmers would provide opportunities for farmers to receive higher prices for their bananas. To achieve this requires greater co-ordination between marketing and value chain actors; improved marketing infrastructure; and wider access and dissemination of domestic and regional market information.

Bananas are a major commodity in the wholesale markets of Nairobi, Mombasa and other major towns. Wholesalers make transport and loading arrangements from the bulking sites to the wholesale market where the ripening process is done. More often groups of wholesalers pool transport thereby sharing the cost of transport and municipal cess charged for the produce.

Retailers consisting of supermarkets, kiosk owners, hawkers and green grocers buy bananas at various stages of ripening from wholesaler from green stage to full yellow. Supermarkets like Uchumi, Tuskys, Naivas and Nakumatt purchase bananas at green stage from agents who are registered by Horticultural Crops Development Authority (HCDA) or directly from wholesalers. Hawkers, estate vendors and kiosk owners on the other hand sell to the low end of the market segment that constitutes more than 90 percent. Bananas sold to this end of the market are ripened without controlled temperatures or humidity and are of mixed grades.

Figure 21: Banana Value Chain Map



Source: MoA

Service providers

MoA has overall responsibility for agricultural policy through the Agriculture Sector Coordination Unit (ASCU). It also provides extension services to banana farmers throughout the country. It has a key role in the banana industry regarding the development of market infrastructure. Research and development directly, and indirectly, related to the banana value chain is carried out by KARI, JKUAT, Egerton University and Tegemeo Institute. KARI is the main research institute producing and releasing improved varieties of banana. HCDA is the national regulatory agency for the horticultural sub-sector with a mandate to regulate the horticulture industry through licensing and application of rules as prescribed under the Agriculture Act, Cap 318, including bananas. Its role within the banana value chain is to supervision and register TC banana nurseries for quality control. KEPHIS (Kenya Plant Health Inspectorate Services) is the national agency charged with the mandate to protect Kenya's agriculture from pests and diseases that could impact upon the environment, economy and human health. Banana plantlet production is regulated by KEPHIS, which is responsible for certification of domestically produced planting material. The Pest Control Products Board (PCPB) provides regulatory services for

importation, exportation, manufacture, distribution, transportation, sale, disposal and safe use of pest control products, and to mitigate potential harmful effects to the environment.

The banana industry is driven by the private sector. The National Banana Association was launched in 2009 to aid banana farmers with access to cost-effective tools and inputs, and link them to marketers and processors. The goal of the Association is to accelerate the transformation of banana production from its traditional low status to a commercial and profitable crop for smallholders. The Banana Growers Association of Kenya was officially launched in December 2009 by the Kenya National Federation of Agricultural Producers with support from TNS and Alliance for a Green Revolution in Africa. It was formed as a platform for banana farmers in the country to improve adoption of modern technology, influence policy, and information sharing and networking. However, the Association has been inactive with farmers due to lack of administrative infrastructure and funds to drive the recruitment process.

Several NGO's and projects (USAID-KHCP, Farm Concern International (FCI), Technoserve, and Africa Harvest) have been involved in trying to improve the banana value chain. Most of these focus on developing entrepreneurs, building businesses and industries, and improving the business environment. They mainly work with the farmers to develop their business skills and access market to improve their incomes.

The Ministry of Agriculture is mainly involved in formulation of policy, promotion of technology, provision of extension and regulatory Services for agriculture development. The Ministry has in its employ extension workers in all districts of the country to deliver the aforementioned services. Various statuotary boards have been created under the ministry and are responsible for regulating specific commodities and services that are outlined in their mandate. It also undertakes programmes and projects with co-funding from donor agencies inorder to execute their mandate of improving rural livelihoods, food security and increasing incomes. The Kenya Industrial Research and Development Institute (KIRDI) is mandated to undertake research and development in all industrial and allied technologies among them food. The institute has set up a modern processing plant as a pilot project for processing banana products among others as a way of transferring processing technologies. The facility can also process flour, crisps, juice and wine.

4.5.4 Value Accumulation

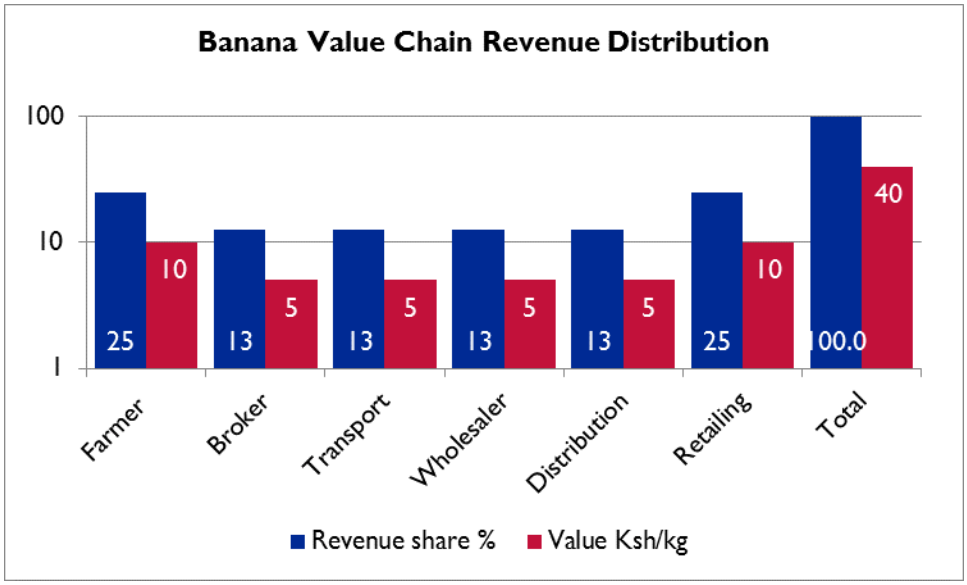
The typical production budget for an efficient small-scale banana grower is shown in Table 11. Yields of over 50 metric tons per hectare (20 MTs per acre), about 4,500 bunches are possible by the third year of production, with gross margins of Ksh 350,000 (US$ 4218) per hectare or Ksh 140,000 (US$ 1686) per acre.

Table 11: Banana Production Budget

	Year 1		Year 2		Year 3		Year 4	
Activity/Input	**Cost KSh**	**Percent**	**Cost KSh**	**Percent**	**Cost KSh**	**Percent**	**Cost KSh**	**Percent**
Suckers	82,500.00	45.8	0	0.0	0	0.0	0	0.0
Fertilizer	32,500	18.1	40,000	84.3	47,000	89.5	47,000	88.6
Agrochemicals	30,000.00	16.7	0	0.0	0	0.0	0	0.0
Labor	33000	18.4	7,000	14.7	5,000	9.5	5500	10.4
others	1,780.00	1.0	470.00	1.0	520.00	1.0	525.00	1.0
Total direct costs	179,780.00	100.0	47,470.00	100.0	52,520.00	100.0	53,025.00	100.0
Yield – kg/acre	0		12,375.00		18,555.00		24,750.00	
Production cost Ksh/Kg	-		3.84		2.83		2.68	
Price - Ksh/kg	10		10		10		10	
Sales value	0		123,750.00		185,550.00		247500.00	
Gross Margin	**-179,780.00**		**76,280.00**		**133,030.00**		**144,975.00**	

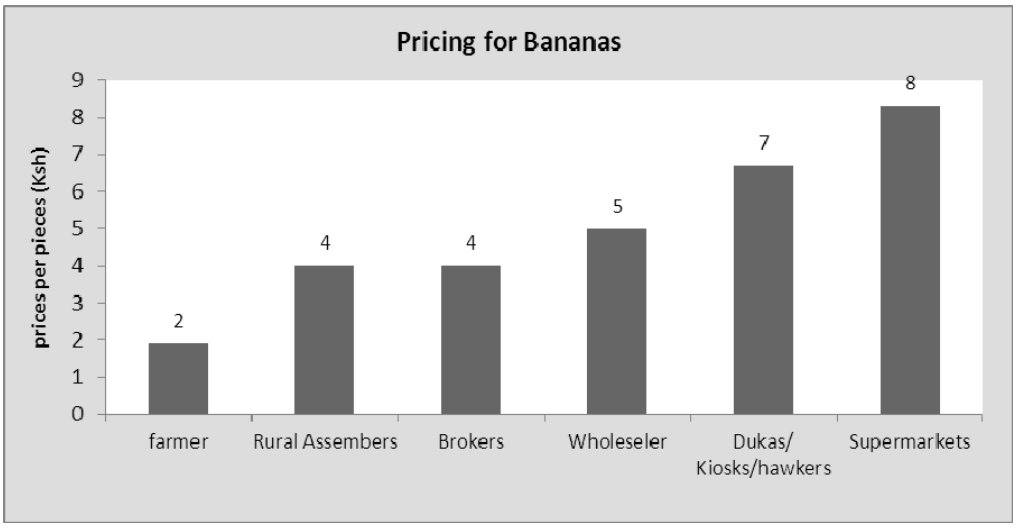
The various marginal increases along the value chain from grower to consumer are shown in Figure 22a from data collected by the KVC survey. On average, farmers receive about 25 per cent of the final retail price. The other 75 percent is distributed fairly evenly amongst different levels of traders with retailers taking the highest proportion, presumably because they take the biggest risk on spoilage and price reduction. In a separate survey carried out by USAID-KHCP in partnership with Africa Harvest in 2011, farmers sold bananas to assemblers, rural retailers, brokers and rural consumers at a mean of Khs 264 per bunch which is equivalent to Ksh 1.90 per banana piece from an average bunch. Assemblers and brokers sold bananas at a mean of Ksh 4.00 per piece to wholesalers. Wholesalers resold the bananas at Ksh 5.00 per piece to retailers. Retailers (*dukas*, kiosks and hawkers) sold ripe /cooking banana to consumers at an average of Ksh 7.00 per piece, while the supermarkets sold directly to consumers at an average price of Ksh 8.00 per piece (Figure 22b). Although the figures vary slightly, each survey gives similar results in terms of value chain equity.

Figure 22a: Banana Value Accumulation



Source: USAID-KHCP Banana Value Chain Analysis, 2012

Figure 22b: Pricing of bananas along the value chain

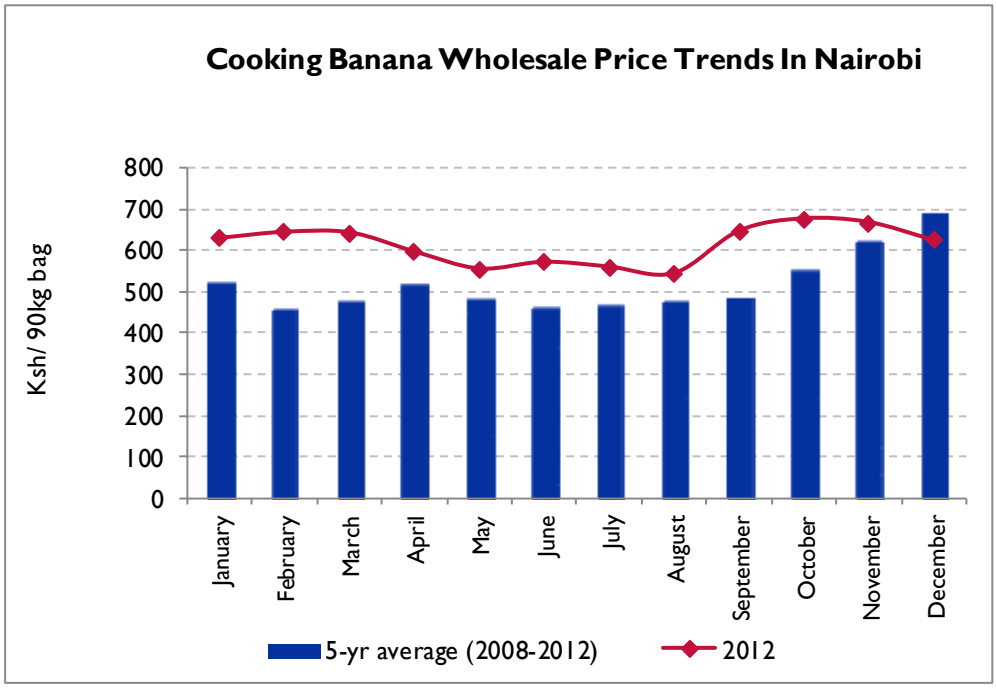


4.5.5 Market Potential

The supply of bananas in the country is dependent on weather patterns and varies with the season. In the months of October, November, January, and February the prices are low due to glut while the highest prices are during the months of August, and September (Kinyua 2008). Average monthly prices for green bananas are shown in Figure 22c.

A recent report from HCDA stated that there is a gap of 71,000 MT of unmet market demand in the banana market (Horticulture Validated Report, 2011) based on information from traders and retailers.

Figure 22c: Cooking Banana Wholesale Price Trends in Nairobi



Development of value addition for bananas in making crisps, flours and essence has also increased consumption and demand of bananas especially for processing companies and individuals. Export prospects for the crop have improved over the last decade and a number of entrepreneurs are exporting banana fruit and processed products, tapping into the organic market in Europe. However the exported quantities are still very small as the main means of transportation from East Africa is by air which is expensive.

4.5.6 Upgrading the Value Chain

To more effectively respond to the constraints facing banana production, current interventions need to be re-assessed to ensure they are appropriately oriented to meet farmers' needs. To improve productivity of banana efforts should be made to; Increase the farmers' access to quality inputs including tissue culture plantlets, introduce new varieties that meet market demand, increasing quality of fresh produce and invest in value addition and processing opportunities. Considering the widespread occurrence of *Fusarium* wilt and other soil borne banana pests, efforts to improve access to planting materials should be implemented in tandem with an effective approach to address farmers' perceptions and attitudes regarding their current sources of planting, e.g. raising awareness on plant health risks linked to use of naturally regenerated suckers.

Relative to other crop enterprises, banana enterprises have some of the highest gross margins and are thus important to both the nutritional and economic health of the farmers throughout the country. Investment in the banana value chain is a high priority to increase the reducing land area under banana cultivation and ensure that farmers are able understands the importance of clean planting material to reduce losses from wilt.

Finally, to increase the incomes for smallholders, there is great need to commercialize banana through adopting market led production, collective bulking and marketing among farmer organizations. Therefore, capacity development for smallholder farmers on postharvest management, commercialization, market development and business partnerships development strategies is critical.

Based on these factors, the following interventions will be prioritized by USAID-KAVES:

- Increase capacity for production of quality planting material whose requirement is projected at 7 million seedling by 2016
- Increase accessibility of planting material through establishment of TC banana hardening nurseries at farm level
- Increase access to input credit for farmers and other value chain players involved transportation, storage, and trade;
- Enhance regulations, standards, and guidelines to guarantee the quality (less than 2 percent somachromal) of the seedlings and enforcing of virus-indexing inspection of imported material;
- Support farmers capacity in proper crop husbandry through improved extension services and creating public awareness on diseases of economic importance to cub spread of disease through infected suckers;
- Introduce new high yielding varieties that meet market demand;
- Reduce postharvest losses through proper produce handling;
- Increase investment in value addition and processing opportunities;
- Support market led production, collective bulking and marketing among farmer organizations commercialize banana through.

4.6 SORGHUM

4.6.1 Background

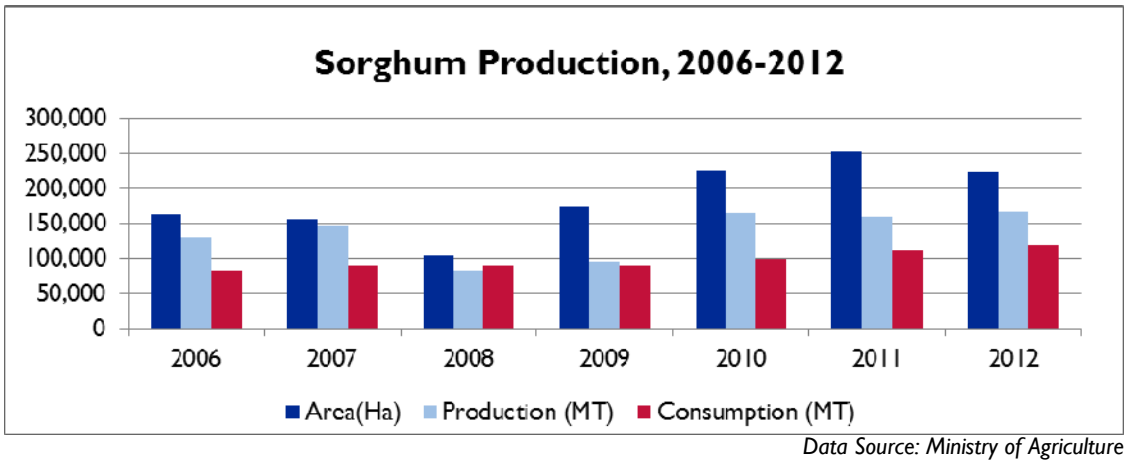
Sorghum is a food staple for millions of Kenyans and can be used both as an industrial raw material and as animal feed. It is grown to some degree in most parts of Kenya but the major producers are in Eastern province which accounts for 50 percent of the total area of 104,041 hectares, Nyanza for 33 percent, Western for 12 percent, and Rift Valley for 3 percent and the rest for 1 percent of the area. Sorghum is one of the most important but under-utilized cereal crop which is both highly tolerant to drought and able to withstand periods of water-logging.

It is a traditional staple food crop in some semi-arid areas, contributing to the food security of low income rural households. It is an alternative crop in areas where maize crop failure is common and could play an important future role in areas where rainfall is decreasing, since sorghum produces white flour that is closely related to maize in utilization. The grain has high levels of iron hence may be used to reduce micronutrient malnutrition. There is presently a high demand for sorghum in the brewing industry to replace barley. Some farmer groups have been contracted by the East African Breweries Limited (EABL) but there is a market opportunity for many others since existing contracts will only supply a small proportion of the total need.

4.6.2 Production Trends

Production of sorghum has gradually increased over the past six years (Figure 23). It approximately doubled from 903,000 bags (81,000 tons) in 2008 to 1.89 million bags (170,000 tons) in 2012, mainly due to an increase in the area planted. Average yields over the period actually reduced from 781 (9 bags) to 745 kilos (8 bags) per hectare or 302 Kg per acre compared with a potential yield of 1,600 Kg. The area under sorghum increased to 224,000 hectares in 2012, slightly down from the peak of 253,000 hectares recorded in 2011. The growth in production is attributed to rising land area dedicated to the crop on account of its drought resistance and more reliable contribution to household food reserves than maize in marginal areas. It can also be attributed to increased focus on sorghum for food security by stakeholders and also as a cash crop following the announcement by EABL that it requires large quantities of sorghum for beer production in future. According to MoA data, human consumption or demand for sorghum has consistently been less than supply. The balance is either purchased by humanitarian agencies, exported to regional markets, particularly South Sudan, purchased by animal feed companies or used for local beer production.

Figure 23: Sorghum Production Trends, 2006-2012



Data Source: Ministry of Agriculture

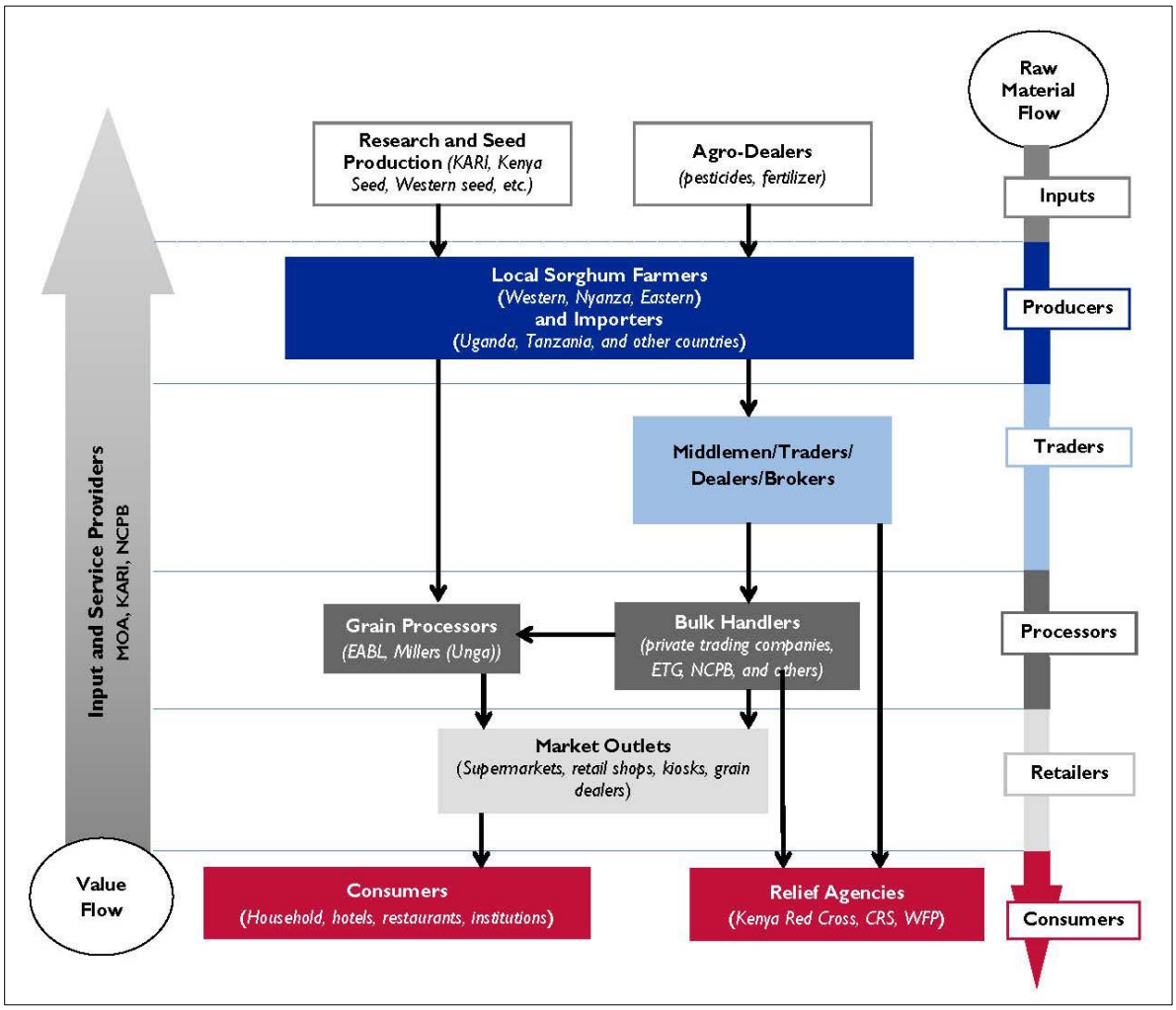
4.6.3 Value Chain Actors

The sorghum value chain is relatively short. The crop is produced exclusively by smallholders who either consume at home or sell it locally to traditional beer makers or to small-scale rural traders who aggregate for larger trading companies. These companies bulk up the surpluses for distribution to wholesalers and retailers in deficit areas, export to South Sudan and other regional markets or supply to humanitarian relief agencies (Figure 24).

Production

It is estimated that there are close to 240,000 small-scale sorghum farmers with farm sizes varying from 0.4 to 0.6 hectares. They prepare land using oxen but yields are low since farmers' plant retained seeds and use no fertilizers. They rarely apply agrochemicals to control pests and diseases even though kernel head smut disease is emerging as a major problem sorghum is produced mainly as a source of food for the household alongside maize, cowpea, green grams, finger millet and pearl millet and only a few sell to supplement their income. Production of sorghum is estimated at about 170,000 metric tons which is either eaten at home or traded for food, animal feed and industrial uses (brewing). There has been slow adoption of varieties resistant to diseases and pests and the low production volumes are insufficient for growth of 'industrial' processing.

Figure 24: Sorghum Value Chain Map



Marketing

There are over 5,000 small traders buying sorghum from farmers and selling on to larger trading companies and wholesalers after collecting and bulking. The Small-scale traders operate in the local market dealing with farmers especially during the harvesting season and rarely store the produce. They tend to immediately sell to wholesalers in the local or urban markets making purchase price and transport as the main cost incurred by this category of traders.

Wholesalers sell to retailers, grain millers and few exporters. In Nyamakima and Gikomba markets in Nairobi, there are about 150 wholesalers/retailers dealing with sorghum along with other grains and pulses. Smart Logistics and Mwailu Enterprises are examples of successful traders in eastern Kenya that have diversified to purchase white Gadam sorghum for industrial use in brewing. These categories of traders are storing the produce for periods of up to 2-3 months before offloading to the miller and retailers at various times depending on market price. The main costs incurred at this level are grain purchase and storage which includes chemical treatment against pests including rodents.

Processing/Milling

Sorghum milling is done along with other grains by the major milling companies and is targeting manufacturers of nutrition foods and the animal feed sector. The large mills produce flour and by-products which go to the animal feeds industry while small hammer mills handle greater volumes in the rural areas and at Gikomba for human consumption. It is estimated that 16,000 metric tons is utilized in animal feeds on-farm and for manufacturing while by-products from large mills also enters the feeds industry. Millers perform functions of storage, milling of the grain and distribution and the main costs being grain purchase and losses from wastage during milling as well as manufacturing operations.

Service Providers

Commercial sales of sorghum by seed companies are low and restricted to a few specialist suppliers. The KARI Seed Unit at Katumani has produced four improved varieties of sorghum (KARI Mtama 1, Seredo, Serena and Gadam) and the sales of these varieties rose after the intervention of the USAID funded Agri-business Development Support Project (ADSP) from a mere 6,382 metric tons in 1997 to 30,543 metric tons by 2003. The varieties available have maturity periods varying from 3 months to 8 months and yields ranging from 12 –15 bags/acre (29.6 – 37 bags/ha or 2.7MT – 3.3 MT/ha). However, most farmers plant their own seed and do not use improved varieties or the recommended farming practices. The government extension service is responsible for information dissemination while KARI has also introduced the other approaches for dissemination of research technologies to Community Based Organizations especially involved in seed bulking.

4.6.4 Sorghum Value Accumulation

Table 12 shows the costs and returns obtained by a typical sorghum farmer at current prices. The major production costs are for land preparation services and payments to labor for planting, weeding and threshing. This is a relatively inefficient system where purchased inputs are not used and yields are low. If labor is fully costed the farmers is making a loss of over Ksh 16,000 per acre. Even if family labor is employed for all tasks, the net return to the household is just Ksh 2,000 per acre. This means that as a cash crop sorghum is providing little or no income to the average smallholder. Where the opportunity cost of labor is close to zero sorghum still has value as a crop for home consumption that would cost the family more to buy than it does to produce.

Table 13 illustrates what can be achieved by efficient growers if they plant a high yielding variety, utilize good seed, apply fertilizer at optimum rates and control pests and diseases with Integrated Pest Management (IPM) techniques including effective use of agrochemicals. This type of high input system can produce a yield of at least 1.3 tons per acre and a gross margin of around Ksh 14,250. The price of Ksh

30 per kilo is the current contract price paid by the brewery. The gross margin increases significantly if farmers sell a proportion of the crop to traders for the local market.

Table 12: Typical Sorghum Production Budget per Acre

Activity/Input	Cost/Value Ksh	Percent	Note
Land preparation	5,500	23.5	
Seed	140	0.6	Own seed or bought at market @Ksh 28/kg
Fertilizer	0	0	
Agrochemicals	0	0	Storage fungicide only
Labor	17,600	75.1	Hired cost, H/H return higher on family labor
Bags, sisal	200	0.9	
Total direct costs	23,440	100	
Yield - Kg	200		
Production cost/Kg	117		
Price – Ksh/Kg	30		
Sales value	6,000		
Gross Margin	**-17,440**		

Table 13: Efficient Sorghum Production Budget per Acre

Activity/Input	Cost/value Ksh	Percent	Note
Land preparation	5,500	21	
Seed	700	2.9	Certified seeds
Fertilizer	6,000	22.9	
Agrochemicals	1,500	5.7	Birds, storage
Labor	10,600	75.1	Hired cost, H/H return higher on family labor
Bags, sisal	1,500	5.7	15 bags @ Ksh 100/bag
Transport	1,000	3.8	
Total direct costs	26,250	100	
Yield - Kg	1,350		
Production cost/Kg	19		
Price – Ksh/Kg	30		
Sales value	40,500		
Gross Margin	**14,250**		

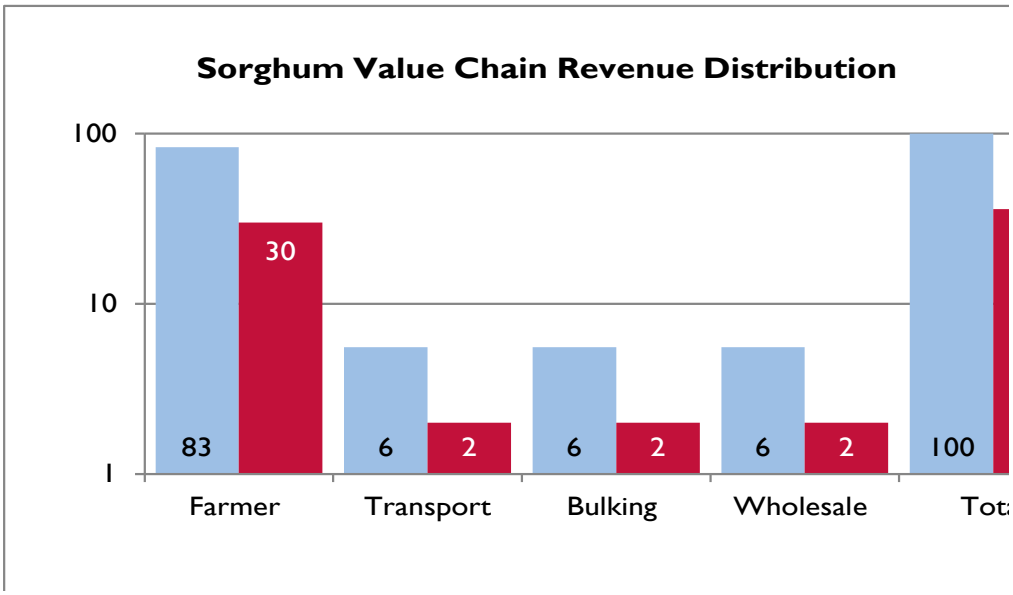
The main cost difference between the two production systems is in the purchase of fertilizer and agrochemicals, which has a direct impact on yield. The efficient system also includes a more intensive level of management to ensure optimal plant population and weed control to reduce labor costs per unit of production.

The increase in value of sorghum grain from farm gate through traders to final users and consumers is shown in Figure 25. The farm-gate price received by the producer accounts for 83 percent of the final retail value. The farm to market operations of collection, bulking, transporting, wholesaling and retailing take only 17 percent, so marketing margins are low and traders rely on volume to cover their overhead costs. Traders who buy directly from growers deal in small quantities and collecting from the farm or rural collection points or village markets. They handle few bags at a time and often use bicycles or motor

cycles for low-cost transportation. They are generally cash poor and make very small margins so they are forced to sell on quickly to bigger traders who bulk up truck loads for urban wholesale companies who either sell to retailers or to processors. These wholesalers also take low margins but deal in large quantities and focus on having many connections and market information to minimize risk.

Based on their high share of the value chain equity, farmers drive the final price and so have the biggest influence on value chain efficiency and competitiveness. Improvements at farm level that increase productivity can increase profits for all actors and reduce prices for consumers at the same time.

Figure 25: Sorghum Value Accumulation

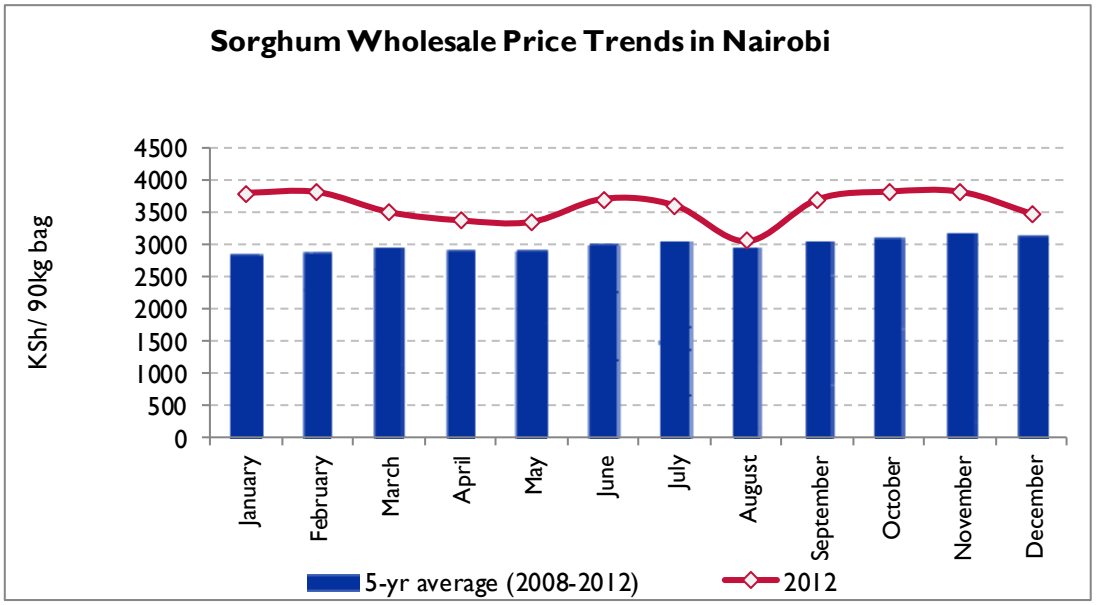


4.6.5 Market Potential

The annual increase in production to double the 2008 level has been in direct response to market demand for sorghum. Climate change, product diversification and regional market demand are the main drivers of this growth. Sorghum flour is already being utilized as a nutritious ingredient in fortified flours and other food products because of its high levels of iron and zinc, year-round availability and competitive price relative to other flours. Sorghum flour demand is increasing in both domestic and export markets.

The new market provided by the breweries and the predictable increase in beer consumption as the economy grows provides a huge market opportunity for growers who can produce competitively at prices the breweries can pay. Average wholesale prices in 2012 were Ksh 3,000 to 3,800 per bag (Ksh 33-42 per kilo), 16 percent over the previous five year average (Figure 26). Production of sorghum is rain fed and prices tend to follow the periods of plenty and during the low supply. EABL requires an estimated 60,000 metric tons annually, equivalent to 30 percent of current production, at a price of Ksh 30 per kilo which seems reasonable for efficient farmers relative to the cost of production and high volume sales that will be achieved.

Figure 26: Sorghum Wholesale Price Trends in Nairobi



4.6.6 Upgrading the Sorghum Value Chain

Despite the high market demand, sorghum is still not very profitable as a cash crop under current systems because of low yields caused by poor agricultural practices and inadequate value addition as for industrial alternatives. Nevertheless, sorghum has potential for dry areas and can play a role in reducing pressure on maize as the only significant staple crop.

USAID-KAVES will therefore focus on productivity enhancing interventions including the following:

- Work with commercial partners to increase uptake of sorghum varieties for specific ecological zones and production systems, particularly in semi-arid areas of SA2 counties.
- Improve plant health and crop management practices in cooperation with input suppliers at national and village level.
- Provide business analysis of processing opportunities with the breweries and other food manufacturers and collect more comprehensive market information for analysis in cooperation with the companies.
- Partner with animal feeds manufacturers and distributors who supply over 800,000 metric tons of feed to the livestock industries to identify and develop opportunities for utilizing sorghum as an ingredient either or to enhance the nutritional status of cassava based products.

4.7 DRY BEANS

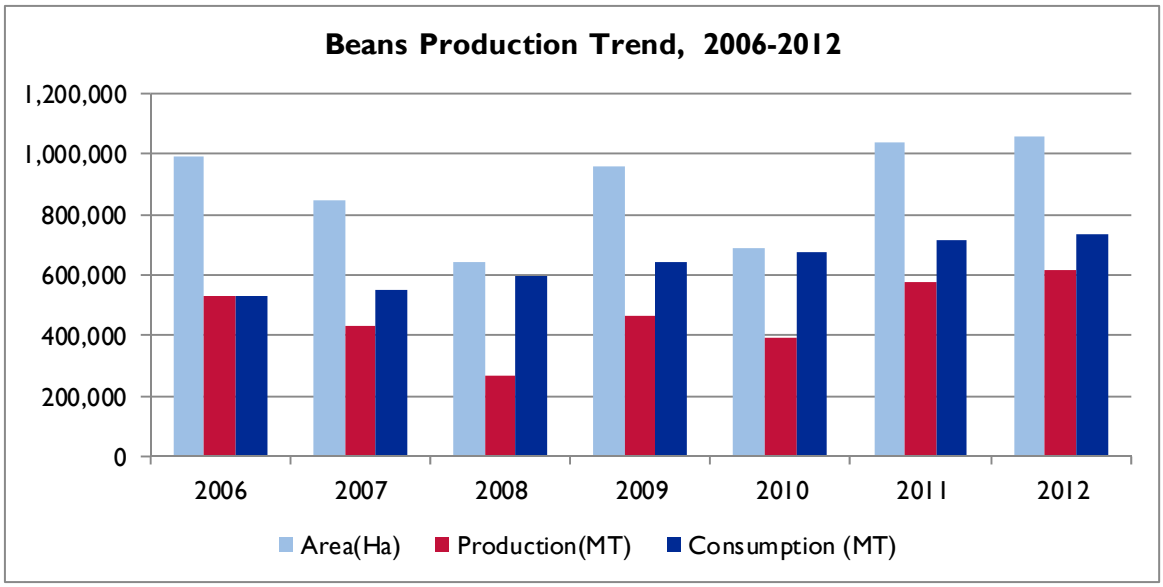
4.7.1 Background

Dry beans are the second most important source of dietary protein and the third most important source of calories for rural and poor urban communities. The per capita consumption of beans is estimated at 66 Kg per year and it is one of the staple crops with critical relevance to national food security, especially for rural households in western Kenya. It is also the most popular source of protein for many low income households who cannot afford to buy meat. Bean production is usually the responsibility of women in smallholder households and it is commonly referred to as a "woman's crop", grown traditionally for home consumption but now increasingly for income generation. Apart from the importance of beans for household food security, nutrition and cash, they are also planted in rotational systems with maize as a no-cost source of nitrogen and organic matter that increases maize yields. The current farm gate value of dry beans produced nationally is estimated at Ksh 13 billion although much of this never enters the formal market system and production varies from year to year depending on the weather. Yields and productivity are low since beans are often intercropped and do not receive specific attention apart from weeding. Nevertheless, the scale of production means that dry beans have the potential for high impact as a supplementary cash crop for smallholders if their production systems can be improved and commercialized.

4.7.2 Production Trends

Kenya is a net importer of beans despite being the seventh largest producer in the world (FAO). The annual production has ranged from 264,980 to 613,902 tons since 2006 (Figure 27), however this falls short of annual demand/consumption that is currently more than 700,000 tons. To make up this shortfall in domestic supply beans are imported both formally and informally from Ethiopia, Uganda, Tanzania and Central Africa to meet the demand.

Figure 27: Dry Bean Production Trends, 2006-2012



Source: MoA

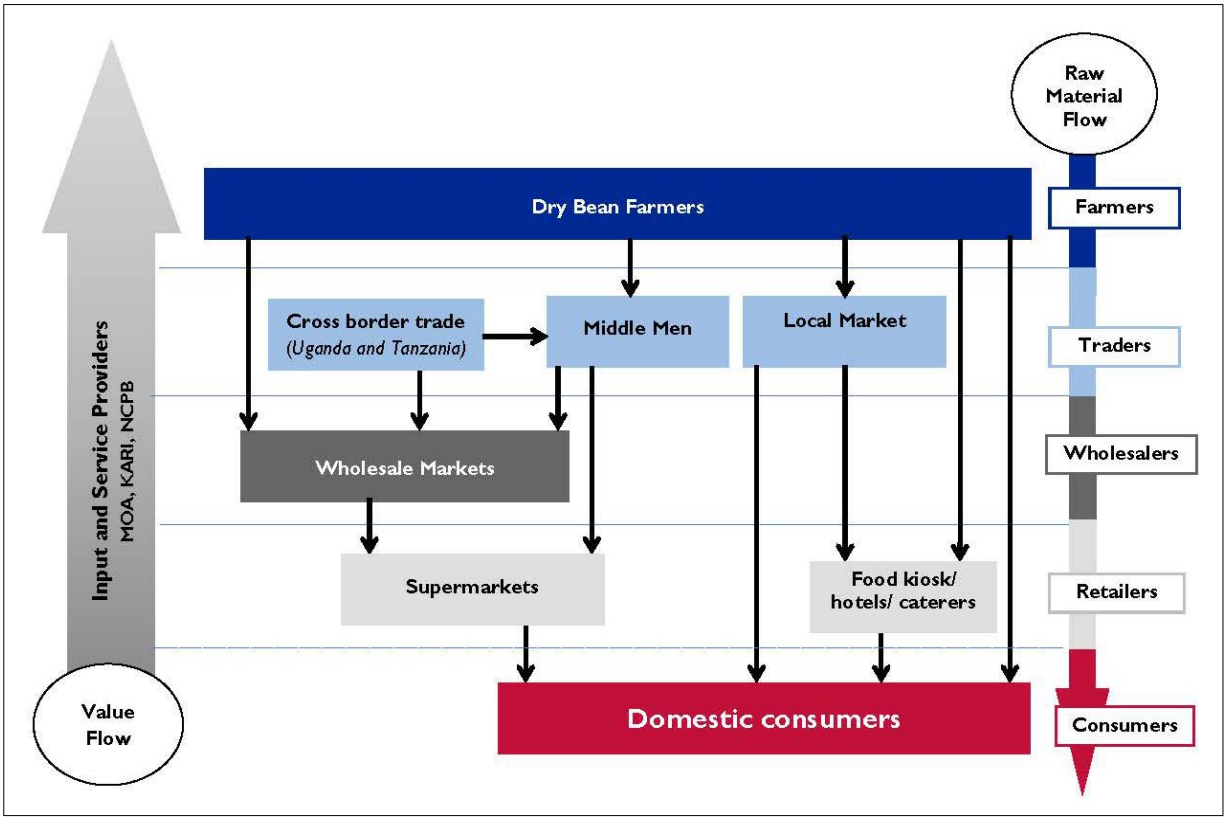
4.7.3 Value Chain Actors

The dry bean value chain is short and low cost with just a few traders involved in moving beans from producers to end market consumers (Figure 28). The main players are smallholder farmers, farm gate traders who assemble and supply agents and brokers in rural market towns who store, bulk and transport to wholesale and retail outlets in urban centers. Grading, processing and packaging operations are minimal and postharvest trading margins are low.

Production:

Dry beans are cultivated almost exclusively by small scale farmers under rain fed production systems and usually intercropped with maize. The number of smallholder households engaged in bean production is estimated at 2.5 million, traditionally growing the crop for home consumption but increasingly, as urban populations have grown, enterprising farmers have started producing surpluses to supply local markets.

Figure 28: Dry Bean Value Chain Map



Production has tended to increase mainly as result of expansion of cultivated area rather than through yield and productivity increases. On average smallholder farmers produce only 2 bags of 90 Kg per acre (440 Kg/ha) while with use of improved varieties and application of optimal agricultural practices should yield 7-12 bags (1,500 -2,500 Kg/ha). The persistent low yields are mainly due to use of retained seed or old varieties with low genetic yield potential and no tolerance to pest and disease pressures. The informal nature of marketing systems also acts as a disincentive to farmers who know the benefit of investing in improved seed and inputs to increase yield but are unsure of market opportunities.

A number of improved bean varieties have been produced in Kenya over the years (Rosecoco, Mwitemania, Wairimu, Mwezi Moja, and Nyayo), adapted to different ecological conditions, but continuous recycling of seed by farmers has reduced their vigor and yield potential. Replanting of retained seed for many crop generations by smallholders also discourages seed companies from registering and marketing new varieties. KARI has developed short duration, drought tolerant varieties in recent years suitable for SA1 areas (KARI bean 1, bean 9, KATEX 56) which have been registered by specialist seed companies such as Dryland Seeds and others'. They are multiplying and bulking up foundation seed through sales to selected farmers in semi-arid areas, under buy-back agreements. The success of these ventures will depend upon large numbers of small-scale farmers adopting a commercial approach to farming.

Marketing

Smallholder farmers sell their produce at farm gate or in rural market places to small-scale traders who aggregate the beans from many suppliers and sell on to wholesale buyers and retailers. Field surveys show that about 50 percent of the annual bean production is marketed but this varies widely between households depending on their production and home needs. Rural assemblers visit farms at harvest time and buy beans in cash or credit whenever adequate trust has been built between the buyers and the farmers. The assemblers often handle relatively smaller volumes of 1-3 bags that they carry to local markets centers to sell to regional traders on designated market days.

At market centers, medium and large traders handling over 10 bags buy directly or through their agents from either smallholder farmers or small-scale traders. They are opportunistic buyers, procuring at on a cash basis, with no supply contract arrangements. After further consolidation they transport truck loads to markets in large urban centers such as Nyakima in Nairobi which is the major market destination for many of the wholesale traders. Because of limitations in operating capital, most women tend to be in the small to medium-sized category of traders buying directly from farmers, while men dominate the large assemblers' category. Wholesalers buy and sell exclusively in bags as the minimum transaction volume and operate at several levels, locally, regionally or nationally. They are also the main type of supplier to the NCPB.

Retailers sell for very low margins in open market places and cereal shops, however, mixed retailing and wholesaling is the norm for most of the bean traders whether in both rural and urban centers. Some of the traders store beans to speculate on prices and add to the value of their stock by cleaning, sorting, grading and packaging. This type of operation is mainly restricted to medium and large traders since it requires access to capital, storage space and business knowledge.

4.7.4 Dry Bean Value Accumulation

Tables 14 and 15 illustrate the main differences between the typical smallholder production cost and what can be achieved using efficient production technologies that will take them from a negative gross margin (i.e. subsistence) to a commercial return per household of Ksh 5-14,000 per acre depending on how much labor is provided by the family.

For most rural households, production of dry beans is still geared to home consumption so farmers stick to a low input-low output system that incurs little or no financial risk but ties up a lot of family labor. If this labor is costed at market rates, they incur a net loss of about Ksh 2,000 per acre in bean production (Table 14).

Table 14: Typical Dry Beans Production Budget per Acre

Typical Dry Beans Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	5,500	40.9	Oxen
Seed	980	7.3	Bought seed at market at Ksh 70
Fertilizer	0	0.0	None used
Agrochemicals	340	2.5	Actellic
Gunny bags	240	1.8	
Labor	6,400	47.5	Planting, weeding, harvesting, threshing
Total direct costs	13,460	100.0	
Yield - kgs	180	180	
Production cost/kg	75	75	
Price - Ksh/kg	45		
Sales value	8,100		
Gross Margin	**-5,360**		High return, 2-3 crops/year possible

To obtain positive gross margin farmers need to invest in good quality seed, of the right variety for their location, and apply fertilizer to achieve the yield potential of the variety. Yield will increase further if farmers follow good practices of keeping a weed-free field and planting the optimum plant population. If this basic level of investment and management is followed, smallholder households can earn a gross margin of Ksh 14,000 per acre for dry beans. Enterprising farmers can do even better by using Integrated Pest and Disease Management (IPDM) practices to eliminate production losses and investing in on-farm storage to hold back on sales until prices rise.

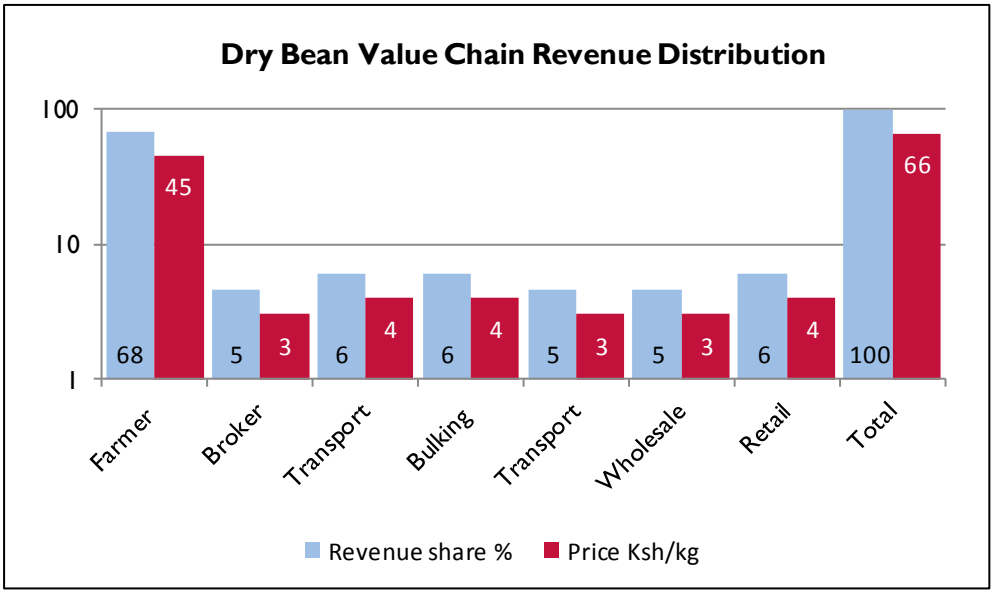
Table 15: Efficient Dry Beans Production Budget per Acre

Efficient Dry Beans Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	6,500	24.6	Oxen
Seed	2,100	8.0	Bought seed
Fertilizer	4,550	17.2	Manure and planting fertilizer used
Agrochemicals	2,680	10.2	Actellic
Gunny bags + transport	1,360	5.2	
Labor	9,200	34.9	Planting, weeding, harvesting, threshing
Total direct costs	26,390	100.0	
Yield - Kg	900	180	
Production cost/kg	29		
Price - Ksh/Kg	45		
Sales value	40,500		
Gross Margin	**14,110**		High return, 2-3 crops/year possible

Value Accumulation

Dry bean value accumulation from farmer to retailer is shown in Figure 29. At a current average farm gate price of Ksh 45 per kilo, the grower holds 68 percent of the "value chain equity" and drives the final price of beans sold to consumers at wholesale and retail markets. The other seven actor categories share 32 percent of the price accumulation but incur significant transport costs and inevitably make very low margins. At retail level prices vary widely. The average mark up and final price of Ksh 66 per kilo shown in the chart refers to low budget retailers in urban markets. In high end supermarkets such as Nakumatt, prices of graded, pre-packed beans can be as high as double.

Figure 29: Dry Bean Value Accumulation



4.7.5 Market Potential

The current national bean deficit is more than 120,000 tons with a farm-gate value of Ksh 5.4 billion at current prices (Figure 30). This is a market which is immediately accessible to smallholders if they apply basic improvements to their production systems as outlined above. The mass market for beans has grown at an average annual rate of 6 percent over the last five years (Figure 30) and this growth will continue as the population increases. Supermarkets have started promoting graded, high quality beans and other pulses at premium prices in consumer. Although supermarkets account for less than 10 percent of retail sales at the moment, they are growing rapidly and offer opportunities for product diversification and development in future.

Demand for new food products is high and traditional bean-based dishes such as githeri are regaining popularity amongst urban consumers. Beans feature globally in a wide array of health products because of their low cholesterol and high vegetable protein levels. Increases in global prices for beans will also make imports less competitive against Kenyan smallholders who are adopting good agricultural and management practices. These smallholders already dominate the European Union market for some types of fresh and processed French beans through organized partnerships with export processing companies and there is no reason why they cannot do the same with dry beans in regional and international markets.

Figure 30: Dry Bean Wholesale Prices in Nairobi

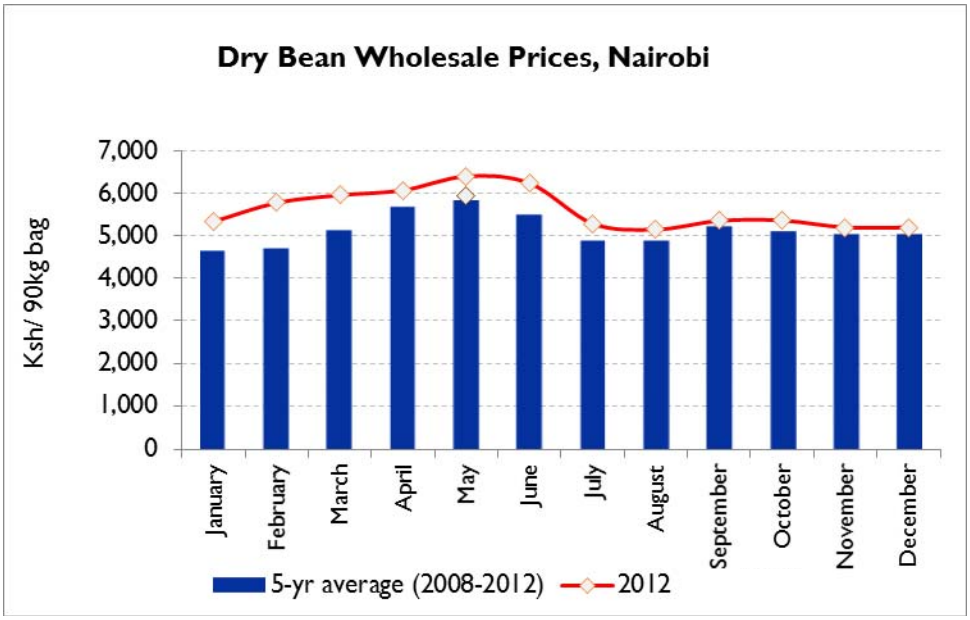


Figure 30 above shows the price trend for beans in the Nairobi wholesale market and the price trend are reflecting the high prices at planting in March to April, and September to October and relatively low prices at harvest in December to February, and July and August.

4.7.6 Upgrading the Dry Bean Value Chain

Given the importance of beans to national food security, increasing global prices and domestic production deficit, USAID-KAVES will work with smallholders to increase productivity and yields and transform thousands of subsistence producers into small-scale commercial dry bean producers. Specific interventions include:

- Promotion of high yielding, early maturing, pests and diseases resistant/tolerant dry bean varieties in partnership with seed companies.
- Training in IPDM technologies on consumer preferred bean varieties.
- Supporting farmer groups to create joint marketing agreements with buyers that reduce marketing costs and provide growers with the confidence to invest in new production systems.
- Introduction of postharvest handling techniques that minimize storage losses at household and small trader levels, facilitate private sector storage and allow financial providers to develop appropriate short-term financial products for traders.

4.8 PIGEON PEA

4.8.1 Background

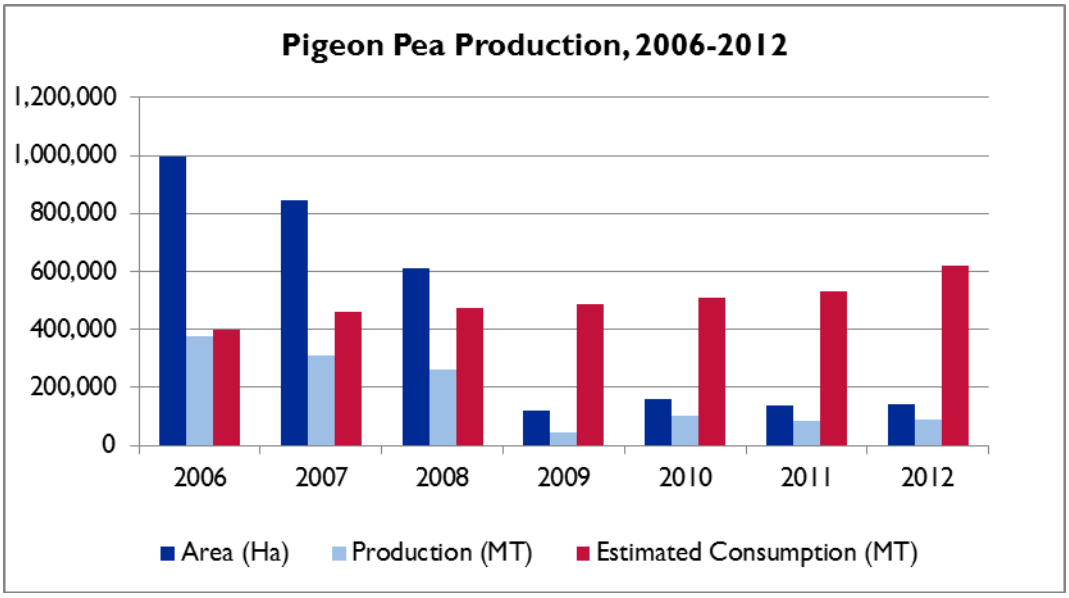
Pigeon pea is the third most important legume in Kenya after beans and cowpeas and is cultivated by smallholder farmers in the semi-arid lands as a source of food and cash. The crop has multiple benefits to the rural poor; it serves as a cheap source of protein-rich edible peas consumed both fresh and dry, and has a ready market. It contributes to soil fertility as a rotation crop since it has the ability to fix atmospheric nitrogen and solubilize iron-bound phosphorus, an important factor in semi-arid regions where soils are deficient in nitrogen and phosphorus. Pigeon pea has a deep rooting system that enables it to exploit moisture from deeper soil layers, making it well suited for the drier SA2 areas targeted by USAID-KAVES.

The main pigeon pea-producing counties are Machakos, Makueni, Kitui, Meru, Embu and Mbeere. Productivity is still low due to continuous use of saved seed with poor yield potential and low density planting systems. Consequently, marketable volumes have been low, with sporadic and unplanned production increasing buyers' costs and reducing the margins earned by growers. The leaves and hulls are also used as livestock feeds and the stems as fuel wood.

4.8.2 Production Trends

Despite attempts by projects and researchers to raise pigeon pea production in semi-arid areas of eastern Kenya, production has been on the decline since 2006 with a massive 82 percent drop to 46,474 metric tons in 2009 compared with 261,111 metric tons in 2008 (Figure 31). Since the area under the crop also fell almost six-fold during the period this is generally attributed to political instability in 2008/09 but the failure of production to increase back to previous levels in the 2010-12 period suggests that smallholders do not see it as a profitable crop to plant. Given the strong market demand and other benefits of pigeon pea, declining yield is probably a major factor that has stopped farmers from going back to the crop. Since it competes favorably as a cash crop with other legumes grown in the dry areas including beans, green gram and cowpea, interventions to increase production are needed.

Figure 31: Pigeon Pea Production Trends, 2006-2012

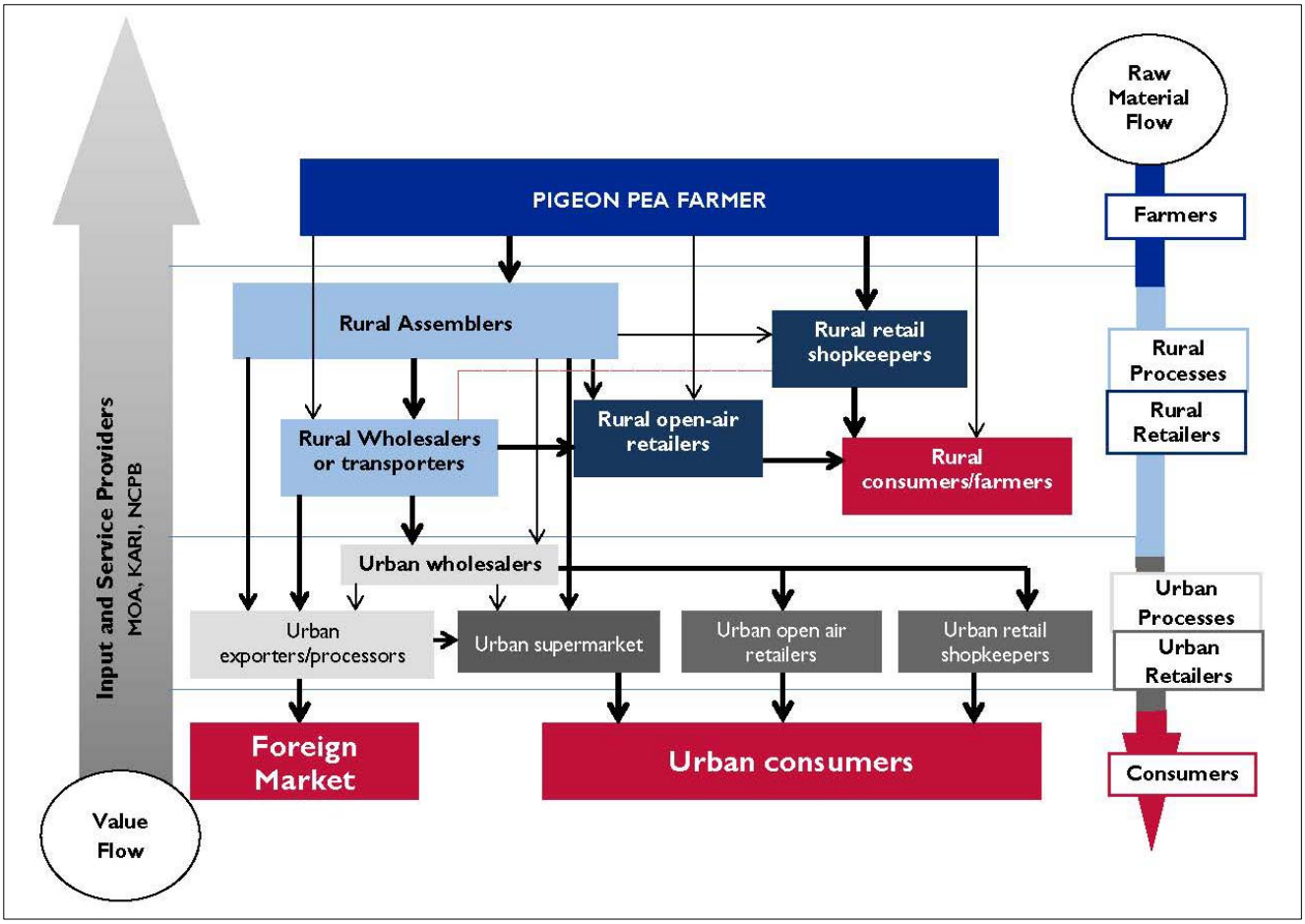


4.8.3 Value Chain Actors

The main actors in the pigeon pea value chain and their interactions are shown in Figure 32 below. Extension, research and product development services have a big role to play since farmers urgently need to adopt new varieties with high yield potential and greater pest tolerance than traditional varieties. Intensive use of inputs is not required for pigeon pea but suppliers can promote selective use of fertilizer and IPM, including targeted use of pesticides, as a profitable way to increase yields, to reduce risk and to improve pea quality.

Marketing systems that reduce aggregation costs and add value through grading and packaging are also needed. This will require establishment of stronger market linkages between farmers, assemblers/brokers and wholesalers both at rural and urban level. If production can be raised significantly there is also demand from exporters and processors trading with buyers in the Indian sub-continent. Pigeon pea marketing channels are currently characterized by low technology, low volumes and low costs and typically involve many small traders with limited market assets and exchanging small amounts of produce with no or very limited value addition.

Figure 32: Pigeon Pea Value Chain Map



Source: Shiferaw et al: (2008): Unlocking the Potential of High-Value Legumes in the Semi-Arid Regions: Analyses of the Pigeon Pea Value Chains in Kenya. ICRISAT; Nairobi

Production

Pigeon pea farming is dominated by smallholder farmers who grow the crop both for household consumption and for cash to meet food security and other requirements. The main production activities are carried out manually although some is done with oxen. Planting, weeding and harvesting activities are all carried out by hand, using family labor, on small plots ranging from 0.5 to 2.0 acres. The crop is usually planted at the onset of the September/October short rains and inter-cropped with cereals such as maize and sorghum, as well as other legumes including beans, green gram and cowpea. Pigeon pea grown are short, medium and long maturing varieties with the short and medium duration varieties harvested as green/fresh vegetable, in February and April while the long-duration types are harvested as dry grain in August and September. Farmers do not use fertilizer on the crop, although in some cases they apply manure.

Pigeon peas is produced under rain fed system, therefore, the bulk of trade is limited to one season with very minimal inter-seasonal trade. Crops are sold immediately after harvest to local traders. Low volume production and high market demand are the main reasons why storage is limited to home consumption needs but pigeon pea is susceptible to bruchids and other storage pests when held in larger quantities. Farmers are generally willing to invest in inputs that enhance yield, such as pesticides and improved varieties; however, the unavailability of improved seed and its perceived high cost when available have prevented adoption on a commercial scale.

Marketing

Pigeon pea trading involves farmers selling grains to rural assemblers that typically bulk the grains by collecting small quantities from individual farmers and then sell to rural wholesalers. The assemblers store the dry grain in sacks for limited periods of 2-3 days before moving it, rarely dusting the grains with pesticides; nor storing the product for longer periods due to lack of storage facilities. The rural wholesalers are the main outlets for most small-scale traders; however, assemblers also sell to rural open air retailers and rural retail shopkeepers. Rural wholesalers have better storage facilities and combine wholesale function with retail of other commodities. Some rural assemblers sell to urban wholesalers and/or processors and exporters.

The main purchasers of the grain from rural traders are the urban wholesalers and processors/exporters, and in some cases, open-air market traders and roadside kiosk and shopkeepers. Urban wholesalers order truck loads delivered to their warehouses and sell in bulk from the same premises without incurring any transport costs. Exporters are mainly processors who convert pigeon pea into dhal or use it as an ingredient in other added value products.

Retailing is done by small, medium retail stores, supermarkets and market traders. Supermarkets get their supplies from the urban processors in pre-packed and well labeled packets while small and medium retailers and urban open-air retailers source most of their grain supplies in bulk or with basic packaging from urban wholesalers.

Pigeon pea is a good example of the disconnect that exists between traders and smallholder farmers. Although global and national demand is strong, commodity traders have been unable to stimulate production. This is because of the large distances between smallholder producers, poor road infrastructure in many production regions, weak communication systems, lack of electricity and unavailability of stores for aggregation in SA2 rural areas. Seasonality of rain-fed production also makes prices unpredictable and increases trading risks as well as logistics costs. Consequently most production areas are served by only a few buyers, resulting in lack of competition and low demand at village level. Some national traders have tried to source through marketing agreements but have been put off by high transaction and transport costs involved in procuring and selling produce. These also reduced the price they could pay farmers and depressed margins at all levels in the value chain.

Traders at all levels also incur extra cleaning and sorting costs after receiving aggregated loads from many farmers including a proportion of low-quality grain, and a wide range of pea sizes and grades. Any expansion and commercialization of pigeon pea will require this variability to be reduced before farm gate prices can increase.

Processing

Pigeon pea processing entails de-hulling and splitting the pea or grain into *dhal* using vertical decorticators. The recovery of grain to dhal ranges from 65 percent – 75 percent of the original dry grain pigeon pea weight depending on quality. About 80 percent of dry grain bought by processors is processed into *dhal* while the remaining 20 percent is sold as grain. Close to 70 percent of dhal is exported to UK and US while the Kenyan Asian community consumes the remainder and provides a consistent and growing domestic market. Processors are located in the main urban centers in Nairobi and Mombasa. Multi-product companies such as Kenya Millers Ltd, Spice World and Pisu & Company buy the largest quantities but many smaller scale processors also produce specialist products using dhal as an ingredient.

The biggest challenge to processing of pigeon peas is the high raw material prices for dry whole grain from domestic producers and high procurement and processing costs (Freeman et al., 1999). This has reduced the competitiveness of Kenyan *dhal*, particularly for export, limiting processing only to small quantities serving the Asian population settled in major urban centers.

4.8.4 Pigeon Pea Value Accumulation

Tables 16 and 17 show pigeon pea production budgets under low and high productivity regimes. The low productivity illustrated in Table 16 is typical of systems and practices being used by smallholder farmers at present. They replant their own seeds, rarely spray against common insect pests, have low planting populations, incur high labor costs and generally apply poor agronomic practices leading to low yields of around 200 Kg per acre and a gross margin of Ksh 4,000 per acre. Net household receipts add up to double this if family labor is used.

Table 16: Typical Pigeon Pea Production Budget per Acre

Typical Pigeon Pea Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	700	12.5	Oxen
Seed	225	4.0	Retained seed
Fertilizer	0	0.0	None used
Agrochemicals	500	8.9	Actellic for storage
Gunny bags	60	1.1	
Labor	4,120	73.5	Planting, weeding, harvesting, threshing
Total direct costs	5,605	100.0	
Yield - Kg	218	180	
Production cost/Kg	26	26	
Price - Ksh/Kg	45		
Sales value	9,810		
Gross Margin	**4,205**		

Table 17 shows a system with higher productivity which could be adopted by most smallholders at little risk and with only a small additional investment in seed and agrochemicals. By adoption of good agricultural and management practices yields can triple to 600Kg per acre. The increase results from planting of certified seed with high yield potential, planting on time, optimal plant population to reduce weed competition and spraying with insecticides against the common pests of pigeon pea.

Table 17: Efficient Pigeon Pea Production Budget per Acre

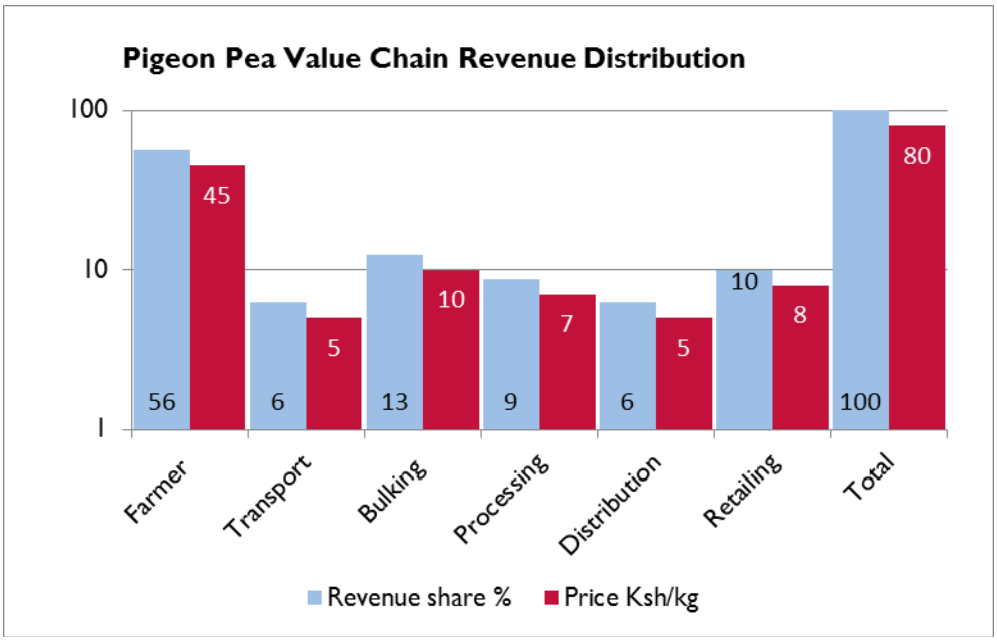
Efficient Pigeon Pea Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	700	6.5	Oxen
Seed	750	7.0	Certified seed@ Ksh 150
Fertilizer	0	0.0	None used
Agrochemicals	4,250	39.4	For pest control at field and storage levels
Gunny bags + transport	120	1.1	
Labor	4,960	46.0	Planting, weeding, harvesting, threshing
Total direct costs	10,780	100.0	
Yield - Kg	600	180	
Production cost/Kg	18		
Price - Ksh/Kg	45		
Sales value	27,000		
Gross Margin	**16,220**		

If farmers make these changes their gross margin rises fourfold to Ksh 16,000 and net household income to Ksh 20,000 if family labor is employed. Techniques to reduce labor needed for land preparation and weeding are essential for pigeon pea commercialization by USAID-KAVES since labor constitutes the biggest cost in both systems.

Value Accumulation

Pigeon pea value accumulation from farmer to processor and retailer is shown in Figure 33. At the current average farm gate price of Ksh 45 per kilo, the grower holds 56 percent of the "value chain equity" and drives the final price of raw and processed products. The other five actor categories share less than 50 percent of the price accumulation but incur significant costs.

Figure 33: Pigeon Pea Value Chain Revenue Distribution



The rural assemblers buy bulk and transport the dry peas and add 19 percent to the value. They incur direct costs from wastage, fuel and labor for cleaning, sorting, treating and storage either at local or urban areas. Larger wholesalers incur similar costs but store for longer periods and take 12 percent of the final price depending on how much processing is carried out. The high cost of raw materials, caused by the very low productivity of pigeon pea farmers, is effectively preventing any expansion or commercialization of a crop that is in high market demand. Interventions that double or triple yield will have immediate impact on the whole value chain and will be a priority for USAID-KAVES. By increasing productivity and reducing farm gate prices, smallholder producers will increase net returns per acre and stimulate market interest at the same time. As volumes increase in localized areas and buyers can source whole truck loads, their direct costs will also go down and enable their domestic and export prices to become more competitive.

4.8.5 Market Potential

Demand for pigeon pea is high in domestic, regional and export markets. Processors are already exporting it as dhal or as an ingredient in other processed products but their prices are not competitive with other sources. Low productivity at farm level leading to high farm gate prices is the main reason for this. If production costs come down, Kenyan smallholders, already successful with fresh peas and beans, can become major suppliers of pigeon pea to markets in Europe, the Middle East, South Africa, U.S. and

Canada where exporters already have orders that cannot be met. The huge Indian market for dhal is also accessible to Kenyan exporters with regular shipping at competitive rates, low import duties and relatively low expectations on product quality. There is also a significant potential for developing the fresh pigeon pea market for both domestic consumption and for exports if the availability of short- and medium-duration pigeon pea cultivars can be increased

4.8.6 Upgrading the Pigeon Pea Value Chain

For the pigeon pea industry to become competitive globally and provide fair returns to smallholder farmers, productivity needs to be increased, planting and production scheduled to achieve year-round production, marketing costs reduced and quality standards improved.

Specific interventions by USAID-KAVES will include:

- Working with seed companies and extension providers to increase availability and uptake of improved seed that will significantly increase productivity.
- Developing realistic medium term marketing agreements with traders and processors in order to lower post farm-level logistics costs. Linking producers more directly with traders, exporters and processors will also reduce marketing transaction costs and thereby increase the competitiveness of Kenyan produce locally and internationally.
- Supporting farmers to develop viable marketing groups for planning production in commercial quantities and aggregating to reduce marketing costs and add value at group level.
- Integrating farmer organizations, community seed producers and rural agro-dealers to commercialize the seed distribution and technology transfer system in rural areas. Building the capacity of these service providers will greatly improve smallholder farmers' access to improved seed and other technologies.

4.9 GREEN GRAM

4.9.1 Background

Green gram is a warm season annual pulse grown mostly as an intercrop with maize, sorghum or millet in the lowland zones of eastern, western and coastal regions of Kenya. It is one of the principal cash crops grown by smallholders in counties of eastern Kenya who sell 71 percent of the crop grown. In other areas, green grams are utilized for human consumption as whole grains boiled with cereal grains such as maize or sorghum. Commercially the crop is marketed either as dry grain or processed (split) dry grain called dhal which is increasingly in demand globally as supplies from India become more expensive.

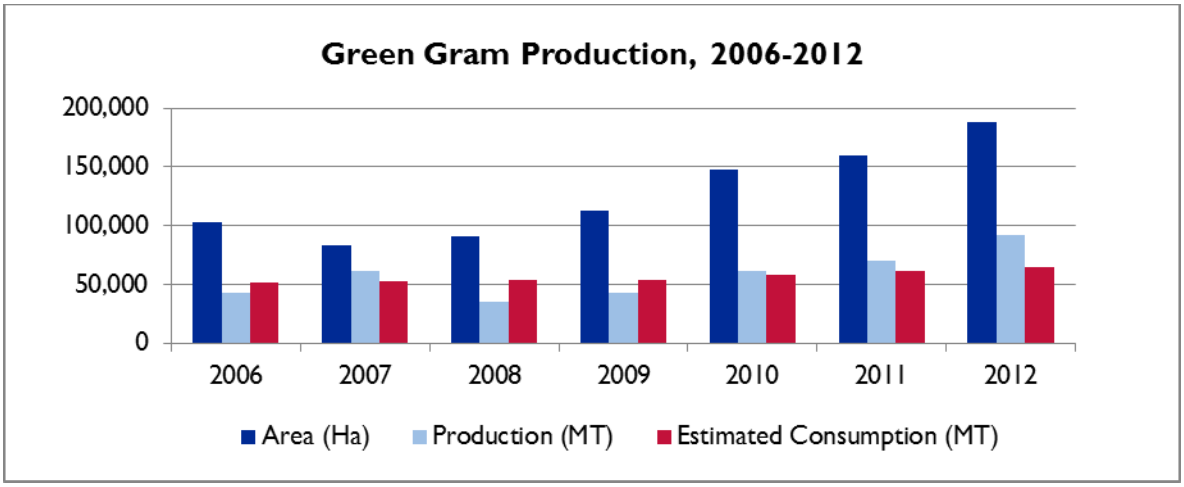
The largest group of domestic consumers of dhal is made up of Kenyans of Asian origin, many of whom is vegetarian and requires plant protein in their diet. Dhal is also a traditional part of diet in India where demand is growing and processors are looking for sources of green gram to import competitively. The use of green grams as a health food has also gained popularity in Kenya and other countries and milling of green grams into flour for combining with other flours is being carried out locally by Kirinyaga flour mills and others.

Green gram is produced under rain fed systems and the production zones have two cropping seasons. Long season planting starts in March and ends in May with harvesting taking place in July-August and the short season is from October to December with harvesting taking place in January and February. Green gram is a short duration crop and the bulk of production occurs during the short rainy (October-December) season in eastern Kenya. The seasonality of production has a major influence on buying prices, with prices lowest in February-March, just after harvesting and highest during the September-October planting period.

4.9.2 Production Trends

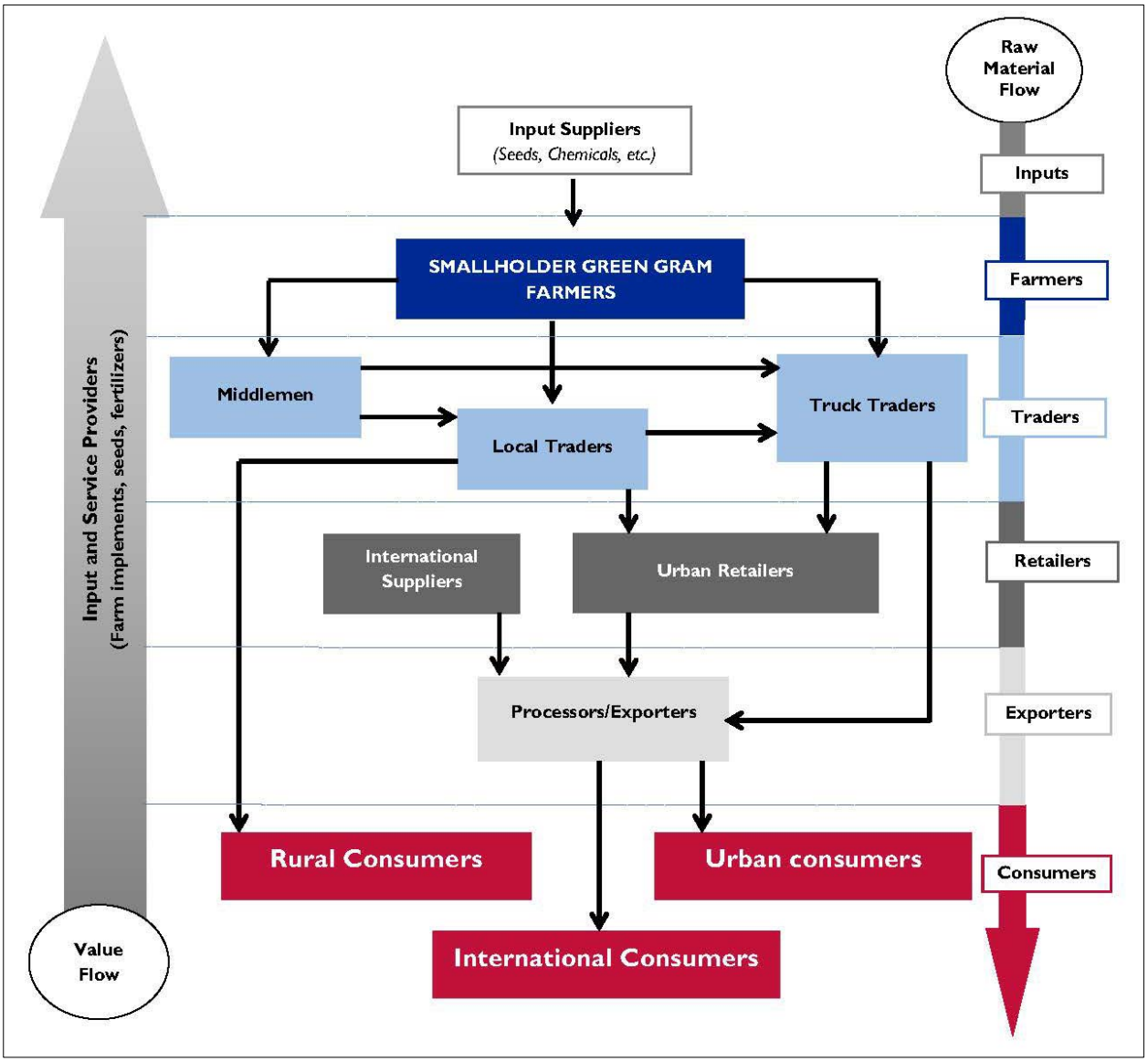
Green gram production has been fluctuating over the years but annual production started to increase steadily from year 2006 (43,399 tons) rising to 91,824 tons in 2012, with a slight reduction recorded in 2008 (35,713 tons) which has been generally attributed to political upheavals in the same period although cyclical drought could also have been a factor.

Figure 34: Green Gram Production Trends, 2006-2012



Farmers have responded to market demand by planting both local and improved varieties of green gram. The local variety has small seeds and the plant seeds maturing at different times; thus the prevalence of a lot of stony seeds, which make it less palatable and reduces the price that processors are willing to pay. Green gram production zones are mainly in the semi-arid areas where periodic droughts have a regular impact on yields achieved by smallholders who are the only producers and depend on rainfall. Interventions that focus on in-field water conservation techniques and rainwater harvesting could have a significant impact on maintaining the growth trend in production.

Figure 35: Green Gram Value Chain Map



4.9.3 Value Chain Actors

The green gram value chain and end products are similar to pigeon pea with a large number of smallholders selling to local traders who aggregate and sell on in larger quantities to wholesalers who bulk, grade and package for processors and retailers.

Production

Green gram production is mainly done by small-scale farmers owning relatively small parcels of land, on average, 1-2 hectares. The farmers mostly plant retained seeds from the previous harvest, intercropped with maize, sorghum or millet. In some instances they plant pure stands of green gram. Yields are low and most growers generally harvest 1-2 bags/acre of 90 Kg. As interest in the crop has grown, researchers have urged growers to adopt simple techniques that can increase this to 10 bags per acre. Gradually the more commercial smallholders have adopted improved seed varieties and the application of good agronomic practices. Farmers have also learnt to winnow and sort their crop to meet market preferences which significantly improve the grain quality and price. This is done by use of different grade sieves in order to have grains of almost the same size packaged together.

Farmers have limited access to improved varieties which can only be sourced from the local agri-stockists or from KARI-Katumani in Machakos County. The green gram breeding program at KARI has not released any new varieties for many years; however, other sources of improved seed varieties are available from Kenya Seed Company, Dryland Seeds Western Seed Company. The improved varieties presently in the market include nylon, N26 or K26 which are preferred for their high yields of shiny large seeds that ripen at the same time. Nylon is the variety most preferred by traders.

Table 18: Seasonal activity calendar for Green Grams

Activities	Months											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Land preparation		X	X					X	X			
Planting			X	X						X	X	
Weeding					X						X	
Pest control	X	X			X	X	X					
Harvest	X	X				X	X					
Threshing	X	X	X			X	X					
Packing/dusting		X	X			X	X					
Transport to store		X	X			X	X					
Storage		X	X	X		X	X	X				
Sales and marketing	X	X	X				X	X	X			

The green gram activity calendar is shown in Table 18. Field activities are mainly conducted within the cropping periods of March-April to June-July and September to January. The postharvest activities sorting, packaging and marketing are then taken up in February-March and June-July. The low productivity of smallholder farmers is caused by shortages in seed varieties best for their area at planting time, lack of specific technologies for green gram and general reluctance to invest without formal marketing agreements.

Lack of customized postharvest equipment is also a constraint for farmers who want to commercialize, increase volumes and add value at farm or group level. There is a need for stronger farmer groups to bulk production prior to marketing and deliver technical services to members in cooperation with buyers, researchers and input suppliers.

Marketing

Small scale farmers generally sell their produce immediately after harvest at farm gate to brokers who buy and transport in small quantities to local grain traders with stores. Farmers also sell during weekly open air markets to truck traders delivering their produce in baskets or half full gunny bags either on their back, donkeys, ox-carts or bicycles. Packaging into full gunny bags of standard weights is usually done by the traders or Producer Marketing Groups (PMGs) at the collection or bulking centers.

The farm gate buyers are both women and men with local knowledge who contact farmers before harvesting or intercept them at meeting points before they reach the weekly markets. They buy the green grams on behalf of local traders with stores or truck traders who carry as much as they can load directly to urban markets. In most cases they use money advanced to them by the bigger traders and make a small margin between farm and the nearest delivery point. They carry bicycle loads of about 30-50 kg at a time using volume measures or *gorogoro* with a holding capacity of about 2.5 Kg. They deliver to the local grain stores and truck traders and sell to them in kilograms, giving rise to a general lack of trust between farmers and buyers on the actual weights purchased at farm gate.

These small traders operate at village level and handle 10 to 50 tons of green grams per season. They purchase produce at harvest time (January/ February or July/August) when the prices are low and store to sell when the prices improve especially as seed or bulk and sell to truck traders. Some also hire trucks and deliver green grams to bigger traders in urban centers. Some PMGs fall into this category. The main challenges at these rural levels of the value chain are poor and undeveloped physical and marketing infrastructure, low and unpredictable supply of commodity, inadequate storage facilities for traders, lack of grades and standards to enable international trade and no transparency of pricing.

Service Provision

Green gram is an emerging commercial crop without well-developed service providers. They rely on a range of intermittent sources for technical information including Government extension workers, input suppliers, agrochemical companies, research organizations and buyers.

Seed and agro-chemical are purchased by smallholders from stockists located in the local and urban trading centers. Apart from selling seeds, fertilizers and chemicals, input suppliers play a crucial role in dissemination of appropriate agronomic practices and technical advice on improved varieties, fertilizer use and safe use of agro-chemicals. The costs associated with this are low and embedded as a business service but of variable quality.

So far the demand for seed is too low for established seed companies to start selling the improved, broad seeded green gram variety. Farmers rely on specialist suppliers including the KARI Seed Unit (KSU), Western Seed Company and Dryland Seeds but they have limited multiplication and distribution systems. Green grams are highly susceptible to field and storage pests especially aphids, bean fly, bollworms, pod sucking beetles (kiwi beetle) and *bruchid* weevils. They are also affected by powdery mildew. The crop is therefore sprayed with agro-chemicals especially from flowering to pod filling stages and dusted with storage chemicals before storage. Farmers buy the agro-chemicals from the local stockists or from nearby urban centers and rely the information provided by these input suppliers. In many cases the staff in these shops has very little technical knowledge. Because of low demand by green gram farmers for improved technologies that include certified seeds and agro-chemicals, they do relatively small business and have to combine agro-stockist shops with other businesses as timber, hardware and other food provisions.

4.9.4 Green Gram Value Accumulation

With current low levels of productivity, cash income from green gram is negative if labor is costed at market rates (Table 19). Average farmers are achieving a gross margin of around KSh 11,000 and net contribution to household income of KSh 9,000 if family labor is employed (Table 20). However, farmers who plant two crops per year can double this income which may be one reason why production of green gram is increasing whilst production of the others have remained static or fallen.

Table 19: Typical Green Gram Production Budget per Acre

Typical Green Gram Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	5,500	36.7	Oxen
Seed	170	1.1	Bought seed market @Ksh 34/Kg
Fertilizer	0	0	None used
Agrochemicals	0	0	Actellic
Gunny bags	300	2	
Labor	9,000	60.1	Planting, weeding, harvesting, threshing
Total direct cost	14,970	100	
Yield – Kg	270	180	
Production cost/Kg	55		
Price – Ksh/Kg	34		
Sales value	9,180		
Gross Margin	**-5,790**		

Most farmers harvest 2 to 5 bags of 90 kg per acre but by adopting good agricultural practices and making small, low risk investment in seed this can increase to 10 bags per acre and a gross margin per crop cycle of Ksh 26,000. With family labor and two crops per year, households can generate an annual income of more than Ksh 11,000 (Table 20).

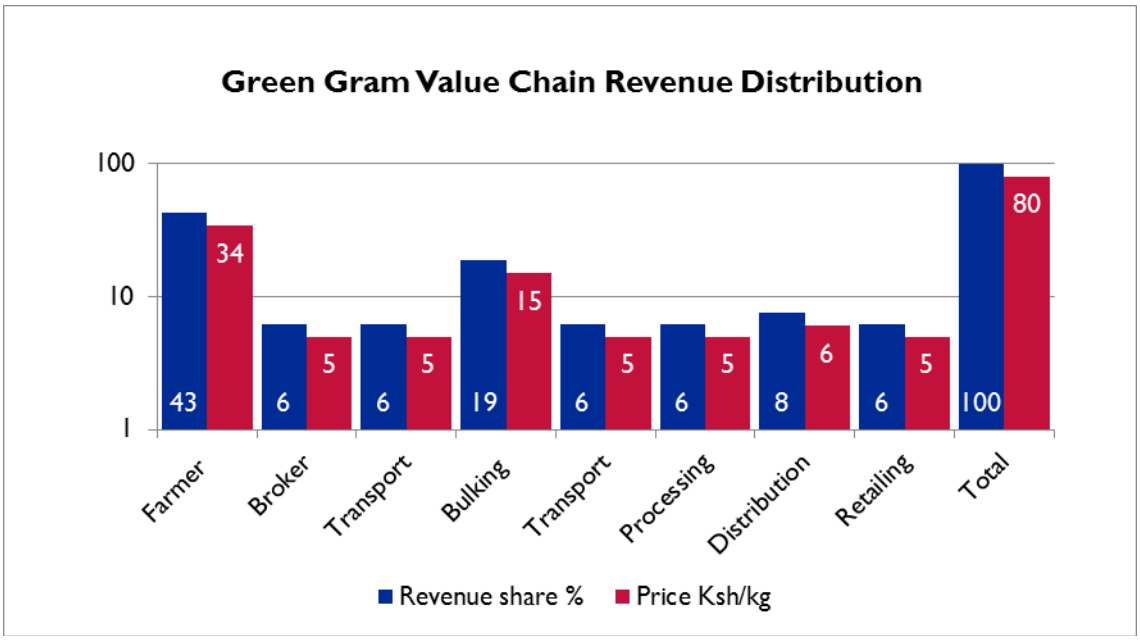
Table 20: Efficient Green Gram Production Budget per Acre

Efficient Green Gram Production Budget per Acre			
Activity/Input	**Cost/value Ksh**	**Percent**	**Note**
Land preparation	5,500	28.4	Oxen
Seed	750	3.9	Bought seed market @Ksh 34/Kg
Fertilizer	0	0	None used
Agrochemicals	520	2.7	Pest control at storage and field
Gunny bags + transport	1,000	5.2	Gunny bags @ Ksh 100
Labor	11,600	59.9	Planting, weeding, harvesting, threshing
Total direct cost	**19,370**	**100**	
Yield – Kg	900	180	
Production cost/Kg	22		
Price – Ksh/Kg	34		
Sales value	30,600		
Gross Margin	**11,230**		

Value accumulation

Green gram value accumulation from farmer to processor and retailer is shown in Figure 36. At the current average farm gate price of Ksh 34 per kilo, the grower holds 43 percent of the "value chain equity" and drives the final price of raw and processed products. The other seven actor categories share 57 percent of the price accumulation but incur significant costs.

Figure 36: Green Gram Value Accumulation

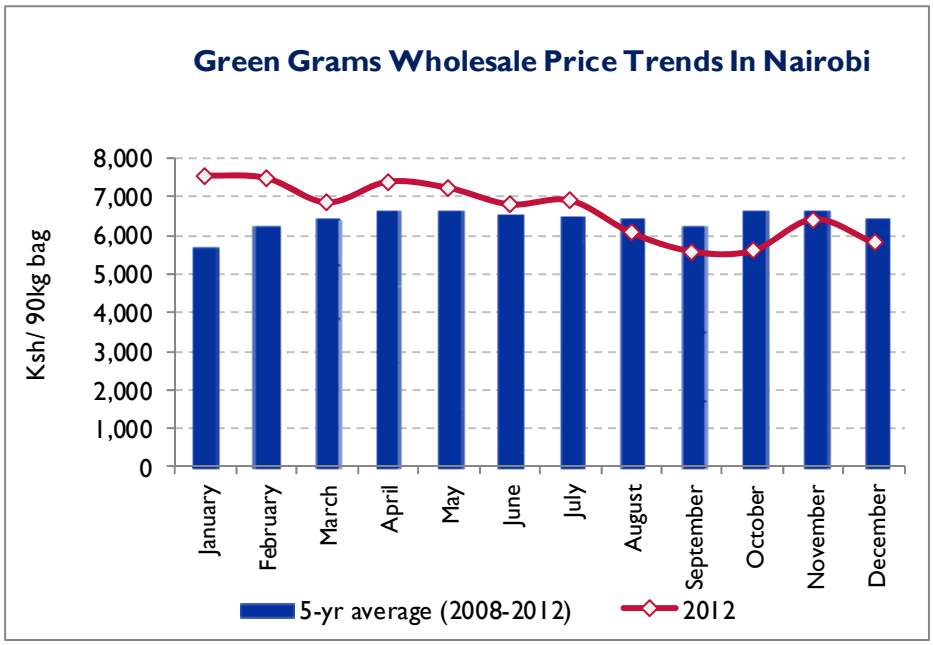


The rural assemblers and wholesalers buy bulk and transport the dry peas and add 31 percent to the value. They incur direct costs from wastage, fuel and labor for cleaning, sorting, treating and storage either at local or urban areas. Processers, packers, distributors and retailers take the remaining 26 percent, a relatively low mark up to achieve profitable margins. Since growers are taking the biggest share of revenue, interventions that increase yield will have immediate impact on the whole value chain and will be a priority for USAID-KAVES. By increasing productivity and reducing farm gate prices, smallholder producers will increase net returns per acre and create more market confidence at the same time. As volumes increase in localized areas and buyers can source whole truck loads, their direct costs will also go down and enable their domestic and export prices to become more competitive.

Price Trends

The seasonality of green grams production affects the supply and demand and hence prices Figure 37 below. The prices vary from farm gate to the those offered by the large traders as discussed above and is mostly influenced by seasonality of production and to some extent, the transaction costs. However, prices are most influenced by the international market prices especially India which is the biggest export market and is also supplied by Burma, one of the biggest green gram exporters to India.

Figure 37: Green Grams Wholesale Price Trends in Nairobi



4.9.5 Market Potential

As for pigeon pea, the demand for green gram is high in domestic, regional and export markets. Processors are already exporting it as dhal or as an ingredient in other processed products but increased productivity at farm level will increase their competitiveness. If production costs come down, Kenyan smallholders and processors can become major suppliers of green gram products to markets in Europe, the Middle East, South Africa, USA and Canada where exporters already have orders that cannot be met. The huge Indian market for dhal is also accessible to Kenyan exporters with regular shipping at competitive rates, low import duties and relatively low expectations on product quality.

Green gram is one of the few annual crops with proven potential for smallholder income generation in SA2 since although production and market demand have grown in recent years there still remains a large deficit that can be exploited by increasing productivity. With more widespread adoption of newly released varieties and mainstreaming of green grams, it can become a sustainable cash crop for thousands of small-scale commercial farmers.

As for other legumes, there is also growing demand as an ingredient in health foods since it is a relatively cheap source of cholesterol-free protein with good flavor and palatability on both domestic and export markets. If production costs can be reduced to competitive levels, rapid expansion in to international markets is possible, particularly India, where demand is being driven by its growing population and increasing incomes

4.9.6 Upgrading the Green Gram Value Chain

Since market opportunities appear to be strong and commercialization has already started to a limited degree, USAID-KAVES will focus on green gram as a key product for commercialization in SA2 counties.

The upgrading efforts will focus on:

- Raising productivity and grain quality through better access to and adoption of improved seed by involving commercial seed suppliers as partners.
- Introduction of new technologies that increase productivity, reduce labor costs and result in higher quality grain for international markets.
- Customizing training and business development on integrated pest management that includes extension workers, contract sprayers and input suppliers as partners.
- Supporting farmers to create viable marketing groups to take advantage of economies of scale by consolidating buying and selling activities.
- Testing on-farm storage technologies with private sector partners including small-scale traders
- Raising quality standards based on end user needs that will enable farmers, traders, and exporters to exploit quality-conscious niche markets in Europe and North America.
- Conducting market research on medium-term export competitiveness to regional and global markets, especially India.

4.10 GROUNDNUT

4.10.1 Background

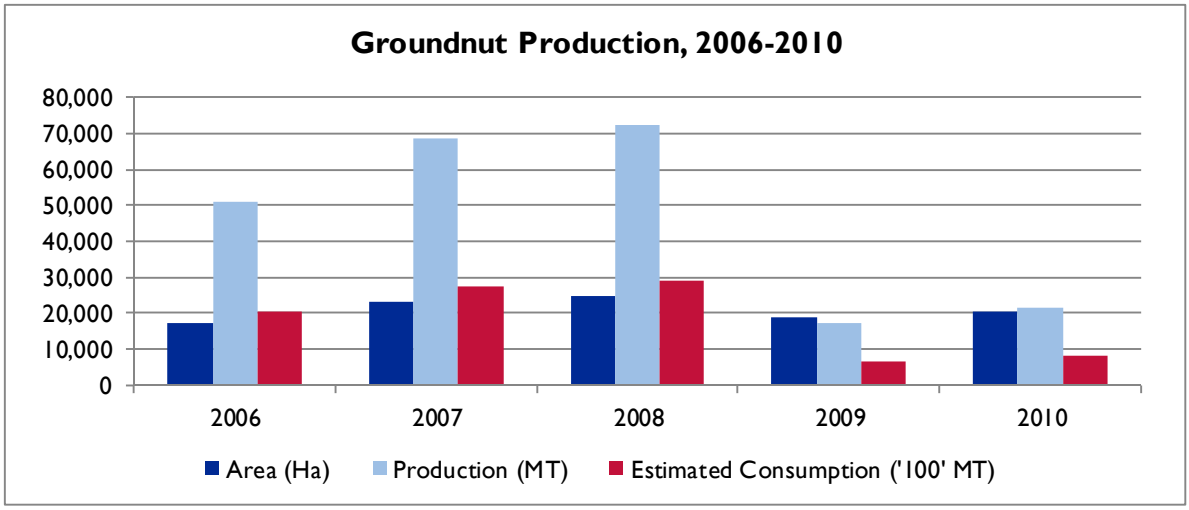
Groundnuts are traditionally grown under rain-fed conditions by smallholder households in eight of the USAID-KAVES' target counties - Homa Bay, Kisii, Siaya, Kakamega, Bungoma, Busia, Tharaka-Nithi, and Meru. It is either intercropped with cereals or grown on small plots around family homesteads, mainly by women who also sell or barter surpluses in small quantities with local traders. Although it has been mainly grown for home consumption and 'neighborhood marketing' in the past, there is a growing domestic demand for groundnut as a snack food and for processing into a range of different products. It is a relatively drought-tolerant crop and new varieties are available for commercial planting that give higher yields of larger nuts than those produced by growers from retained seed. On a per kilo basis, groundnut sells for about twice the value of other legume crops so it clearly has potential as a cash crop for smallholders if yields can be increased.

4.10.2 Production Trends

Since it has not been considered as a significant commercial crop in the past and had no well-organized marketing channels, groundnuts production data is not well captured and reported in the MoA annual statistical reports. The official production data shown in Figure 38 suggest that production was rising in 2005-2007 and peaked at 72,513 tons in 2008 but then fell to around 20,000 tons in 2009 and 2010. FAO figures indicate an increase in production to over 30,000 tons in 2011 but validation of current production levels is needed in counties where it has commercial potential.

Since nut packers have increased their use of local groundnuts in recent years and some commodity traders even report exports to India, it is possible that production significantly under-reported. According to the official data Nyanza Province accounted for 75.6 percent of production in 2010, followed by Western Provinces (16.3 percent), Eastern (4.1 percent) and Rift Valley (4 percent).

Figure 38: Groundnut Production Trends



Data Source: Ministry of Agriculture

4.11.3 Value Chain Actors

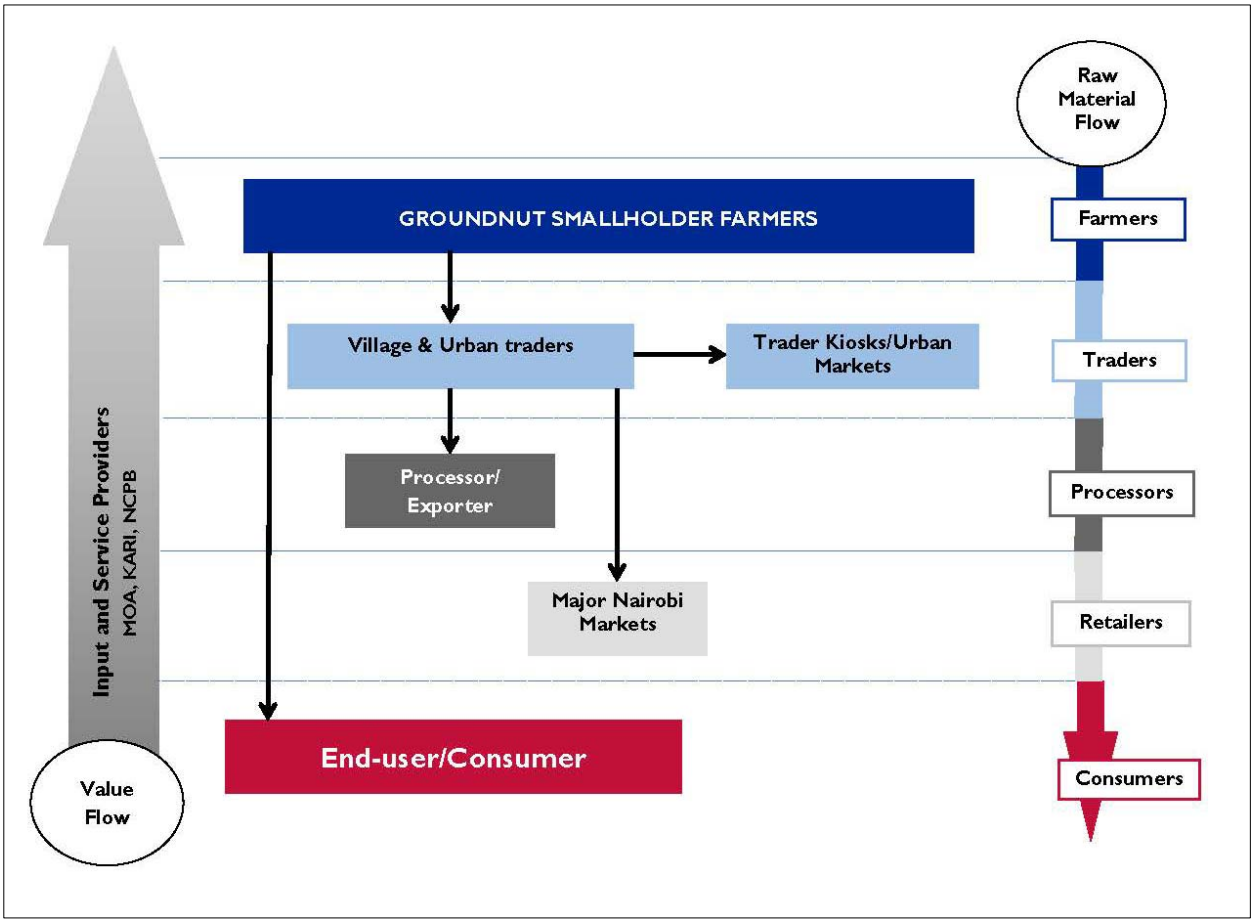
Movement of groundnut from farm gate through several traders to end market consumers is shown in Figure 39, below. It is a short value chain but increasingly value is added by processors who buy groundnuts to mix with other nuts in snack packs or as an ingredient in confectionary and health food products. Traditionally, some processing into paste was carried out on-farm for home use and local sales in small quantities. This 'peanut butter' is now produced for mass marketing to higher income families by food processing companies, both small and large-scale, who offer a ready market to commercial groundnut growers.

Production

Groundnuts tend to be grown by the smallest scale farmers owning small pieces of land up to 1.0 hectares although market interest is now bringing some of the more progressive smallholders into groundnut production. The growers, mainly women, generally plant retained seeds from their previous harvest or buy from other growers. They do not usually buy improved seed or use inorganic fertilizer or pesticides on the groundnut crop. They intercrop groundnuts with cereals or plant in small plots of up to a quarter of an acre around their homes. Crop yields are very low, ranging from 400 to 800 kilograms per hectare with a national average reported at less than 500kg/ha. Potential exists to increase yields by more than threefold through introduction of high yielding varieties and adoption of more efficient production technologies and good husbandry practices.

Harvesting and drying of nuts-in-shell is done by hand and the dried nuts are stored in gunny bags inside the family home. Conditions are often humid and this can lead to growth of aflatoxin producing fungae on the stored nuts which is a major food safety and marketing problem. Before eating or selling the nuts, they are shelled by hand using family labor which is a time consuming process that could be mechanized to reduce costs by organized groups of smallholder growers if they were targeting commercial markets for groundnuts.

Figure 39: Groundnut Value Chain Map



Source: MoA

Marketing

Farmers usually have only small quantities of less than 90 kilos available for marketing so they sell shelled nuts to village traders on bicycles who collect and aggregate small quantities of 2 to 5 bags of nuts directly from several farmers and transport the same day to traders in local markets either as agents or as traders operating with a very low margin. Nuts can be bought and sold several times both on the way to market and between traders in the same rural market who receive orders from specific buyers in urban areas who need the nuts for processing. At this level the traders operate with very limited capital, low margins and no access to market information except from the urban buyers they are selling to. Nevertheless, since groundnut is a high value product and prices can rise quickly, they often store nuts and speculate on prices being offered by larger traders and processors.

Traders complain that Kenyan nuts are small and poor quality but have good flavor. This causes problems in storage since small nuts shrivel, lose weight and soften quickly whilst broken nuts are prone to spoilage and aflatoxin build-up. Any serious commercialization of groundnut needs to address the issues of short-term storage and quality assurance. Production and trading is seasonal which is reflected in price fluctuations with lowest prices recorded in the July-September harvest period.

The larger commodity traders handle groundnuts year-round using imported nuts when none are available domestically or the price is too high. They are well-informed about markets, have access to trading capital and have established relationships with sellers/brokers, wholesalers, retail outlets and processors. They trade between 10 and 100 metric tons monthly and have facilities and equipment for

cleaning the raw nut deliveries to extract chaff, stones and soil to meet the retail and processing requirements. These traders, because of their capacity to store and supply produce on demand, are price setters in the groundnut industry.

Despite the apparent problems with production, some traders export Kenyan groundnuts to India where market demand is massive and traders sell by source and flavor rather than quality. These are niche sales, with orders and deals often made through family connections. Nevertheless it indicates that Kenyan groundnuts could be traded globally in larger quantities if productivity was improved and price made competitive

Processing

Groundnuts are either cleaned and cooked to sell as confectionary 'peanuts' or transformed by processing into peanut butter, or used as an ingredient in other types of sweets, biscuits and snack foods. At village level, women buy groundnuts from either open retail markets or from larger traders in small quantities of 10 to 90 kilograms, roast them in traditional pans in batches of 3 to 7 kilograms, and pack in polythene packs of 100 to 500 grams. The packaged nuts are then distributed through hawkers or in kiosks in the neighborhoods and down-town outlets.

At national level processors use factory equipment to sort, peel, roast and package peanuts for up-market retailers and food service suppliers. The nuts are sold in 25 to 250 grams packs of groundnuts under brand names to supermarkets, convenience stores at petrol stations, tourist hotels, exports and airlines. Because of their target clientele, the processors require higher quality groundnuts to satisfy the customer demands. The quality components considered by the processors include moisture content, pea size, taste, uniformity, maturity, texture and absence of shriveling.

The demand for peanut butter appears to have grown in recent years although statistics are not available. Some processing of nuts into butter takes place in rural areas using peanut butter mills powered by electricity and polythene bags for packaging and local sale. At national level there are at least four processors converting 10 to 15 tons per week of groundnuts into branded peanut butter. They source the nuts from urban traders operating in Nyamakima or from importers buying from Malawi and other regional sources. The processors all have plans to expand to meet the rising domestic demand and, eventually, to supply regional export markets.

4.10.4 Groundnut Production budget

The crop production budget for a typical groundnut farmer is shown in Table 21. The main production costs are land preparation and labor for weeding, harvesting and shelling. Under this system, farmers produce about three bags per acre with a total value of up to Ksh 27,000 although only a proportion is actually sold. If family labor is costed at market rates this provides a gross margin of around Ksh 1,400 per acre that increases to provide gross household income of Ksh 16,000 if family labor is employed.

Table 21: Typical Groundnut Production Budget per Acre

Typical Groundnut Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	5,500	324	
Seed	1,750	7.6	
Fertilizer	0	0	
Agrochemicals	340	1.5	Storage fungicide only
Labor	15,000	65.5	Hired cost, H/H return higher on family labor
Bags. Sisal	300	1.3	
Transport	0	0	
Total direct costs	22,890	100	
Yield – Kg	270		
Production cost/Kg	85		
Price – Ksh/Kg	90		
Sales value	24,300		
Gross Margin	**1,410**		

The effect of using inputs and better practices to make the production system more efficient is shown in Table 22. With improved seeds, fertilizers and efficient use and timing of labor at planting and weeding, the yield per acre increases threefold to 1,100 kilograms per acre and gross margin rises close to Ksh 70,000. Even if the average price reduces to Ksh 70 per kilogram as volumes increase, the gross margin is still higher than competing crops at Ksh 56,000 or gross household income of up to Ksh 72,000 if family labor is used.

Table 22: Effective Groundnut Production Budget per Acre

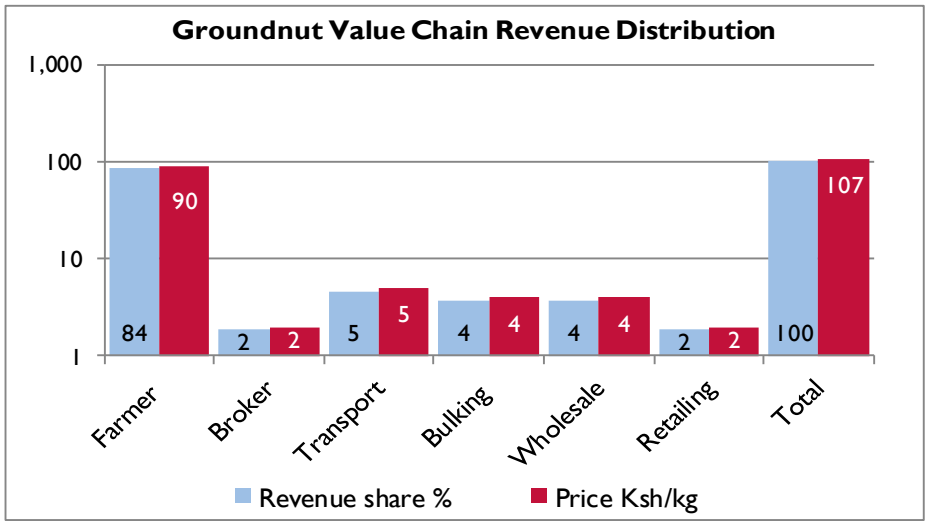
Effective Groundnut Production Budget per Acre			
Activity/Input	**Cost/value Ksh**	**Percent**	**Note**
Land preparation	5,500	324	
Seed	2,100	7.1	
Fertilizer	4,200	14.2	
Agrochemicals	600	2	Storage
Labor	16,000	54.1	Hired cost, H/H return higher on family labor
Bags. Sisal	1,200	4.1	
Transport	0	0	
Total direct costs	29,600	100	
Yield – Kg	1,100		
Production cost/Kg	27		
Price – Ksh/Kg	90		
Sales value	99,000		
Gross Margin	**69,400**		

Value Accumulation

Figure 40 shows the increase in value of groundnuts at each stage as it moves through the whole value chain from farm gate to final buyer. It does not take processing into peanut butter and other products into account since the processors essentially buy at the same prices as wholesalers.

As a general rule, food manufacturing margins are low and raw material prices drive profitability which is the case with groundnut. The farm-gate value accounts for 84 percent of the "equity" in the final retail price and slightly more at wholesale level so it is the main component of the end-market price. Bulking, transport and wholesaling activities account for a total of only 16 percent indicating the margins are low for the traders. Interventions by USAID-KAVES that increase productivity at farm level and reduce production cost per kilo will therefore have most impact on smallholder incomes.

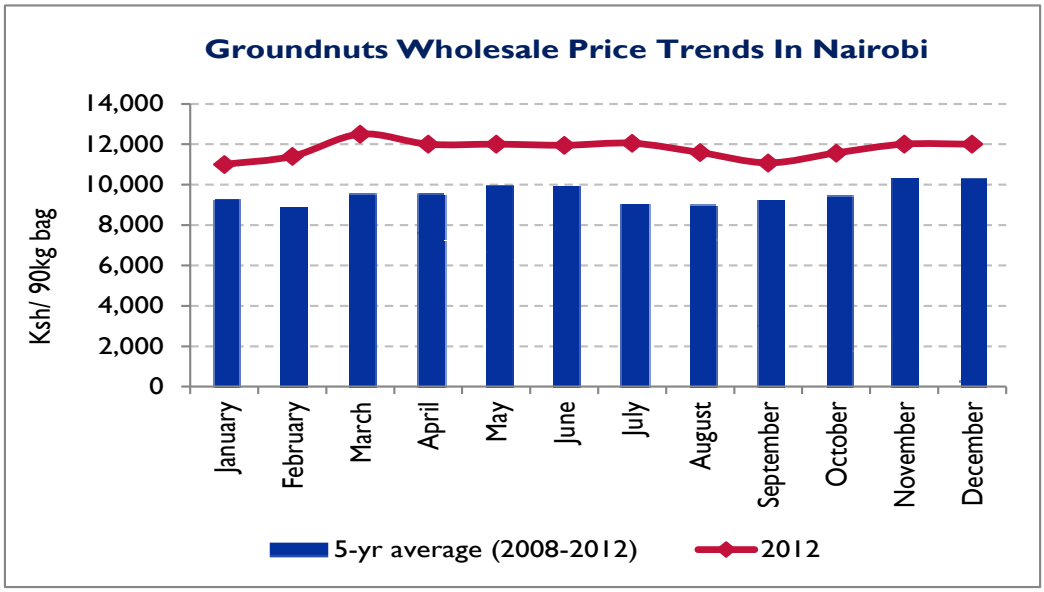
Figure 40: Groundnut Value Accumulation



4.10.5 Market Potential

It has been estimated that 40 percent of current groundnut production is consumed at household level (Muthee 2007). The balance is insufficient to meet domestic demands and this deficit is supplied by imports from Malawi and Tanzania. Figure 41, confirms that the five year average wholesale price from 2007 to 2012 at Nyamakima market in Nairobi was slightly over Ksh 9,000 per bag or Ksh 100 per kilogram. This rose to Ksh122 per kilogram in 2012. The current shortfall in supply and strong demand from processors mean that prices should hold at rates which are highly profitable for growers over the medium term. Growers in western Kenya have comparative advantage over other areas and are in a good position to dominate the market if they commercialize their production systems.

Figure 41: Groundnut Wholesale Price Trends in Nairobi



4.10.6 Upgrading the Groundnut Value Chain

To take advantage of strong market potential and address the challenges facing the groundnut industry, USAID-KAVES will address productivity, storage and quality issues.

Specific interventions will include:

- Intensification of groundnut production systems through adoption of technologies that incorporate improved seed varieties, precision fertilizer use and timely agronomic practices to increase yields, including labor saving technologies for shelling and drying.
- Development of stronger market linkages between farmer groups, wholesalers and processors to reduce marketing costs and improve quality.
- Investment in customized storage facilities at all levels to minimize postharvest build-up of aflatoxin and preserve nut quality.
- Strengthen the organization of the farmers into groups and associations that can provide services for accessing production technologies, credit and markets for their members and increase value chain efficiency.

4.11 CASSAVA

4.11.1 Background

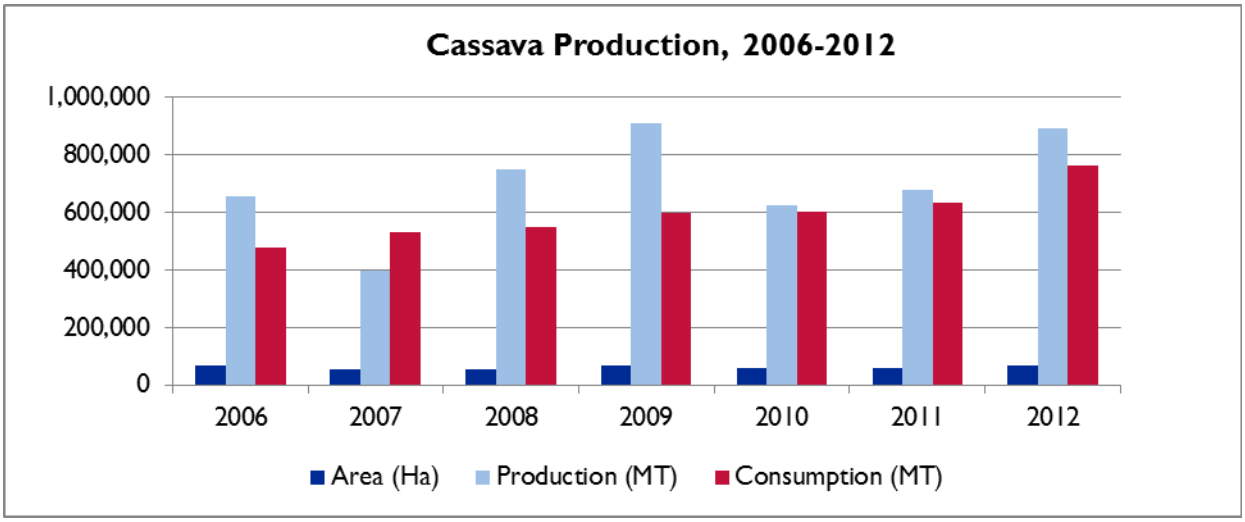
Cassava is the second most important root crop after Irish potato in Kenya and supports the livelihood of over 2.5 million people. It is mainly grown as a food crop for home consumption but is increasingly in demand as a raw material for the brewing and animal feed industries. It is grown across a wide range of agro-ecological zones including the semi-arid counties targeted by USAID-KAVES. It is the most important root crop in hot lowland areas especially in western, coast and central counties that contribute 63 percent, 30 percent, and 7 percent of national respectively. Cassava is usually grown as a subsistence crop for household consumption only but surpluses are sold if prices are good or production exceeds expectation. It is valued by the lowest income families as the cheapest source of calories and is widely consumed by rural households as a supplement to cereals. In all production areas preference is for fresh roots that are roasted or boiled immediately after harvesting but in Nyanza and other Western areas of Kenya, roots are also peeled, chopped into small pieces, dried, and milled into flour for *ugali*. This is normally in combination with a cereal (maize or sorghum). In coastal regions cassava leaves are used as a vegetable while in Machakos and Kitui, cassava roots are eaten raw as a snack (Karuri et al. 2001).

Cassava has persisted as a food crop grown by households in drought prone areas because of its characteristics of surviving in poor soils and being drought tolerant. Small-scale farmers depend on it as reserve crop when everything else has failed or been eaten. The market for fresh cassava as a food is more lucrative than for starch extraction but can be high risk for both growers and traders due to its very short postharvest storage life. In recent years there has been increased interest from food, feed and beer manufacturers in cassava as a cheap source of starch needed to produce sugar syrups, livestock feed, bio-ethanol and beer. However, the farm gate prices that can be offered as a raw material for manufacturing are currently about half of the fresh market price and this is discouraging farmers from increasing their production, especially if they have small land areas.

4.11.2 Production Trends

Cassava production has gradually increased since 2006 from around 500,000 tons in 2006-2007 to more than 800,000 tons in 2012. In 2009 production peaked at 911,074 tons while the lowest recorded production was in 2007 at 397,705 tons (Figure 42). The national average yield is about 8 tons/hectare but there is wide variation between areas with western counties achieving the highest levels and individual farmers achieving more than 20 tons in some cases. To compete globally average yields need to increase to 20- 30 tons/hectare depending on variety and location.

Figure 42: Cassava Production Trends, 2006-2012



4.11.3 Value Chain Actors

Fresh cassava is a relatively low value product that is marketed quickly with minimal added value at any level. The value chain is short with farmers often selling directly to local retailers or, if they have sufficient quantities, directly to urban market buyers (Figures 43 and 44).

Production

Cassava production is dominated by smallholder farmers who produce for household consumption with little surplus for sale and production remains traditional with virtually no use of purchased inputs or cuttings of improved varieties and organic manure, hence the low yields. Cultivation is generally for subsistence on small areas of up to one acre per household, however some farmers in western and Nyanza counties have started to plant areas of more than five acres, to produce sufficient quantities to have bargaining power with Nairobi traders.

Marketing

Most cassava is marketed as fresh roots at farm gate or at their closest rural markets but there is limited demand for peeled and dried cassava chips that some farm households produce for home consumption but sell when cash is needed. Fresh cassava has a very low value/bulk ratio and is highly perishable, so marketing has traditionally been to very local markets. However there are now well-organized trading networks for moving cassava across the country from western production areas to high demand markets on the coast. Farmers sell to various types of buyers from small traders in rural markets who bulk it up to truck loads or directly to Nairobi and Mombasa traders who often send trucks to high production areas in western Kenya for overnight delivery to Nairobi and Mombasa.

Farmers interviewed during the KVC 2013 survey reported that more than 60 percent of their production is now sold directly to buyers from large urban wholesale and retail markets (Figure 43). The balance of around 40 percent is sold to traditional retailers and traders in local village and town markets.

Figure 43: Direct Sales by Buyer Reported by Cassava Farmers

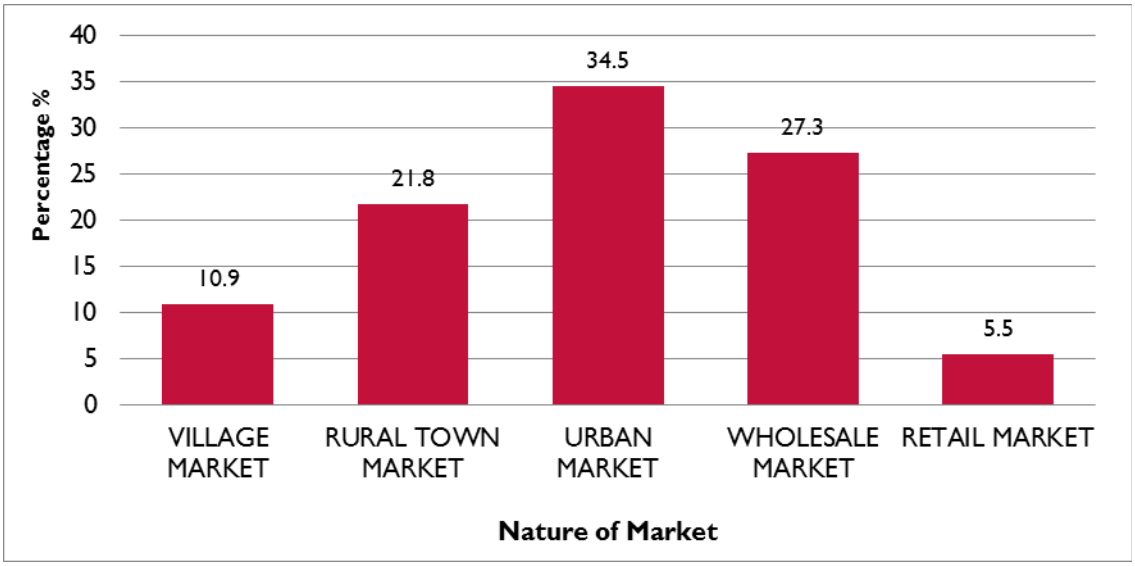
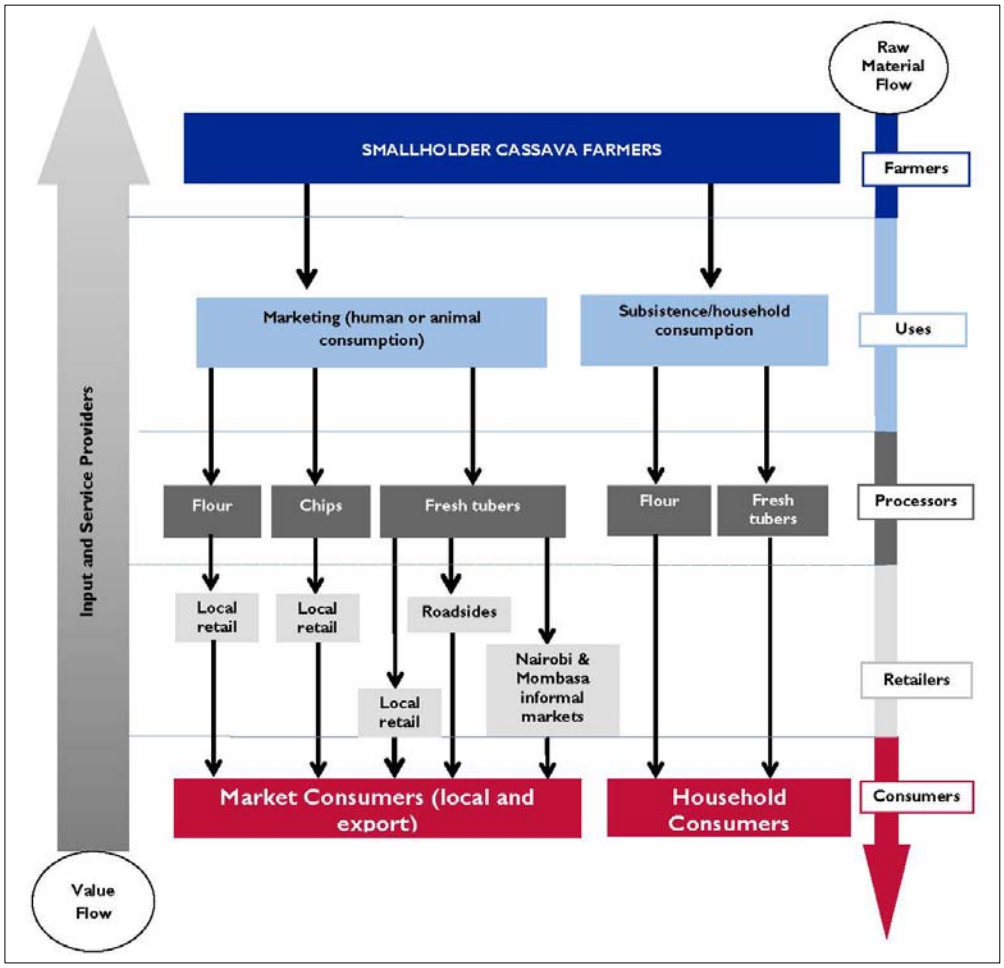


Figure 44: Cassava Value Chain Map



Some of these rural traders aggregate fresh roots and dried cassava chips on behalf of larger urban wholesalers as well as selling on to other local markets or directly to retailers and consumers. Although this all happens quickly, localized imbalances between supply and demand can easily occur, giving rise to sporadic losses caused by physiological deterioration of unsold cassava. The large, uniquely shaped roots are also damaged easily during handling which accelerates the rates of spoilage.

Service Provision

Input suppliers have little interest in cassava since growers rarely purchase inputs specifically for the crop. A few larger producers may use small amounts of fertilizer if they have supplies available from other crop production but the effect is not easy for them to measure given the long production cycle of cassava which can be more than one year. MoA has an interest in cassava as an important food security crop and its extension workers provide regular advice to farmers on production and marketing. KARI also has a breeding program to produce varieties with virus resistance and distribution of varieties with lower cyanide levels. The presence of cyanide in cassava roots is a significant factor in expanding the market to non-traditional consumers. Transporters play a key role in supplying cassava cuttings for planting and in moving fresh roots efficiently to the final buyers. They are often accused of charging high prices but this is inevitable given the high volume to bulk ration and perishability of the product which limits the amount a truck can carry and forces trucks to move on very tight schedules.

4.11.4 Cassava Value Accumulation

Since cassava grows well without fertilizer compared to other food crops, farmers can obtain relatively high returns per unit area and high gross margins if they manage to sell their entire crop. However it is a long duration crop, taking 12-18 months to mature and after harvest there is a high risk of wastage if reliable marketing arrangements are not in place. This is not a problem for home consumption since cassava can be left in the ground for more than two years without spoiling and harvested when needed.

Table 23 shows a typical crop budget using unimproved cuttings for planting material purchased from other local growers. With occasional weeding and no gap filling, growers can obtain a yield of six tons per acre. If all of this is consumed or sold it has a gross market value of Ksh 150,000 and a margin of Ksh 125,000. In practice it is difficult to achieve this unless farmers operate in marketing groups and sell whole truckloads directly to urban buyers. Surpluses over quantities that can be sold as fresh roots can be sold to industrial processors if advance orders are made but this will reduce the average price and gross margin.

Table 24 shows the higher yield and gross margin that can be achieved using cuttings of improved varieties and organic manure combined with good agricultural practices of planting an optimum population, gap filling and maintaining a weed free field. The main additional costs in this system are for purchase and transportation of certified cuttings and the additional labor needed for harvesting and postharvest handling operations which are highly labor-intensive for cassava.

Table 23: Cassava Production Budget

Typical Cassava Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	5,500	22.7	
Seed	3,000	12.4	Less if own cuttings used
Fertilizer	0	0.0	
Agrochemicals	0	0.0	
Labor	12,500	51.6	Includes postharvest
Bags, sisal	720	3.0	
Transport	2,500	10.3	
Total direct costs	24,220	100.0	
Yield - Kg	6,000		
Production cost/Kg	4		
Price - Ksh/kg	25		Fresh market, processing price half this
Sales value	150,000		
Gross Margin	**125,780**		

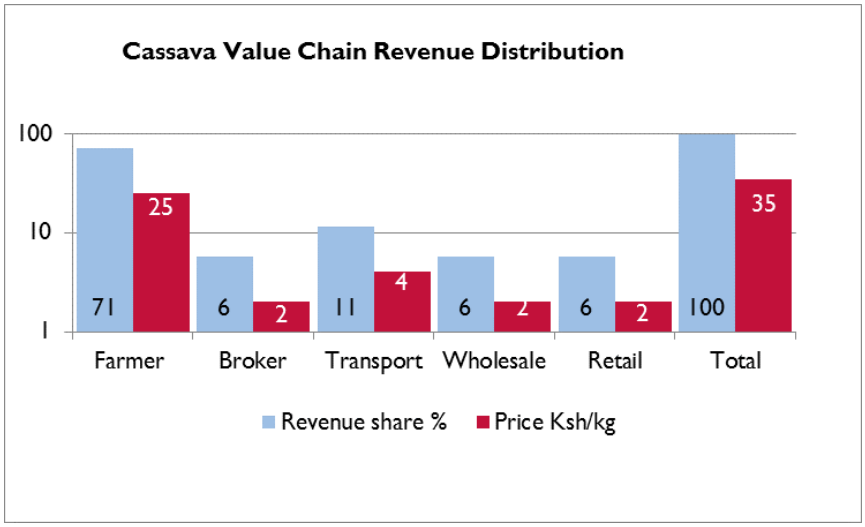
Table 24: Efficient Cassava Production Budget per Acre

Efficient Cassava Production Budget per Acre			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Land preparation	5,500	10.5	
Seed	9,000	17.2	Less if own cuttings used
Fertilizer	0	0.0	
Agrochemicals	0	0.0	
Labor	31,500	60.2	Hired cost, h/h return higher on family labor
Bags, sisal	1,320	2.5	Includes postharvest
Transport	5,000	9.6	
Total direct costs	52,320	100.0	
Yield - Kg	12,000		
Production cost/Kg	4		
Price - Ksh/kg	25		Fresh market, processing price half this
Sales value	300,000		
Gross Margin	**247,680**		

Figure 45 shows the accumulation in price along the fresh cassava value chain using 2013 market price data and information on farm gate prices from the 13 field survey. Under current conditions it seems that farmers hold 71 percent of the value chain equity and are making a gross margin of 500 percent compared to negligible margins made by traders. In fact, at the time of the survey, farmers reported prices higher than the selling prices for in Nairobi wholesale markets. There are a number of reasons for this. Firstly since farmers can keep cassava in the ground for long periods, they are reluctant to sell if prices fall below their minimum expectation. Secondly, urban consumers are generally in the lower income brackets so there is a limit to the price they are prepared to pay and prices in 2012 rose to as

much as 30 percent over the five year average for much of the year (Figure 46). Thirdly, traders probably made good returns on cassava during 2012 and are staying in the market despite the fact that it is not profitable for them at present. Commodity traders may also purchase cassava as a 'loss leader' in order to procure other, more profitable products from the same growers and rural traders.

Figure 45: Cassava Value Chain accumulation



4.11.5 Market Potential

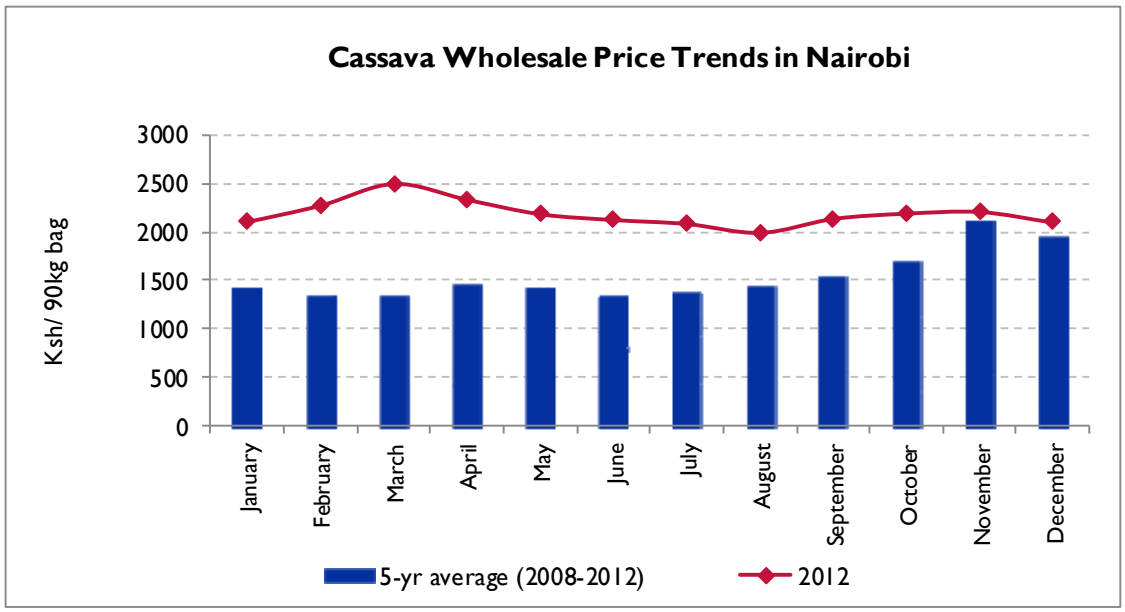
From the value chain discussion above it seems that expansion of the fresh market may be difficult unless growers are prepared to reduce their prices. Even then the demand may be limited since cassava is a high risk commodity for traders and a specialty crop without any nutritional or cosmetic attraction for urban consumers unless they are culturally linked to cassava. However, Kenya has over 40 animal feed manufacturing units with a capacity of over 800,000 metric tons that can use cassava flour as a carbohydrate source for their products. This and the immediate market being offered by East African Breweries for beer production provide high volume market opportunities for cassava, albeit at lower prices.

There are many other Kenyan companies who use imported starch for making food and other industrial products but they need High Quality Cassava Flour (HQCF) as a raw material. The technology for this is not expensive but is not being used in Kenya at the moment. Any concerted effort to commercialize cassava to levels that will attract processors will also need private sector investment in HQCF equipment.

In terms of food security HQCF could also have a role in production of blended flour that will reduce pressure on maize. There is also immediate demand for HQCF and high quality chipped cassava from paperboard and biscuit manufacturers.

Figure 46 below show the price trend for cassava in Nairobi and the 2012 prices are above the 5-year average, however, the prices are higher during the planting season and lowest in months of June to September which are normally the harvesting periods.

Figure 46: Cassava Wholesale Price Trends in Nairobi



4.11.6 Upgrading the Cassava Value Chain

Opportunities for increasing cassava production are not straightforward. The market demand for fresh cassava is not clear but rural consumers are probably well supplied through home or local production and urban sales are probably limited to a relatively small segment of the urban population. The domestic demand for cassava starch is undoubtedly massive but will require farmers to increase production and accept reduced prices on a large scale. It will also require new private investment in equipment and facilities.

USAID-KAVES interventions on cassava will therefore be limited to the following:

- Validation of production and market data with farmer groups who are interested in high volume production of cassava and have sufficient land amongst their members.
- Development of more formal market linkages between grower groups, wholesalers and processors.
- Identification of niche opportunities for processing and piloting of HQSF production with commercial partners.

4.12 FRENCH BEANS

4.12.1 Background

French beans, also referred to as green beans or snap beans, are an important source of livelihood for many smallholder farmers who produce the crop mainly for export to Europe. French bean is by far the largest vegetable export crop from Kenya and accounts for 19 percent and 25 percent by value and volume, respectively of total fresh vegetable exports. Other than fresh French bean, Kenya exports processed French beans that account for more than 50 percent of processed vegetables exports. Earnings from fresh and processed French bean amount to Ksh 4.13 billion and Ksh 1.19 billion per year, respectively. (Horticulture Validated Report, HCDA 2011and 2012; Horticulture Market Study Kenya, 2012).

In Kenya, French Beans were initially grown exclusively for the export market. However, over the years they have gained popularity in the domestic market with an estimated 11 percent of the total volumes produced being consumed locally. The leading counties in the production of French beans are Kirinyaga, Meru, Embu, and Murang'a.

The main importing countries are the UL, France, Germany, Holland, Belgium, and South Africa. Kenya's original success in French Beans exports is based on its climatic and geographic competitive advantage and with the growth of tourism and international organizations based in Nairobi it is now also well served by south-north airfreight. Success has also been due to market segmentation, compliance to certification schemes, and value addition through sophisticated packaging.

The French beans industry employs between 45,000 and 60,000 people depending on the season with 60 percent estimated as women. Youth engaged in export horticulture is higher compared to other farm level enterprises due to the high returns per unit area, short production period, and regular income (DFID, 2010).

4.12.2 Production Trends

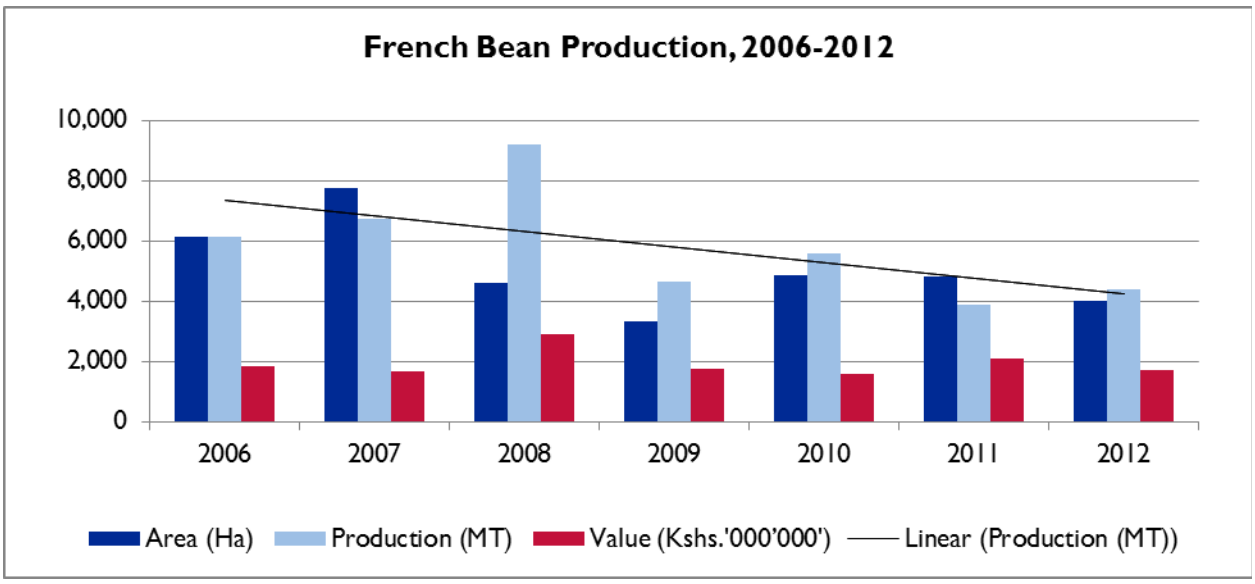
The area under French bean production increased by 35 percent from 6,154 hectares in 2006 to 4000 hectares in 2012. During the same period, productivity increased from 10 metric tons per hectare in 2006 to 11 metric tons in 2012. The significant increase in area under production is attributed to short growing period thus facilitating consistent cash income to growers. Smallholders typically plant as much as they can sell, and those with contracts or a firm commitment from an exporter may devote 100 percent of their land to the cultivation of green beans (DFID, 2010; Edewa et al., 2013).

The marginal increase in French bean productivity can be attributed to declining soil fertility and limited use of high quality seed among majority of smallholder French bean growers. In addition, productivity has been significantly affected by erratic weather patterns. Muranga, Kirinyaga, Embu, and Meru counties account for 77 percent by value of the total French bean production (Horticulture Validated Report, 2012). However, there is increasing interest among exporters to expand production to western Kenya mainly in Trans Nzoia, Bungoma, Kakamega, Vihiga, and Kisii counties. This has been attributed to a number of negatively impacting factors in traditional export vegetable growing areas of central Kenya that include: declining soil fertility, erratic weather patterns that significantly affected exporters' ability to meet markets orders, and failure of farmers to abandon use of dimethoate which has been the main cause of interception of Kenyan produce destined to EU market.

Figure 47 shows how, despite year-to-year fluctuations, average national production has reduced by 43 percent, from 7,200 metric tons in 2006 to 4,300 tons in 2012. This has been attributed to several factors:

- Declining soil fertility and disease pressure in traditional production areas of Kirinyaga, Meru, Laikipia, and Muranga
- Changes in weather patterns
- Decline in number of growers due to stringent market requirement such as traceability and Maximum Residue Limits (MRLs) , and high cost of certification

Figure 47: French Bean Production, 2006-2012



Source: Ministry of Agriculture

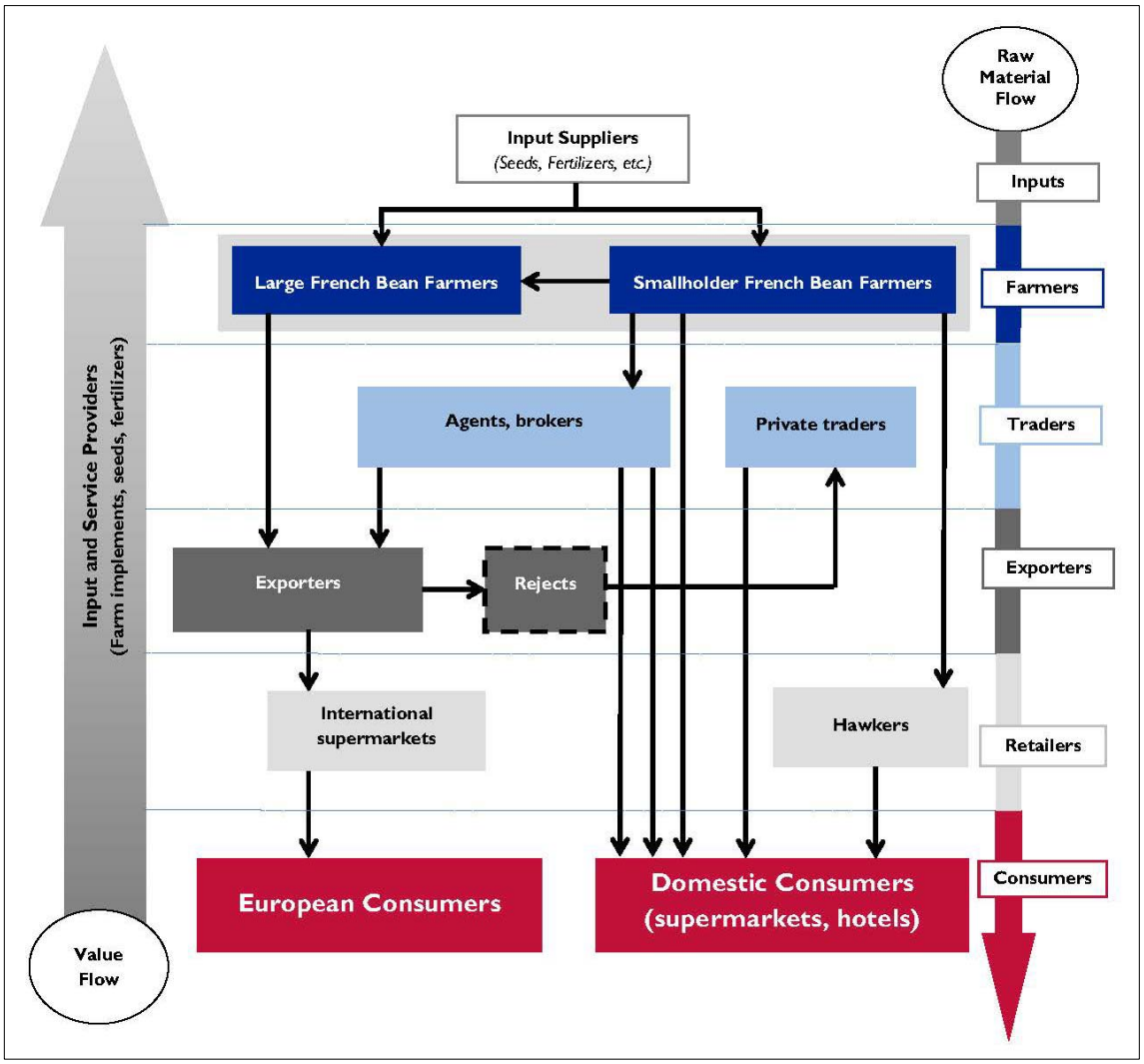
4.12.3 Value Chain Actors

The French bean sector incorporates large and small scale farmers and exporters. The main functions in the value chain are input supply, growing/production, brokering, exporting, transporting, and importing). Others are final product markets (i.e. wholesale, and supermarket retail markets).

Producers

It is estimated that up to 60,000 smallholder farmers are involved in French bean production with an average farm size of less than 2 acres per farmer and account for 77 percent of the total production. As with all export crops, French bean production is regulated through arrangements between farmers and exporters (HCDA Order, 2011). However, farmers will typically grow as much as they can sell, and those with contracts or a firm commitment from an exporter may devote 100 percent of their land to the cultivation of green beans (Edewa, et al., 2013). Despite successful implementation of different certification schemes, there is limited knowledge on Good Agricultural Practices (GAPs) among new smallholders venturing in export farming. This is validated by increased interception of produce destined for international market.

Figure 48: French Bean Value Chain Map



Source: Adapted from SNV, 2012, USAID 2007

French bean is mainly grown by smallholder farmers under irrigation. Most farmers are organized into groups bound by regulations forbidding sale to the local market. The smallholder farmers either sell French beans to brokers or directly to small-scale exporters, while brokers sell to exporters. There are a few large-scale farmers who grow their own crop and export directly without having to go through brokers/agents.

Brokers

Marketing agents also commonly referred to as brokers are registered by the HCDA as dealers in the value chains. A dealer is defined as a person involved in buying and selling of horticultural produce (HCDA Order, 2011). Marketing agents play a significant role of consolidating, initial sorting and grading, and delivering produce to the exporters. In addition, marketing agents also supply French beans to local markets: processors, wholesaler, retailers and institutions. However, most produce is transported in un-recommended manner thus compromising the produce quality. In addition, marketing agents are often

cited as the main cause for failure in produce traceability. Capacity of marketing agents on postharvest handling is necessary in making local produce more competitive.

Exporters

Exporters are the primary market for French beans. Exporters rely largely on marketing agents for supply of produce and to a limited extend on individual large and medium scale farmers. There has been a decrease in number of smallholder production schemes sponsored by exporters. This is attributed to inability of exporters to recover costs due to side selling of produce by smallholder farmers. However, exporters provide significant support towards certification of smallholder production system.

Exporters can be categorized into small and medium-scale companies. They are integrated backwards into the production, for at least some of their product sourcing. They provide a smaller range of products to the export market. Increasing cost and quality constraints make it uneconomical for them to deal with individual/small-scale growers, so they must work with either larger out grower schemes or larger individual farmers. Large-scale exporters have integrated their operations both forwards and backwards. There are only about eight to ten firms that fall into this category, with varying degrees of integration. These large exporters have very strong market links and generally provide a fairly consistent amount of product over the course of the year.

Input suppliers

French beans are susceptible to a number of pest and diseases. There are a number of recommended pesticides for use in French bean production. However, high cost of pesticides has resulted in farmers using cheap products that are either counterfeits or are not recommended for use in French bean production. Seed availability is often a challenge resulting in farmers relying on low quality seed supplied through illegal seed multiplication.

Service providers

HCDA regulates the French bean industry through licensing of exporters, registration of marketing agents, and issuing of export certificate. In addition, the Authority is mandated to enforce contracting farming for export crops and provide market information. KEPHIS regulates seed quality and inspect produce quality conformity of French bean destined for export market. In addition, KEPHIS is mandated to undertake pesticides monitoring. Inadequate number of staff has hampered HCDA and KEPHIS to effectively regulate the industry in accordance to their respective mandates. Most exporters are members of the Fresh Produce Exporters Association of Kenya (FPEAK) whose function is to bring together exporters to lobby both with government and the markets for conditions favorable for trade. Several NGOs support small holder farmers within the French bean value chain. The input sector is also mainly dominated by private sector players who offer various types of extension and training to farmers.

4.12.4 French Bean Value Accumulation

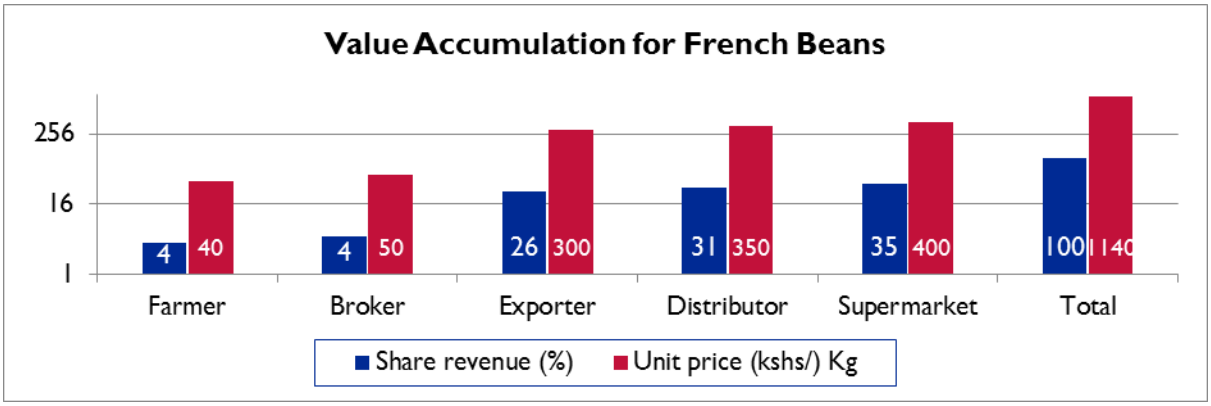
Table 25 summarizes the French bean crop budget for a typical smallholder grower. With efficient use of inputs and access to supplementary irrigation growers can achieve a yield of 4 metric tons/acre and a gross margin of Ksh 186,000 per crop cycle. Most growers aim to double this by producing at least two crops per year and some achieve three.

Table 25: French Bean Production Budget

French Bean Production Budget			
Activity/Input	**Cost/Value Ksh**	**Percent**	**Note**
Seed	16,000	29.9	Assumes new seed each crop
Fertilizer	2,700	5.1	
Agrochemicals	5,000	9.4	
Labor	29,200	54.7	Main cost is picking
Other	530	1.0	Contingency
Total direct costs	53,430	100.0	
Yield - kg	6,000		Assumes efficient producer and1.5 crops per year
Production cost/kg	13		
Price - Ksh/kg	40		Assumes high quality
Sales value	240,000		
Gross Margin	**186,570**		

Figure 49 shows the value accumulation from grower through to EU supermarket retailer. The farmer gets about 10 percent of the final price compared to 63 percent of the value increase at exporter level. However, at least Ksh 200 of the Ksh 250 mark up at exporter level is taken up by air freight, packaging and wastage during processing. When grower and exporter costs are deducted it seems that they are making similar net returns per kilogram.

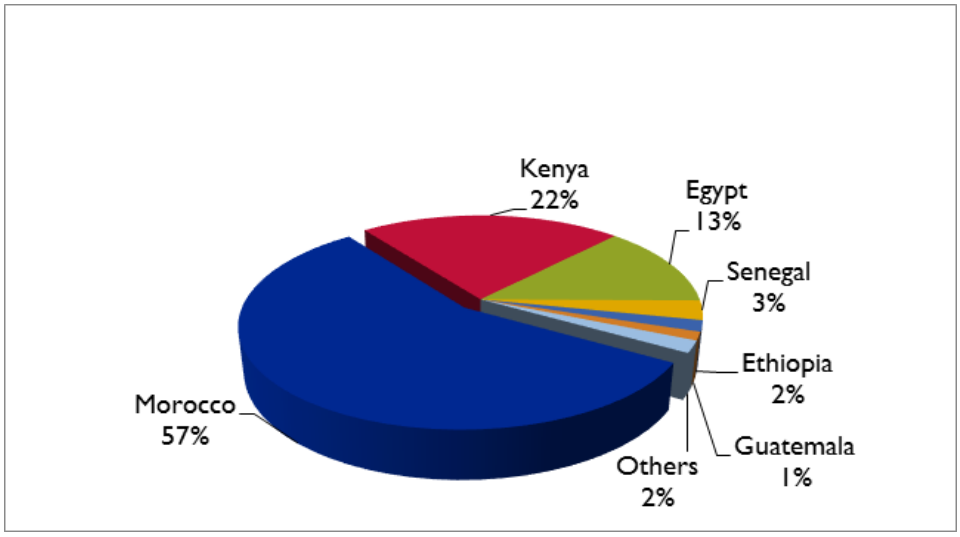
Figure 49: French Bean Value Accumulation



4.12.5 Market Potential

French beans grow best on well drained, silty loam to heavy clay soils with a pH of 6.5-7.5, optimum temperature range of 20-25 degrees and altitude of 1,000-2,100 meters to give a 10-15 degree day-night temperature change. These conditions exist in many parts of the country and have been a major factor in Kenya becoming a market leader in export of "fine" grade beans to Europe. However, exports to EU declined by 18 percent in the first quarter of 2013 as compared to the same period in 2012. The decline in export is attributed to amendment of EU regulation 669/2009 subjecting Kenyan beans and peas on pod to 10 percent increase on physical checks at designated ports of entry. This was necessitated by persistent failures to comply with MRL requirements and the inability for Kenya to demonstrate systems and mechanism to monitor and effect pesticide compliance in the supply chain. In this regard, there is apprehension among French bean smallholder farmer and marketing agents of loss in livelihood. In addition, exporters are reported to be experiencing low margins because of the pre requisite MRL testing before shipments and at the EU point of entry. It is estimated that up to Ksh 500 Million loss in revenue has been incurred following the EU directive (HCDA, 2013). Kenya is the second largest exporter of total beans but market leader for fine beans (Figure 51).

Figure 50: Main Exporters of French beans

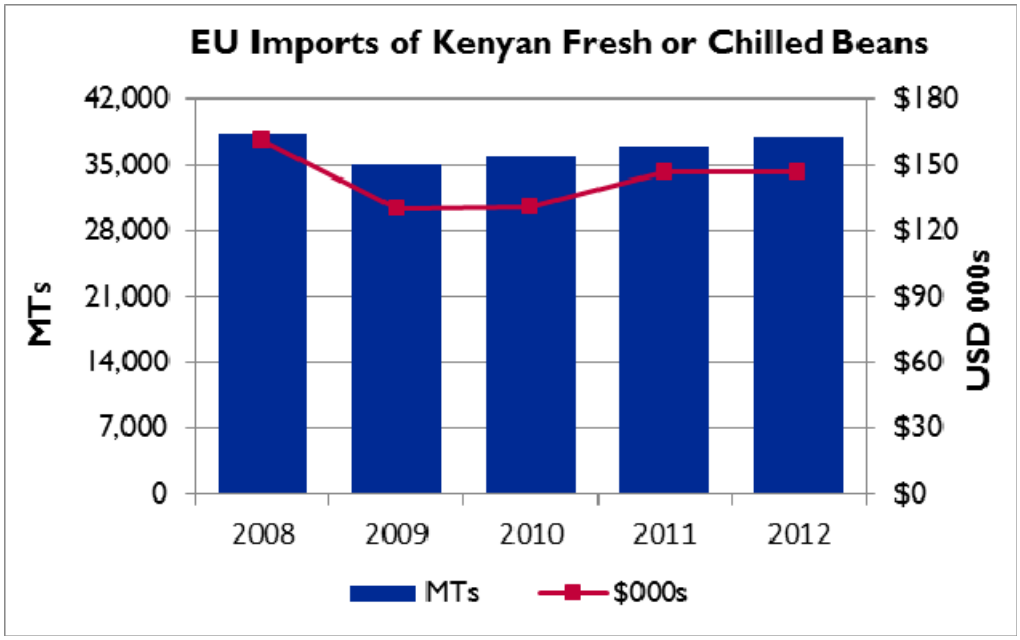


Source: Eurostat

In addition to declining exports associated with amendment of EU regulation 669/2009, the vegetable sector is currently under pressure resulting from increasing costs of transport and overhead associated with quality standards and certification requirements for exporters. Furthermore, there is increasing international competition from Egypt, Morocco, Senegal, Ghana, Peru, and Israel that has resulted in decline for demand for Kenyan vegetables (Horticulture Market Study Kenya, 2012). The future of the French bean industry in Kenya remains uncertain following the EU directive to subject Kenyan beans and peas on pod to 10 percent physical checks at designated ports of entry. This directive negatively affect the competitiveness of the French bean export from Kenya in four folds: produce quality is like to deteriorate due to delayed delivery to the supermarkets; reduced profit margins due to additional cost for produce inspection; loss of consumers' confidence in French bean exports from Kenya; and loss of livelihood for smallholder producers due to reduced French bean exports for fear of heavy penalty imposed on exporters whose produce fail to meet the set pesticides MRLs. The main importing countries for French beans are UK, France, Germany, Holland, Belgium and South Africa. Other emerging export markets are the USA and Asia.

French bean processing offers a large market for local producers. The three major local processors of French bean operate below 50 percent due to lack of adequate supply of quality raw material. The local demand for French beans is increasing given the increase in population and the rising number of people joining the middle class. Imports of French bean from Kenya into European market increased by 8.6 percent from 3500 metric tons in 2009 to 38000 metric tons in 2012. French bean exports to EU could increase beyond the current percent with increase in compliance to the market's requirements. Further with new markets opening up in the USA and Asia, there is market potential for French beans.

Figure 51: EU Imports of Kenyan Fresh or Chilled Beans



Source: Eurostat

4.12.6 Upgrading the Value Chain

The major challenges facing French bean production are high cost of inputs, fluctuating prices, and high postharvest losses (HCDA and MoA, 2009-2011). Other constraints to French beans production include; challenges in accessing inputs and equipment, limited market information, pests and diseases, poor infrastructure services, poor coordination and organization skills, limited market and market information, stringent regulations, standards and laws as well as carbon footprints.

The following interventions are necessary in up grading the French bean value chain:

- Enhancing produce traceability to facilitate compliance to good agricultural practices and in particular use of recommended pesticides
- Support capacity building of small export companies, marketing agents and smallholder farmers in market requirements
- Support capacity building of small export companies in produce sorting, grading, traceability, and postharvest handling to guarantee competitive quality
- Guaranteeing availability of quality seed
- Enhance pre-shipment produce quality conformity inspections
- Exploring of less stringent alternative markets for French beans
- Facilitating investment in processing of French beans.

4.13 MANGO

4.13.1 Background

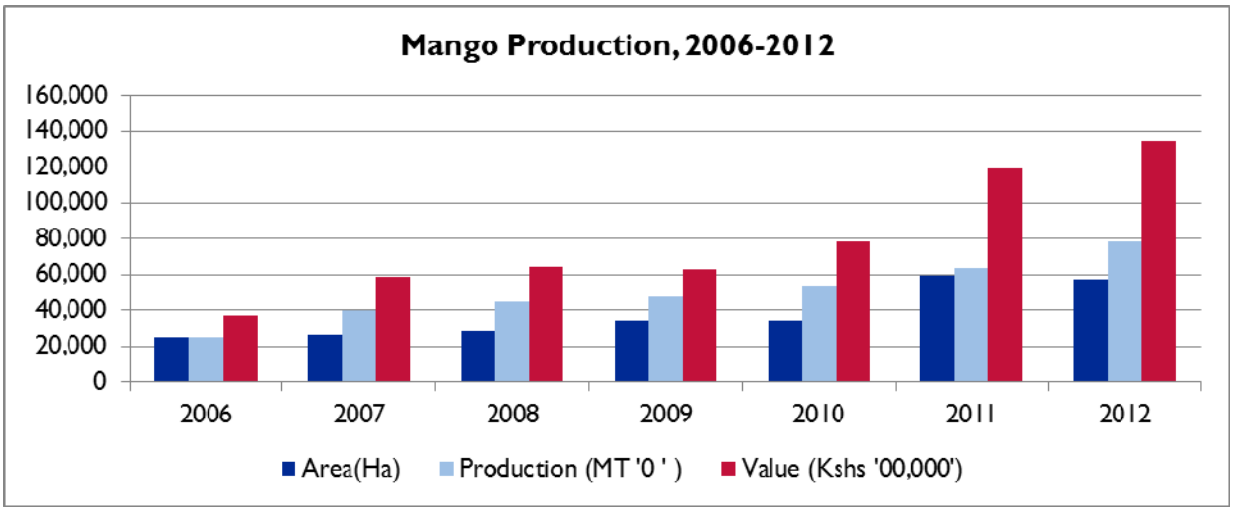
Mango is one of the most important fruit crops in Kenya. It is the second most important fruit in terms of area and total production over the last ten years after bananas (Horticulture Validated Report, 2011). There are two types of mango commonly grown in Kenya – the local and the exotic (or improved) varieties. The improved varieties are usually grafted on local mangoes and are mainly grown for the export market. Most local varieties tend to have high fiber content, making them unpopular for fresh consumption. The local varieties are Ngowe, Dodo, Boribo, and Batawi while exotic varieties include Apple, Kent, Keit, Tommy Atkins, Van Dyke, Haden, Sensation, Sabre, Sabine, Pafin, Maya, Kenston, and Gesine (PSDA, 2007)

Most of the mangoes produced in Kenya are consumed within the same production area, or sold in urban markets of Kenya. There are two main market destinations for fresh mangoes – the local and export markets. Exports of fresh mangoes comprise a small proportion of national production. Mango is mainly grown in Embu, Meru, Muranga, Makueni, Machakos, Kitui, Lamu, and Kilifi counties. In all these counties, production is primarily rain-fed (HCDA, 2005). However, a number of orchards under irrigation have been established for production of exotic varieties for export. The majority of mangoes are produced by smallholder farmers, presenting a large opportunity for a commercial nucleus-out growers scheme to guarantee production to wholesalers/retailers, processors and exporters (Nancy, 2006).

4.13.2 Production Trends

Mango output in Kenya has increased steadily over the past decade as farmers planted new trees of improved varieties across the country and average yields have improved to the current level of 10.74 tons per hectare (Figure 52). The biggest increase has been in Eastern counties with 50 percent of national production. The balance comes from coastal areas (30 percent), central Kenya (6 percent) and Rift Valley (5 percent). The trend is projected to increase yearly by about 10 percent. This is made possible by a number of factors that give Kenya a competitive advantage (MoA, 2010). These include; excellent almost year-round production conditions, Kenya is already a small-scale exporter of mango, strong local markets and proximity of Gulf markets for fresh fruit, substantial recent investment in fruit juice processing facilities, established global marketing capability of export companies and excellent private sector support services available

Figure 52: National Mango Production 2006 - 2012

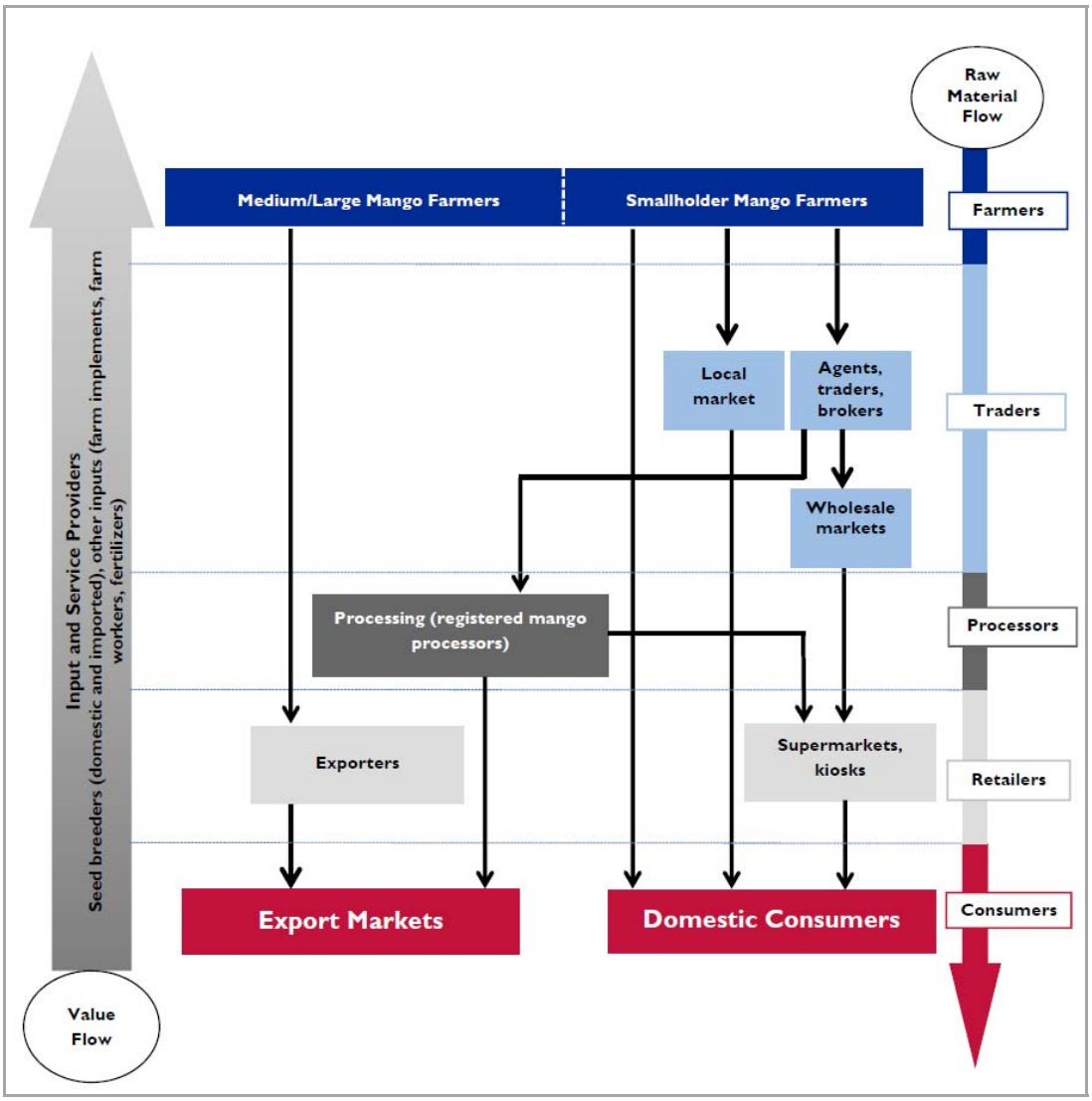


Data source: *Horticultural Crops Development Authority*

4.13.3 Value Chain Actors

The sub sector map (Figure 54) shows how mango products currently flows via several alternative supply chain paths from farm to various end market consumers in Kenya and beyond. Most mango produced in Kenya is consumed as fresh fruit but processors of juice in particular are becoming more important as production increases.

Figure 53: Mango Value Chain Map



Source: MoA

Farmers

Farmers play a major role in the production of mangoes. Individual farmers and the organization of farmers in different region make it possible to supply the local and export market for mangoes.

Mango is largely produced by smallholder farmers and it is a source of livelihood to more than 172,000 farm families in the two largest mango producing regions of coast and eastern Kenya (ADB Mango survey report, 2009, ADB Mango survey report, 2011). Famers mainly produce two local varieties: Apple and Ngowe; and three Florida varieties: Kent, Sensation and Tommy Atkins. On average, farmers cultivate three to six different mango varieties. There is limited production (0.4 percent) of Florida mango

varieties popular in the EU market (Kent, Tommy Atkins, and Van Dyke) mainly in central Kenya. In addition, there is insignificant production of varieties such as alphonso which is very popular in the international market despite the local availability of the variety (Kehlenbeck *et al*., 2011). The major challenges facing farmers include inadequate knowledge on pest and disease management, and poor agronomic practices.

Inputs

There are 50 mango varieties cultivated in Kenya. Most of the varieties are not yet fully evaluated and disseminated; subsequently, some varieties are grown in unsuitable agro-economic zones thus leading to lack of suitable planting material (Kehlenbeck *et al*., 2011). Export of mango to EU market is hampered partly by prevalence of fruit fly infestation. Control of fruit fly in Kenya is constrained by regulations that restrict use of hormones and pheromones in farming; integrating use of hormonal compounds is essential in control of fruit fly attracts (Horticulture News, 2011). In addition, use appropriate input is constrained by limited access to credit for inputs with only 8 percent reported to apply pesticides due to the high cost. Nurseries provide the improved planting material needed to produce fruit desired by the market. There are both private nurseries and those operated by organizations such as the Kamurugu Agricultural Development Initiative.

Processors

The mango processing companies mainly source produce from smallholder producers. Some processors like Sunny Processors and Kevian manage their own fruit farms of 250 and 60 acres, respectively. The main varieties cultivated by processors are Tommy Atkins, Ngowe and Kent mangos, among smaller numbers of Apple, Alphonso, Maya, Haden, Keitt, Sabine and Van Dyke. However, supply from processors mango farms is inadequate with factories operating between 35-40 percent of the installed capacity. Main challenges facing processors are inadequate quantity and quality of fresh mango fruits and high production costs, partly due to high taxes and fees, resulting in high prices for the end product. (Kehlenbeck *et al*., 2011; National Mango Business Plan 2012-2022).

Exporters

Kenya exports only 2 percent of the total mango production. Up to 95 percent of Kenya's mango exports go to Middle Eastern markets, which are becoming increasingly important destinations for Kenya's horticultural exports. Kenya does not export fresh mangoes to Europe because of three main factors: it does not produce sufficient quantities of the varieties demanded in Europe, it lacks GAP certification for mangoes, and it can't compete with low cost supplies in South America, India, Pakistan and West Africa due to high freight costs and protracted transit times. The EU and U.S market each account for the 28 percent of global mango trade.

Research services

There is limited research on mango in Kenya. Priority areas of research include: systematic characterisation of the different mango varieties, including the minor ones, and evaluation of their performance in different agro ecological zones; results of the varietal evaluation will contribute to give farmers better recommendations on the most suitable mango varieties for their respective farm environment. In addition, there is need for sufficient distribution of the genetic pool of mango varieties through motherblock in KARI for conservation of a broad range of mango genetic resources. In view of this, there is need for increased budget towards fruit tree research

Policy/Legal/Regulatory Services

Production of mango seedlings like that of other fruit tree and vegetable seedlings is regulated by the HCDA and KEPHIS. HCDA regulates registration of nurseries and in essence therefore provides primary information on produce traceability. However, lack of traceability has been cited a major limitation for

mango exports to EU markets. KEPHIS is mandated to certify the seedling quality with regard to pest and disease free; and to inspector quality conformity of mangoes destined for export market. Inadequate number of staff to undertake quality inspections has been cited as a major cause lapses for produce destined for export mango thus making local mango uncompetitive in the international market.

4.13.4 Cost/Value Accumulation

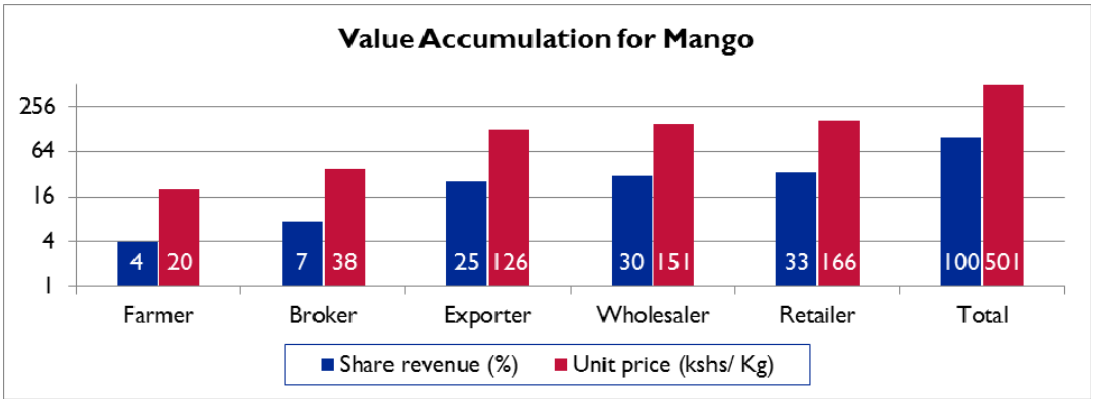
Many smallholders have planted mango as a long term investment over the past 5-10 years. If grafted trees of specific varieties are planted and cultivated commercially, it takes five years to recover start-up costs start making an annual profit. From year gross returns should be at least Ksh 300,000 per acre (Table 26).

Table 26: Mango Production Cost

Mango Budget								
	Years 1-4		Year 5		Year 6		Year 7	
Activity/Input	Cost Ksh	Percent	Cost Ksh	Percent	Cost Ksh	Percent	Cost Ksh	Percent
Seedlings/suckers	12,300	16.3	0	0.0	0	0.0	0	0.0
Fertilizer	11,600	15.4	3,600	20.9	3,600	19.7	3,600	19.7
Agrochemicals	8,500	11.3	6,500	37.7	6,500	35.7	6,500	35.6
Labor	42,530	56.4	7,000	40.6	8,000	43.9	8,000	43.8
Other	430	0.6	130	0.8	130	0.7	170	0.9
Total direct costs	75,360	100.0	17,230	100.0	18,230	100.0	18,270	100.0
Yield - fruit/ha	18,450		36,900		61,500		98,400	
Production cost/fruit	4		<1		<1		<1	
Price - Ksh/fruit	5		5		5		5	
Sales value	92,250		184,500		307,500		492,000	
Gross Margin	**16,890**		**167,270**		**289,270**		**473,730**	

Figure 54 shows the value distribution for mango exported to the Middle East market. Farmers take about 12 percent of the final price but exporters have major costs of transport and packaging. The domestic market offers higher margins for traders but is rapidly becoming over-supplied at certain times of the year.

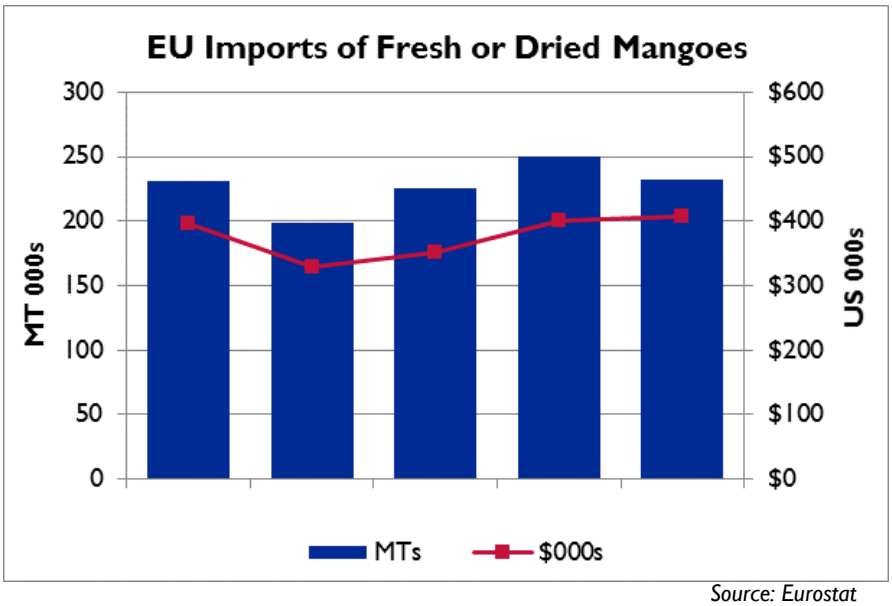
Figure 54: Mango Value Accumulation



4.13.5 Market Potential

There are two main market destination for fresh mangoes, the local and export market. The Export market consumes about 2 percent of mangoes produced in Kenya while the local market consumes 98 percent of mangoes produced in Kenya (50 percent consumed at farm level, 49 percent sold for local consumption). Kenya Mangoes fetch better prices in Europe and Middle East especially in November and December (MoA, 2011). However the European market is well supplied from many sources and Kenya has no comparative advantage except for a few weeks in the year when price rise to profitable levels for air freighting top quality fruit.

Figure 55: EU Imports of Fresh or Dried Mangoes



Source: Eurostat

The markets of the Arabian Gulf, which account for virtually all Kenyan fresh mango exports, represented an estimated 7 percent of world mango trade. The Arabian Gulf market has less stringent requirement and offers significant mango export market for Kenya. Although Kenyan mangoes are more expensive in the Middle East market compared to its competitors, they are able to sell due to differences in mango seasons between Kenya and its competitors mainly India and Pakistan; the late have a short mango season of March – April. In addition, Arabian Gulf market has preferences for the higher juice content of the Kenyan Apple variety (National Mango Business Plan 2012-2022).

Kenya has a rapidly growing demand for mangoes; local consumption grew 24 percent each year from 2006 to 2009; Regional and global consumption of mangoes grew at annualized rates of 3.4 percent and 2.2 percent respectively from 2006 to 2009; global imports of mango pulp grew at an annualized rate of 4 percent, from 2007 to 2009 while juice grew at 7 percent in the same period (HCDA, 2010). Reports indicate that demand for mango juice in the domestic, regional and international market was strong and growing. However, lack of planned production system and none compliance to market requirements have been cited as constraints in meeting mango demand for various markets. The local mango processors operate at 35-40 percent of installed capacity due to lack of adequate supplies of quality mangoes; Kenya processes about 8 percent of the mango production. Despite the demand, processed mango juice has failed to penetrate premium EU market due to lack of produce traceability (National Mango Business Plan 2012-2022, National Mango Conference, 2011).

Kenyan mango processors cite that deficits in the mango supply resulting to low processing utilization rates (as low as 40 percent). Similar complaints have also been raised by Local fruits exporter who are only able to meet about 50 percent of the export demand in the Ngowe product category. The Demand for increased mangoes is driven collectively by local consumption, global exports, and increased demand for mango processed products like juice and pulp.

4.13.6 Upgrading the Mango Value Chain

Issues of quality and traceability are the most limiting for Kenya's mango in the lucrative markets in EU: Fruit fly *(Bactrocera invadens)* is a quarantine pest and therefore greatly impacts international trade. The first incidence of fruit fly in Kenya was reported in avocado in 2003 (Lux et al. 2003). The pest currently affects virtually all fruits and threatens to impede Kenya's fruit exports. In view of this, there is need to increase the scope of the fight against fruit fly in avocado to cover all major fruit exports from Kenya.

Unlike is the practise in the vegetable industry, smallholder do not directly work with mango exporters. This has been cited as a limitation to traceability of produce and farmers complying with GAPs thus losing out on markets with stringent requirements. In addition, lack of direct working between farmers and exporters has been cited as the main cause of low margins on the part of the farmer due to inability to capture intermediary margin.

Kenya with its diverse agro-ecological zones is very suitable for almost year-round production of high quality mango fruits to meet the increasing demands of domestic and export markets for fresh and processed fruits. However, Kenya's potential for mango production is not yet fully exploited. To improve this situation, many issues along the whole mango value chain need to be addressed. Suitable, high quality planting material is a prerequisite for improving the mango production. There is need to develop high yielding, drought, pest and disease resistant varieties suitable for different region in the country. High quality planting material should also be made available to the farmers.

Second, key players in the sub-sector must put in place the necessary initiatives to build capacity of the farmers on basic agronomy and best husbandry practices and the agri-business aspects of mango farming to empower them to fully exploit the potential of the sub-sector.

Finally, there is need for greater private sector participation especially in processing of mango products to enhance value addition. Kenya Mango Producers and Marketing Association can be engaged to play an active role in getting prospective investors in the mango sub sector in this region. Private sector approach is necessary to increase productivity in this subsector.

The smallholder mango farmers have great potential to meet the market demand and also compete with other mango producing countries in the region. However, the major problems are lack of organization and weak organizational linkages among and within the different stakeholders/actors along the whole mango value chain. The actors also lack capacities in various areas including technical, financial and business management skills, as well as limited information flow along the chain. These factors have significantly contributed to the poor performance of the industry.

Intervention in the mango value chain is of high priority. The value chain has great potential and would make significant contribution to better livelihood of the smallholder farmers and lead to wealth creation for the resource-poor mango farmers most of whom are women; create job opportunity especially for the youth as well as improving the nutritional status of the Kenyan population.

Based on these considerations the following interventions are necessary in up grading the Mango value chain:

- Reduction in postharvest losses by addressing the underlying factors leading to the losses by partly increasing the proportion of mangoes processed.
- Increasing investment in efficient marketing and logistics.
- Increasing the volume of commercially available mangoes through the reduction of postharvest losses and training and certifying farmers in GAP and traceability in order to enable processors to access international markets.
- Promoting linkages between farmers and exporters and processors, thus reducing intermediary margin and guaranteeing mango growers higher economic returns.

4.14 PASSION FRUIT

4.14.1 Background

Passion fruit is an important fruit crop in Kenya and is mainly grown for export and domestic markets. It is mainly used as fresh fruits or processed into juices. In 2011, passion fruit contributed about Ksh. 2.3 billion accounting for about 1.1 percent of the domestic value of Kenya's horticultural produce and 3.1 percent value of the fruit subsector (MoA, 2011). Passion fruit is an important fruit crop with great potential for commercial production since demand for both fresh and processed juice is on the increase. New varieties of sweet yellow passion fruit have been introduced in major growing regions with great success due to their high yielding trait and tolerance to *Fusarium* wilt. The adoption of these varieties (KPF4, KPF11 and KPF12) presents an opportunity for growth and expansion of the passion fruit industry.

The major passion fruit growing areas are within Central (Kiambu, Muranga, Nyeri and Kirinyaga districts), Eastern (Embu and Meru counties), Rift Valley (Nakuru, Nandi and Baringo counties), Western (Transzoia, Bungoma, Kakamega Counties), Nyanza (Kisii County) and Coast (Taita-Taveta, Kwale and Kilifi counties) provinces. Most passion fruit is produced by small-scale farmers on 0.25 to 2 acres of land (Wasilwa, *et al*., 2004).

The major challenge in production is lack of clean planting materials free from diseases such as *woodiness*, *Fusarium wilt and die-back* which have become major constraints to passion fruit production in the Kenya. In addition, premature harvesting of fruits has negatively affected the global competitiveness of the passion fruit from Kenya.

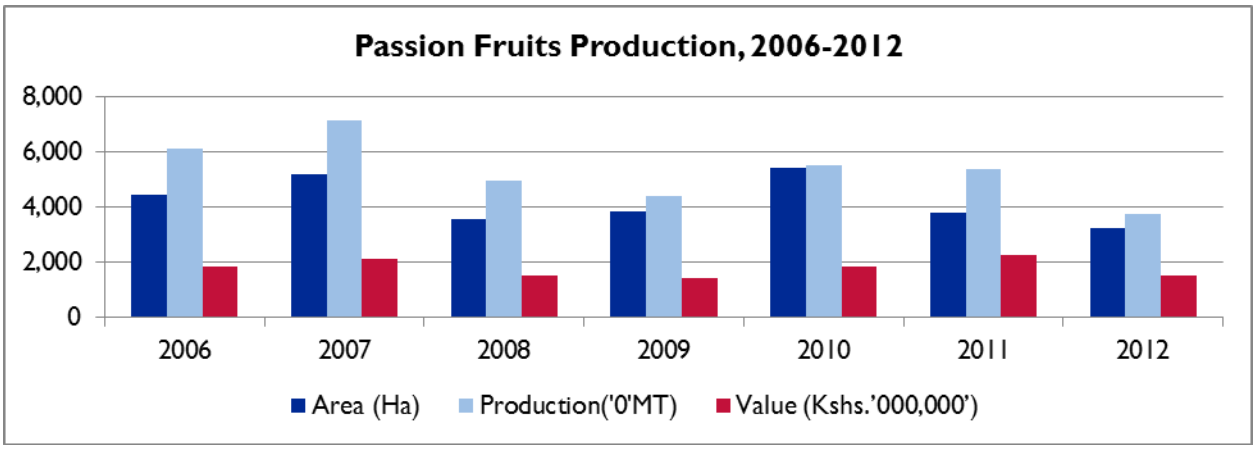
4.14.2 Production Trends

There was a slight but steady increase in the area of production, production volume and value of passion fruit from 2005 to 2007. In 2008 and 2009 there was a decline the area of production, production volume and value of passion fruit. However, in 2010, the area of production, production volume and value of passion fruit rose slightly due to the increasing demand for fresh and processed juice both for the domestic and export market (Figure 56).

Passion fruit from central Kenya that was previously exported has fallen frequently a victim of interceptions at the international market due to non-compliance with the MRL requirements. Subsequently, most companies dealing with export of passion fruits shy away from buying the fruits from the region. The frequent interception of passion fruit consignments originating from central Kenya has been attributed to use of coffee pesticides in passion fruits production. This in turn has been attributed to limited pesticides recommended for passion fruit production and cheaply available pesticides recommended for use in coffee production. There are less than five pesticides registered in Kenya for use in controlling pest and diseases in passion fruit (Horticultural News, 2011).

The shift in production from central Kenya where passion fruit was traditionally produced under irrigation to areas depending on rain fed production is considered the major cause for decline in national productivity. It suffices to note that under inadequate soil moisture as is often the case for rain fed production, most produce weigh less than 40 grams per fruit which is considered reject for export market. Dependence on passion fruit produced under rain fed has therefore been cited as the major cause for uncompetitive quality thus decline in premium EU market share for local passion fruit. The high grade passion fruit should weigh 40-45 gram per fruit hence 40-48 fruits per 2 kg carton (Horticultural News, 2011).

Figure 56: Passion Fruit Production Trends, 2006-2012



Data source: Horticultural Crops Development Authority

Smallholder farmers in USAID-KAVES target counties produced a recorded 34,251 metric tons in 2011, equivalent to 63 percent of national production (Table 27). Meru was the highest producing county followed by Elgeyo-Marakwet.

Table 27: Passion Fruit Production, Selected Counties, 2011

County	Production in Tons
Meru	13,108
Elgeyo-Marakwet	11,642
Nandi	3,579
Uasin-Gishu	3,510
Kisii	1,404
Tharaka-Nithi	1,008
Total	**34,251**

4.14.3 Value Chain Actors

The complex map of stakeholders in passion fruit is shown in Figure 57. Since the purple passion fruit variety grown in Kenya requires to be grafted to a yellow passion rootstock for maximum yield and disease tolerance, a subsidiary business is essential to specialise in production of clean planting material. Exporters who buy fruit for shipping to Uganda, Rwanda and Southern Sudan are also essential to keep prices in Rift Valley and western counties high enough to justify investment in pole in the trellising needed for successful passion fruit production. Processors also play a part although juice manufacturers generally prefer to buy imported concentrate which is cheaper and easier to handle.

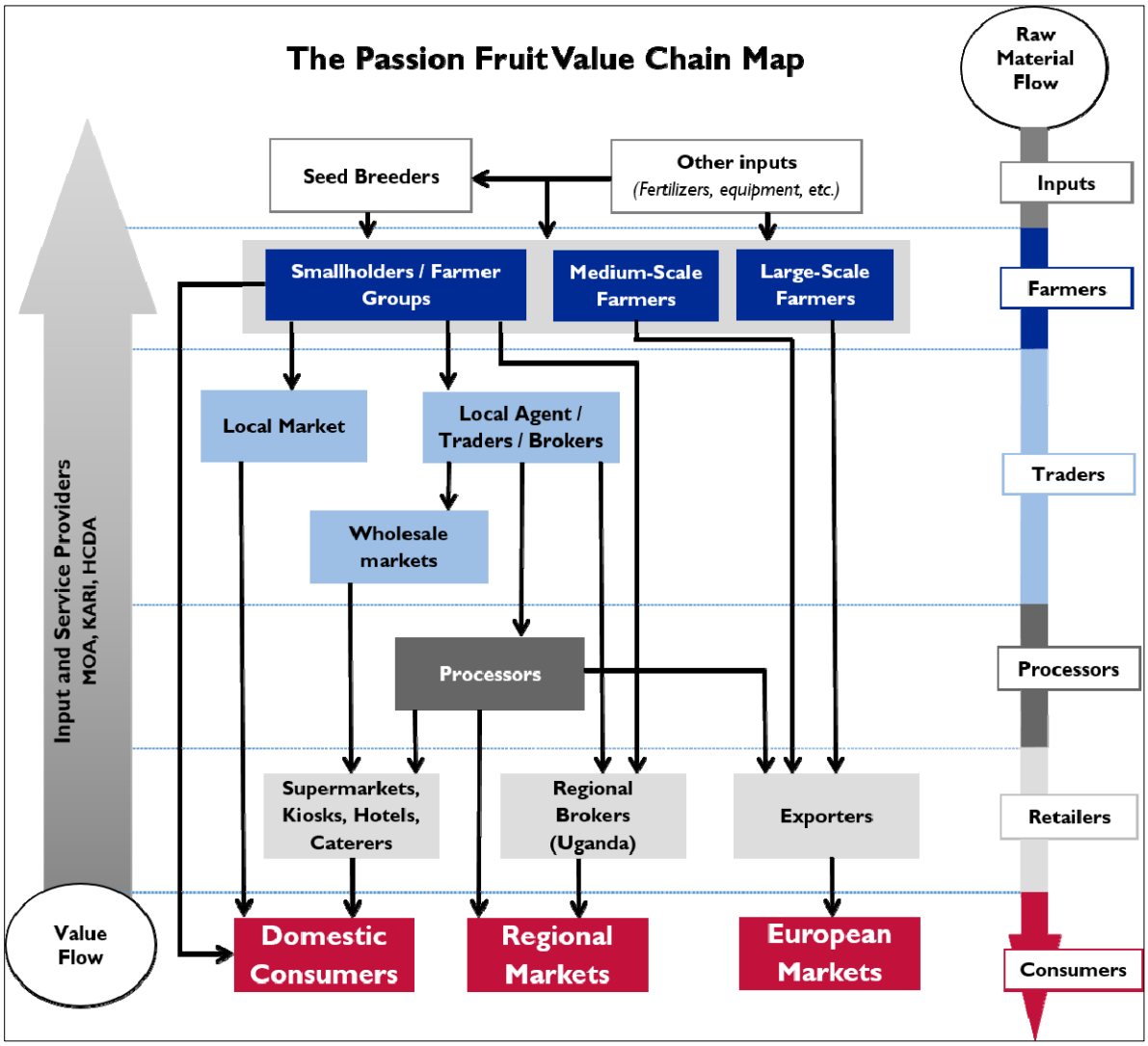
Producer/Farmers

Passion fruit is mainly produced by smallholder farmers on 0.25 to 2 acres of land (Wasilwa *et al*., 2004). Other than production in central and upper eastern which is largely under irrigation, passion fruit production in other parts of Kenya is mainly under rain fed system which doesn't guarantee adequate soil moisture necessary for optimal productivity all year round. In addition, under inadequate soil moisture, most fruits weigh less than 40 grams per fruit which is considered reject for export market. Moreover, rain fed system is prone to severe pest and disease infestation thus necessitating heavy use of

pesticides at the risk of the produce failing to comply with the MRL requirements. Passion fruit produced at high altitude areas take too long to ripen, this has led to picking of premature fruits by impatient farmers and unscrupulous exporters thus negatively impacting on the competitiveness of the produce at the international markets. Eastern Kenya is accredited for producing the best quality passion fruit for export market compared to other areas in Kenya.

Due to high input investment requirement in passion fruit production, most smallholders do not apply optimal recommended inputs leading to low productivity and uncompetitive quality produce at the international market. The average income from passion fruit is Ksh1.3 – 1.5 Million per acre within the economic lifespan of 3 years of an orchard. Cases of up to Ksh 2.0 Million income during the economic lifespan of 3 years of a passion fruit have been reported for orchards under irrigation.

Figure 57: Passion Fruit Value Chain Map



Inputs/input suppliers

In Kenya, passion fruit is categorized as minor crop; a fact that has limited pesticides efficacy trials on passion fruits production leading to fewer pesticides recommended for pest and disease control in passion fruit. There are less than five pesticides registered in Kenya for use in controlling pest and diseases in passion fruit. KARI is currently the sole supplier of seeds for improved sweet yellow passion varieties (KPF4, KPF11, and KPF12). However, there are a number of smallholder farmers at the coast who grow local yellow passion fruit for supply of seed. The cost per kilogram of yellow passion seed is Ksh 6,000 making growing of yellow passion fruit for purposes of seed production a lucrative business.

There are several farmer-owned insect proof passion fruit nurseries intended to supply woodiness virus free purple passion fruit seedlings in major passion fruit producing areas. The insect proof passion fruit nurseries with a capacity of supplying more than 60,000 per year purple passion fruit seedlings are located in Busia (75,000), Lugari (75,000), Bungoma (6200,0000), Kigumo (60,000), Siaya (75,000), Homa Bay (75,000), Kisii (60,000), Keiyo (310,000), and Eldoret (250,000)

Processors

Passion fruit processors in Kenya operate under installed capacity. This has been attributed to inadequate supply of quality raw material partly due to low productivity associated with rain fed production system that is common among smallholder farmers. The major passion fruit processors include: Delmont, Sun Mango, Millie fruits, All fruit ETZ limited, Coca Cola Ltd, Kevian Ltd, Milly processors, and FIPS Ltd.

Extension services

Passion fruit production receives significant extension services from the government and the private sector. Passion fruit farmers receive extension services from a number of government and non-governmental institutions and program which include the Horticultural Crops Development Authority (HCDA), Njaa Marufuku Kenya (NJM), USAID-KHCP, PSDA, Project Nurture - Technoserve, the Agriculture Business Development (ABD), and FCI. However, a holistic business approach linked farmers to markets has been identified as necessary in mitigating quality challenges that have caused decline in Kenya's passion fruit market share in the international market.

Exporters

The main export market is Uganda, supplied by truckers/traders who collect from areas accessible from the border including Uasin-Gishu and Elgeyo-Marakwet on a weekly basis. The number of exporters to Europe dealing in passion fruit has declined due to uncompetitive quality produce attributed to excessive MRLs, immature and under size fruits. Picking of immature fruits is common in high altitude passion producing areas partly due to difficulty in ascertaining fruit physiological maturity under cold environment. The main cause of under size fruits is low soil moisture associated with rain-fed production system.

Non-Governmental organizations

A number of NGOs have been involved in the passion fruit value chain at different levels. These include USAID-KHDP and FCI. Collaborative work between the Coca-Cola Company and the Bill and Melinda Gates foundation has seen the growth of passion fruit production in the last six years.

USAID-KHDP has conducted extensive work in promoting the development of smallscale nurseries to produce and sell grafted passion fruit seedlings, which are more resistant to root disease. FCI worked mainly on building capacity of farmers on collective marketing and development of business skills.

4.14.4 Passion Value Accumulation

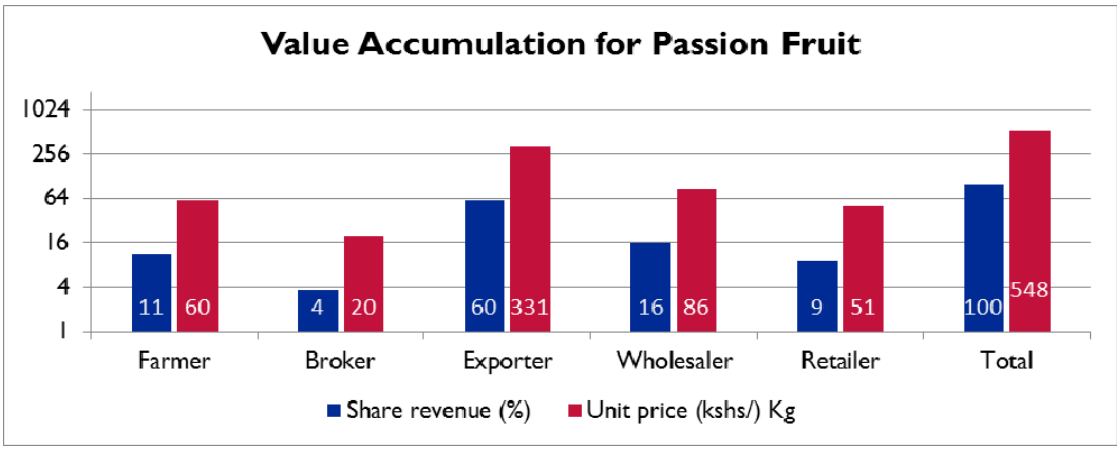
Commercial passion fruit production requires investment in poles and wire for trellising, grafted seedlings and a consistent supply of fertilizer and agrochemicals for yield maximization. Irrigation is also necessary to achieve year-round production and maintain healthy vines. For farmers who can make this investment, high returns of over Ksh 4 million per hectare (1.6 million per acre) are possible in the second year of full production (Table 28).

Table 28: Passion Fruit Production Cost

Efficient Passion fruit Production Budget per Hectare						
	Year 1		Year 2		Year 3	
Activity/Input	Cost Ksh	Percent	Cost Ksh	Percent	Cost Ksh	Percent
Seedlings	66,000	5.5	0	0.0	0	0.0
Fertilizer	95,700	7.9	95,700	40.2	95,700	40.2
Agrochemicals	81,000	6.7	81,000	34.1	81,000	34.1
Labor	93,400	7.7	61,100	25.7	61,100	25.7
Irrigation	450,000	37.3		0.0		0.0
Trellising	420,000	34.8		0.0		0.0
Total direct costs	1,206,100	100.0	237,800	100.0	237,800	100.0
Yield - kg/ha	14,000		84,000		50,000	
Production cost/kg	86		3		5	
Price - Ksh/kg	60		60		60	
Sales value	840,000		5,040,000		3,000,000	
Gross Margin	**-366,100**		**4,802,200**		**2,762,200**	

Figure 58 below, shows the accumulation of value along the EU export value chain which involves high air freight costs that leave the grower with about 11 percent of the final value and incurs high freight and packaging costs for the exporter. The costs of exporting to Uganda are not known but both markets have the advantage of giving a high average farm gate price of Ksh 60 per kilo to the grower, equivalent to more than Ksh 50 per kilo (Figure 58)

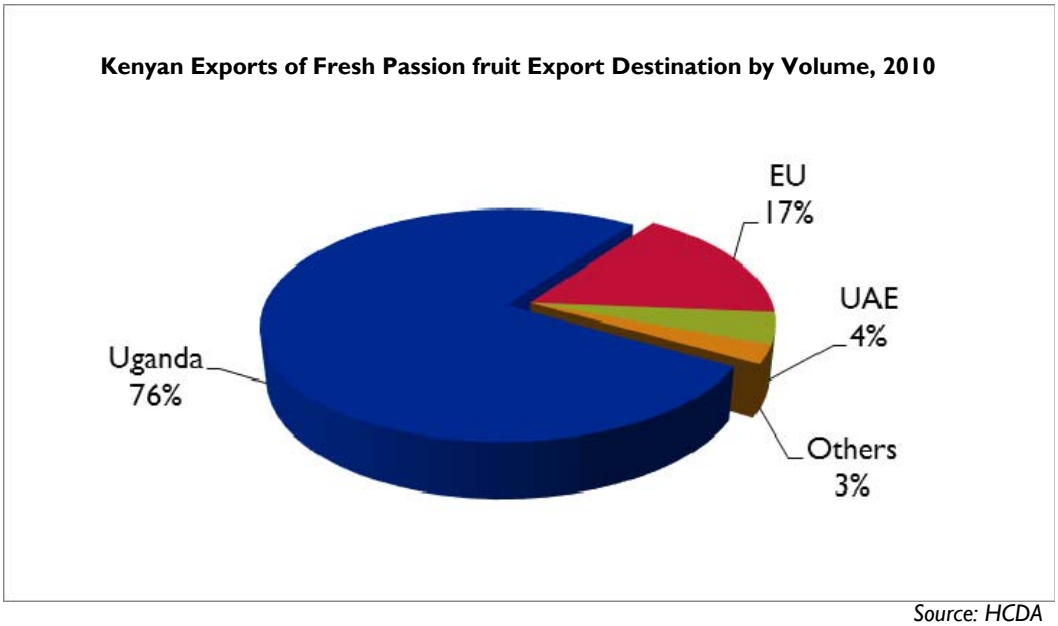
Figure 58: Passion Fruit Value Accumulation



4.14.5 Market Potential

There is a great market potential for passion fruit both in the domestic, regional and global markets. In the domestic market, there is high demand for passion fruit for fresh juice and concentrate for use in fruit canning factories. In the regional market, Uganda has significant passion fruit processing capacity and strong demand for purple passion fruit for fresh juice. Brokers from Uganda are active seasonal buyers in Kenya, especially in areas in Western and Rift provinces close to the border.

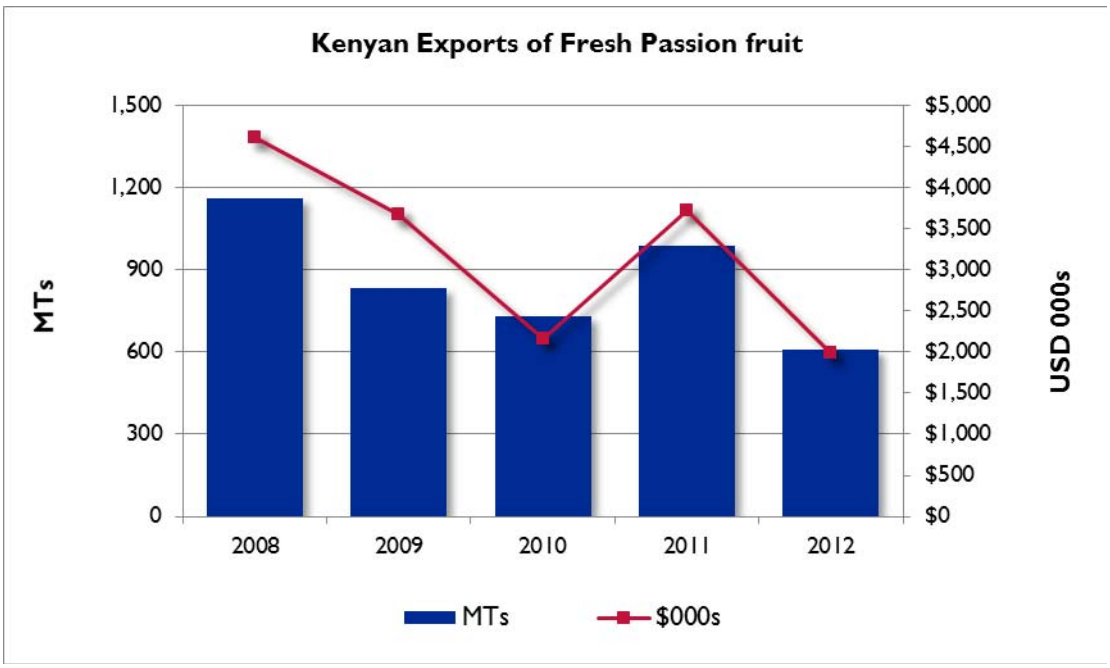
Figure 59: Kenyan Exports of Fresh Passion Fruit Export Destination by Volume, 2010



Source: HCDA

The volume of Kenyan passion fruit exported to Europe is smaller but has increased over the past few years. While passion fruit exporters are optimistic about market growth for Kenyan fruit, they say that traceability systems must be present and pesticide residue levels controlled. Fruit supplied by brokers cannot provide this level of assurance, so exporters are motivated to seek supplies more directly through contracts with smallholder groups. However, the volume of smallholder fruit supplied through contracts still meets only a small percentage of exporter requirements, so brokers remain the main player in this value chain.

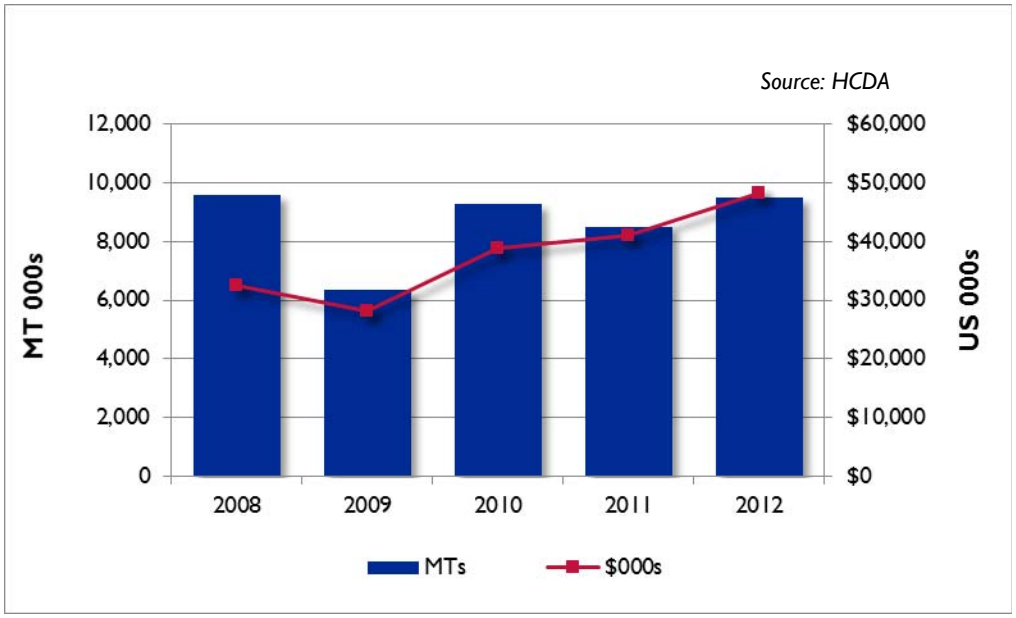
Figure 60: Kenyan Exports of Fresh Passion Fruit



Kenya is ranked among the leading five exporters of passion fruits to EU. The EU demand for passion fruit has been expanding at 13 percent per year outstripping the global supply. However, Kenya's passion fruit supply to EU has been declining by 2 percent per year and its market share dropped from 20 percent in 2006 to 11 percent in 2010.

The decline in exports of passion fruit to EU is attributed to lack clear planting material, inadequate linkages between smallholders and national exporters, low rate of compliance to the market requirements, inefficient collection and onward distribution system which impedes smallholder success in capturing intermediate margins, and expensive and unreliable overland, air and ocean export transportation systems which lead to uncompetitive costs, excessive transit times, and unreliable quality upon arrival (National Passion Fruit Business Plan, 2012 – 2022).

Figure 61: EU Imports of Fresh Passion Fruit and Other Minor Tropical Fruit



4.14.6 Upgrading the Value Chain

The main challenge to passion fruit production is lack of clean planting material free from fusarium wilt, woodiness virus and die-back diseases. Passion fruit production requires skilled crop management and is capital intensive. The passion fruit plant is perennial in habit and quite ideal for irrigated production. Major interventions to boost passion fruit production include capacity building in crop husbandry, coordinated marketing and availing affordable credit to smallholder farmers to meet the high capital outlay for farm establishment. Further, production and provision of clean planting material will greatly mitigate the disease problem and ensure good returns for the smallholder producers.

Production of passion fruit requires erection of structures to support the climber twigs of the crop, which is capital intensive. The smallholder producer of passion fruit is therefore disadvantaged by the high capital out lay for the farm establishment of the crop and the requirement for high agronomic skills in crop production management. The market target for passion fruit products is high-end and therefore the crop plays little role in ensuring food security among resource limited marginal communities. The priority for intervention in passion fruit production is therefore considered to be medium.

This is a priority value chain and among the key issues that should be addressed to increase productivity of passion fruit include:

- High disease incidence.
- Low productivity due to failure of farmers to follow good agronomic and hygiene practices which makes disease and pest management all the more difficult.
- Lack of skill and knowledge in postharvest handling, little selection of fruits is practiced with the result that diseased, unripe, overripe and blemished fruits are packed together and during transportation fruits are exposed to mechanical damage resulting in high losses.

4.15 AVOCADO

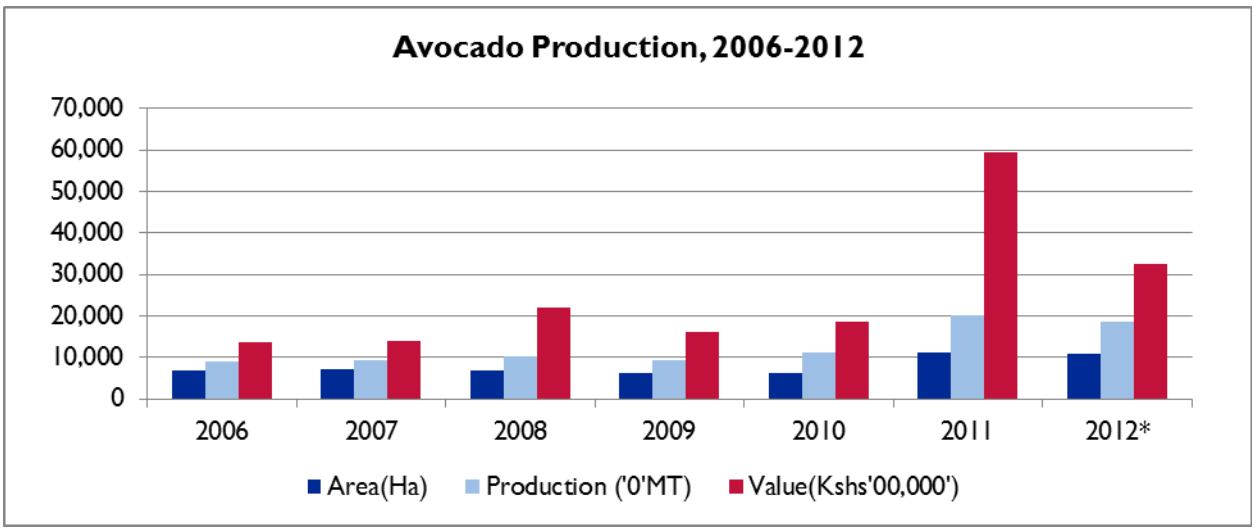
4.15.1 Background

Avocado is one of the top four fruits grown in Kenya, ranking alongside mango, banana and pineapple. Most production comes from small-scale growers but several major investments in large scale commercial plantations for export have been made in recent years by private companies. It is a popular local market fruit and Kenya is the fifth largest exporter of fresh avocado to Europe. Climatic conditions for avocado production are excellent and prospects for export growth in future are good if some key constraints can be addressed. In the past, export shipments have suffered from inefficiency in Mombasa port that leads to long shipment delays and poor quality on arrival. The difficult logistics of collecting fruit from thousands of smallholder farmers has also been problematic but systems are improving.

4.15.2 Production Trend

The cumulative production area over years has been increasing at a slow pace while the volumes and values have increased between 2002 to in 2011 as shown in figure 2 (FOA STAT, 2013). Production and value of avocado declined by 9.8 percent and 26.9 percent, respectively in 2009 compared to 2008. The decline was due to the drought in the 2009 that affected the productivity and fruit quality. This resulted to low volumes of export in the same year. However, production increased by 21 percent and 115 percent in 2010 and 2011, respectively compared to 2009. The significant increase in production in 2011 can be attributed to alternate bearing which is a common phenomenon with fruit trees.

Figure 62: National Avocado Production Trends, 2006-2012



Data source: Horticultural Crops Development Authority

Central (38.6 percent), Nyanza (33.7 percent), and Eastern (12.1 percent) province account for 84.4 percent of the total avocado production. Central and Eastern provinces grow mainly export varieties, Hass and Fuerte which account for 8 percent and 22 percent of the total production, respectively. Nyanza grows mainly none export varieties which include Pinkerton, Ettinger, Reed, Simmonds and Puebla (Mugambi, 2002). The high proportion (70 percent) of none export varieties in Nyanza provide opportunity for top-working these trees with varieties that are on demand. This will result in increased production of market demand driven varieties within 15 months as opposed to planting seedling that takes 36 months. The major avocado producing counties in the respective provinces is as follows: central Muranga and Kiambu; Eastern, Embu and Meru; Kisii County in Nyanza; Trans-nzoia in Western province; and, Taita Taveta County Coast province.

Table 29: Production per Province, 2008-2010

	Production (MT)			Value (Ksh '000')		
Province	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**
Central	35,370	33,398	43,748	813,510	351,945	404,487
Coast	870	1,172	1,334	17,400	23,440	26,670
Eastern	12,639	13,320	13,716	202,224	163,842	168,808
Western	8,333	6,392	7,250	149,994	191,770	217,500
Nyanza	33,484	33,086	38,157	770,132	760,970	896,701
Rift Valley	12,675	5,780	8,856	240,825	109,151	132,840
Nairobi	152	180	145	3,344	4,500	3,635
Total	**103,523**	**93,328**	**113,206**	**2,197,429**	**1,605,618**	**1,850,631**

Source: HCDA 2012

4.16.3 Value Chain Actors

Figure 63 show the major actors in the avocado value chains and their relationships that engage and support avocado producers. These relationships are essential to increase the supply of quality avocados and improve access to product markets by smallholders in the domestic, regional and global markets.

Farmers/producer groups

Smallholder farmers grow 70 percent of avocado while medium and large farmers grow 20 percent and 10 percent of avocado, respectively. Avocado is grown in several agro-ecological zones mainly as a cash crop targeting either domestic or export market. Avocado is therefore a major source of income to smallholder farmers and an important foreign exchange earner to Kenya. In 2012, production of avocado was 186,292 MT with a domestic value of Ksh 3.3 Billion. During the same period, Kenya exported avocado worth Ksh 2.5 Billion. Avocado account for 17 percent of the total horticulture exports from Kenya. The domestic and export market share for avocado are 75 percent and 25 percent of the total production, respectively (Horticulture Validate Report, 2012; HCDA Export Statistics 2012).

Avocado productivity among smallholder farmers remains low due poor agronomic practices attributed to limited extension services and sub-optimal application of inputs associated with limited access to input credit. Low or no fertilizer application and poor management of pest (fruit fly *Bactrocera invadens*) and diseases (anthracnose) are the main causes of low productivity and high postharvest losses.

Nurseries (seedling suppliers)/ input suppliers

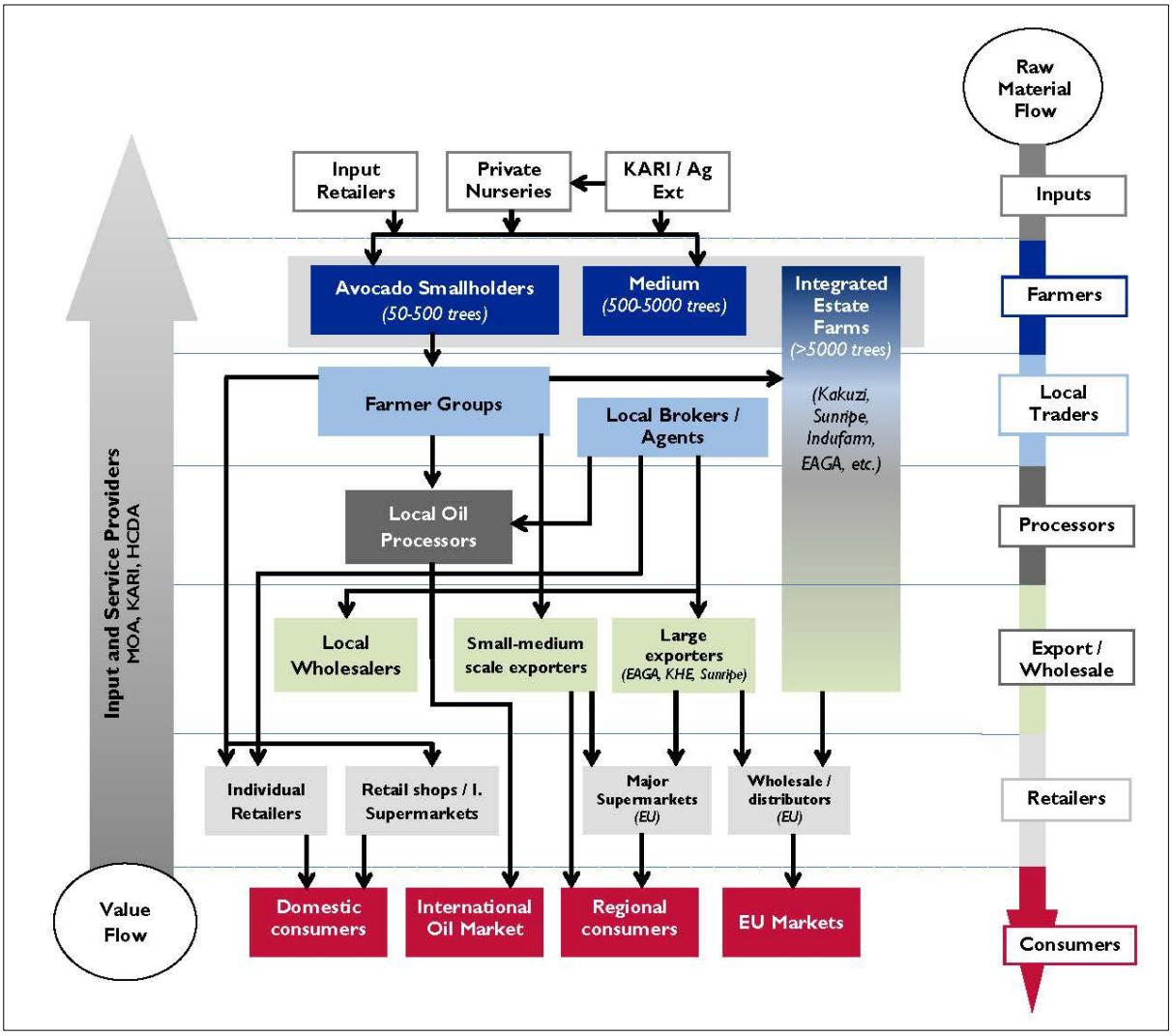
Seedling suppliers are essential in provision of quality planting material to the farmers. Most of the avocado farmers are not able to produced quality avocadoes because they lack good planting materials. In addition, high cost of seedling has also deterred planting of high quality seedling among smallholder farmers. Imparting grafting skill among local nursery operators is necessary in reducing seedling prices to affordable level and increasing accessibility. Grafting is needed to produce superior seedling in the tropics. These services require technical services and reasonable investments. A number of stakeholders supply input mainly fertilizer and pesticides.

Oil processors

Currently there are three avocado oil processors in Kenya. The three avocado oil processors operate in the Thika area and purchase Grade 2 fruit from farmers. The grade 2 fruit is as a result of the widespread black spot disease problem. The oil produced by Kenyan processors for export is mainly crude (unrefined). However, Olivado ltd also process high quality ultra-healthy and delicious edible avocado oil reported to The end uses of avocado oil are cosmetic or edible oil products. The free fatty acid content

should be low for food applications but higher for cosmetic uses. Processors prefer the high oil content of Fuerte variety avocados.

Figure 63: Avocado Value Chain Map



Exporters

Kenya accounts for 3 percent of the global trade in avocado. There are many companies in Kenya involved in avocado exports. In addition, there is adequate avocado packing infrastructure essential in meeting international market fruit grading requirements. Avocado exporters in Kenya can be categorised into three tiers with regard to quality of produce supplied.

The first category consist of companies large scale farms with integrated operations from pre-production practices to postharvest handling that guarantee competitive produce quality all the time.

The second category consists of experienced companies that do not grow their own crop but whose experience with quality control, scheduling and logistics enables them to deliver produce that is often competitive.

The third category consist of companies that purchase fruit from consolidators, poorly sorted and selected, with no reliable information as to agricultural practices, fruit maturity, mode of transport to the collection point, or even time elapsed since harvest.

There is need to build capacity of exports in categories II and II; and to link the exports to smallholder farmers to enhance production and marketing of avocado. The major avocado exporters include East African Growers Agriculture (EAGA), Kenya Horticultural Exporters, Kakuzi, Indu-Farm and Sunripe.

Extension services

The government ratio of extension staff to farmer is estimated at 1:1500. The challenge of low staff farmer ration is compounded by limited facilitation for government staff. In order to address this situation, the government encourages private extension services. However, most community based private extension service providers lack adequate capacity to effectively deal with smallholder farmers' challenges. In this regard, there is need to build capacity of private extension service providers to guarantee quality services to smallholder farmers.

Regulatory Services

Production of avocado seedlings like that of other fruit trees and vegetable seedlings is regulated by the HCDA and KEPHIS. HCDA regulates registration of nurseries and in essence therefore provides primary information on produce traceability. KEPHIS is mandated to certify the seedling quality with regard to pest and disease free; and to inspector quality conformity of avocado destined for export market. Inadequate number of staff to undertake quality inspections has been cited as a major cause of lapses in inspection of avocado destined for export making local produce less competitive in the international market. The other cause less competitiveness of local fruit and fruit products low traceability partly because of large number of smallholder farmers involved in fruit farming. In this regard, there is need to support HCDA in developing more effective traceability system for all produce destined for export markets.

Marketing agents/Brokers

Marketing agents also commonly referred to as brokers are registered by HCDA as dealers in the value chains. A dealer is defined as a person involved in buying and selling of horticultural produce (HCDA Order, 2011). Marketing agents play a significant role of consolidating, initial sorting and grading, and delivering produce to the exporters. In addition, marketing agents also supply avocado to local markets: processors, wholesaler, retailers and institutions. However, most produce is transported in recommended manner thus compromising the produce quality. Capacity of marketing agents on postharvest handling is necessary in making local produce more competitive.

4.16.4 Avocado Value Accumulation

Avocado requires a high establishment cost. Seedlings, fertilizer, and agrochemicals account for 43 percent of the crop establishment with seedlings costing about of the cost. In addition, the cost of fertilizer and agrochemicals for each year in the subsequent years is more than 50 percent of direct cost (Table 30). This implies that an average smallholder farmer without access to input credit can't undertake economically viable avocado farming. In view of this, there is need to facilitate access for input credit to smallholder farmers and to build capacity of local avocado nursery operators in order to reduce cost of seedlings and increasing accessibility. The viability of the proposed input credit is supported by bigger gross margin for the smallholder farmer in the successive years.

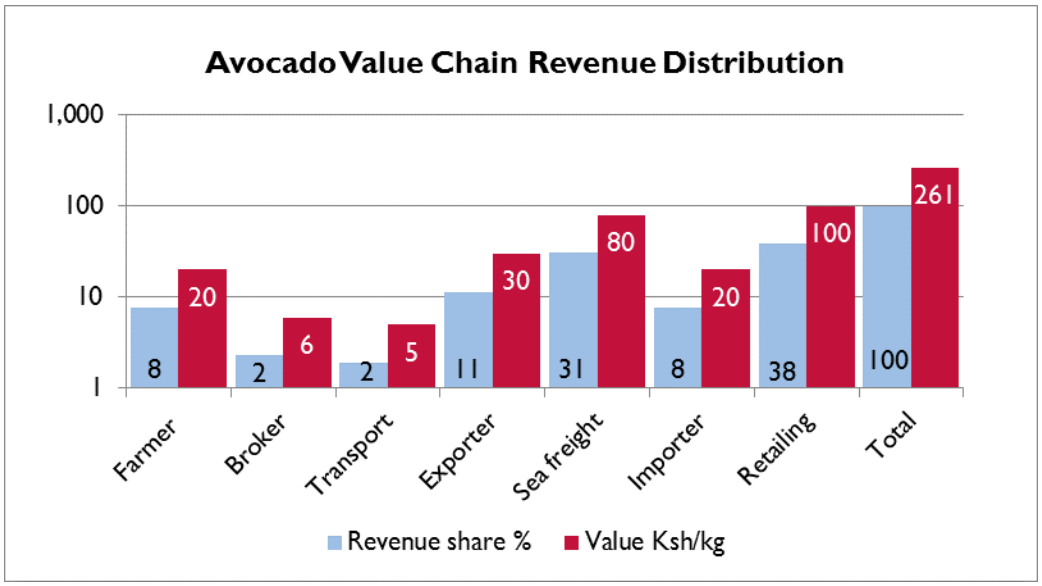
The value accumulation for avocado (Figure 64) below indicates that a farmer at 8 percent has more revenue share compared to a broker and a transporter. This is contrary to common misconception regarding farmer exploitation by the broker. However, farmers can their revenue share through produce

aggregation thus facilitating direct marketing of the produce to exporters. In order to achieve this, there is need for capacity building in sorting and grading; and to establish produce collection and sorting grades at community levels.

Table 30: Avocado Production Cost

Avocado Production Budget								
	Years 1-4		Year 5		Year 6		Year 7	
Activity/Input	Cost Ksh	Percent	Cost Ksh	Percent	Cost Ksh	Percent	Cost Ksh	Percent
Seedlings	12,300	16.3	0	0.0	0	0.0	0	0.0
Fertilizer	11,600	15.4	3,600	20.9	3,600	19.7	3,600	19.7
Agrochemicals	8,500	11.3	6,500	37.7	6,500	35.7	6,500	35.6
Labor	42,530	56.4	7,000	40.6	8,000	43.9	8,000	43.8
Other	430	0.6	130	0.8	130	0.7	170	0.9
Total direct costs	75,360	100.0	17,230	100.0	18,230	100.0	18,270	100.0
Yield - Kg/ha	18,450		36,900		61,500		98,400	
Production cost/fruit	4		0		0		0	
Price - Ksh/fruit	5		5		5		5	
Sales value	92,250		184,500		307,500		492,000	
Gross Margin	**16,890**		**167,270**		**289,270**		**473,730**	

Figure 64: Avocado Value Accumulation

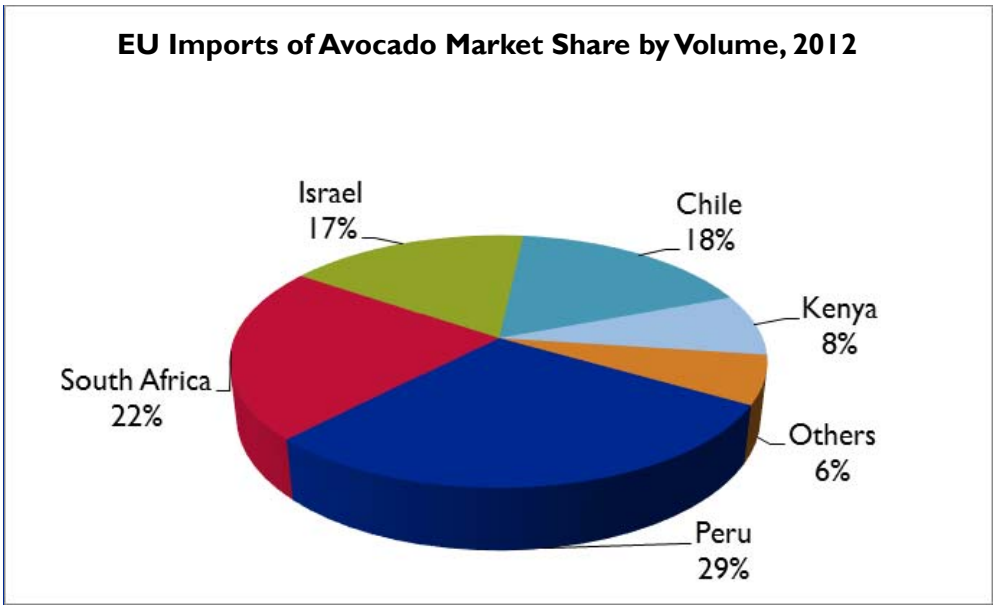


4.15.5 Market Potential

The domestic and export market for avocado account for 75 percent and 25 percent, of the total production, respectively. Avocado account for 17 percent of the total horticulture exports from Kenya. The market share for Kenya avocado for 2012 is indicated in Figure 65 with Kenya ranking 5th after Peru, South Africa, Israel and Chile among avocado exporters to the European market (Eurostat, 2005).

Kenya's global market share for avocado decline from 5 percent in 2001 to 3 percent in 2010. This is mainly attributed to steady change in preference of green over purple skin avocadoes and the entrance of Peru onto the EU market. In addition, less competitive quality has been cited as reason for declining market share for Kenyan avocado in the EU. In this regard, there is need to support a market driven production system through top working of local varieties with the right varieties and establishment of local nursery for quality seedlings to increase accessibility. In addition, there is need to support small and medium exporter in sorting, grading, proper postharvest handling, and produce traceability.

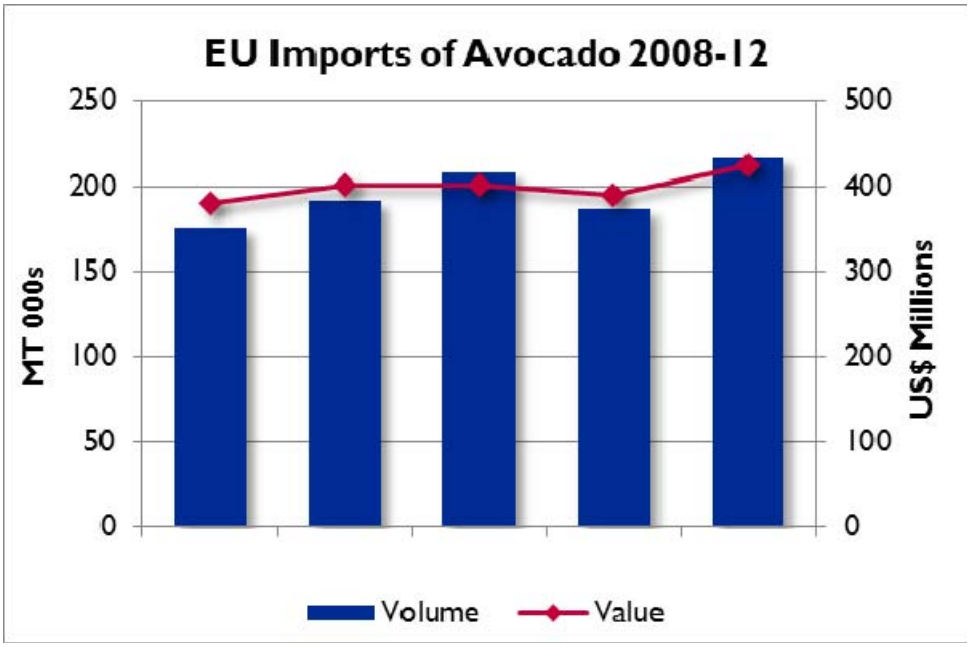
Figure 65: EU Imports of Avocado



Source: Eurostat

The EU market for avocado increased by 23 percent between 2008 and 2012; the market has generally been increasing over this period. The increasing avocado market in EU signifies the potential to absorb more produce from Kenya. At the current 217,000 metric tons in avocado imports, the EU market has the capacity to absorb the total avocado production which currently stands at 113,206 metric tons. In view of this, there is need to support the aforementioned measure to in order to make the local produce more competitive in the EU market.

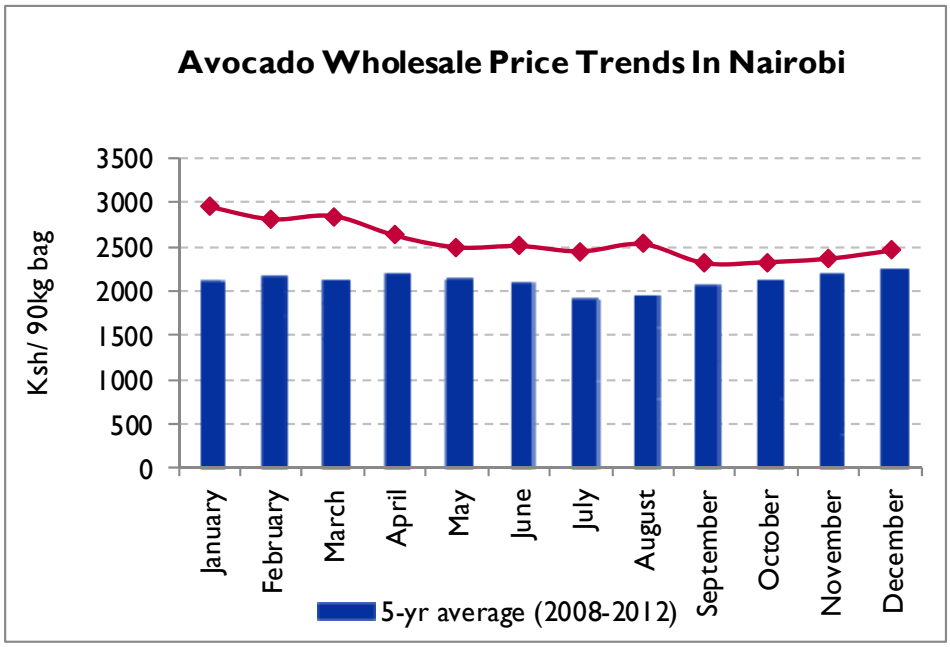
Figure 66: EU Imports of Avocado, 2008-2012



Source: Eurostat

The yearly avocado wholesale price between 2008 and 2012 indicate a sight 6 percent variation in price within the year (Figure 66). The slight variation in price within a year indicates a stead market for producers. This implies a steady demand that is capable of absorbing more produce. The steady price is also significant in supporting the repayment of input credit to smallholder farmers.

Figure 67: Avocado Wholesale Price Trends in Nairobi



Smallholder farmer in Kenya produce avocado under conditions that can largely be considered as organic. There are more than 640 farmers in Kenya with avocado organic and fair trade certification status. Kenyan avocado can be processed into high quality extra virgin avocado oil. This provides an opportunity to increase the local demand and income from avocado. Currently, Olivado Kenya (EPZ) ltd processing about 3 million fruits per year only source produce from central Kenya.

4.15.6 Upgrading the Value Chain

There is great potential to increase exponentially earnings from avocado sub-sector due to huge demand in the domestic and export markets. In this regard, there is need for KAVES will focus on the following intervention to upgrade the avocado value chain:

- Promote production that meets fresh and processing market requirements; including aspects of food safety and supply of sufficient quantities of varieties on demand in the international markets.
- Capacity build community based extension service providers to provide quality services regarding the avocado value chain.
- Capacity building of local nursery operators to increase accessibility and affordability of avocado seedlings.
- Linking farmers to exporters, processors, and local traders to guarantee market; and
- Supporting government agencies in developing effective traceability system.

5. CONCLUSIONS AND RECOMMENDATIONS

Markets are strong for all the products reviewed but farmers need to become more aware of market opportunities and trading companies need to adapt their business models to work on a long-term basis with smallholder farmers

Smallholder farmers generally receive a fair share of the final price achieved at retail level. The highest "value chain equity" is over 80 percent achieved by growing sorghum and groundnut for which farm gate prices are high, markets are very local and low volume, post-harvest value addition is minimal and trader margins small. However, for maize and milk, the two highest volume products, average farm gate prices are relatively high at 49 percent and 36 percent of the final price going back to the producer.

Based on this, increases in productivity at farm level will have the most significant impact on smallholder income for most crops and products reviewed.

Grower equity for Irish potato is disproportionately low compared with other crops, at 13 percent of retail price, and this may be a reason why smallholder production has not developed.

If the high postharvest margins are validated, interventions are needed at marketing level to provide incentives for smallholders to invest in seed and other inputs that would increase their productivity

Gross margins are high at more than 60 percent return on direct costs for all products except dry beans and Irish potato. Some crops such as cassava and groundnut give high gross margins at current prices but these are unlikely to be maintained if production increases significantly (Table 31)

More market analysis is needed to establish competitiveness of these staple crops at current gross margins if volumes increase before major investments are made in these crops

Dairy farming is a good way for enterprising smallholders to build their asset base and generate year-round income. The major constraint facing smallholder dairy milk producers is lack of credit to purchase cows with high genetic potential

Access to a complete package of technical assistance and credit is required for expansion of smallholder dairy production in the USAID-KAVES target counties

At present, French beans for export have the more commercial potential than any other crop that smallholders can grow competitively. Farmers can obtain 2-3 crops per year at a gross margin per crop of KSh 60,000 per acre for each crop. Kenya is a market leader and exporters claim that they can handle at least 50 percent more product if it is grown under traceable and compliant smallholder systems. KHCP is supporting initiatives on smallholder traceability systems but has no significant intervention to scale up production.

USAID-KAVES should make a major joint investment with export companies to scale up production of French beans in both HR1 and SA2 regions

Passion fruit is the highest earning crop grown by smallholders but requires a high capital investment that prevents many smallholders from planting or expanding despite the strong market.

USAID-KAVES should work with credit agencies to develop financial products that are accessible by smallholder passion fruit growers

Tree crops such as mango and avocado also provide high annual returns but require investment and long start-up period of five years. There are signs that the local market for mango is becoming saturated at the same time as new trees are coming into production

Recommendations by KHDP, FPEAK and other projects for a major initiative to increase production of mango and passion fruit concentrate from Kenyan fruit should be implemented after review of previous reports and discussions with commercial partners in the processing industry

Overall, mixed farming systems that include a combination of staples, horticultural crops and dairy farming will produce the highest increase in net income. For staple crops, smallholders gain the highest contribution to net income from home consumption. As sellers of surplus maize, sorghum and pulses, they lose competitive advantage because of the high postharvest costs of aggregation and quality control.

Mixed farming systems are essential for small-scale farmers with less than one hectare of land to make a significant contribution to their income from commercial agriculture

If farmers double their current yields which can be achieved, without financial risk, by simply adopting good agricultural practices, it is estimated that they can increase their net income per acre, by up to Ksh 60,000. This can be increased further by good farmers who are able to access credit

For smallholders to achieve this level of income from small areas of land they need to farm intensively and include at least one high value horticultural crop or three dairy cows in their farming system.

Table 31: Potential Returns from Smallholder Production of various products

Enterprise	Yield per acre (Kg)	Unit price per (Ksh/Kg)	Gross Income per acre (Ksh)	Total direct costs (Ksh)	Gross margin per acre (Ksh)
Dairy	3,000	32	96,000	42,000	54,000
Irish potato	7,600	10	76,000	54,483	21,517
Banana*	10,020	10	100,200	21,927	78,273
Mango	4,560	20	91,200	18,160	73,040
French bean	3,400	40	136,000	75,932	60,068
Avocado*	3,800	30	114,000	21,190	92,810
Passion fruit**	5,387	40	215,460	37,895	177,565
Maize	2,250	31	69,750	36,900	32,850
Sorghum	1,350	30	40,500	26,250	14,250
Cassava	12,000	25	300,000	52,320	247,680
Cassava - processing	12,000	8	96,000	52,320	43,680
Sweet potato	6,050	7	42,350	26,800	15,550
Dry bean	900	45	40,500	26,390	14,110
Green grams	900	34	30,600	19,370	11,230
Pigeon peas	600	45	27,000	10,780	16,220
Ground nuts	1,100	90	99,000	29,600	69,400
*Values provided for year 4					
**Values provided for year 2					

Source: KVC 2013

ANNEX 1: PRIORITY CROPS PER COUNTY

Value Chain Rating by County

County	Maize	Dairy	Irish potato	Sweet potato	Banana	Sorghum	Pulses	Ground-nut	Cassava	French beans	Mango	Passion fruit	Avocado	Preferred Value Chains
Uasin-Gishu	XXX	XXX	X							XX		XXX		Maize, Dairy and Passion fruits
Bomet	XX	XXX	XXX									XXX	X	Dairy, Irish potato and Passion fruits
Kericho	XXX	XXX	X		X					XXX		XX		Maize, Dairy, and French beans
Kisumu	X	XXX		X	X	XX		X	X	XXX	X	XXX		Dairy, French Beans and Passion fruits
Kisii	XX	XXX		X	XXX	X				XXX		X		Dairy, Bananas and French beans
Homa Bay	X	XXX		XX	X	XX	XX	XXX	XX	XX		XXX		Dairy, Groundnuts and Passion fruits.
Busia	X	X			XXX	XX	XX	XXX	XX	X		XXX		Bananas, Groundnuts and Passion fruits
Kakamega	XXX	XXX		X	X	X	XX	X	XX	XXX		XX	XX	Maize, Dairy and French Beans
Bungoma	XXX	XXX		XX	XX	X	XX	X	X	XXX		X		Maize, Dairy and French Beans
Nyamira	XX	XXX		XX	XXX		X			XX		XXX		Dairy, Bananas and French beans
Migori	XX	XXX		XX	X	XX	XX	XX	XX	XXX		XXX		Dairy, French Beans and Passion fruits
Siaya	XXX	X		XX	XXX	XX	XX	X	XX	XX		XXX		Maize, Bananas and Passion fruits
Vihiga	X	XXX	X	XX	XXX		X			XXX		XX	XX	Dairy, Bananas and French beans
Trans-Nzoia	XXX	XXX	XX		X		X			XXX		X		Maize, Dairy and French Beans
Nandi	XXX	XXX	XX		X					XXX		XX		Maize, Dairy and French Beans
Elgeyo-Marakwet	XXX	XXX	XX		XX	X	X			X	XXX	X		Maize, Dairy and Mangoes
Meru	X	XX	XXX	X	XXX	X	XX	XX		X		XXX		Irish Potatoes, Bananas and Passion fruits
Tharaka-Nithi		X	X		XXX	XXX	XXX			X				Bananas, Sorghum and Pulses
Machakos	X	XXX				XX	XXX		XX	XXX	XXX	XX		Dairy, Pulses and Mangoes
Makueni	X	XX		X	X	XX	XXX		X	XX	XXX	XXX		Pulses, Mangoes and Passion fruits
Kitui	X	XX		X	X	XX	XXX		XX	XX	XXX	XXX		Pulses, Mangoes and Passion fruits
Taita-Taveta	X	XXX		X	XXX		X			XX		XXX		Dairy, Bananas and Passion fruits

XXX High
XX High to Medium,
X Medium to Low

(Based on the highest income generating potential compatible with soil, water and other environmental conditions across the county

ANNEX 11: CROP BUDGETS

Dairy Farm Budget

A. GENERAL DESCRIPTION		USD 1 = KSh 83	
Farm sector	Smallholder	Reproduction	Artificial insemination
Prod system	Semi-zero	Calf sales	Yes
Region	Eastern		

B. MAIN CHARACTERISTICS (annual yield and prices)		BASIC	IMPROVED
B.1 Farming Practices			
	Breed:	75% Friesian	Pure Friesian
	Feed:	Graze and cut/carry	Graze, cut/carry, & concentrates
	Animal Care:	Limited vet services	Basic vet services & dip
	Market:	Vendor & Basic co-op	Improved Co-op
	Reproduction:	1 calf per cow every 18 mos	1 calf per cow every 12 mos
	Herd composition (size):	3 cows, 1 calf	3 cows, 2 calf
	Liters per cow per day	6	24
C. MILK PRODUCTION (total liters per year per herd)			
Total production per year		5,400	21,960
Milk used at home		730	730
Milk fed to calf		240	1,080
Management losses		270	878
Milk available for sale		4,160	19,272
Milk sold and paid for		4,160	19,272
D. FINANCIAL INDICATORS (annual per herd unless indicated)		**KSh**	**KSh**
D.1 Gross Revenue			
Cash Revenue			
Milk sales	(total cash sales * cash sales)	145,600	674,506
Calf and cull-cow sales	(annual equivalent occasional revenue)	97,808	179,506
Manure sales	(share sold * cash price)	-	24,500
Total Cash Revenue		**243,408**	**878,512**
Imputed Revenue			
Milk used at home	(total saved * imputed value)	21,900	21,900
Manure used at home	(total used at home * imputed value)	31,500	98,000
Total Imputed Revenue		**53,400**	**119,900**
Total Gross Revenue	(cash and imputed revenue)	**296,808**	**998,412**
Total Milk Revenue	(cash and imputed revenue)	**296,808**	**998,412**
Milk used at home	(total saved * imputed value)	21,900	21,900
Manure used at home	(total used at home * imputed value)	31,500	98,000

Dairy Farm Budget (continued)

A. GENERAL DESCRIPTION	USD 1 = KSh 83		
Farm sector	Smallholder	Reproduction	Artificial insemination
Prod system	Semi-zero	Calf sales	Yes
	Eastern		

D. FINANCIAL INDICATORS (annual per herd unless indicated)	KSh	KSh
D.2 Production Costs		
Variable Costs		
Annual pasture crops	-	695
Bought feed & water	74,780	123,740
Recurrent veterinary	40,660	57,300
Milk hygiene	450	450
Selling expenses	7,072	38,543
Reproduction	6,000	8,000
Overheads	5,000	5,000
Hired labor	60,000	62,000
Total Variable Costs	**193,962**	**295,728**
Depreciation	28,129	71,007
Total Production Costs	**222,091**	**366,736**
D.3 Cost per Liter of Milk		
Variable cost per liter of milk produced	36	13
Total cost per liter of milk produced	41	17
Variable cost per liter of milk sold	47	15
Total cost per liter of milk sold	**53**	**19**
D.4 Farmer's Cash Profit (excluding imputed revenue)		
Gross cash profit		
Gross cash profit from milk (total milk sales – variable costs)	(48,362)	378,778
Total gross cash profit (total milk sales – variable costs)	49,446	582,784
Net cash profit		
Gross cash profit from milk (total milk sales – variable costs)	(48,362)	378,778
Total gross cash profit (total milk sales – variable costs)	49,446	582,784
D.4 Farmer's Cash Profit (excluding imputed revenue)		
Total gross profit		
Total gross profit from milk (total milk revenue - variable costs)	(26,462)	400,678
Total gross profit (total revenue - variable costs)	102,846	702,684
Total net profit		
Total net profit from milk (total milk sales – variable costs)	(54,591)	329,670
Total net profit (total revenue - total costs)	74,717	631,677

2. Maize Budget per acre (Inefficient / Efficient)

MAIZE BUDGET PER ACRE

INEFFICIENT			
Gross Yield	Bags (90 Kg)	6	Bags
Producer price		2800	Per bag
Gross income GI-(KSh		16800	KShs

VARIABLE COSTS

Inputs	Item	unit	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land Preparation	1st ploughing	Acre	1	3500	3500
	2nd ploughing	Acre	1	2000	2000
Seed	Seed	10 kg	1	1800	1800
Fertilizers	DAP	0	0	4200	0
	CAN	0	0	2800	0
Planting labor	Laborers	Days	10	200	2000
1st weeding	Laborers	Days	10	200	2000
2nd weeding	Laborers	Days	10	200	2000
Harvesting	Laborers	Days	10	300	3000
Drying, sorting and, shelling	Laborers	Days	5	200	1000
Purchase of gunny bags	Bags	No.	10	60	600
Storage pesticide	Kg	Kg	1	450	450
Sisal twine	No.	No.	1	200	200
Total Variable costs - TVC					**18,550**

RETURNS

Gross Margin (profit/loss)	-1,750.00
Cost per bag (KShs/bag)	3091.67
Break even yield (bags/acre)	6.63
Family labor required (days)	45
Return to family labor (KShs/man-day)	-38.8888889

EFFICIENT			
Gross Yield	Bags (90 Kg)	25	Bags
Producer price		2800	Per bag
Gross income GI-(KSh		70000	KShs

VARIABLE COSTS

Inputs	Item	unit	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Hire of Land	Land	Acre	1	6000	6000
Land Preparation	1st ploughing	Acre	1	3500	3500
	2nd ploughing	Acre	1	2000	2000
Seed	Seed	10 kg	1	1800	1800
Fertilizers	DAP	50 kg	1	4200	8400
	CAN	50 kg	1	2800	5600
Planting labor	Laborers	Days	10	200	2000
Herbicide	Weed control	Liters	1	1200	1200
Herbicide spraying labor	Laborers	Days	1	250	250
2nd weeding	Laborers	Days	10	200	2000
Topdressing labor	Laborers	Days	7	200	1400
Harvesting	Laborers	Days	15	300	4500
Transport to store	Trip	Km	1	1500	1500
Purchase of gunny bags	Bags	No.	25	60	1500
Storage pesticide	Kg	Kg	1	450	450
Sisal twine	No.	No.	4	200	800
Total Variable costs - TVC					**42,900**

RETURNS

Gross Margin (profit/loss)	27,100
Cost per bag (Kshs/bag)	1716
Break even yield (bags/acre)	15.32
Family labor required (days)	43
Return to family labor (KShs/man-day)	630.2325581

IRISH POTATO (Var. Tigoni) BUDGET

Item	Units	Total
Gross Yield	Kg per acre	8,000
Recovery rate	% gross yield	95%
Net Yield (NY)	Kg per acre	7,600
Producer price (PP)	Kes per Kg	10
Gross Income (GI)	Kes	76,000

VARIABLE COSTS					
Inputs	**Item**	**Unit**	**Quantity per acre**	**Unit price (KSh)**	**Total cost (Ksh)**
Planting materials	Seed	Kg	16	1,500	24,000
Fertilizers	DAP	Kg	80	80	6,400
	CAN	Kg	40	70	2,800
	N.P.K (17.17.17)	Kg	40	40	3,200
	Foliar Feed (Easy Grow)	Kg	0.72	0.4	288
Pesticides- (Insecticide/Fungicides)					
	Antracol	Kg	2.16	1,500	3,240
	Kocide	Kg	2.16	600	1,296
	Karate	Lts	0.48	1,500	720
Labor					
	Land preparation	Mds	18	250	4,500
	Fertilizer application and planting	Mds	8	250	2,000
	1st weeding	Mds	4	250	1,000
	2nd weeding	Mds	4	250	1,000
	Pesticide and foliar application	Mds	6	250	1,500
	Harvesting	Mds	8	250	2,000
1% contingency					539.44
Total Variable Cost (TVC)					**54,483.44**

RETURNS					
Gross margin (GI-TVC)		KES/Acre			**21,516.56**
Cost per Kg (TVC/NY)		KES/kg			**7.17**
Break even Yield (TVC/PP)		kg/acre			**5,448.34**
Net returns per KSh invested (GM/TVC)					**0.39**

3. Sweet Potato Budget per Acre (Inefficient / Efficient)

SWEET POTATO BUDGET PER ACRE

INEFFICIENT			
Gross Yield	Bags (110 Kg)	200	Bags
Producer price		800	Per bag
Gross income GI-(KSh)		20,000	KSh

VARIABLE COSTS

Inputs	Item	unit	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land Preparation 1st Plough	Acre	1	1	3,500	3,500
Land Preparation 2nd Plough	Acre	1	1	2,000	2,000
Planting seed (vines)	Bags	10	10	100	1,000
Ridging	MD	15	15	201	3,015
Planting labor	MD	8	8	200	1,600
Weeding	MD	10	10	200	2,000
Harvesting (MD)	MD	20	20	200	4,000
Cleaning and bagging	MD	5	5	200	1,000
Harvesting (gunny bags)	No	No.	30	60	1,800
Total Variable costs - TVC					**19,915**

RETURNS

Gross Margin (profit/loss)	85	KShs
Cost per kg	797	KShs
Break even yield	25	Bags
Family labor required (days)	58	MD
Return to family labor (KShs/man-day)	1.5	KShs/MD

EFFICIENT			
Gross Yield	Bags (110 Kg)	55	Bags
Producer price		800	Per bag
Gross income GI-(KSh		44,000	KSh

VARIABLE COSTS

Inputs	Item	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land Preparation 1st Plough	Acre	1	3,500	3,500
Land Preparation 2nd Plough	Acre	1	2,000	2,000
Ridging	Acre	1	2,000	2,000
Seeds (vines)	Bags	10	250	2,500
Planting labor	MD	8	200	1,600
1st weeding labor	MD	10	200	2,000
2nd weeding	MD	10	200	2,000
Harvesting labor	MD	30	200	6,000
Harvesting costs (cleaning, sorting and grading etc.)	MD	8	200	1,600
Purchase of gunny bags	No.	60	60	3,600
Total Variable costs - TVC				**26,800**

RETURNS

Gross Margin (profit/loss)	17,200	KShs
Cost per bag (KSh/bag)	487.27	KShs
Break even yield (bags/acre)	34	Bags
Family labor required (days)	66	MD
Return to family labor (KSh/man-day)	260.6060606	KShs/MD

Banana (var. Cavendish) Budget Year 1-4

Item	Units	Year 1	Year 2	Year 3	Year 4
Gross Yield	Kg/acre	0	12,375	18,555	24,750
Recovery Rate	% gross yield	100%	100%	100%	100%
Net Yield (NY)	Kg/acre	0	12,375	18,555	24,750
Producer Price (PP)	KSh/kg	10	10	10	10
Gross Income (GI)	KSh	0	123,750	185,550	247,500

VARIABLE COSTS											
				Year 1		Year 2		Year 3		Year 4	
Inputs	Item	Unit	Unit price (KSh.)	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Planting materials	Seedlings	Pcs	100	825	82,500	0	0	0	0	0	0
Fertilizers	TSP	50Kg	4,000	1	16,000	0	0	0	0	0	0
	Manure	Debe	20	825	16,500	1,650	33,000	145	2,900	290	5,800
	N.P.K 17-17-17	50Kg	3,500	0	0	2	7,000	1	3,500	2	7,200
Pesticides-(Insecticide/Fungicides)											
	Mocap	Kg	600	50	30,000	0	0	0	0	0	0
Labor											
	Ploughing	Mds	250	30	7,500	0	0	0	0	0	0
	Digging holes	Hole	10	825	16,500	0	0	0	0	0	0
	Planting	Mds	250	16	4,000	0	0	0	0	0	0
	NPK and manure topdressing	Mds	250	0	0	4	1,000	4	1,000	4	1,000
	De-suckering	Mds	250	0	0	2	500	4	1,000	4	1,000
	1st weeding	Mds	250	10	2,500	10	2,500	5	1,250	5	1,250
	2nd weeding	Mds	250	10	2,500	10	2,500	5	1,250	5	1,250
	Harvesting	Mds	250	0	0	2	500	2	500	4	1,000
1% contingency					1,780		470		520		525
Total Variable Cost (TVC)					**179,780**		**47,470.00**		**52,520**		**53,025**

RETURNS					
Gross Margin (GI-TVC)	KSh/acre	-179,780	76,280	133,030	144,975
Cost Per Kg (TVC/NY)	KSh/kg	∞	3.84	2.83	2.68
Break even Yield (TVC/PP)	Kg/acre	17,978	4,747	5,252	5,302
Net Returns per Kshs invested (GM/TVC)		-1	1.61	2.53	2.73

BANANA (Var. Cavendish) BUDGET YEAR 5-7

Item	Units	Year 5	Year 6	Year 7	Totals
Gross Yield	Kg/acre	24,750	19,800	19,800	120,030
Recovery Rate	% gross yield	100%	100%	100%	
Net Yield (NY)	Kg/acre	24,750	19,800	19,800	120,030
Producer Price (PP)	KSh/kg	10	10	10	70
Gross Income (GI)	KSh	**247,500**	**198,000**	198,000	1,200,300

VARIABLE COSTS									
				Year 5		Year 6		Year 7	
Inputs	**Item**	**Unit**	**Unit price (KSh.)**	**Quantity**	**Value**	**Quantity**	**Value**	**Quantity**	**Value**
Planting materials	Seedlings	Pcs	100	0	0	0	0	0	0
Fertilizers	TSP	50Kg	4,000	0	0	0	0	0	0
	CAN	50Kg	3,500	1,650	33,000	825.00	16,500.00	825.00	16,500.00
	N.P.K 17-17-17	50Kg	3,500	4.00	14,000	2.00	7,000.00	2.00	7,000.00
	Manure	Debes	20	0	0	0	0	0	0
	Foliar Feed (Easy grow)	Kg	400	0	0	0	0	0	0
Pesticides-(Insecticide/Fungicides)									
	Antracol	Kg	1,500	0.96	1,440	0.96	1,440	0.96	1,440
Labor									
	Ploughing	Mds	0	0	0	0	0	0	0
	Digging holes	Hole	0	0	0	0	0	0	0
	Planting	Mds	0	0	0	0	0	0	0
	NPK and manure topdressing	Mds	4	1,000	2	500	2	500	4
	De-suckering	Mds	4	1,000	2	500	2	500	4
	1st weeding	Mds	5	1,250	2	500	2	500	5
	2nd weeding	Mds	5	1,250	2	500	2	500	5
	Harvesting	Mds	4	1,000	4	1,000	4	1,000	4
1% contingency				525		265		265	
Total Variable Cost (TVC)					**53,025.00**		**26,765.00**		**26,765.00**
RETURNS									
Gross Margin (GI-TVC)		KSh/acre			194,475		171,235		171,235
Cost Per Kg (TVC/NY)		KSh/kg			2.68		1.35		1.35
Break even Yield (TVC/PP)		Kg/acre			5,302.50		2,676.50		2,676.50
Net Returns per Kshs invested (GM/TVC)					3.67		6.40		6.40

Sorghum Budget per acre (Inefficient / Efficient)

SORGHUM BUDGET PER ACRE

INEFFICIENT		
Gross Yield	200	Kgs
Selling Price	70	Per kg
Gross Income GI-(KSh)	14,000	KSh

VARIABLE COSTS				
Inputs	**Item**	**Quantity /Acre**	**Price KSh/ unit**	**Cost (KSh)**
Land preparation plough	Acre	1	3500	3,500
Land preparation harrowing	Acre	1	2000	2,000
Seed	Kg	8	200	1,600
Planting	MD	10	200	2,000
1st weeding labor	MD	10	200	2,000
2nd weeding MD	MD	10	200	2,000
Bird scaring	MD	45	200	9,000
Harvesting	MD	10	200	2,000
Drying, threshing, winnowing	MD	6	100	600
Purchase of gunny bags	No	4	50	200
Total Variable costs - TVC				**24,900**

RETURNS	
Gross Margin (profit/loss)	-10,900.00
Cost per kg	124.50
Break even yield	356
Family labor required (days)	91
Return to family labor (KShs/man-day)	-119.7802

EFFICIENT		
Gross Yield	800	Kgs
Producer price	70	Per bag
Gross income GI-(KSh)	56,000	KSh

VARIABLE COSTS				
Inputs	**Item**	**Quantity /Acre**	**Price KSh/ unit**	**Cost (KSh)**
Land preparation plough	Acre	1	3,500	3,500
Land preparation harrowing	Acre	1	2,000	2,000
Seed	2kg pkt	4	320	1,280
DAP	50 kg bag	2	4,200	8,400
CAN	50 kg bag	2	2,700	5,400
Planting	MD	10	200	2,000
Weeding	MD	10	200	2,000
Topdressing	MD	10	200	2,000
Harvesting	MD	10	200	2,000
Threshing, drying and bagging	MD	10	200	2,000
Bird repelling spray	Liter	1	1,000	1,000
Dusting (actelic) 600g	Pkt	1	500	500
Transport	Unit	1	1,000	1,000
Total Variable costs - TVC				**33,080**

RETURNS		
Gross Margin (profit/loss)	22,920	KShs
Cost per bag (Kshs/bag)	41	KShs
Break even yield (bags/acre)	473	Kgs
New returns per KShs invested	1	

Dry Beans Budget per acre (Inefficient / Efficient)

DRY BEANS BUDGET PER ACRE

INEFFICIENT			
Gross Yield	Bags (90 Kg)	2	Bags
Producer price		6,300	Per bag
Gross income GI-(KSh)		12,600	KSh

VARIABLE COSTS

Inputs	Item	unit	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land Preparation 1st Ploughing	Acre	1	1	3,500	3,500
Land Preparation 2nd Ploughing	Acre	1	1	2,000	2,000
Bean Seeds	Kg	kg	14	150	2,100
Planting	Laborers	MD	10	200	2,000
Weeding	Laborers	MD	10	200	2,000
Harvesting	Laborers	MD	10	200	2,000
Threshing & winnowing	Laborers	MD	2	200	400
Gunny Bags	No.	4	4	60	240
Actellic Super	Kg	1	1	340	340
Total Variable costs - TVC					**14,580**

RETURNS

Gross Margin (profit/loss)	-1,980	KShs
Cost per kg	7290	KShs
Break even yield	2.31	Bags
Family labor required (days)	32	
Return to family labor (KShs/man-day)	-82.5	

EFFICIENT			
Gross Yield	Bags (90 Kg)	5	Bags
Producer price		6,300	Per bag
Gross income GI-(KSh)		31,500	KSh

VARIABLE COSTS

Inputs	Item	Quantity /Acre	Price KSh/ unit	Cost (KSh)
1st ploughing	Acre	1	3,500	3,500
2nd ploughing	Acre	1	2,000	2,000
Furrowing	Acre	1	1,000	1,000
Seed	Kg	14	150	2,100
Planting fertilizer (DAP)	50Kg	1	4200	4,200
Planting MD	MD	10	200	2,000
1st weeding	MD	10	200	2,000
2nd weeding	MD	10	200	2,000
Foliar feed	Liter	1	350	350
Foliar application	MD	1	200	200
Fungicide	Kg	1	1,400	1,400
Insecticide	Liter	0.5	1,200	600
Spraying labor	MD	1	200	200
Harvesting	MD	12	200	2,400
Gunny bags	No	6	60	360
Transport	Trips	1	1,000	1,000
Threshing and winnowing	MD	2	200	400
Storage chemicals	Kg	2	340	680
Total Variable costs - TVC				**26,390**

RETURNS

Gross Margin (profit/loss)	5,110	KShs
Cost per bag (Kshs/bag)	5278	KShs
Break even yield (bags/acre)	4.19	Bags
Family labor required (days)	44	
Return to family labor (KShs/man-day)	**116.1363636**	

Green Gram Budget per acre (Inefficient / Efficient)

GREEN GRAM BUDGET PER ACRE

INEFFICIENT			
Gross Yield	Bags (90kgs)	3	Bags
Producer price		9,000	Per bag
Gross income GI-(KSh)		27,000	KSh

VARIABLE COSTS

Inputs	Item	unit	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land preparation 1st plough	Acre	Acre	1	3,500	3,500
Land preparation 2nd plough	Acre	Acre	1	2,000	2,000
Seed	Kg	Kg	6	200	1,200
Planting	Labor	MD	10	200	2,000
Weeding	Labor	MD	10	200	2,000
Harvesting	Labor	MD	20	200	4,000
Threshing, winnowing and bagging	Labor	MD	5	200	1,000
Harvesting (Gunny bags)	No.	No.	6	60	360
Total Variable costs - TVC					**16,060**

RETURNS

Gross Margin (profit/loss)	10,940	KSh
Cost per kg	5,353	KSh
Break even yield	2	Bags
Family labor required (days)	45	MD
Return to family labor (KShs/man-day)	243	

EFFICIENT			
Gross Yield	Bags (90kgs)	5	Kg
Producer price		9,000	Per bag
Gross income GI-(KSh		45,000	KSh

VARIABLE COSTS

Inputs	Item	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land hire	Acre	1	6,000	6,000
1st ploughing	Acre	1	3,500	3,500
2nd ploughing	Acre	1	2,000	2,000
Seed	Bags	6	200	1,200
planting labor	MD	5	200	1,000
1st weeding labor	MD	10	200	2,000
2nd weeding	MD	10	200	2,000
Harvesting labor	MD	25	200	5,000
Threshing, winnowing, sorting, bagging	MD	8	200	1,600
Purchase of gunny bags	No	6	60	360
Total Variable costs - TVC				**24,660**

RETURNS

Gross Margin (profit/loss)	20,340	KShs
Cost per bag (KSh/bag)	4,932	KShs
Break even yield (bags/acre)	3	Bags
Family labor required (days)	58	MD
Return to family labor (KSh/man-day)	350.68966	

Ground nut Budget per acre (Inefficient / Efficient)

GROUND NUT BUDGET PER ACRE

INEFFICIENT			
Gross Yield	Kgs	270	Kg
Producer price		100	KSh
Gross income GI-(KSh)		27,000	KSh

VARIABLE COSTS

Inputs	Item	unit	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land Preparation 1st Plough	1st ploughing	Acre	1	3,500	3,500
Land Preparation 2nd Plough	2nd ploughing	Acre	1	2,000	2,000
Planting	Labor	MD	10	200	2,000
Seed	Kg	Kg	14	125	1,750
Weeding	Labor	MD	10	200	2,000
Harvesting	Labor	MD	30	200	6,000
Drying and shelling	Labor	MD	25	200	5,000
Harvesting (gunny bags)	Unit	No.	5	60	300
Storage pesticide	Kg	1	1	340	340
Total Variable costs - TVC					**22,890**

RETURNS

Gross Margin (profit/loss)	4,110	KSh
Cost per kg	84.78	KSh
Break even yield	228.90	Kg
Family labor required (days)	75	
Return to family labor (KShs/man-day)	171.25	

EFFICIENT			
Gross Yield	Kgs	800	Kg
Producer price		100	Per bag
Gross income GI-(KSh		80,000	KSh

VARIABLE COSTS

Inputs	Item	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land Preparation 1st	KShs	1	3,500	3,500
Land Preparation 2nd	KShs	1	2,000	2,000
Seed	Kg	14	150	2,100
Planting	MD	10	200	2,000
Planting Fertilizer DAP	Bag	1	4,200	4,200
1st Weeding	MD	10	200	2,000
Harvesting	MD	30	200	6,000
Drying and shelling	MD	30	200	6,000
Storage pesticide	Kg	0.5	1,200	600
Gunny Bags	No.	10	60	600
Total Variable costs - TVC				**29,000**

RETURNS

Gross Margin (profit/loss)	51,000	KShs
Cost per bag (KSh/bag)	36.25	KShs
Break even yield (bags/acre)	290	Bags
Family labor required (days)	80	MD
Return to family labor (KSh/man-day)	2,125	KShs/MD

Cassava Budget per acre (Inefficient / Efficient)

CASSAVA BUDGET PER ACRE

INEFFICIENT			
Gross Yield	Bags (90 Kg)	6000	Kg
Producer price		25	Per kg
Gross income GI-(KSh)		150,000	KSh

VARIABLE COSTS

Inputs	Item	unit	Quantity /Acre	Price KSh/ unit	Cost (KSh)
Land Preparation 1st Plough	Acre	1	1	3,500	3,500
Land Preparation 2nd Plough	Acre	1	1	2,000	2,000
Planting seed (cuttings)	Bags	5	5	500	2,500
Planting seed (cuttings) –Transport	Trip	1	1	500	500
Planting Labor	Labor	MD	10	150	1,500
1st Weeding	Labor	MD	10	200	2,000
2nd Weeding	Labor	MD	10	200	2,000
3rd Weeding	Labor	MD	10	200	2,000
Harvesting	Labor	MD	10	200	2,000
Transport	Trip	No.	5	500	2,500
Processing (peeling, drying, etc.)	Labor	MD	15	200	3,000
Gunny bags	unit	No.	12	60	720
Total Variable costs - TVC					**24,220**

RETURNS

Gross Margin (profit/loss)	125,780	KShs
Cost per kg	4.04	KShs
Break even yield	969	Kgs
Family labor required (days)	65	
Return to family labor (KShs/man-day)	1935.08	

EFFICIENT			
Gross Yield	Bags (90 Kg)	12,000	Kg
Producer price		25	Per kg
Gross income GI-(KSh		300,000	KSh

VARIABLE COSTS

Inputs	Item	Quantity /Acre	Price KSh/ unit	Cost (KSh)
1st ploughing	Acre	1	3,500	3,500
2nd ploughing	Acre	1	2,000	2,000
Seed cuttings	Bags	5	500	2,500
Planting seed (cuttings) - Transport	Trip	1	500	500
Planting labor	MD	10	200	2,000
1st weeding	MD	10	600	6,000
2nd weeding	MD	10	600	6,000
3rd weeding	MD	10	600	6,000
Harvesting	MD	15	500	7,500
Transport	Trip	10	500	5,000
Processing (peeling, drying, etc.)	MD	20	200	4,000
Gunny bags	No.	22	60	1,320
Total Variable costs - TVC				**46,320**

RETURNS

Gross Margin (profit/loss)	253,680	KShs
Cost per bag (Kshs/bag)	3.86	KShs
Break even yield (bags/acre)	1853	Kgs
Family labor required (days)	75	
Return to family labor (KShs/man-day)	3382.4	

Mango (Var. Apple) Budget Year 1-4

Item	Units	Year 1	Year 2	Year 3	Year 4
Gross Yield	Kg/acre	-	-	3,000	4,800
Recovery Rate	% gross yield	0.95%	0.95%	0.95%	0.95%
Net Yield (NY)	Kg/acre	-	-	2,850	4,560
Producer Price (PP)	KSh/kg	20	20	20	20
Gross Income (GI)	KSh	-	-	57,000	91,200

VARIABLE COSTS											
				Year 1		Year 2		Year 3		Year 4	
Inputs	Item	Unit	Unit price (KSh.)	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Planting materials	Seedlings	Pcs	100	145	14,500	0	0	0	0	0	0
Fertilizers	TSP	50Kg	4,000	1	4,000	0	0	0	0	0	0
	CAN	50Kg	3,500	1	3,500	1	3,500	0	0	0	0
	Manure	Debes	20	145	2,900	145	2,900	145	2,900	290	5,800
	N.P.K 17-17-17	50Kg	3,500	0	0	0	0	1	3,500	2	7,200
	Foliar Feed (Easy grow)	Kg	400	1.20	480	1.20	480	2.40	960	2.40	960
Pesticides-(Insecticide/Fungicides)											
	Antracol	Kg	1,500	0	0	0	0	0.48	720	0.48	720
Labor											
	Ploughing	Mds	250	12	3,000	-	-	-	-	-	-
	Digging holes	Holes	10	145	1,450	-	-	-	-	-	-
	Planting	Mds	250	4	1,000	-	-	-	-	-	-
	Weeding	Mds	250	10	2,500	10	2,500	10	2,500	10	1,250
	Spraying	Mds	250	1	250	1	50	3	750	4	1,000
1% contingency					335.80		96.30		113.30		179.80
Total Variable Cost (TVC)					**33,915.80**		**9,726.30**		**11,473.30**		**18,159.80**

RETURNS					
Gross Margin (GI-TVC)	KSh/acre	-33,915.80	-9,726.30	45,556.70	73,040.20
Cost Per Kg (TVC/NY)	KSh/kg	∞	∞	4.02	3.98
Break even Yield (TVC/PP)	Kg/acre	1,695.79	486.32	572.17	907.99
Net Returns per Kshs invested (GM/TVC)		-1	-1	4.02	

Mango (var. Apple) Budget Year 5-7

Item	Units	Year 5	Year 6	Year 7	Totals
Gross Yield	Kg/acre	5,600	7,000	7,600	26,700
Recovery Rate	% gross yield	95%	95%	95%	95%
Net Yield (NY)	Kg/acre	5320	6650	7220	25365
Producer Price (PP)	KSh/kg	30	30	30	30
Gross Income (GI)	KSh	159,600	199,500	216,600	760,950

VARIABLE COSTS									
				Year 5		Year 6		Year 7	
Inputs	Item	Unit	Unit price (KSh.)	Quantity	Value	Quantity	Value	Quantity	Value
Planting materials	Seedlings	Pcs	100	0	0	0	0	0	0
Fertilizers	TSP	50Kg	4,000	0	0	0	0	0	0
	CAN	50Kg	3,500	0	0	0	0	0	0
	N.P.K 17-17-17	50Kg	3,500	290	5,800	290	5,800	290	5,800
	Manure	Debes	20	2	7,000	2	7,000	2	7,000
	Foliar Feed (Easy grow)	Kg	400	3.20	1,280	3.20	1,280	3.20	1,280
Pesticides-(Insecticide/Fungicides)									
	Antracol	Kg	1,500	0.96	1,440	0.96	1,440	0.96	1,440
Labor									
	Ploughing	Mds	250	-	-	-	-	-	-
	Digging holes	Holes	10	-	-	-	-	-	-
	Planting	Mds	250	-	-	-	-	-	-
	Weeding	Mds	250	5	1,250	6	1,500	6	1,500
	Spraying	Mds	250	5	1,250	5	1,250	5	1,250
1% contingency					180.20		182.20		182.70
Total Variable Cost (TVC)					**18,200.20**		**18,452.20**		**18,452.70**

RETURNS				
Gross Margin (GI-TVC)	KSh/acre	95,799.80	110,747.30	114,547.30
Cost Per Kg (TVC/NY)	KSh/kg	3.19	2.86	2.77
Break even Yield (TVC/PP)	Kg/acre	910.01	922.64	922.64
Net Returns per Kshs invested (GM/TVC)		5.26	6.00	6.21

PASSION FRUIT (Var. purple passion) BUDGET

Item	Units	Year 1	Year 2	Year 3	total
Gross Yield	Kg/Ha	8,000	14,000	6,000	28,000
Recovery Rate	% gross yield	0.95	0.95	0.95	0.95
Net Yield (NY)	Kg/Ha	7,600	13,300	5,700	26,600
Producer Price (PP)	KSh/kg	40	40	40	40
Gross Income (GI)	KSh	304,000	532,000	228,000	1,064,000

VARIABLE COSTS									
				Year 1		Year 2		Year 3	
Inputs	**Item**	**Unit**	**Unit price (KSh.)**	**Quantity**	**Value**	**Quantity**	**Value**	**Quantity**	**Value**
Planting materials	Seedlings	Pc	50	1,650	82,500	0	0	0	0
Fertilizers	TSP	50Kg	4,000	4	16,000	0	0	0	0
	CAN	50Kg	3,500	4	14,000	4	14,000	2	7,000
	Manure	Debe	10	1,650	16,500	0	0	0	0
	N.P.K 17-17-17	50Kg	3,500	4	14,000	4	14,000	2	7,000
	Foliar Feed (Easy grow)	Kg	400	2	800	2	800	2	800
Pesticides-(Insecticide/Fungicides)									
	Antracol	Kg	1,500	3	4,500	6	9,000	3	4,500
	Karate	Lts	1,500	2	3,000	4	6,000	2	3,000
Support systems									
	Posts	post	250	940	235,000	0	0	0	0
	Wire 10 gauge	Kg	140	250	35,000	0	0	0	0
	U-nails	Kg	100	10	1,000	0	0	0	0
Labor									
	Ploughing	Mds	250	30	7,500	0	0	0	0
	Digging holes	Hole	10	1,650	16,500	0	0	0	0
	Planting	Mds	250	16	4,000	0	0	0	0
	Erecting posts	Mds	250	23	5,750	0	0	0	0
	Trellising	Mds	250	10	2,500	0	0	0	0
	Pruning and training	Mds	250	4	1,000	8	2,000	8	2,000
	1st Weeding	Mds	250	20	5,000	20	5,000	20	5,000
	2nd Weeding	Mds	250	20	5,000	20	5,000	20	5,000
	Spraying	Mds	250	24	6,000	24	6,000	12	3,000
	Harvesting	Mds	200	70	14,000	150	30,000	50	10,000
1% contingency					4,895.50		918		473.00
Total Variable Cost (TVC)					**494,445.50**		**92,718**		**47,773.00**

RETURNS				
Gross Margin (GI-TVC)	KES/Ha	**-190,445.50**	**439,282**	**180,227**
Cost Per Kg (TVC/NY)	KES/kg	**65.06**	**6.97**	**8.38**
Break even Yield (TVC/PP)	Kg/Ha	**12,361.14**	**2,317.95**	**1,194.33**
Net Returns per Kshs invested (GM/TVC)		**-0.39**	**4.74**	**3.77**

Avocado (var. Hass) Budget Year 1-4

Item	Units	Year 1	Year 2	Year 3	Year 4
Gross Yield	Kg/acre	0	0	2,500	4,000
Recovery Rate	% gross yield	95%	95%	95%	95%
Net Yield (NY)	Kg/acre	0	0	2375	3800
Producer Price (PP)	KSh/kg	30	30	30	30
Gross Income (GI)	KSh	0	0	71,250	114,000

VARIABLE COSTS											
				Year 1		Year 2		Year 3		Year 4	
Inputs	Item	Unit	Unit price (KSh.)	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Planting materials	Seedlings	Pcs	100	145	14,500	0	0	0	0	0	0
Fertilizers	TSP	50Kg	4,000	1	4,000	0	0	0	0	0	0
	CAN	50Kg	3,500	1	3,500	1	3,500	0	0	0	0
	N.P.K 17-17-17	50Kg	3,500	0	0	0	0	1	3,500	2	7,200
	Manure	Debes	20	145	2,900	145	2,900	145	2,900	290	5,800
	Foliar Feed (Easy grow)	Kg	400	1.20	480	1.20	480	2.40	960	2.40	960
Pesticides-(Insecticide/Fungicides)											
	Antracol	Kg	1,500	0	0	0	0	0.48	720	0.48	720
	Karate	Lts	1,500	1	1,500	1	1,500	2.00	3,000	2	3,000
Labor											
	Ploughing	Mds	250	12	3,000	-	-	-	-	-	-
	Digging holes	Holes	10	145	1,450	-	-	-	-	-	-
	Planting	Mds	250	4	1,000	-	-	-	-	-	-
	Weeding	Mds	250	10	2,500	10	2,500	10	2,500	10	1,250
	Spraying	Mds	250	1	250	1	50	3	750	4	1,000
1% contingency					350.80		111.30		143.30		209.80
Total Variable Cost (TVC)					**35,430.80**		**11,241.30**		**14,473.30**		**21,189.80**

RETURNS					
Gross Margin (GI-TVC)	KSh/acre	(35,430.80)	(11,241.30)	56,776.70)	
Cost Per Kg (TVC/NY)	KSh/kg	∞	∞	6.09	
Break even Yield (TVC/PP)	Kg/acre	1,181.03	374.71	482.44	
Net Returns per Kshs invested (GM/TVC)		(1)	(1)	(3.92)	

Avocado (var. Hass) Budget Year 5-7

Item	Units	Year 5	Year 6	Year 7	Totals
Gross Yield	Kg/acre	5,600	7,000	7,600	26,700
Recovery Rate	% gross yield	95%	95%	95%	95%
Net Yield (NY)	Kg/acre	5320	6650	7220	25365
Producer Price (PP)	KSh/kg	30	30	30	30
Gross Income (GI)	KSh	159,600	199,500	216,600	760,950

VARIABLE COSTS									
				Year 5		Year 6		Year 7	
Inputs	Item	Unit	Unit price (KSh.)	Quantity	Value	Quantity	Value	Quantity	Value
Planting materials	Seedlings	Pcs	100	0	0	0	0	0	0
Fertilizers	TSP	50Kg	4,000	0	0	0	0	0	0
	CAN	50Kg	3,500	0	0	0	0	0	0
	N.P.K 17-17-17	50Kg	3,500	2	7,000	2	7,000	2	7,000
	Manure	Debes	20	290	5,800	290	5,800	290	5,800
	Foliar Feed (Easy grow)	Kg	400	2.40	960	3.60	1,440	3.60	1,440
Pesticides-(Insecticide/Fungicides)									
	Antracol	Kg	1,500	0.96	1,440	0.96	1,440	0.96	1,440
	Karate	Lts	1,500	3.00	4,500	3.00	4,500	3.00	4,500
Labor									
	Ploughing	Mds	250	-	-	-	-	-	-
	Digging holes	Holes	10	-	-	-	-	-	-
	Planting	Mds	250	-	-	-	-	-	-
	Weeding	Mds	250	5	1,250	5	1,250	5	1,250
	Spraying	Mds	250	5	1,250	6	1,500	6	1,500
1% contingency					226.80		229.30		229.30
Total Variable Cost (TVC)					**22,906.80**		**23,159.30**		**23,159.30**

RETURNS				
Gross Margin (GI-TVC)	KSh/acre	136,693.20	176,340.70	193,440.70
Cost Per Kg (TVC/NY)	KSh/kg	4.31	3.48	3.21
Break even Yield (TVC/PP)	Kg/acre	763.56	771.98	771.98
Net Returns per Kshs invested (GM/TVC)		5.97	7.61	8.35

French Bean (var. Amy) Budget

Item	Units	Total
Gross Yield	Kg/acre	4,000
Recovery Rate	% gross yield	85%
Net Yield (NY)	Kg per acre	3,400
Producer Price (PP)	KSh/kg	40
Gross Income (GI)	KSh	136,000

VARIABLE COSTS					
Inputs	**Item**	**Unit**	**Unit price (KSh.)**	**Quantity**	**Value**
Planting materials	Seed	Kg	1,500	12	18,000
Fertilizers	DAP	Kg	80	80	6,400
	CAN	Kg	70	40	2,800
	N.P.K (17.17.17)	Kg	70	40	2,800
	Foliar Feed (Easy Grow)	Kg	400	0.4	160
Pesticides- (Insecticide/Fungicides)					
	Antracol	Kg	1,500	0.48	720
	Kocide	Kg	1,500	0.48	720
	Decis	Gms	750	0.48	360
	Karate	Kg	1,500	0.48	720
Labor					
	Ploughing	Mds	250	12	3,000
	Planting	Mds	250	10	2,500
	1st weeding	Mds	250	10	2,500
	2nd weeding	Mds	250	10	2,500
	Spraying	Mds	250	4	1,000
	Top dressing	Mds	250	4	1,000
	Harvesting and sorting	Mds	250	120	30,000
1% contingency					751.80
Total Variable Cost (TVC)					**75,931.80**

RETURNS					
Gross Margin (GI-TVC)		KSh/acre			**60,068.20**
Cost Per Kg (TVC/NY)		KSh/kg			**22.33**
Break even Yield (TVC/PP)		Kg/acre			**1,898.30**
Net Returns per KSh invested (GM/TVC)					**0.79**

ANNEX III: REFERENCES

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ANNEX IV: LIST OF ACRONYMS

ADC	Agriculture Development Cooperation
ADSP	Agri-business Development Support Project
AI	Artificial Insemination
ASCU	Agriculture Sector Coordination Unit
CIMMYT	International Maize and Wheat Improvement Center
CMA	Cereal Millers Association
COMESA	Common Market for Eastern and Southern Africa
EABL	East African Breweries Limited
EAC	East African Community
EAGA	East African Growers Agriculture
FAO	Food and Agriculture Organization
FCI	Farm Concern International
FPEAK	Fresh Produce Exporters Association of Kenya
HCDA	Horticultural Crops Development Authority
HQCF	High Quality Cassava Flour
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IPM	Integrated Pest Management
IPDM	Integrated Pest and Disease Management
KARI	Kenya Agricultural Research Institute
KDB	Kenya Dairy Board
KEBS	Kenya Bureau of Standards
KEPHIS	Kenya Plant Health Inspectorate Services
KHE	Kenya Horticultural Exporters
KSU	KARI Seed Unit
MoA	Ministry of Agriculture
NGOs	Non-governmental organizations
PCPB	Pest Control Products Board
PMG	Producer Marketing Groups
PSDA	Promotion of Private Sector Development in Agriculture
USAID	United States Agency for International Development
USAID-KAVES	Kenya Agricultural Value Chain Enterprises
USAID-KHCP	Kenya Horticulture Competitiveness Project

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