Kenya Agricultural Value Chain Enterprises (USAID-KAVES)

MAIZE VALUE CHAIN ANALYSIS

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FOREWORD

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 targeted agriculture value chains, thereby enhancing food security and improving nutrition.

This report is one of a series of detailed value chain analyses covering five value chains (maize, dairy, mango, Irish potato, and French (green) beans conducted by USAID-KAVES to identify critical constraints/gaps and prioritize high-return program interventions that will contribute to the program's core objectives of:

- *Increasing the competitiveness of selected agricultural value chains to increase incomes, mitigate food insecurity, improve nutrition, and increase the incomes of the rural poor;*
- *Fostering innovation and adaptive technologies and techniques that improve nutritional outcomes for rural households, sustainably reduce chronic under-nutrition, and increase household consumption of nutrition-dense foods; and*
- *Increasing the capacity of local organizations to sustainably undertake value chain work.*

While drawing upon the extensive body of existing research on targeted Kenyan valued chains, USAID-KAVES' analyzes further, builds on and updates those findings with primary data obtained through field surveys and interviews with value chain participants.

CONTENT

EXECUTIVE SUMMARY

Maize is critical to food security in Kenya and, as the most widely consumed and produced staple crop, is central to household and national income. However, yields have declined from 2.2 metric tons (MT) per hectare (ha) in the 1990s to 1.74 MT in 2012, largely as a result of low and inappropriate soil fertilization. Based on population and consumption growth trends, we expect an increase in aggregate demand for maize from 3.21 million MT in 2013 to 3.48 million MT in 2022. If Kenya can increase its average maize yield by just 15% (to 2MT/ha), it can more than meet expected national demand. Above this yield a surplus will be generated for strategic storage and regional export. Since the country has surpassed this threshold in the past, it should not be a difficult task for Kenya could attain maize self-sufficiency if interventions that target farm productivity and postharvest losses are made in the high maize potential counties. These interventions are likely to have high returns, not only at the national supply level, but also through increased incomes for farmers and traders.

INTRODUCTION AND METHODOLOGY

The USAID-KAVES (hereafter "KAVES") project prioritizes maize because of its major role as both a food crop and a source of household income. Maize is Kenya's main staple, providing 65 percent of food crop caloric intake and 36 percent of total food caloric intake for both urban and rural households (FAO Stat, 2009). The KAVES baseline survey in 2013 found that 97 percent of the estimated 3.5 million small-scale farmers include maize in their farming systems and a 2015 survey of KAVES beneficiaries showed no significant change. Maize drives food security directly, while contributing to livestock productivity and the commercialization of higher value, nutritious crops through crop rotation. It offers the most accessible market and source of income for farmers through an extensive network of local buyers of surplus maize. Maize is important to smallholder dairy and livestock farmers for which the cost of feed is the main factor affecting their competitiveness.

Methodology

Since many studies in the past have analysed various aspects of the maize value chain, a preliminary SWOT analysis was carried out in consultation with all members of the KAVES technical team; KAVES' subcontractors; and other maize stakeholders, to determine existing gaps in the literature and identify areas for further data collection and analysis. Based on this process, field surveys, focus group discussions (FGDs) and key informant interviews were carried out to update existing information, validate secondary sources, and provide primary data specific to the KAVES target areas. Relevant secondary sources were reviewed and analysed and are discussed in this report with, in some cases, alternative analyses and interpretations carried out. Primary data validation was collected through a series of FGDs with farmers, traders and processors in selected target counties. Data collected as part of the KAVES baseline survey of 1,800 farmers was analyzed and pooled with a second panel survey selected from the first 16,000 farmers receiving KAVES' support. Finally, smaller rapid market surveys of traders were carried out to obtain specific information on costs and margins at different levels of the value chain. The report was finally validated by a small group of leading researchers, industry players and technocrats in November 2014. Minor updates were made in July 2015 to reflect changes in data analysis and conditions.

SUMMARY OF KEY FINDINGS

Consumption and Demand Analysis

Per capita maize consumption shows a steady downward trend from about 90 kilograms in 2003 to 67.5 kilograms in 2012. It is projected to decline further to 56.3 kilograms in 2022, as consumers increasingly substitute cooking bananas, Irish potato, sweet potato, and cassava in place of maize as a result of increasing incomes, and higher urbanization rates. Population growth, however, is likely to lead to modest (1% per year) overall increase in aggregate demand for maize (including human consumption, seed, animal feed, and other industrial uses). The Table below summarizes demand projections into 2022, and indicates an increase from 2.96 million metric tons in 2012 to 3.3 million tons in 2022. Urban consumption will drive most of the growth in demand, as the total maize consumption by rural areas is projected to grow at only 0.5 percent per year, and will be only 5 percent higher than its 2012 levels (compared to 25 percent for urban areas).

Consumption Segment	2012	2017	2022	Growth
Rural households	2,253,409	2,319,370	2,358,002	0.5%
Urban households	514,174	569,957	641,270	2.2%
Animal feeds industry	122,373	176,179	233,556	6.7%
Seed and other domestic uses	71,463	74,044	82,026	1.3%
Total	**2,961,419**	**3,139,550**	**3,314,854**	**1.1%**

Supply Analysis and Production Potential

Average maize yields have declined from 2.2 MT/ha in the 1990s to 1.74 MT/ha in 2012. The 2013 USAID-KAVES baseline survey for the Feed the Future (FtF) target counties found an average yield of 1.8 MT/ha, ranging from 0.4 MT in Taita Taveta and Kericho to 3.33 MT in Nandi. While Kenyan yields may be considered fair relative to other producers in sub-Saharan Africa, they are well below potential, as illustrated by Kenya's previous ability to achieve average yields above 2.0 MT/ha (a reasonable target for rain-fed systems).

We portray two scenarios for the medium and long-term maize markets in Kenya, one optimistic and one "status quo". Under the optimistic scenario we assume yield increases of 1 percent per year, continued expansion of planted area at 2.5 percent, and no significant weather or disease events. Under this scenario we estimate that, by 2022, production area will grow to 2.7 million hectares, production volume will expand to 5.23 million MT, total maize availability will increase to 3.9 million MT, creating a surplus of 0.91 million MT. However, continued expansion of maize area at historical rates may be overly optimistic given increasing land pressures and fragmentation. Without effective interventions at national level, yield increases may also be overly optimistic, having stagnated in high potential counties over the last seven years. Under the status quo scenario, production is still projected to meet domestic food demand in 2022 but unlikely to contribute significantly to farmers' incomes. Under the optimistic and status quo scenarios, projected surpluses are thin enough that they can easily turn into deficits in years with unfavorable weather conditions. Higher yield increases than 1 percent per year are required to avoid this threat.

Our analysis shows that Kenya could attain maize self-sufficiency, without increasing planted area, with modest increases in yields and reductions in postharvest losses. **Interventions that target higher farm yields and lower postharvest losses will have the highest returns, not only at the national supply level, but also through increased income for farmers and traders.** Going forward, risks to Kenya's rain-fed farming system will need to be proactively managed, addressing technology and management gaps in the face of the growing challenges of shrinking farm size, increased climatic variability and pressure from new pests and diseases.

The Maize Value Chain

Input Suppliers: Four importers control more than 85 percent of the fertilizer market. While Kenyan fertilizer prices compare favorably against those of its East African neighbors, they are well above prices in major exporting countries. Since only about 41 percent of all farmers use fertilizers consistently, there is substantial room for market growth. Interventions could include soil nutrient amelioration and fertilization; soil management education and training; soil testing and mapping; and customized fertilizer blending to meet nutrient requirements of various soils.

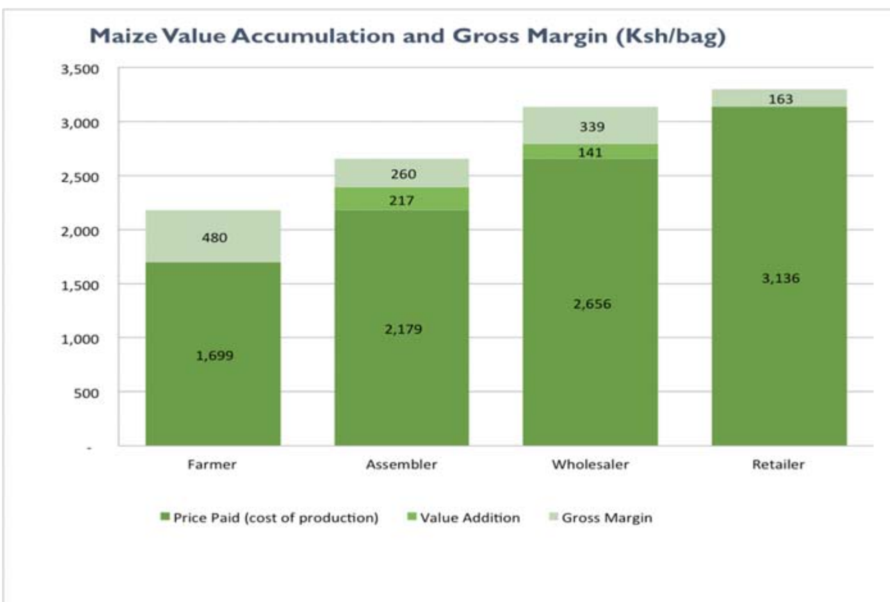
Maize seeds range from local landraces to composites and hybrids. Local landraces are poorer yielding but have an advantage of being suited to local conditions. Many farmers still plant their own saved seed, or acquire seed directly from other farmers in their communities. Certified seed from registered companies is readily available, with 90 percent locally produced and the balance imported. Whilst the yield potential of hybrid varieties is not in doubt, the USAID-KAVES baseline data showed that, in practice, farmers are only achieving small differences in yields between hybrid and local seed when combined with fertilizer. **There is a clear need for KAVES to stress the importance of total productivity packages in order for farmers to benefit from investment in improved seed.**

Farmers: While more than 3.4 million smallholders plant maize, less than one-quarter of them actually sell maize commercially and most are net buyers. Due to limited capital and lack of application of good agriculture practices, many do not use productivity-enhancing inputs such as fertilizer and improved seeds effectively. For those that do use inputs, their main sources are thousands of small-scale agro-dealers and stockists located within rural market centers. Despite the efforts of previous projects, smallholders face limited access to other important services such as mechanical tillage and harvesting services, drying facilities, and safe storage technologies.

Marketing Actors: Maize marketing is a comple system consisting of thousands of small assemblers, brokers, medium-scale wholesalers, large wholesalers, transporters, and retailers. Farmers primarily sell in small quantities to small-scale, under-capitalized traders (assemblers), making aggregation time-consuming and incurring substantial costs for assembly, handling, and grading. Rural-based traders suffer from low margins, poor access to credit, and inadequate storage facilities. **More efficient aggregation by better-organized farmer groups can have an immediate impact on margins and incomes at the village level.**

Margins Analysis

By normal trading standards the average gross margins for post-farm value chain actors are not excessive. The relatively small margins they achieve, coupled with high risks of wastage and other forms of economic loss, leave little room for increasing farm gate prices by squeezing other actors' margins. These thin margins are indicative of the high cost of doing business along the maize value chain, starting with the cost of assembly and transportation. **The best opportunity for increasing producer margins is by raising on-farm productivity, improving quality, reducing post-harvest losses, and increasing market efficiencies of scale though well-managed aggregation systems.**



Enabling Environment

Policy regime: Government intervention in the maize market to support domestic production and manage imports is a common occurrence. There is a high level of political sensitivity to maize prices, leading to attempts to support, suppress, or stabilize prices and often creating uncertainty within the sector.

Supporting Organizations & Institutional Actors: Public regulatory institutions are generally weak because of insufficient resources and low credibility, so their ability to regulate and enforce quality standards is limited. The legal institutions regulating rural commerce are ineffective and thus contribute to market inefficiencies.

Devolution of decision-making: Emerging county agriculture policies and regulations will significantly reshape Kenya's agricultural policy regime in the future, changing local organization in the areas of extension and education, supply of inputs, marketing policies, and production support strategies. Intervention projects must be tailored to the unique needs of the devolved units and provide capacity building to establish well-functioning governance structures at county level.

Infrastructure: The poor state of storage facilities and roads contributes to high production costs, low sale prices, and economically significant post-harvest losses. The decline in investment in rural infrastructure after trade liberalization, especially rural access roads, has increased the costs of maize marketing players and limited the ability of smallholder farmers to negotiate better market prices.

UPGRADING INTERVENTIONS

Based on the information and analyses carried out, using data from both previous studies and surveys carried out in 2013/14 by KAVES, three strategic components are recommended for the KAVES approach to upgrading the maize subsector. These are supported by eight strategic interventions and twenty upgrading objectives that will increase on-farm productivity, streamline and commercialize crop aggregation, and improve storage and postharvest systems. Interventions have been selected that will contribute directly to the goals and objectives of the project and are highly scalable through private sector partnerships, with varying levels of public sector support. The interventions all rely heavily on the mass adoption of new technologies, supported with specialist training and extension; new sources of investment and credit to unlock value chain constraints; and engagement of private sector partners for market development and sustainability.

Recommended intervention	Specific upgrading objectives	Challenges	Expected outcomes
Strategic component 1: Increase Productivity			
1. Promote reduction in average area of maize planted per household by smallholder farmers	1. Farmers will focus more on increasing yield per unit area by optimizing use of inputs 2. Greater use of irrigation for mixed horticulture and maize production systems	• On-time availability of inputs • Traditional low input approach to maize production • Weak input distribution systems	• Increased yields • Higher farm incomes • Increase in county and national production
2. Support application of integrated soil fertility management systems (ISFM)	3. Site specific soil analysis and fertilizer selection 4. Precision application of fertilizer 5. Increased use of lime, blended and customized fertilizer	• Cost of extension to reach 500,000 farmers • Finance for farmers to buy inputs. • Finance for stockists to supply inputs. • Fertilizer suppliers lack capacity to serve smallholder sector	• Increased yields • Lower costs per unit of production • Higher gross margins • Increase in total production

3. Increase availability of labor-saving technologies	6. Distribution networks improved for small-scale technologies 7. New rental businesses established at village level for cultivation, harvesting, shelling and drying equipment 8. Widespread adoption of herbicides and foliar feeds	• Capital cost of equipment • Land size limits range of equipment that is cost-effective • Environmental objections to herbicide use	• Reduced cost of production • Higher yields • Higher margins • Progressive farming systems • Youth participation • Less farm and more productive work for women
4. Introduce precision selection of varieties	9. Greater adoption of location-specific varieties with optimum yield potential 10. Increased availability and adoption of "water efficient maize for Africa" (WEMA) varieties and striga resistant seed	• Cost of hybrid seed • Weak outreach of seed suppliers • Regulatory bottlenecks	• Reduction in crop failure • Less financial risk • Higher yield potential
Strategic component II. Strengthen Marketing and Aggregation			
5. Promote collective marketing	11. Greater on-line access to market information 12. Marketing agreements and contracts between farmer groups and buyers 13. Well-managed collection centers	• Traders slow to adopt new business models • Side selling	• Increased smallholder bargaining power • Lower costs • Higher quality • Less wastage
6. Stimulate new investments in equipment and facilities	14. Minimal wastage 15. Cost and quality efficient logistics	• Availability of capital • Lack of volume to justify investments	• More competitive prices and quality • Less wastage
Strategic component III. Reduce Postharvest Losses			
7. Facilitate new investments in household and commercial storage systems	16. Cost-benefit analyses of on-farm and aggregated bulk storage systems 17. Widespread adoption of cost-effective hermetic bags for household storage 18. Investment in silos and storage structures by aggregators	• Cost of systems • New technology • Lack of competition between suppliers	• Reduced value of wastage • Increased availability of maize at household level • Safer products, better nutrition
8. Provide training to raise quality standards	19. New grading systems introduced 20. Adoption of digital scales and moisture meters by aggregators and traders	• No price/quality incentives • Cost of equipment	• Higher quality grain • Safer maize products • Higher net returns

1. INTRODUCTION AND BACKGROUND

INTRODUCTION

Maize is Kenya's principal staple food crop, providing substantial caloric intake to most urban and rural households. In 2012 an estimated 2.1 million hectares[1] of maize were planted and 97 percent of the estimated 3.5 million small-scale farmers across the country include it in their farming system (KAVES baseline survey 2013, Tegemeo Institute, 2009). Maize accounts for nearly 20 percent of total food expenditures among the poorest urban households[2], therefore any factor that threatens maize production and supply becomes a national food security issue. For this and other reasons (see text box), maize was selected as a priority crop for USAID-KAVES.

Justification for Maize as a USAID-KAVES Targeted Value Chain

- Main staple crop that drives food security directly, while also contributing to livestock productivity and the commercialization of higher value, nutritious crops through crop rotation.
- High potential impact on household and national incomes by increasing production, trading and value due to high production (3.81) and distribution (8.33) multipliers.
- Offers the most accessible market and source of income for many farmers through extensive network of existing local buyers of surplus maize.
- Likelihood of increasing smallholder competitive advantage in the domestic market due to trending higher global prices (with import parity prices expected to continue to increase over the medium-term).
- Importance to dairy and livestock farmers for which the cost of feed is the main factor affecting their competitiveness.
- High potential maize zones located within Feed the Future target counties, including opportunities for particularly vulnerable households in marginal semi-arid (SA2) areas (e.g. newly available short-cycle maize varieties along with low-cost water management techniques).
- Potential for integration with cash crops production (the most viable system for most farmers in the target areas for agronomic, marketing and food security reasons).
- Promising emerging business models (e.g. contract farming and warehouse receipts) with potential to make maize production and marketing systems more efficient.
- Strong world-class partnership opportunities with private-sector companies and national and international maize research institutions based in Kenya (i.e. valuable resources that can be utilized to increase outreach and impact through collaboration).

As background and a starting point, Section 2 provides an analysis of domestic consumption and demand characteristics, and Section 3 examines production/trade trends and estimates future supply under various scenarios. Section 4 looks at the maize value chain in detail (highlighting key actors, their interactions and critical constraints and gaps). Section 5 examines gross margins along the value chain using primary data collected through field surveys, while Section 6 provides an overview of key constraints to the business-enabling environment (inclusive of infrastructure and regulatory/policy constraints). Based on the gaps, constraints and opportunities identified, Section 7 provides recommendations for "upgrading interventions" along the value chain where USAID-KAVES is best placed to stimulate increases in productivity and incomes.

METHODOLOGY

Because various aspects of the maize value chain have been the subject of numerous other studies and analysis over the past decade, a preliminary SWOT analysis was carried out in consultation with all members of the USAID-KAVES technical team, subcontractor Farm Concern International (FCI) and other maize sector experts to

[1] Ministry of Agriculture statistics
[2] Similar data on food expenditures in rural areas was not available, but it is estimated to be higher than urban areas.

determine the most critical gaps and constraints within the value chain and to identify areas where further data collection, research, and analysis were needed to prioritize interventions. Based on this initial SWOT analysis (see Table 1), field surveys, focus group discussions (FGDs), and key informant interviews were carried out to update outdated information, validate secondary sources, and particularly to obtain primary information specific to USAID-KAVES' targeted geographical areas.

Sources: USAID-KAVES technical team, focus group discussions (FGDs) and key informant interviews (June 2013)

Table 1: Preliminary SWOT Analysis for Maize Production and Marketing

Strengths	Weaknesses	Opportunities	Threats
• Availability of subsidized fertilizer • Availability of certified seeds • Introduction of drought resistant varieties • Availability of fertile and productive land • Favorable climatic conditions (including generally reliable rains) • Availability of ready markets with maize being the primary staple food • Value chain with many actors (and a very high multiplier effect)	• High cost of inputs, including fuel, fertilizer, and seed • Inefficient input and output markets • Poor soil fertility management • Price fluctuations and delayed payment by buyers • Inadequate storage facilities • Weed and pest infestation • Poor postharvest management • Lack of heat and drought resistant varieties • High cost of aggregation	• Ready markets and substantial installed milling capacity • Value addition into other products • Formation of producer groups for better marketing (and aggregation) • Climate change to open new areas suitable for maize production (e.g. high altitude) • Potential export markets in South Sudan and other deficit areas in the COMESA region • Introduction of nitrogen- and water-efficient seed varieties	• Rapidly declining soil fertility • High and escalating cost of inputs • Unpredictable weather patterns • High prevalence of pests and diseases • Aflatoxin contamination • Adulterated seeds • Increasing urbanization leading to loss of farmland • Devolved policies creating unpredictable, less favorable business environment

All relevant studies and data were reviewed and are discussed in this study, in some cases with alternative analyses carried out and interpretations made. These are referenced throughout the study and all sources are listed in Annex I. Primary validation data was collected by subcontractor FCI through a series of FGDs with farmers, traders and processors in selected target counties. Data collected as part of the USAID-KAVES baseline survey of 1,800 farmers was analyzed and pooled with a second panel survey of farmers selected from the first 16,000 USAID-KAVES farmers receiving support. Finally, a smaller survey of traders was carried out to obtain specific information on margins at different levels of aggregation. The study was carried out between March and November 2013. All the growth rates reported in this report use the Compounded Annual Growth Rate (CAGR) formula.

LESSONS LEARNED FROM PAST USAID INTERVENTIONS

USAID's Kenya Maize Development Program (KMDP) was implemented from 2002–2010, providing technical assistance to targeted smallholder maize farmers mainly in the high- and mid-potential maize producing districts of Kenya's Western and Rift Valley provinces. It was designed to increase household incomes for value chain actors by promoting increased awareness and involvement in every step of the maize value chain. Five key lessons were learnt by KMDP that informed the design of USAID-KAVES and will contribute to project implementation:

1. KMDP and other USAID-funded projects were successful in creating many new partnerships between farmer groups and other actors in Kenya's maize value chain but the relatively low value of maize as a cash crop was a disincentive for investment in inputs and adoption of improved practices by many farmers with less than two acres of productive land.
2. Smallholder maize farming as it is commonly practiced in Kenya, as a low input-low output system, is not sustainable over the long-term. The globalization of world markets and the

liberalization of trade require development of new business models for efficient aggregation and quality management that increase the competitiveness of small-scale producers.

3. KMDP successfully reached out to a large number of smallholder farmers but to transform the three million maize producers in Kenya requires more investment and innovations to spread change beyond the direct participants in projects. There are still many farmers in Kenya who are in need of technical assistance.
4. Over the long term, smallholder maize farmers need to become more diversified and include higher value crops in their farming systems to become economically viable.
5. KMDP subcontractor Farm Input Promotions Services Africa (FIPS) established a network of demonstration plots for new maize varieties and fertilizer trials. These showed that maize yields can increase significantly by focusing on soil fertility management, soil testing, liming, use of hybrid seed and modern land preparation technologies. The introduction of mini-input packs that smallholders can afford was particularly effective.

USAID supported One Acre Fund for a year in 2012-13, to implement the **Asset-Based Financing for Smallholder Farmers Project (ABFSF),** building on the progress made in upgrading the maize value chain by KMDP. ABFSF established a permanent revolving fund that increased smallholder farmers' access to finance through the provision of credit for high quality seed and fertilizer. In addition, it linked farmers to seed and fertilizer firms; provided technical assistance through a network of trained field officers; formed groups for aggregating surplus production. Ket lessons learnt were:

1. It is important to diversify the number of crops that are offered within the loan package.
2. Changing the planting behaviors of farmers is a challenge but opportunity exists through training and messaging on crop diversification.
3. Farmer group leaders can make good extension agents at community levels and there is a need to continue building the capacity of support field staff and group leaders to ensure sustainability and greater outreach
4. Grain storage commitment mechanisms, such as group storage pledges and 'bag tags', can increase local storage, boost harvest profitability, and potentially reduce the effect of the hunger season on farm families.

The USAID-Kenya Agricultural Research Institute (KARI) Partnership for Increased Rural Household Incomes (2004-2013), built on previous collaborations from 1967. Under this program, KARI researched a range of agricultural and natural resource management systems that included the maize value chain. Specific lessons and results relevant to KAVES include:

1. A range of improved varieties were produced by KARI scientists for different ecological zones. Research focused on mid-altitude and highland varieties that are resistant to three specific problems: Grey Leaf Spot, Maize Streak Virus and Striga. However, the developed research products have not been adopted on the scale needed to impact on national production.
2. With private sector partners, KARI is investing in commercial production and distribution of its products and reaching out to stimulate demand from smallholder producers.
3. Researchers have linked low productivity to the long-term use of di-Ammonium Phosphate (DAP) and Calcium Ammonium Nitrate (CAN), continuous cropping; soil erosion on sloping lands; and poor water conservation practices.

Transferring these results and solutions to commercial practice is a continuous challenge for KARI and provides immediate opportunities for USAID-KAVES that are included in priority interventions recommended below in section 7. Interventions by other donors and GOK are also taken into account in this study. In particular the DFID-funded activities of the African Agricultural Technology Foundation on drought-tolerant and striga-resistant maize varieties and the work of FAO and Purdue University on smallholder-scale, storage systems.

2. CONSUMPTION AND DEMAND ANALYSIS

This section examines how much demand is likely to increase in the next five to ten years. We build consumption and demand scenarios to evaluate the future of the maize industry in Kenya, including how changing food preferences (i.e. the increasing shift to consumption of alternatives to maize) will affect the national outlook for the industry. We use population statistics, urbanization rates, and per capita consumption trends to project Kenya's maize needs into 2022.

As Kenya's population and economy grow and the level of urbanization increases, demand for maize will increase both for human and animal consumption (the latter as feed for the expanding beef, dairy, poultry, and pig industries). Kenya's total population is currently estimated at 44 million and is growing at approximately 2.7 percent annually, with urban population growing at a faster rate of 4.4 percent per year compared to 2.2 percent in rural areas (WDI, 2014). To feed this population, maize supply must keep pace with its growth and changing food preferences.

2.1 NATIONAL DEMAND ESTIMATION

Maize is the main staple food in Kenya, accounting for 65 percent of caloric intake from staple foods and 36 percent of total caloric intake. Data on maize consumption is thin and have mixed quality. The actual consumption per person is less understood, with most estimates assuming one 90-kg bag per year. Kirimi et al. (2011) estimated Kenya's average per capita consumption at 88 kilograms of maize products per year, in the form of maize flour for ugali, grain for githeri/nyoyo (a mixture of maize and beans or other pulses), mukimo (a mixture of maize, mashed potatoes and vegetables), and steamed/roasted green maize.

Popular assumption is domestic demand for maize has consistently exceeded local production in recent years. New data however show significant declining per capita consumption of maize products, especially in urban areas. When we account for these declines and variations in consumption between the rural and urban areas, the analysis in this report suggests the official estimates may be overestimating Kenya's actual consumption requirements.

Aggregate demand for maize will continue to increase although at a lower rate than population growth due to decreasing per capita consumption, as consumers increasingly diversify to substitutes.

The analysis in this section uses several sources of secondary data to arrive at an estimate of the national per capita consumption. Tegemeo Institute Household Panel Surveys since 1995 are the only sources of historical consumption data in urban areas; the latest series is 2009. The data is published in: Muyanga, Jayne, Argwings-Kodhek, & Ariga (2005), using 1995 and 2003 data; Musyoka, Lagat, Ouma, Wambua, & Gamba (2010), using 2003 data; and, Kamau, Olwande, & Githuku (2011), 2003 and 2009 data. The surveys show urban per capita maize consumption steadily declined between 1995 and 2009, by about 3% per year. From an average consumption of 89.8kg per person in 1995, consumption declined to 57.6kg in 2009 (see Table 2). Consequently, the 2009 average per capita maize consumption in Nairobi was only 64 percent of its 1995 levels. The average declines were steepest among the lowest 40 percent households, at 4.5% and 3.4% per year in the lowest and lower quintiles, respectively. These rates of decline however slowed in later series of the surveys (2003-2009), except for households in the highest income quintile, where it significantly accelerated (5.9% per year); it increased at a decreasing rate of 10 percent during the period (2.8%).

Reasons for the declining trend in maize consumption are less understood. Basic demand theory however points to three possible explanations: i) maize is an inferior good, with less of it consumed as average incomes rise; ii) maize is highly price elastic - both own price and cross price elasticities are greater than one, so price inflation drives consumers to reduce consumption levels and/or switch to relatively cheaper alternatives; iii) increased substitution with alternatives that are considered healthier and/or have become more available – increased dietary diversity. We use Table 2 and growth in per capita income to test proposition (i), price trends to test (ii), and per capita consumption of maize alternatives to test the third proposition.

Table 2: Annual Per Capita Maize Consumption in Nairobi, kilograms, 1995-2009

Year	By Income Quintile					Average
	Lowest	2	3	4*	Highest	
1995	107.4	100.7	94.8	83.6	69.4	89.8
2003	70.8	67.3	68.9	51.8	65.6	68.4
2009	56.4	62.4	61.2	57.6	45.6	57.6
CAGR (2003-2009)	***-3.7%***	***-1.3%***	***-2.0%***	***1.8%***	***-5.9%***	***-2.8%***
CAGR (1995-2009)	***-4.5%***	***-3.4%***	***-3.1%***	***-2.6%***	***-3.0%***	***-3.1%***

*Source: Muyanga et al. (2005); Kamau et al. (2011). *The only quintile showing increased consumption between 2003 and 2009. We suspect entry or typographical error in the 2003 data.*

In urban areas, Muyanga et al. (2005), Musyoka et al. (2010), and Kamau et al. (2011) found maize products are inferior goods whose consumption drops significantly with increases in average income. Muyanga et al found an inverse relationship between maize consumption and household income, with per capita consumption dropping by 7 percent as one moves from the lowest income quintile to the highest quintile. Moreover, Musyoka et al. (2010) found income (expenditure) elasticity of demand for maize and its products (posho and sifted flour) is less than one; a 1% increase in food expenditure increases the expenditure on maize products by less than 1 percent, which means the share of maize products in total food expenditure declines with income. This is confirmed in Muyanga et al., which found the share of maize in staple carbohydrates consumption declined by 100 percent between the poorest 20% households (43.8%) and the wealthiest 20 percent (22%).

Table 2 confirms the wealthiest 20% households consumed about 37 percent less maize per person compared to the poorest 20% households in 2009. Kenya's per capita incomes have however not grown significantly enough to fully explain the 3 percent average annual decline in consumption. Over the past decade (2004-2013), the national per capita income grew at an average 2 percent per annum (probably higher in urban areas, but we lack data to support it). For every 1% increase income, maize consumption is expected to decline by 0.4 percent (Musyoka et al.); this translates to 0.8% decline per year and a total of 5 percent over six years, which is significantly less than the 16.8 percent decline recorded between 2003 and 2009.

The second possible reason for declining per capita consumption of maize is price inflation. This effect can manifest itself in average prices rising beyond the levels most consumers can afford (reduced consumption) and/or relative maize prices rising to make its alternatives more attractive to consumers (substitution). The former is explained by the effect of own price elasticity for maize products, while the latter functions through cross price elasticity and should lead to greater substitution into other foods. Musyoka et al. found own price elasticity of maize products in urban areas was minus 1.85 (sifted flour) and minus 1.74 (maize), with much higher elasticity's among the non-poor households. The authors also found substantial substitution effect for maize, in both the poor and non-poor households, with the latter the most likely to substitute maize when prices increase. Demand for maize products is therefore highly sensitive to marginal price changes. We analyze price trends, including nominal, real and relative prices to test this proposition.

Nominal wholesale maize prices have increased significantly since 2005, more than doubling over the period, 2005-2013, as noted Table 3. The national average wholesale price increased at 9.4 percent per year during this period. During the period between 2009 and 2013, average prices grew at 7 percent per year, then accelerated to 32.6 percent per year during 2011-2013. In contrast, the Table further shows average real prices stayed flat during the period 2005-2013, and declined by 2.9 percent per year between 2009 and 2013.

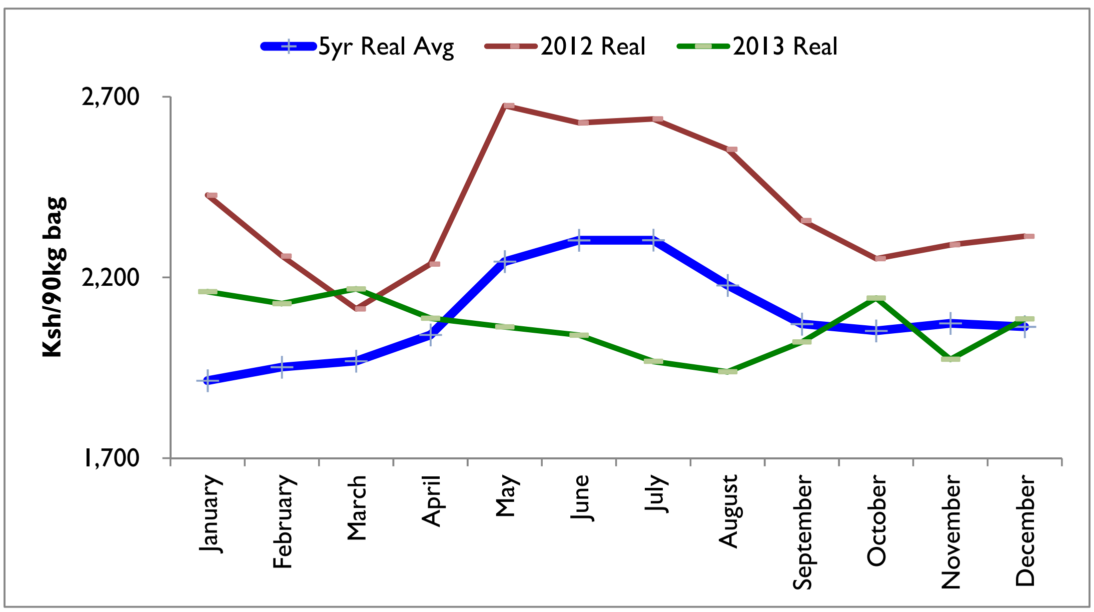
Table 3: Change in Average Wholesale Maize Prices, 2005-2013

	CPI (Feb. 2009=100)	Nominal Price (KSh/90-kg bag)	Real Price (KSh/90-kg bag)
January 2005	70.48	1,461	2,073
January 2009	97.55	2,292	2,349
January 2011	110.57	1,706	1,543
Dececember 2013	143.85	3,000	2,086
CAGR (2005-2013)		***9.4%***	***0.1%***
CAGR (2009-2013)		***7.0%***	***-2.9%***
CAGR (2011-2013)		***32.6%***	***16.3%***

Source: USAID-KAVES calculations from MOALF market data

Maize prices have either kept up with or trailed inflation rates. The recent sharp increases follow a general spike in international maize prices between 2010 and 2012, and a 2.2 percent decline in maize production in 2011. The monthly real prices in 2013 were however lower than those in 2012 and the 5-year averages (Fig. 1). For price inflation to explain declining per capita maize consumption, real prices needed to rise 10 percent over the period 2003-2009.

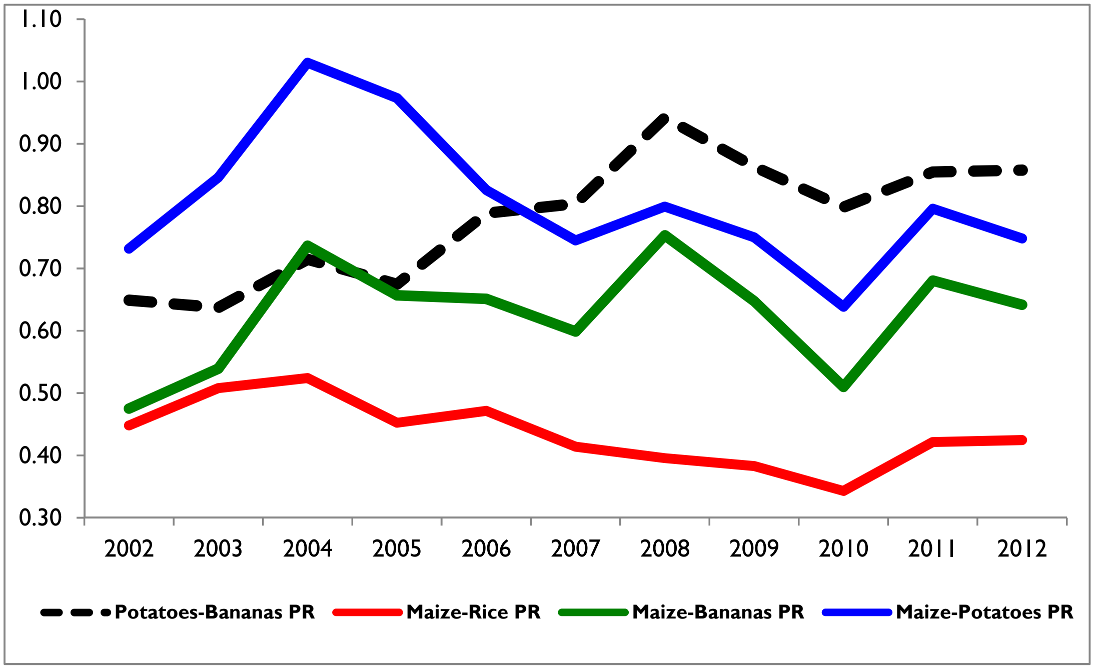
Figure 1: Real Prices for Maize



Source: KAVES calculations from MOA/KNBS

An analysis of relative prices for maize against its closest alternatives, such as rice, cooking bananas and potatoes further clarifies the price effect. Fig. 2 shows maize price ratios against selected substitutes between 2002 and 2012, with maize price in the numerator. It is evident that, except for cooking bananas, changes in maize prices have trailed those of substitutes. Since 2004, average prices of rice and potatoes changed faster than that of maize, thereby making them relatively more expensive to maize. In contrast, cooking bananas became relatively much cheaper than maize and potatoes since 2002. Changing relative prices of maize can thus explain only a small part of the decline in its per capita consumption. Part of the reason for relative price effect is the increased availability and acceptance of alternatives to maize, with cooking bananas, Irish and sweet potatoes, cassava and sorghum/millet emerging as important substitutes. These substitution trends are discussed next.

Figure 2: Retail Price Ratios for Maize, Bananas, and Potatoes, 2002-2012



Source: KAVES calculations from KNBS (2013)

Finally, consumption shares of alternatives staples are growing due to increased availability and accessibility to a diversified basket of foods. The role of maize has therefore diminished in most households' diets. Part of this is attributable to increased awareness about health and nutrition benefits of alternative foods, especially among higher income households, the preference for more convenient foods, and changes in relative maize prices. The share of maize in staples consumption of urban households has declined precipitously since 1995. As a share of total staples consumed, maize products constituted 58 percent in 1995, 45 percent in 2003, and 33 percent in 2009 (Muyanga et al.; Kamau et al). The largest declines occurred among the middle 20% and the wealthiest 20%. In an expanded list of staples that includes potatoes, cassava, and millet/sorghum, the share of maize was only 23 percent in 2009 (Kamau et al, p. 18). Additionally, whereas maize products contributed 42 percent and 32 percent of the total staples consumption expenditure in 1995 and 2003, respectively, its share further declined to 29 percent in 2009. Musyoka et al (2010) found consumption rates for maize products in Nairobi were much lower than those of alternatives, such as wheat products and rice, with the wealthiest households consuming less maize products and more wheat and rice products than their poorest counterparts.

The aforementioned consumption differences are captured in Tegemeo's panel survey results contained in Table 4. There have been large increases in the per capita consumption of alternatives to maize since 1995; most notable is the sharp rise in per capita consumption of cooking bananas across all income groups, compared to flat or modest increases for rice and wheat products. Confirming the relative price trends captured in Fig. 2, cooking bananas has emerged as the leading alternative to maize and other sources of starchy food in urban areas. Its consumption increased by 333 percent between 1995 and 2003, and by an additional 201 percent in the period, 2003-2009. Overall, the urban per capita consumption of bananas in 2009 was 13 times higher than in 1995, increasing its share in total staple consumption from 2.6 percent in 1995, 11 percent in 2003, to 30 percent in 2009. When the list of staples is expanded to include potatoes (Irish/sweet), cassava, sorghum and millet, cooking bananas contributed 20.6 percent of the total consumption in 2009, with per capita consumption nearing parity with potatoes (Irish/sweet).

It is also notable that the correlation between the consumption of bananas and income levels is weak, and it is most popular among households in the middle-income group (Muyanga et al.). As average per capita incomes increase toward the middle-income quintiles, the consumption of cooking bananas is expected to rise. The switch to bananas therefore appears decisive and provides the most plausible explanation of the declining maize consumption per capita. If the trends shown in Table 4 continued, our analysis estimates that cooking bananas had overtaken potatoes and maize as the leading staple food in urban areas by 2012.

Table 4: Annual Per Capita Consumption of Maize Alternatives in Nairobi, kilograms, 1995-2009

Food item	Year	By Income Quintile					Average
		Lowest	2	3	4	Highest	
Cooking bananas	1995	4.1	1.4	2.8	7.6	3.4	4.0
	2003	9.0	14.3	22.6	21.7	18.2	17.2
	2009	25.2	33.6	52.8	67.2	87.6	51.6
	CAGR (1995-2009)	***26%***	***48%***	***45%***	***31%***	***50%***	***38%***
	CAGR (2003-2009)	***19%***	***15%***	***15%***	***21%***	***30%***	***20%***
Wheat products	1995	25.3	31.9	44.8	42.7	48.7	39.2
	2003	27.0	37.0	41.6	57.1	67.0	46.0
	2009	23	32	50	54	70	46
	CAGR (1995-2009)	***-1%***	***0%***	***1%***	***3%***	***5%***	***2%***
	CAGR (2003-2009)	***-3%***	***-2%***	***3%***	***-1%***	***1%***	***0%***
Rice	1995	17.4	18.7	21.8	22.3	25.6	21.4
	2003	13.9	18.6	16.6	21.5	24.1	19.0
	2009	12	18	23	26	26	20
	CAGR (1995-2009)	***-5%***	***0%***	***1%***	***2%***	***0%***	***-1%***
	CAGR (2003-2009)	***-2%***	***-1%***	***6%***	***3%***	***1%***	***1%***

*Source: KAVES calculations from Muyanga et al. (2005) & Kamau et al. (2011). * No comparable data for Irish/sweet potatoes in 2003.*

In conclusion, therefore, maize consumption trend is conforming to its "inferior good" properties and succumbing to intense pressures from increasingly accessible substitutes. As incomes increase, the rate of urbanization rises, and bananas, potatoes, and other starchy foods become more available and acceptable to consumers, we expect the per capita consumption of maize to decline even further in the next ten years. The decline will occur at a decreasing rate of 10 percent in the near term and possibly higher rates in the medium term, as consumers approach what would be considered optimal consumption levels and maize substitutes become relatively more expensive than presently.

No consumption data are available for other urban and rural areas. This analysis therefore derives comparable consumption data for these areas from the Nairobi data. By its cosmopolitan nature Nairobi is fairly representative of other major urban centers. We adjusted the Nairobi consumption numbers for other urban areas using proportions of the population in each income class, following the 2013 Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID) report on inequality (henceforth, KNBS/SID, 2013). A further assumption is that per capita maize consumption in the rural areas should not deviate significantly from those of urban lower income classes.

We estimate the poorest 40% and middle 20% households in rural areas consume about 1.3 times the average per capita of their counterparts in urban areas, and the rural upper 40% households consume

1.2 times their urban equivalents. These multipliers account for relatively higher proportion of whole/posho meal in rural maize diets than urban areas. Table 5 contains the population shares and estimated consumption by income quintiles for 2009. After adjustments, the average per capita consumption in 2009 was 55.2 kg in urban areas and 75.4 kg in rural areas. These estimates form the basis of the consumption and demand analysis in this report.

Table 5: Population Shares and Estimated Per Capita Maize Consumption in 2009

Item		Income Quintiles					Total
		Lowest	2	3	4	Highest	
Population Share (%)	Nairobi	0.6	19.2	15.3	20.2	44.7	100
	All Urban	2.6	28.7	15.3	19.3	34.1	100
	Rural	44.6	21.1	20.5	12.2	1.5	100
Estimated Consumption Per Capita (kg/year)	Nairobi	56.4	62.4	61.2	57.6	45.6	**54.0**
	All urban	56.4	62.4	61.2	57.6	45.6	**55.2**
	Rural	73.3	81.1	79.6	69.1	54.7	75.4
Consumption Multiplier	Rural-urban	1.3	1.3	1.3	1.2	1.2	1.36

Source: KAVES calculations from KNBS/SID (2013) & Kamau et al. (2011)

We have used the aforementioned survey results and various demand parameters and assumptions to estimate per capita consumption and project demand over the next five to ten years. The parameters include disaggregated rural and urban projections for population, urbanization, and per capita consumption. The analysis estimates per capita consumption in urban areas declines at an average compounded rate of 2.6 percent per year until 2017, then at a decreasing rate (10 percent slower) to 2022. In the rural areas, per capita consumption declines at 1.6 percent per year until 2017, and thereafter slows down by 10 percent. These translate to compounded annual rates of decline of 3 percent in urban areas and 1.9 percent in rural areas over the ten years under analysis.

Table 6 contains the consumption estimates and projections from 2009 to 2022. We estimate annual per capita consumption was 67.5 kilograms in 2012, consisting of 70.7 kg in rural areas and 50 kg in urban areas. This is projected to further decline to 61.3 kilograms by 2017 and 56.3 kilograms by 2022 due primarily to increasing incomes, higher urbanization rates, and higher demand for substitute food items. Our estimates are generally in line with the Kenya Economic Survey 2014 Food Balance Sheets, which reported the national per capita maize consumption at 64.9 kg in 2012 and 63.1 kg in 2013 (KNBS, 2014).[3]

The overall projections indicate national per capita consumption will decline at an annual average rate of 1.8 percent over the ten-year period to 2022. Even with population increase, this will lead to only a modest overall increase in aggregate consumption/demand of maize of approximately 1 percent per year, from 2.77 million MT (30.7 million bags) in 2012 to 2.89 million MT (32.1 million bags) and 3.0 million MT (33.3 million bags) in 2017 and 2022, respectively.[4] Urban consumption will drive most of the growth in maize demand, as the total maize consumption by rural areas is projected to grow at

[3] The main difference is the KNBS quantities are derived from supply data and assume waste levels (30%) higher than that used in this report.

[4] These estimates and projections are largely in line with The World Bank (2013) estimates placing Kenya's maize requirements at 32-34 million bags per year.

only 0.5 percent per year into 2022. In fact, the projected rural consumption in 2022 will be only 5 percent higher than the 2012 levels (c.f. 25 percent for urban areas).

Table 6: Estimated and Projected Maize Demand, 2009-2022

		2009	2012	2017	2022
Population Projections	Population ('000)	37,920	42,184	49,496	57,401
	Urban share of population (World Bank estimate)	23.2%	24.4%	26.9%	30.1%
	Annual population growth rate (from previous period)	2.7%	2.7%	2.7%	2.5%
Per Capita Consumption (kg/year)	National*	70.6	67.5	61.3	56.3
	Rural	75.4	70.7	64.1	58.7
	Urban	55.4	50.0	42.8	37.2
Local Consumption & Demand Estimates	National (MT)	2,682,691	2,767,583	2,889,326	2,999,272
	Rural (MT)	2,195,267	2,253,409	2,319,370	2,358,002
	Urban (MT)	487,424	514,174	569,957	641,270
	National (million 90-kg bags)	29.8	30.7	32.1	33.3

*Source: USAID-KAVES estimates/calculations. * Urban per capita consumption continues to decline at CAGR of -2.6% through 2017, thereafter slows by 10% through 2022. Rural per capita consumption declines by -1.6% annually to 2017 and at a rate slower by 10% thereafter.*

These projections could change with decreases in relative maize prices, the emergence of new uses for maize, and innovations that develop maize products currently not in the market. Our rates of decline in per capita consumption could be lower if incomes do not increase fast enough and the room for dietary diversification shrinks with diminished access to alternative staples. Figure 2 indicates a brief improvement in the relative price of maize against cooking bananas between 2008 and 2010. Whether such changes bring consumers back to maize is a question beyond the scope of the present report, and therefore left for further research and debate. What might shift some of the demand for maize is an increase in industrial processing, specifically animal feeds.

2.2 ESTIMATED IMPACT OF ANIMAL FEEDS INDUSTRY ON DEMAND

The growing animal feeds industry competes for maize and is likely to affect its availability for human consumption. The Kenya Economic Survey 2014 shows animal feeds industry has grown by 25.3 percent since 2009 and 8.6 percent in 2013 alone (KNBS, 2014). In 2010, there were approximately 94 mixed feed manufacturing firms in Kenya, with total installed capacity of approximately 843,000 MT.[5] Official sources however reported the number of animal feeds manufacturing establishments at 58 in 2012 (KNBS, 2013). Annual production range from less than 1,000 MT to over 100,000 MT per firm and capacity utilization rate is under 50 percent, due primarily to lack of reliable raw materials. Table 7 presents the gross feed production trends between 2006 and 2012, and estimations of maize grain requirements. It shows quantity of manufactured feed increased from 141,395 MT to 470,664 MT in 2012, growing at 18 percent per year since 2008. The quantum index in 2012 and 2013 were 15 percent and 25 percent higher than in 2009. Consumption of manufactured animal feeds increased by 46

[5] Karuri (2010)

percent and 33 percent in 2012 and 2013, respectively, as a result of relatively dry weather experienced in parts of the country (KNBS, 2014).

According to Karuri (2010), a typical mixed feed manufacturer uses about 200 kilograms of maize grain and 120 kilograms of maize germ per ton of feed. At 80 percent milling efficiency, it takes 5 kilograms of maize grain to produce a kilogram of germ and bran from sifted flour milling process; to produce 120 kg germ requires about 600 kg of maize grain. Since maize germ and bran are byproducts of the milling process, we assume half of the total requirements are already accounted for in consumption analysis in Table 6. The maize grain equivalent for maize germ is therefore approximately 60 kg per ton of feed; this brings the total maize grains requirement to 260 kg per ton. Calculations from these industry averages indicate the total annual requirement for maize grain was approximately 88,041 MT and 122,373 MT in 2009 and 2012, respectively (Table 7). This would have added about 4.4% to the estimated national human consumption in 2012, and translated to an additional 2.9 kilograms to the per capita consumption.

Table 7: Production of Animal Feeds in Kenya, 2006-2012

	2006	2009	2012	2013*	2017**	2022**	CAGR (2009-2013)
Feeds Output (MT)	141,395	338,620	470,664	511,141	677,610	898,294	11%
Estimated Maize Grain Used (MT)	36,763	88,041	122,373	132,897	176,179	233,556	11%
Per Capita Equivalent (kg)		1.5	2.9		3.6	4.1	
Proportion of Total Human Consumption		3.3%	4.4%		6.1%	7.8%	
Quantum Index (2009=100)		100	115.4	125.3			6%

*Source: KAVES calculations from KNBS (2013, 2014). * Estimates from 2012; ** Projections based on 6% linear annual growth rate.*

If the recent historical growth continues, projections in the Table show manufactured animal feed industry will require 176,179 MT and 233,556 MT of maize in 2017 and 2022, respectively. These will add an equivalent of 3.6 kg and 4.1 kg to the national per capita consumption and translate to 6 percent and 8 percent of the projected human consumption in 2017 and 2022. From the above scenarios, Table 9 in Section 2.5 summarizes the maize demand projections. The impact of a growing animal feeds industry is expected to be an important player in national maize consumption/demand and will provide an alternative channel for surplus maize in the face of near-stagnant growth in human consumption. The expanding livestock production sector further presents opportunities for diversification into the production of yellow and fodder (silage) maize as animal feeds, which is a potential diversification strategy for USAID-KAVES.

2.4 CHARACTERISTICS AND REQUIREMENTS OF PRINCIPAL BUYERS

Surpluses generated by farmers tend to be sold in small quantities to market traders at the district level, making the cost of aggregation high. Maize brokers consolidate production from hundreds of village-level assemblers and traders. Sorting and grading takes place mainly at this level, incurring significant handling costs and requiring space, facilities and equipment. The variability in quality between farmers also increases downstream processing and marketing costs. Maize quality and health standards follow the National Cereals and Produce Board (NCPB) quality specifications based on Fair Average Quality (FAQ) parameters adopted from the Kenya Bureau of Standards (the policy environment for quality standards is analyzed in section 6). Maize quality requirements should conform to the East African Community (EAC) quality standards (EAS 2:2013 for grains and EAS 44:2011 for maize flour). Specifications for dry maize are shown in Table 8. It categorizes grains into three grades on the basis of established tolerable limits.

Table 8: EAC quality standards and requirements for shelled dry maize

Specification	Grade 1	Grade 2	Grade 3
Moisture content, %		13.5	
Foreign matter, % (min, max)	0.5	1.0	1.5
Inorganic matter, % (min, max)	0.25	0.5	0.75
Broken kernels, % (min, max)	2.0	4.0	6.0
Pest damaged grains, % (min, max)	1.0	3.0	5.0
Rotten and diseased grains, %	2.0	4.0	5.0
Discolored grains, %	0.5	1.0	1.5
Immature/shriveled grains, %	1.0	2.0	3.0
Total defective grains, %	3.2	7.0	8.5
Total aflatoxin, ppb (max)		10	
Aflatoxin B1, ppb (max)		5	
Fumosin, ppm (max)		2	

Source: EAC Secretariat

The general requirements for dry maize grain include:

1. Maize may be presented as yellow, white, or red, or a mixture of these colors.

- Yellow maize may contain not more than 5% by weight of maize of other colors. Yellow maize also means maize grains that are yellow and dark red in color, provided the dark red color covers less than 50% of the surface of the grain.
- White maize may contain no more than 2% by weight of maize of other colors. White maize also means maize grains that are white and pink in color, provided the pink color covers less than 50% of the surface of the grain.
- Red maize may contain not more than 5% by weight of maize of other colors. Maize grains which are pink and white, grey or dark red and yellow in color are considered to be red maize, provided the pink or dark red or yellow color covers 50% or more of the surface of the grain.
- Mixed maize includes maize that is not white, yellow, nor red, as defined.

2. Maize may be presented as flint or dent or their hybrids or mixtures. Flint maize includes maize of any color that consists of 95% or more by weight of grains of flint. Dent maize includes maize of any color that consists of 95% or more by weight of grains of dent. Flint and dent maize includes grain of any color consisting of more than 0.5% but less than 95% of flint.

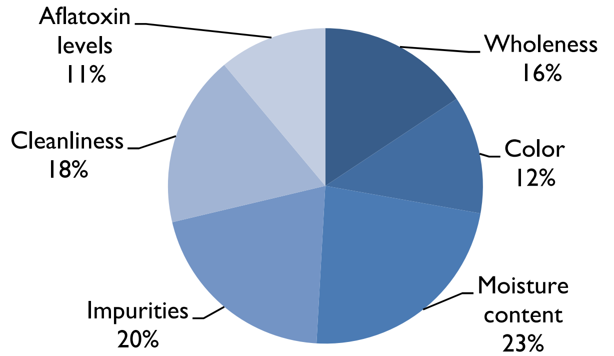
3. Maize should be free from foreign odors, moulds, live pests, rat droppings, toxic or noxious weed seeds and other injurious contaminants as determined from samples representative of the lot. In addition, the grain shall also be of a reasonably uniform color.

The importation of dry shelled maize include the following:

- The trader must obtain a Plant Import Permit from the Kenya Plant Health Inspection Services (KEPHIS), and a Phytosanitary Certificate from the country of origin must accompany imports.
- The imports must meet food safety standards, including moisture content of 12.5 percent (more stringent than required for quality), a maximum aflatoxin level of 10ppb, and free from radioactive materials and other impurities. Other requirements are stipulated in the Food, Drugs, and Chemical Substances Act (CAP 254).

Farmers and maize traders consider different quality attributes important. The USAID-KAVES Value Chain Validation Survey (2013) found producers and maize handlers attached greatest importance to drying, followed by weighing and packaging, while traders ranked moisture content the most important quality attribute followed by impurities, cleanliness, and wholeness (see Figure 3).

Figure 3: Key Quality Aspects Considered by Traders



Source: USAID-KAVES surveys (2013)

Processing and packaging requirements vary depending on the market segment, whether sifted maize meal, posho meal, or maize grain. Maize grain is shelled, dried, sorted and packed in 90-kg bags. Minimal processing occurs at the retail level, where grain is lightly winnowed then sold in 1- to 2-kg tins. According to MOA/KARI (2009), two grades of maize meal (Grade 1 and Grade 2) are produced. Grade 1 is the most commonly produced and is normally packed in 1-kg, 2-kg, 5-kg, 10-kg, or 20-kg packages. Maize meal is also distributed to retail outlets in 90-kg bags. Grade 2 is milled at the posho mills. Byproducts of sifted maize milling (maize germ and bran) constitute approximately 20 percent of the milled grain and form important raw materials for the animal feeds industry. The extraction rate amongst participating mills was 80 percent for Grade 1 and 95 percent for Grade 2, but it may be as low as 70 percent among some millers (KAVES' survey, 2013). The high variation may be due to differences in machinery types and age. At 80 percent extraction rates, it takes 2.5 kilograms of maize to produce 2 kilograms of maize meal.

2.5 SUMMARY OF FINDINGS

While there is a declining per capita consumption of maize, our analysis shows growing opportunities for smallholders as Kenya's population and economy both grow although price trends are uncertain and depend upon global factors beyond the control of Kenyan farmers. We estimate annual per capita consumption was 67.5 kilograms in 2012, consisting of 70.7 kg in rural areas and 50 kg in urban areas. This is projected to further decline to 61.3 kilograms by 2017 and 56.3 kilograms by 2022 due primarily to increasing incomes, higher urbanization rates, and higher demand for substitute foods. The national per capita consumption is projected to decline at an annual average rate of 1.8 percent over ten years, to 2022, and will lead to only a modest growth in aggregate consumption/demand of approximately 1 percent per year. Total human consumption will increase from 2.77 million MT (30.7 million bags) in 2012 to 3.0 million MT (33.3 million bags) in 2022. Urban consumption will drive most of the growth in maize demand, as the total maize consumption by rural areas is projected to grow at only 0.5 percent per year into 2022. In fact, the projected rural consumption in 2022 will be only 5 percent higher than the 2012 levels (c.f. 25 percent for urban). Table 9 summarizes demand projections into 2022.

Table 9: Projected Demand for Maize (MT), 2012-2022

Consumption Segment	2012	2017	2022	Growth
Rural households	2,253,409	2,319,370	2,358,002	0.5%
Urban households	514,174	569,957	641,270	2.2%
Animal feeds industry	122,373	176,179	233,556	6.7%
Seed	71,463	74,044	82,026	1.3%
Total	**2,961,419**	**3,139,550**	**3,314,854**	**1.1%**

Source: KAVES calculations

3. SUPPLY ANALYSIS AND PRODUCTION POTENTIAL

This section examines how much supply is likely to increase in the next five to ten years, and whether this will be able to keep pace with demand. We build supply and production scenarios to evaluate the future of the maize industry in Kenya, including key drivers, trade patterns and supply constraints, to project maize supply into 2022.

3.1 PRODUCTION TRENDS AND PROJECTIONS

Until the early 1990s, Kenya was generally self-sufficient in maize, with production frequently exceeding domestic consumption and thereby generating surpluses for export. Since then, national production decreased by about 1.0 percent per year between 1990 and 2003, with significant annual fluctuations. Regular deficits have been a common feature since 2006. Maize production is largely concentrated in Rift Valley Province, which in 2011 accounted for about 50 percent of the national maize production. Other leading production areas are Nyanza and Western Provinces with each accounting for about 15 percent. The rest come from Eastern (11%) and Central (6%). The 22 FTF target counties account for roughly 55 to 60 percent of total national production area and volume.

Maize area and production trends have been somewhat erratic in recent years. Over the last seven years, an average of 1.9 million hectares have been planted annually, with production around 3 million MT and an average yield of 1.6 MT per hectare (see Table 9). Production declines recorded in 2007-2009 were the result of drought, high fertilizer prices, and disruptions occasioned by the 2008 post-election violence. For 2012/2013, total supply was 4.44 million MT, of which 3.57 million MT was comprised of domestic production, 0.35 million MT from imports, and 0.54 million MT from stocks. According to the Kenya Economic Survey 2014, poor rainfall in some regions of the country led to a decline of 2 percent in maize production, from 3.57 million MT in 2012 to 3.5 million MT in 2013 (KNBS, 2014).

Table 9: Kenyan Maize Production

Year	Area (ha)	Production (MT)	Yield (MT/ha)
2006/2007	1,888,185	3,247,777	1.72
2007/2008	1,615,304	2,928,793	1.81
2008/2009	1,793,757	2,367,200	1.32
2009/2010	1,885,071	2,442,823	1.30
2010/2011	2,008,346	3,464,541	1.73
2011/2012	2,131,887	3,376,862	1.58
2012/2013	2,059,322	3,573,159	1.74
2013/2014	na	3,501,000	na

Source: MOA/KNBS

3.2 KEY DRIVERS OF PRODUCTION AND SUPPLY

Kenya's maize production increases are more a result of increased area under production than yield improvements. Variability in planted areas and yields are primarily attributed to weather, maize prices in previous marketing season, and the accessibility of inputs (particularly seed and fertilizer).

3.2.1 Area Expansion

Studies by Mose et al. (2007) and Olwande et al. (2009) found maize prices and land size have the greatest impact on production. While there have been widespread fears of a slowdown in the growth of cultivated area due to increased population and land fragmentation, available evidence shows maize area has expanded at a compound annual average of 4.7 percent since 2008, and 3.7 percent since 2010. This is in line with results of Tegemeo Institute household panel surveys showing an annual rate of 4 percent over the period 2005-2010. Maize prices on the other hand exhibit substantial intra-year seasonality, with prices lowest around harvest season and highest at the beginning of the planting season until the next harvest.

3.2.2. Climatic Variability and On-farm Yields

Being predominantly rain fed, Kenya's maize crop is highly vulnerable to drought and flooding; crop failure due to drought can cause losses upward of 80 percent. Yields in "good years" tend to be higher or unchanged and those in bad years can be as low as 75 percent of long-term average. Drought conditions that followed the post election violence in 2007/2008, led to 19 percent and 17 percent decline in maize production in 2008 and 2009, respectively (Tab. 9). The average yields recorded during the same period were some of the lowest in Kenya's history.

Recent growth in yields appears to have dissipated, with the average rate in the period 2010-2012 slowing to only 0.3 percent per year, but the average yields in 2012 was lower than in 2006. Average yields have declined from 2.2 MT/ha in 1990s to 1.74 MT/ha in 2012. While Kenyan yields may be considered fair relative to other producers in Sub-Saharan Africa, they are well below potential as illustrated by Kenya's previous ability to achieve average yields above 2.0 MT/ha (a reasonable target for rain-fed systems).[6] Yields vary widely across and within counties, and most are producing significantly below their potential. According to the USAID-KAVES Baseline Survey for FtF target counties, the average yields per hectare averaged 1.8 MT in 2012; ranging from 0.4 MT in Taita Taveta and Kericho to 3.33 MT in Nandi (Table 10).

Table 10: Average Maize Yields by FTF Target County, 2013 (MT/ha)

County	Average Farm Size (acres)	Average Yield (Hybrid Seed)	Average Yield (Local Seed)	Yield Gap*
Homa Bay	0.8	0.8	1.0	-53%
Kitui	1.7	0.8	1.0	-50%
Machakos	1.4	1.1	0.7	-47%
Kisumu	0.8	1.1	0.7	-45%
Nyamira	0.8	1.1	1.4	-44%
Bomet	0.9	1.1	0.9	-43%
Busia	0.6	1.3	1.8	-37%
Vihiga	0.4	1.5	0.6	-26%
Siaya	0.8	1.5	1.0	-24%
Meru	0.8	1.6	1.1	-22%
Taita Taveta	1.0	1.6	0.4	-21%
Makueni	1.4	1.6	0.8	-19%
Kisii	0.7	1.8	1.6	-10%
Tharaka Nithi	1.4	1.8	1.8	-9%
Kakamega	1.0	2.1	2.5	7%
Bungoma	0.8	2.2	1.5	10%
Migori	0.8	2.3	2.2	13%
Kericho	0.9	2.3	0.4	14%
Nandi	1.0	2.7	3.3	34%
Trans-Nzoia	1.0	3.0	2.7	51%
Elgeyo Marakwet	1.0	3.2	3.1	60%
Uasin Gishu	1.8	3.2	2.3	60%
AVERAGE	**0.98**	**1.80**	**1.64**	**-9%**
MEDIAN	**0.90**	**1.60**	**1.44**	**-20%**

*Source: USAID-KAVES Baseline Survey (2013). Notes: * Average yield versus reasonable achievable yield of 2.0 MT/ha for rain-fed maize.*

Average yields differed depending on whether farmers used local and hybrid seed, but the pattern is mixed. In some counties, such as Kitui, Homa Bay, Nyamira, Busia, Kakamega, and Nandi, farmers who

[6] Smale et al. (2013) estimate that regional average yields range from as high as 1.7 MT/ha in West Africa and 1.5 MT/ha in east Africa to only 1.1 MT/ha in southern Africa. The authors treat Mexico's average yields of 2.0 MT/ha as representative of rain-fed systems.

used local seed obtained higher yields than those who used hybrid seed. In the rest, except Kisii, Tharaka Nithi, Migori and Elgeyo Marakwet, average yields from hybrid seed were significantly higher than local seed. Overall, the sample average yield for hybrid seeds was only 10 percent (160 kg/ha) higher than local seed.

Within counties, the least variation occurred in Tharaka Nithi (0.2 standard deviation) and the highest in Trans Nzoia (2.5), while the cross-county average is 1.8. Overall, apart from Kisii, Nandi and Trans Nzoia, the within-county yield variation is lower than cross-county variation. Some counties that reported the lowest yields also recorded maximum yields either comparable or higher than the best producers. For example, while Homa Bay County reported the lowest average yield, some farmers realized yields as high as 3.6 MT and 6.7 MT per hectare. By increasing the yields and productivity of more than half a million growers in the target areas, USAID-KAVES can have a significant and lasting impact on national production.

If Kenya can increase its average maize yield by just 15 percent (to 2 MT/ha) it can more than meet expected national demand. Since the country has surpassed this threshold in the past, it presents one of the greatest opportunities in upgrading the sector.

3.2.3 Postharvest Handling and Management Losses

Postharvest handling constraints substantially reduce the total volume of maize reaching markets although only one comprehensive study has covered losses along the maize value chain. Maize loss estimates vary depending on the calculation method and level of analysis. Most studies focus more on storage losses than other losses along the maize value chain. Studies conducted at the market level tend to produce relatively lower loss levels than those at the farm-level. Affognon, Mutungi, Sanginga, & Borgemeister (2015) find maize loss estimates ranging from 3.9 percent to 29 percent. Losses differ depending on whether there is intervention to mitigate postharvest losses or no intervention. With intervention, losses are lower and range from 3.9 to 19.3 percent. The average loss is higher in cases where there is no intervention, from 7.6 to 29 percent.

USAID COMPETE (2010) estimated maize losses at 9 percent, and the Ministry of Agriculture Food Security Report of September 2012 put it at 15 percent. In 2013, USAID-KAVES surveys estimated average storage losses at the market level at about 6.5 percent. More over, in compiling its statistics, the KNBS assumes national waste levels of about 35 percent of domestic production or 29 percent of total supply (KNBS, 2014). Kenya wastes about 1 million tons of the maize produced annually, as a result of various losses incurred along the value chain. In the past two years, the KNBS estimates Kenya wasted 1.26 million MT in 2012 and 1.2 million MT in 2013.

This analysis uses new results of food losses published in FAO (2014). Table 11 contains estimates of harvest and postharvest losses of maize in Trans Nzoia and Lugari, from the farm to the end market. In their study, Lugari represented the less commercial farmera and Trans Nzoia the highly commercial farmers. We treat maize losses in Lugari as representative of about 80 percent of maize farmers, and Trans Nzoia the rest. The results show substantial maize losses, ranging from 28 percent of total among the highly commercial farmers to 36 percent among the less commercial farmers. More than 90 percent of these losses occur at the farm level, with very minimal losses at market and processing

Table 11: Postharvest Losses of Maize Grain

Loss Type	Lugari	Trans Nzoia	Average
Harvesting	3.3%	1.0%	2.2%
Shelling	8.8%	3.1%	6.0%
Drying	3.0%	0.0%	1.5%
Storage:	16.8%	19.2%	18.1%
Weevils	*8.0%*	*10.7%*	*9.4%*
Discoloration	*8.8%*	*8.5%*	*8.7%*
Broken grain	0.0%	2.9%	1.5%
Traders	0.8%	0.5%	0.7%
Milling	3.5%	1.0%	2.3%
Total	***36.2%***	***27.7%***	***32.0%***
Farm-level	31.9%	26.2%	29.1%
Total (excl. discolored)*	**27.4%**	**19.2%**	**23.3%**

*Source: FAO (2014). Notes: * Assumes most discolored maize is consumed at home as food or chicken feed.*

stages of the value chain. Among the harvesting and postharvest practices, the leading causes of maize loss are shelling and storage.

The combination of weevils damage and discoloration is responsible for 56 percent of the total losses, on average, ranging from 47 percent in Lugari and 70 percent in Trans Nzoia. Of equal importance, especially to the less commercial farmers are losses incurred in preparing maize for either storage or the market. Losses during harvesting, shelling and drying constituted 42 percent of the total in Lugari, with shelling alone responsible for 57 percent of these losses. These losses are substantially lower among the more commercial farmers, who lose most of their maize during storage, especially to weevil attack, and broken grain during shelling.

On average, if we exclude losses due to discoloration, Kenya losses approximately 23.3 percent of the maize produced annually. This is equivalent to about 816,000 MT from the 2013 production, with the noncommercial farmers responsible for about 670,000 MT (82%).[7] The losses are even higher if pre-harvest losses to pests (birds, rodents, insects) are considered. Weevils and discoloration have an added effect on maize quality and returns to farmers. The FAO estimates weevil-infested or discolored grain fetched 65 percent lower prices than the non-infested. Overall, maize buyers paid about 33 percent less per bag as a result of poor quality – largely due to weevil infestation, discoloration and broken grain.

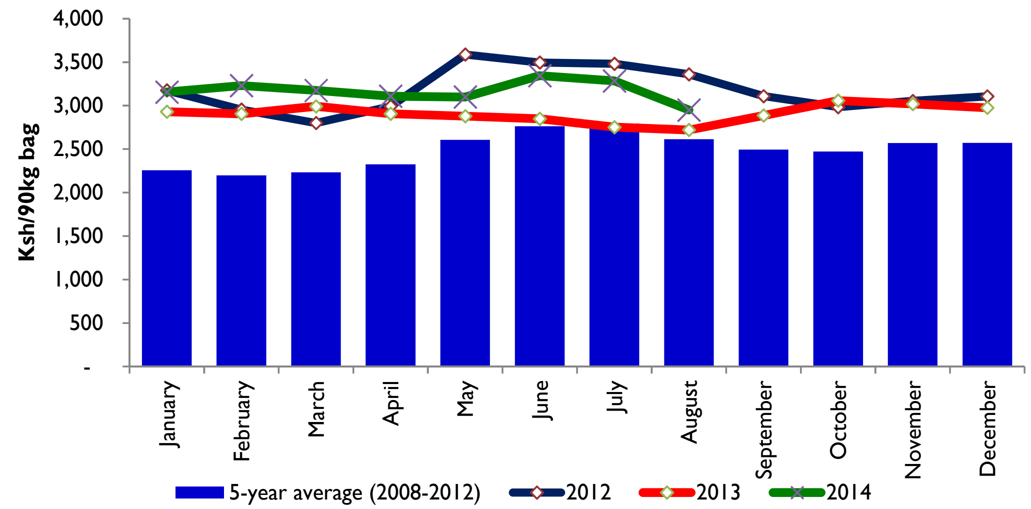
Poor postharvest management and storage practices at the farm and primary markets therefore result in both financial losses and wastage. Storage technology is limited due to liquidity constraints, uncertain returns from storage, technical knowledge gap, and price unpredictability. Addressing these losses, specifically at the farm level, can increase maize supply and boost returns to farmers.

3.2.4 Production Seasonality and Price Trends

National average maize prices follow the seasonal production cycle. Across Kenya, maize is produced between the months of March and November, with harvesting occurring in February/March for the SR crop (a small proportion of annual supply) and June/July and November/December, for the main LR crop. The SR harvests are common in Eastern and Coast, the June/July harvest mostly in Western, Nyanza, Coast, Eastern, and parts of the Rift Valley and Central. The main maize zones in the Rift Valley harvest in November-December. It therefore means maize "hunger period" (lowest supplies) occurs in May-July, and glut period comes around January-March. National market prices generally follow these seasonality trends, largely in conformity with the production cycles in the Rift Valley grain basket, where harvest begins in November and maize stocks reach major markets in December. The seasonal variability in prices is shown in Figure 4.

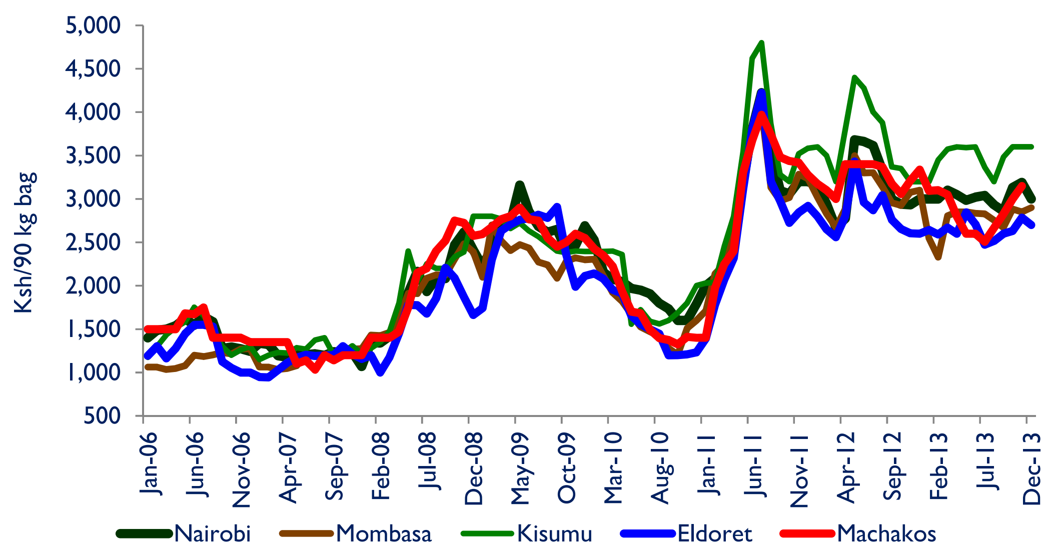
[7] We assume noncommercial farmers produce 70 percent of the total maize and then apply the higher losses for Lugari.

Figure 4: Nairobi Monthly Maize Prices (2012-2014 & 5-year average)



The Figure shows the lowest prices are recorded during January-April and highest in May-July; the period August-December records moderate prices. These seasonal variations are significantly altered during years of poor rains, drought, or flooding, when prices rise and remain relatively higher in all months until the next season's crop. This pattern is shown in the 2012 prices, which were higher than the 5-year average and the 2013 series. Furthermore, Kenya's maize markets appear highly integrated with average prices in various wholesale markets tracking closely with each other (see Figure 5). Prices in Kisumu are relatively higher than other markets and Machakos appears the median market in most years. The maize grain and flour markets also appear to be closely integrated. Kamau et al. (2012) found the price of maize grain and flour generally moved together and maintained a nearly constant price margin. Since the price of grain constitutes at least 85 percent of the total cost of milling, maize millers simply shift the burden of price increases to consumers.

Figure 5: Nominal Maize Prices in Selected Wholesale Markets (KSh/90-kg)



Source: MOA/NCPB

3.2.5 Pest and Disease Outbreaks

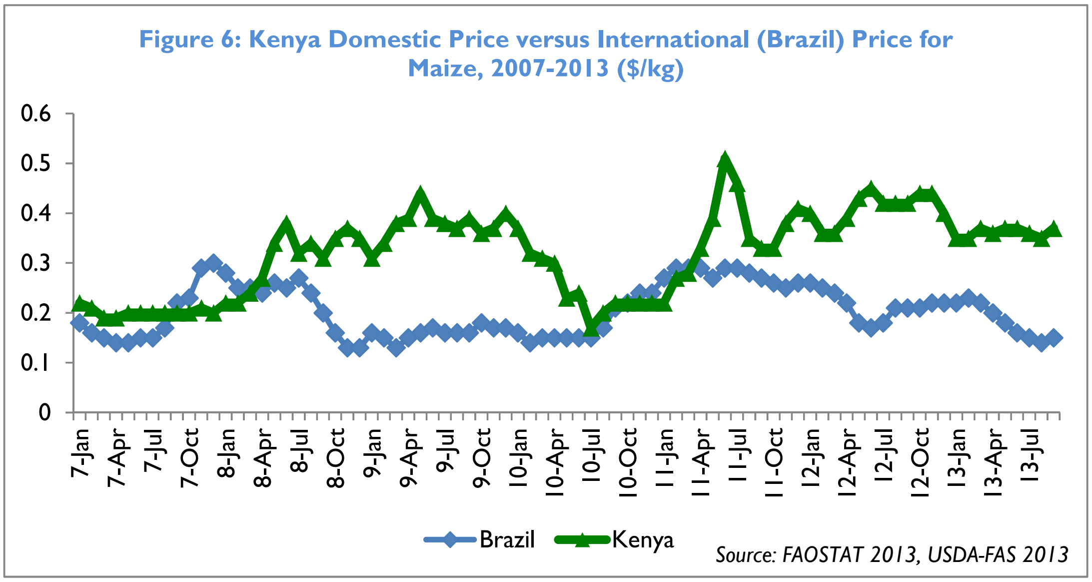
Increasingly unpredictable climatic fluctuations and recent pest (insects and weeds) and disease outbreaks have led to substantial crop losses. One particularly serious threat is the recent outbreak of the *Maize Lethal Necrosis Disease* (MLND), which causes infected plants to stunt, become chlorotic (turn pale yellow), and wither close to the flowering stage. MLND occurs after combined infections by two viruses Maize Chlorotic Mottle Virus (MCMV) and Sugarcane Chlorotic Mosaic Virus (SCMV). MLND infestation was first diagnosed in the South Rift (Bomet and Narok Counties) in 2011 and devastated maize crops in areas spanning Southern Nyanza (Kisii and Nyamira Counties), Central Rift (Nakuru County), and Eastern Region (Embu and Makueni Counties). The MLND has no known cure and all infected maize crops must be cut, isolated and burned. Since the disease is resident in maize seeds, affected plants must not be fed to animals either. The disease persisted into the 2012/2013 growing season, and research and regulatory institutions have no immediate solution. In 2012, the disease destroyed about 90 percent of the maize crop in the South Rift, especially Bomet and Narok counties (Kamau, Karin, Olunga, Onyango, & Makau, 2013).

In many other cereal growing regions, especially Eastern region, the Larger Grain Borer (popularly referred to as "Osama") has caused significant losses of maize crops. Outbreaks of pest weeds, such as Striga and *Prosopis jullifora* (christened 'mathenge'), have also been recorded in the Rift Valley and increasingly threaten maize production. With minimal investment in controlling them and management gaps among farmers, the damages due to pests and diseases extend beyond yield reductions to include poor quality of grain produced. These significantly lower output and returns to farmers.

3.2.6 Trade Patterns

Kenya covers its maize supply shortfalls through formal and informal imports primarily from Tanzania and Uganda, but in particularly high deficit years it has also imported from other African countries, including South Africa and Zambia (Kamau et al., 2012). Ugandan maize is a critical component of Kenya's maize value chains, especially in the border regions of western Kenya. In the period 1990-2010, maize area in Uganda increased dramatically from about 0.4 million hectares in 1990 to 0.9 million hectares in 2010 (Ahmed, 2012). Similarly, production more than doubled during the same period, from 0.57 million MT to 1.37 million MT. The domestic market for maize in Uganda is estimated at about 400,000 MT per annum, so up to one million MT of maize is available for export. Ordinarily, Kenya imports about 250,000 MT (2.7 million 90kg bags) from Uganda and Tanzania every production cycle (RATIN Bulletin, January 2009). The figure fluctuates depending on regional demand for maize. Imports vary according to the season, peaking in July when Ugandan maize is harvested earlier than in Kenya.

Maize import statistics are spotty at best and there is general agreement that informal trade from Uganda and Tanzania is high, and undercounted in official trade statistics. The Ministry of Agriculture (2012) reported maize imports of 253,000 MT in 2011, with 67 percent entering via land (49 percent entering from Tanzania, 15 percent from Uganda, 3 percent from Ethiopia) and 33 percent by sea through Mombasa. For the period July 2011 – June 2012 imports were estimated to have increased to 365,000 MT, and further increased to 600,000 MT in 2012/2013. Domestic maize prices trends in Kenya have not always tracked international trends, and since early 2011 have been significantly higher (see Figure 6).



Using import parity prices of maize (CIF prices), Kamau et al. (2012) found Kenyan maize was fairly competitive compared with that of South Africa, and wholesale prices remained below the import parity price (CIF-Mombasa) between 2007 and 2012. The authors found wholesale prices in Kenya were at par with the FOB price in South Africa during harvest periods, in normal seasons. Only the removal of import duty brings the SA price (CIF-Mombasa) to parity with Kenyan wholesale prices. Since inland transportation cost is relatively high (sometimes higher than international freight to Mombasa), imported maize (at least from South Africa) appears uncompetitive. The imposition and maintenance of import tariffs on maize by Kenya is therefore a curious policy stance, because Kenyan farmers do not seem to need any protection. The results of Kamau et al. are in line with KAR/MOA (2009), which found imported maize more expensive than locally produced (Table 12).

Table 12: International Maize Price Comparisons (February 11 2009, CIF duty free)

Origin-Destination	USD/MT	KSh/90kg
Busia ➔ Kisumu	348	2,443
Busia ➔ Nairobi	359	2,520
Durban ➔ Mombasa	429	3,012
Durban ➔ Nairobi	462	3,243

Source: KARI/MOA (2009, p. 27). Notes: During the survey period, NCPB paid KSh2300 per 90kg bag, while some millers were buying at KSh2550 in Trans Nzoia and Uasin Gishu.

Regional production and trade dynamics significantly influence Kenya's maize markets. Kamau et al. (2012) suggested the relatively more stable maize price from January to July 2012, compared to the same period in 2011 when maize prices skyrocketed, is attributable to increased inflows from neighboring countries. Regional trade in maize occurs in the northeastern corridor, which starts from Tanzania's Mwanza region, through Kenya and Uganda, and ends in South Sudan (see Table 13).

Seasonality differences, geographic characteristics, and the structure of trade in the border and consumption markets drive the corridor's trade patterns. Kenya and South Sudan are the main consumption markets, while Tanzania and Uganda are the main export areas. Border markets include Sirari-Isebania (Tanzania-Kenya), Busia (Uganda and Kenya) and Nimule (South Sudan and Uganda). Other less active trade routes include Malaba border (Uganda and Kenya), and Kaya-Oraba border (South Sudan and Uganda). The main corridors are further subdivided into three active sub-corridors (see Table 14).

Table 13: Maize Transit Markets along the Northeastern Grain Corridor

Country	Borders Points	Main Towns Along the Corridor
Tanzania	Sirari	Mwanza, Magu, Bunda, Musoma, Tarime
Kenya	Isebania, Malaba, Busia	Migori, Kisii, Kisumu, Eldoret, Kitale, Nakuru, Nairobi, Mwingi, Machakos
Uganda	Malaba, Bibia, Oraba, Busia	Mbale, Iganga, Kampala, Soroti, Lira, Bweyale (Kiryandondo), Arua, Koboko
South Sudan	Nimule, Kaya	Yei, Juba

Source: NBI (2012)

Uganda exports most of its maize to Kenya, the Democratic Republic of the Congo (DRC), South Sudan, Rwanda and Tanzania, in that order. Most exports are channeled through informal cross-border trade (ICBT) and originate from three main growing regions (Western, Eastern, and Northern). The quality of maize determines its destination market in Kenya, and largely depends on the region of origin, with Northern maize considered higher quality than maize from the Southwest, and enters the main maize production zones of the North Rift Kenya and then finds its way to national markets, while the latter serves mostly local border markets (Ahmed, 2012).

Table 14: Sub-Corridors in the Northeastern corridors

Sub-Corridor	Production Area	Domestic Markets	Border Markets	Destination Markets
SC I (Tanzania to Kenya)	Mara, mainly Tarime	Tarime market	Isebania	Migori, Kisii, Homabay, Nairobi, Machakos
SC II (Uganda to Kenya)	Mbale, Iganga	Mbale, Iganga towns	Busia	Kisumu, Nairobi, Kitale, Eldoret, Eastern Kenya
SC III (Uganda to S. Sudan)	Larger Masindi, especially Kiryandondo	Bweyale, Masindi towns	Bibia-Nimule	Yei

Source: NBI (2012)

3.4 SUPPLY PROJECTIONS

National supply of maize will depend on future domestic production, trade, and wastage. Table 15 contains the summary of supply projections. Our analysis assumes domestic production is sustained at the 2007-2012 trend, with an annual growth rate of 4.1 percent. Imports are projected to grow at a compounded annual average rate of 5.7 percent, while exports will continue to decline at 11.4 percent per year. From a deficit of 98,433 MT, and given the growth trends, we project surpluses of 367,065 MT from domestic production in 2017 and 973,561 MT in 2022. Accounting for net imports, total surpluses will increase from 210,590 MT in 2012 to over 1.38 million MT in 2022, equivalent to a compounded annual growth rate of 21 percent.

Table 15: Projected Maize Supply (MT), 2012-2022

Consumption Segment	2012	2017	2022	Annual Growth
Domestic Production	3,573,159	4,359,293	5,318,384	4.1%
Availability from Production (adjusted for losses - 23% PHL + 2% retained seed)	2,669,150	3,256,392	3,972,833	4.1%
Production Surplus (Deficit)	(98,433)	367,065	973,561	
Imports	320,229	367,608	412,403	2.6%
Exports	11,206	5,797	3,347	-11.4%
Total Available Surplus (Deficit)	**210,590**	**728,876**	**1,382,617**	**21%**

Source: KAVES calculations

Net imports will depend on domestic production, with bad years attracting higher imports and good years replacing them. Supply projections from domestic production are analyzed in detail in the next subsection. Domestic production of maize will depend on future yields and area planted, with availability also a function of the level of postharvest losses. Table 16 provides various production and supply scenarios based on varying growth rates for planted area and yields. It evaluates future supply assuming scenarios from the "status quo" to the most "optimistic". Under Scenario 3, using annual growth rates equal to the 2010-2012 CAGR of 1.3 percent for planted area and 0.30 percent for yield, domestic production is expected to increase to 3.92 million MT in 2017 and 4.23 million MT in 2022. Available local maize supply would more than meet expected local human consumption demand under this scenario, primarily as a result of increased area planted, and decreasing per capita consumption described in Section 2. The supply will however not be enough to meet the total demand projected in Table 9.

Table 16: National Maize Supply Projections

Scenario			Annual Growth Rate	2017	2022
Scenario 1	Static (no area expansion or yield increases)	Production Area (ha)	0.0%	2,059,322	2,059,322
		Yield (MT/ha)	0.0%	1.74	1.74
		Production Volume (MT)		3,573,159	3,573,159
		Available Production (MT)		2,669,150	2,669,150
		Demand Estimate (from Tab. 6) (MT)		2,889,326	2,999,272
		Surplus (Deficit) (MT)		**(220,177)**	**(330,122)**
Scenario 2	Area expansion at 2010-2012 CAGR; no yield increases	Production Area (ha)	1.3%	2,220,145	2,363,718
		Yield (MT/ha)	0.0%	1.74	1.74
		Production Volume (MT)		3,852,206	4,101,322
		Available Production (MT)		2,877,598	3,063,687
		Demand Estimate (MT)		2,889,326	2,999,272
		Surplus (Deficit) (MT)		**(11,728)**	**64,415**
Scenario 3	Area expansion and yield increases at 2010-2012 CAGR	Production Area (ha)	1.3%	2,220,145	2,363,718
		Yield (MT/ha)	0.3%	1.77	1.79
		Production Volume (MT)		3,919,875	4,234,370
		Available Production (MT)		2,928,147	3,163,075
		Demand Estimate (MT)		2,889,326	2,999,272
		Surplus (Deficit) (MT)		**38,820**	**163,803**
Scenario 4	Faster Area Expansion; Lower Yield Increases	Production Area (ha)	2.5%	2,388,182	2,702,009
		Yield (MT/ha)	1.0%	1.84	1.94
		Production Volume (MT)		4,398,694	5,230,581
		Available Production (MT)		3,285,825	3,907,244
		Demand Estimate (MT)		2,889,326	2,999,272
		Surplus (Deficit) (MT)		**396,498**	**907,973**
Scenario 5	Slower Area Expansion; Higher Yield Increases	Production Area (ha)	1.5%	2,251,752	2,425,776
		Yield (MT/ha)	2.0%	1.95	2.16
		Production Volume (MT)		4,399,969	5,233,361
		Available Production (MT)		3,286,777	3,909,321
		Demand Estimate (MT)		2,889,326	2,999,272
		Surplus (Deficit) (MT)		**397,451**	**910,049**

Source: USAID-KAVES estimates

A combination of faster area expansion and higher yield increases will be necessary to meet total demand. These are presented under scenarios 4 & 5, which produce near-identical results; the combination of area expansion at 2.5 percent and yield increase at 1 percent, per year, generate similar outcomes as that of 1.5 percent area expansion and 2 percent yield increase per year. With annual area expansion of 1.5 percent and yield increases of 2 percent, production is projected at 4.4 million MT in 2017 and 5.23 million MT in 2022 – while still sufficient to meet total domestic demand, the potential surpluses can easily turn into deficits in "bad" production years.

Basing production supply models on the continued expansion of planted area at historical rates may be overly optimistic given increasing land pressures, fragmentation and climate change. Planted area however expanded at an average annual rate of 3.5 percent during the period, 2008-2012. Similarly, assuming yield increases will continue in line with historical averages may be unrealistic given national yields have nearly stagnated over the last seven years. FTF target counties will however only require average yields to increase by about 6 percent to attain the yields required for the best scenarios.

Interventions targeting even small increases in productivity or reduction postharvest losses will have a significant impact on the national maize market.

The above scenarios can provide higher surpluses if combined with reductions in maize (harvest and postharvest) losses. Table 17 builds upon the scenarios given above to illustrate how Kenya could attain maize self-sufficiency, without increasing planted area, by modest increases in yields and/or by reduction in postharvest losses. Had postharvest losses been reduced by 30 percent in 2012 (to 16 percent under Scenario 1), 182,000 MT more domestic maize would have been available for consumption. If yields had been 10 percent higher in 2012 (to 1.91 MT/ha), an additional 266,915 MT would have been available as shown under Scenario 2. A combination of 10 percent higher yield and 30 percent lower postharvest losses would have made an additional 464,051 MT available – or 17 percent more maize than was actually available in 2012 (with yield increase accounting for roughly 57 percent and postharvest loss reduction 43 percent). These additional volumes would have been sufficient to meet total domestic demand in 2012.

The analysis illustrates how small increases in yields or reductions in postharvest losses can have a significant impact on domestic production and supply – not only meeting domestic consumption demand but also producing surpluses for export. **Interventions that target higher farm yields and postharvest loss reduction are likely to have high returns, not only at the national supply level, but also through higher returns for farmers (higher availability combined with lower unit production costs) and traders (through reduced postharvest losses).**

Table 17: Scenarios with 2012 National Maize Production (MT millions)

Scenarios	A Production	B Postharvest Loss + Retained Seed	C Available Supply [A+B]	D National Demand (from Table 6)	E Surplus (Deficit) [C-D]
Baseline/Actual: Yield 1.74 MT/ha; 23% postharvest losses; 2% retained seed	3,573,159	(904,009)	2,669,150	2,767,583	(98,433)
Scenario 1: Baseline with 30% reduction in postharvest losses (to 16%)	3,573,159	(721,947)	2,851,212	2,767,583	83,630
Scenario 2: Baseline with 10% increase in yield (1.91 t/ha)	3,930,475	(994,410)	2,936,065	2,767,583	168,482
Scenario 3: Baseline with 30% reduction in PHL AND 10% increase in yield	3,930,475	(797,274)	3,133,201	2,767,583	365,618

Source: USAID-KAVES estimates

3.5 SUPPLY CONSTRAINTS AND THREATS

Maize is largely produced under rain-fed systems in Kenya, meaning climatic conditions will be a dominant driver of variability and seasonality of production. A combination of factors explains the failure of Kenyan farmers to meet increased domestic demand for maize, including land constraints and the cost of inputs. As a result, Kenyan farmers are highly sensitive to price. Average yields of 1.74 MT per hectare exceed regional averages for rain-fed maize but lag significantly behind Latin American and Asian yields of the same crop. Without irrigation, the scope for significant increases in maize yields among smallholders is relatively limited. However, because 96 percent of maize is sold within five kilometers of the farm gate (Sitko and Jayne, 2014), new marketing systems that aggregate production and increase marketing options could have a significant impact on producer prices by reducing transaction costs.

3.5.1 Productivity Constraints

Productivity constraints can be broadly classified into two types of "gaps": a technology gap and a management gap. These gaps reflect the difference in the knowledge farmers possess and the recommended knowledge at any point of time:

- *Technology Gap*. There are significant gaps in the use of fertilizers, with only about 44 percent of farmers using any form of fertilization and significant variations across production zones. However, the gap in the use of hybrid seeds, although variable, is narrower. Narrowing the technology gap will require additional investment and higher recurring costs for fertilizers and other soil fertility management technologies (e.g., lime).

- *Management Gap*. Poor agronomic, postharvest handling and marketing management practices impose higher unit costs and lower gross margins. In some regions, overuse and abuse of fertilizers has led to soil fertility degradation and poor plant health. On others, lack of fertilization has depressed productivity. Poor postharvest handling and storage wastes lead to 7-15 percent losses in maize output. Interventions that include extension, education and training should offer low-cost means of raising productivity by applying improved management practices.

3.5.2 Farm Size

Farm size for maize producers is a serious constraint to significantly increasing household incomes. The average land sizes across FTF target counties are shown in Table 18. It shows the total land available to households is relatively small (less than 2 hectares), with the largest measuring 1.5 hectares. As discussed in Section 5.1.2, Table 24, at the current production levels, these land sizes are inadequate to meet minimum household livelihood needs. Maize therefore cannot constitute the only source of livelihoods for the target counties.

Counties with larger average land sizes (e.g. Uasin Gishu, Tharaka Nithi, and Makueni) present better opportunities for continued maize production and increasing household incomes, but even here greater intensification and enterprise diversification will be necessary to sustain households. In other counties (e.g. Kisii, Bungoma, Meru and Homabay), the average land sizes are so small they significantly constrain farmers and lead to inordinate pressure on land. For maize producers in these counties to earn a decent income they need to engage in much more intensive production, diversification to higher value crops (or dairy) and value addition. Alternatively, innovative off-farm interventions are required to reduce the size of land necessary to satisfy maize consumption needs or move such farmers out of maize production altogether.

Table 18: Average Land Size for Selected FTF Counties

County	Acres
Bungoma	1.8
Kisii	1.0
Makueni	2.5
Meru	1.6
Homa Bay	1.8
Tharaka Nithi	3.3
Uasin Gishu	3.8

Source: USAID-KAVES baseline survey (2013)

3.5.3 Climate Variability and Change

Since Kenya's maize production is exclusively rain fed, it is highly vulnerable to climate variability and change. However, for East Africa, most climate change projections show maize production may actually increase with climate change (Cairns et al. 2013). A study by Waithaka et al. (2013) finds that overall, Kenyan farmers may not only survive, but could even thrive in the face of climate change because the main impact will be a geographic shift in maize production, as some areas become less productive while others become more conducive to maize production. In the wet lowland mid-altitude of Kenya, there is little projected change in total rainfall during the maize growing season, but rainfall in the dry lowlands is projected to decrease during the maize reproductive stage, with the onset of the short rainy season also delayed. Notably, all the models reviewed for this analysis show rainfall increasing in certain arid and semi-arid regions of Kenya, such as Kitui, Samburu and Isiolo, which would allow maize to be grown in places that previously have been too dry to support the crop in most years. Additionally, some areas in higher elevations, which may have been too cold for maize, would be warm to the point that maize would be a viable crop.

Breeding programs need to focus on developing new maize varieties that are heat tolerant.

Models of maize yields using climate projections for temperature and precipitation in eastern and southern Africa (ESA) show a 2°C increase in temperature would result in greater reductions in maize yields than would a 20 percent decrease in precipitation (Cairns et al., 2013). Until recently maize breeding for drought tolerance in ESA did not include high temperature environments. Breeding programs at CIMMYT and the International Institute for Tropical Agriculture (IITA) have revealed that maize germplasm developed in ESA tended to be susceptible to both heat stress and drought stress at higher temperatures (Cairns et al.). These results highlight the need to incorporate high temperature environments into the maize-breeding pipeline within ESA as the possible larger impact of climate change, at least in East Africa, will be heat not moisture related. Cairns et al. further project maximum temperatures within the highlands of Kenya and Ethiopia will increase above optimum temperatures for existing germplasm.

3.5.4 Postharvest Handling Constraints

At between 20 percent and 36 percent losses, harvest and postharvest handling constraints substantially reduce the total volume of maize reaching markets. Poor quality maize from weevil infestation, discoloration, and broken grains further reduces the returns to farmers by fetching lower prices. Storage is limited due to liquidity constraints, uncertain returns from storage, technical knowledge gap, and price unpredictability. There is no concrete empirical evidence linking the preference by farmers and primary traders to quickly turnover product after harvests to the lack of storage facilities. Since maize is the main enterprise for most farmers and traders, they generally prefer to dispose of their maize immediately after harvest to alleviate immediate financial constraints. After 6-8 months of expenditures with no cash flow, they tend to take the first opportunity they have to sell their harvest.

3.6 SUMMARY OF FINDINGS

A number of recent analyses (e.g., Kamau et al., 2012; MOA/KARI, 2009; and Short et al., 2012) have shown that Kenyan maize is competitive against imports, including South African maize. This section highlights both the challenges and opportunities that the country faces in order to not only meet its own consumption needs but also to generate the surpluses necessary to become a regional exporter. The recent USAID-KAVES Baseline Survey for Feed the Future (FTF) target counties found an average yield of 1.8 MT/ha, ranging from 0.4 MT in Taita Taveta and Kericho to 3.33 MT in Nandi. While Kenyan yields may be considered fair relative to other producers in sub-Saharan Africa, they are well below the national potential, as illustrated by Kenya's previous ability to achieve average yields above 2.0 MT/ha (a reasonable target for rain-fed systems), such as the 2.2 MT/ha attained in the 1990s.

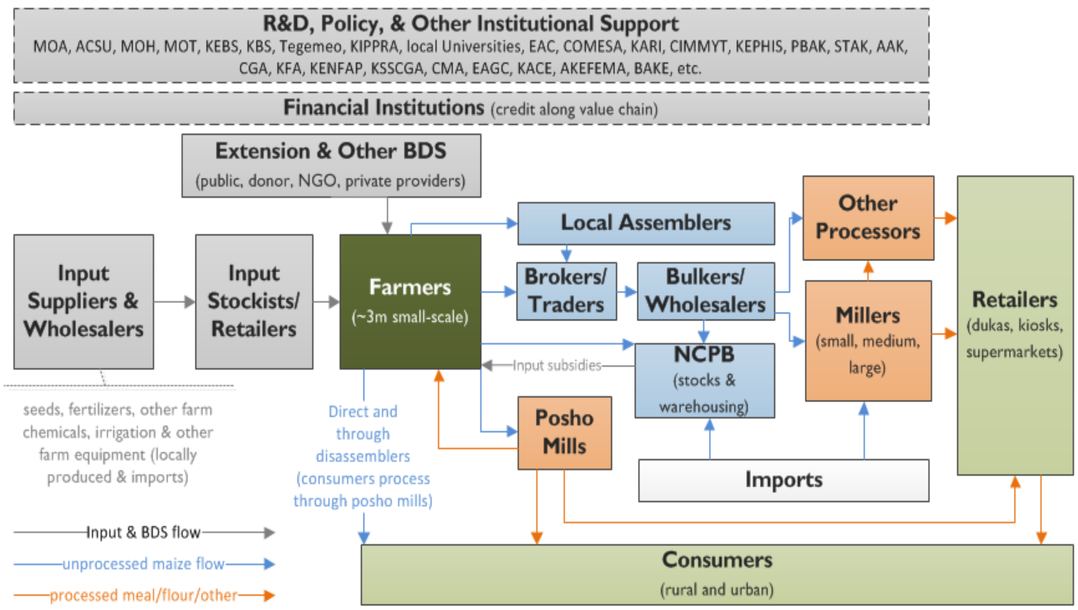
We portray several scenarios for the medium- and long-term maize markets in Kenya, one "status quo" and four optimistic. Under the optimistic scenario we assume yield increases of 1 percent per year, continued expansion of planted area at 2.5 percent, and no significant weather or disease events. Under this scenario we estimate that, by 2022, production area will grow to 2.7 million hectares, production volume will expand to 5.23 million MT, total maize availability will increase to 3.9 million MT, creating a surplus of 0.91 million MT. However, continued expansion of maize area at historical rates may be overly optimistic given increasing land pressures and fragmentation. Yield increases may also be overly optimistic, having stagnated in high potential counties over the last seven years. Under the status quo scenario, production is still projected to meet domestic food demand in 2022 but unlikely to improve farmers returns. Under the optimistic and status quo scenarios, projected surpluses are thin enough that they can easily turn into deficits in years with unfavorable weather conditions.

Our analysis further shows that Kenya could attain maize self-sufficiency without increasing planted area with modest increases in yields and reductions in postharvest losses. **Interventions that target higher farm yields and lower postharvest losses are therefore likely to have high returns, not only at the national supply level, but also through increased returns for farmers and traders.** Going forward, risks to Kenya's rain-fed farming system will need to be proactively managed, addressing technology and management gaps in the face of the growing challenges of shrinking farm size, increased climatic variability and serious new pests and disease.

4. THE MAIZE VALUE CHAIN

In this section, we look at the maize value chain in detail, highlighting key actors, their interactions and critical constraints and gaps, as well as opportunities for USAID-KAVES interventions. For ease of reference, Figure 7 provides a simplified diagram of the Kenyan maize value chain, showing the basic flow of maize from farmers through marketing agents and processors to the end consumer, as well as input and service supplies to the farmer.

Figure 7: Maize Value Chain Actors



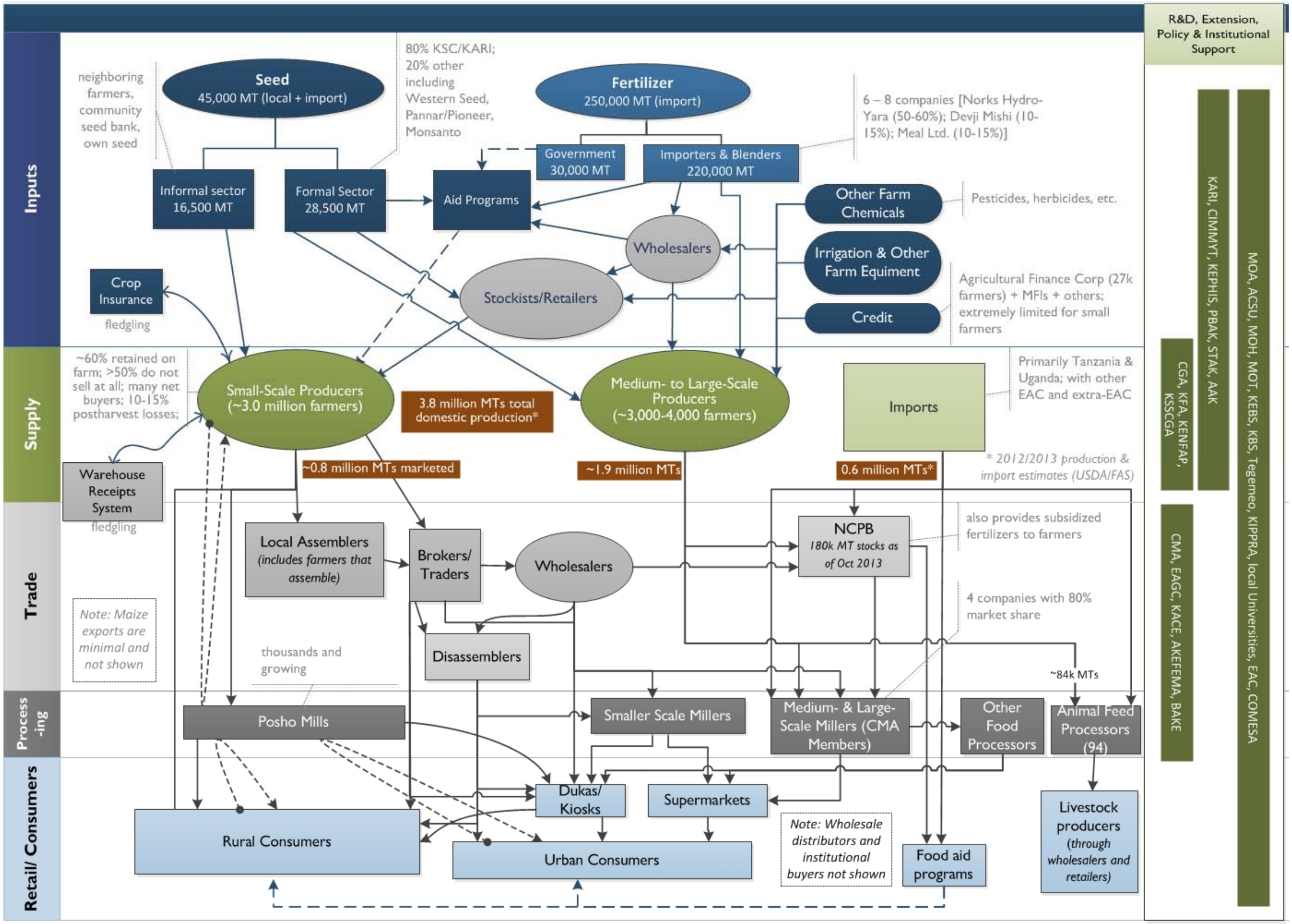
In reality, however, the maize value chain is much more complicated with many more participants and interactions – as shown in the detailed "market map" in Figure 8. This is also illustrated in an analysis conducted by IFPRI on the high "degree centrality" of maize value chain players in Kenya, which is the number of links an actor has with other actors in the "maize network" (see Table 19). USAID-KAVES farmers focus groups conducted in June 2013 confirmed the high degree of centrality of small-scale farmers in the value chain, but also looked at the frequency and level of engagement with those actors. **Those finding suggest that key USAID-KAVES "entry points" to farmers should be through input suppliers, village traders, extension service providers (NGO and government), and rural brokers.** Both the IFPRI and USAID-KAVES analyses highlight the opportunity of reaching farmers through multiple potential "entry points" and designing specific partnerships and interventions by USAID-KAVES and others.

Table 19: Degree Centrality of Kenyan Maize Value Chain Actors

Value Chain Actor	Degree Centrality (Links)
Medium-Scale Farmers	13
Secondary Traders	12
Farm-Level Stores in Market Place	11
Wholesalers	10
Commercial Millers	10
Small-Scale Farmers	9
Prime Traders	9
Small Maize Assemblers	8

Source: Marites Tiongco, IFPRI

Figure 8: Kenya Maize "Market Map"



4.1 INPUT SUPPLIERS

Small agrodealers and stockists are the primary source of inputs for smallholder farmers. Their numbers have increased substantially over the last decade from 8,000 to 10,000 nationwide. Although this has improved access to primary inputs, average distances to the nearest seed or fertilizer stockist remains high in certain counties (Barnett et al., 2011). **Three of the principal constraints reported by farmers that limit their access to inputs include timely availability, high cost (especially of fertilizer) and mislabeled seed.** Extension advice from stockists also tends to be rather limited at the time of sale.

Primary Input Supply Gaps and Constraints

Availability: Timely availability of seeds and fertilizers has been a major problem for smallholder farmers and especially in areas where rains are unreliable and time is of essence.

Distance: Distance for some farmers to input suppliershas also been identified as a critical factor that has implications on cost of the inputs. Although there has been improvement in the last ten years, the average distance to the nearest fertilizer retailer in the low potential areas was estimated at 4.1 km in 2007, while in high potential areas it was 2.9 km (see Mathenge et al., 2012; Barnnet et al, 2011).

Cost: The high cost of fertilizer is considered one of the main impediments to adoption and use. While transport costs are a major contributor, other determinants of the cost are less understood. Despite its important role in most agriculture value chains, the fertilizer sector is one of the least studied and understood. A comprehensive analysis of the fertilizer value chain in Kenya would be useful to design specific interventions around fertilizer utilization.

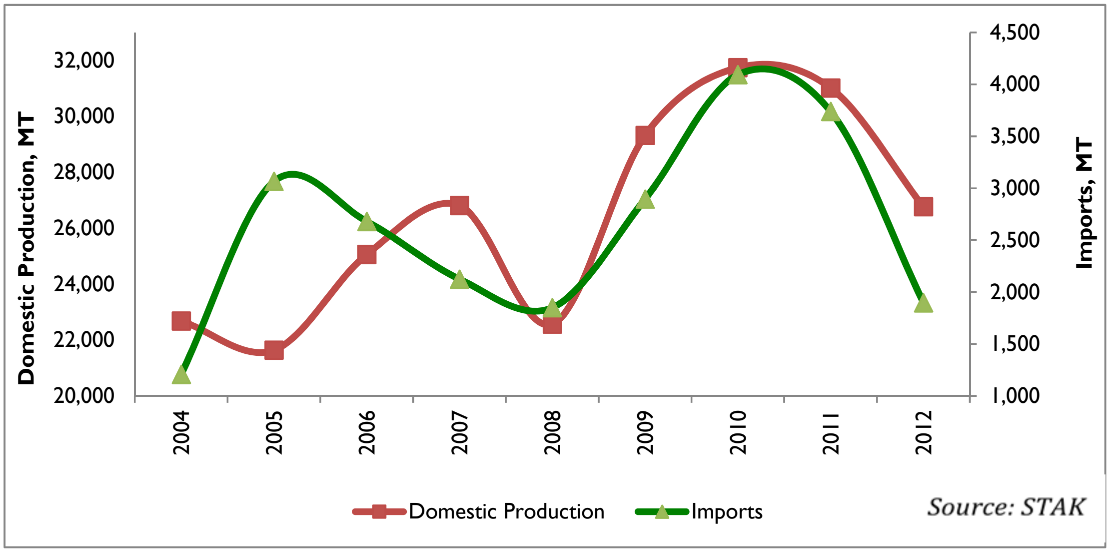
4.1.1 Seeds Suppliers

Maize seeds range from local landraces to composites and hybrids. Local landraces are poorer yielding but have an advantage of being suited to local conditions. Many farmers still plant their own saved seed, or acquire seed directly from other farmers in their communities. Certified seed from registered companies is readily available, with 90 percent locally produced and the balance imported. Farmers obtain seeds either through the informal sector (including farmer's own saved seed, or acquired within communities from other farmers) or the formal sector (certified seed from registered seed companies). Nationally, an estimated 65 to 75 percent of Kenyan maize farmers purchase improved hybrid or OPV seed each season (Smale et al., 2013). The use of improved seed however varies greatly depending on the production region, agroecological zones, and production systems. Consistency of use is particularly important, since smallholder farmers do not buy improved seed every year. Tegemeo Institute's household panel data indicates that the percentage of farmers using hybrid seeds on farms increased from 33 percent in 2004 to 50 percent in 2010 (Mathenge et al, 2012) but this varies widely between counties.

Seed production and importation is regulated by KEPHIS, which is responsible for certification of domestically produced seed and providing permits for seed imports. It also provides training and registration of seed stockists and registers authorized seed sellers. The Kenya Agriculture & Livestock Research Organization (KALRO, formerly KARI) is the main research institute producing and releasing improved varieties in Kenya, accounting for 57 percent of the current 164 maize varieties in the KEPHIS registry. KALRO has produced new varieties suitable for virtually every area of the country although few have been commercialized. Other major owners of registered varieties include Western Seed (18 percent), Pannar Seed (15 percent), Agriseed, Monsanto/Dekalb, and Pioneer (in process of purchasing Pannar).

Kenya had 104 registered seed companies in 2012, compared to 60 in 2007 (AGRA, 2013). Only about 35 companies are active, of which 14 (nine of them local) trade in maize seed. Seed companies produce their own seed and also may use large-scale out-growers to which they provide foundation seed. The Seed Traders Association of Kenya (STAK) estimates the total demand for maize seeds at 47,000 MT, of which the formal sector provides 62 percent and the informal sector 38 percent.[8] During the period 2004-2012, STAK data shows Kenya obtained an average 27,000 MT maize seed from domestic seed companies and imported about 2,700 MT annually (Figure 9). The rest of the seed planted is from farmer retained seed and informal seed systems. The latter system is most predominant among a majority of smallholder maize growers. According to the Cereal Growers Association of Kenya (CGA), seeds and varieties (both OPVs and Hybrids) suited for most regions are available and should not be considered a binding production constraint.[9]

Figure 9: Kenya Formal Seed Supplies, 2004-2012



The seed companies are all members of Seed Trade Association of Kenya (STAK) and currently offer at least 50 different varieties of maize. Major players are the Kenya Seed Company (KSC), which controls approximately 75 percent of national market share, Western Seed Company (WSC) with 3.5 percent, and Faida Seeds with 3 percent (Barnett et al., 2011). The market shares per company are however dependent on the region, with KSC dominating the Highlands and High Potential zones and WSC establishing substantial presence in the mid-altitude and Western Highlands and Lowlands. The companies supplying seed maize include:

- *Kenya Seed Company* – dominant maize seed supplier with 24 varieties customized for range of altitudes and agro-climatic zones, including early-maturing varieties (75-120 days) for semi-arid areas; based in Kitale with wide national distribution network selling through many agents and stockists, and with extensive coverage in FTF target zones; annual maize seed sales estimated at 19,000 MT; during 2012 season working in partnership with the Integrated Striga Management in Africa project to supply herbicide-coated maize seed for Striga control to farmers in Western and Nyanza provinces.

- *Western Seed Company*, also based in Kitale – 16 maize varieties (11 hybrids; 5 OPV) for range of agro-climatic zones; sells through distributors that supply stockists; Western Province accounts for 41 percent of sales, followed by Nyanza (28%), Rift Valley (16%), and Coast/Eastern/Central (combined 15%).

- *Pannar Seed (Kenya)/Pioneer Hi-Bred* – subsidiary of South African-based Pannar; approval recently given for Pioneer Hi-Bred to purchase majority shareholding; Pioneer sells three high- and mid-

[8] Interviews with STAK Managing Director in November 2013.
[9] Interviews with CGA.

altitude hybrids through its own distribution system. It has a research center in Eldoret but no production in Kenya.

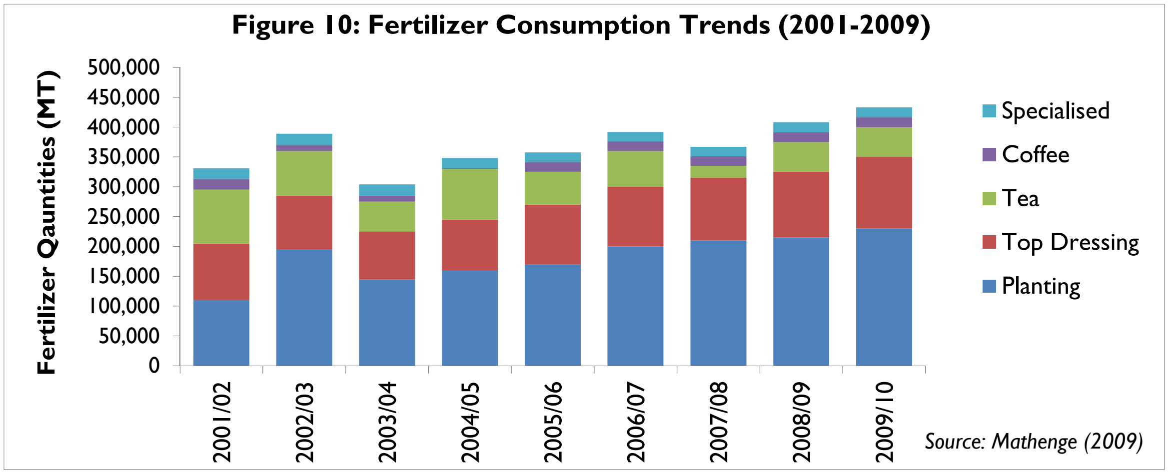
- *Faida Seeds* – brand name of Oil Crop Development Ltd. based in Nakuru; currently produces and distributes four maize varieties (three hybrid; one OPV) with nine other varieties in the research and development stage.
- *Monsanto* – hybrid seed varieties produced in Kenya and Uganda, some with drought tolerance; four Dekalb varieties available, two of which were recently released (May 2012).
- *Seed Co (Agri-Seed Co Limited)* – Seven early to late maturity maize hybrids sold in Kenya; Zimbabwean publically listed company that began operations in Kenya in 2004.
- *Freshco* – Nine maize varieties (three high altitude; two medium altitude; two early maturing/drought tolerant; two quality protein); sources germplasm mainly from KARI and CIMMYT; offices in Nairobi and Nakuru with nationwide network of distributors and stockists.
- *Dryland Seed Company (DSL)* – based in Machakos and specializes in seeds for low- and medium-altitude Arid and Semi-Arid Lands (ASAL); four maize varieties; public-private partnership licensing agreement with KARI; production of seeds through outgrower schemes with local farmers and on DSL-leased land; current high performer under partnership agreement with KHCP.
- *East African Seed Company (EASEED)* – two hybrid (from KALRO) and five OPV varieties; local seed production done through contracted outgrowers.
- *Kenya Agricultural & Livestock Research Organization Seed Unit* (KALRO-SU) produces the following types of seeds; DLC1, Katumani Composite, EMCO, Embu Sytnthetic and KDV1, most of which are suited to the dry land areas.

Maize seed is packaged in 1-kg, 2-kg, 5-kg, 10-kg or larger packs depending on customer requirements. Most seed companies have wide national distribution networks selling through many agents and stockists. KALRO seed retails at 86 percent the price of KSC's hybrids and 55 percent the price of Pioneer seeds.[10] It is one of the drought resistant varieties, but the Seed Unit does not have an efficient distribution network.

4.1.2 Fertilizer Suppliers

Total national fertilizer consumption is estimated at 550,000 MT, with nearly half (~250,000MT) consumed by maize farmers. DAP accounts for 40 percent by weight of the fertilizer used for maize (Figure 10). Utilization of inorganic fertilizers by maize farmers varies by size of farm and growing region (90 to 98 percent in the Western and Central highlands, 30 to 55 percent in the Eastern and Western lowlands). Even for farmers utilizing fertilizers, application rates vary widely, as does efficacy (due to issues of high soil acidity and non-specific application methods). Nationally, only 44 percent of farmers use fertilizers, largely due to cost and unreliable supplies. Tegemeo Institute data obtained from household panel surveys shows that fertilizer use in maize production increased from an estimated 54 percent of maize farmers in 1997 to about 70 percent in 2007 (Kirimi et al., 2011). This was driven by i) increased accessibility of fertilizer by smallholder farmers due to availability of smaller input packets (from 50kg to 25, 10 and 5kg bags), ii) reduction in the distance from the household to the nearest fertilizer retailer, reflecting increased investment in private fertilizer retailing, iii) reduction in real fertilizer prices in Kenya (a trend which has reversed since 2007 with the dramatic rise in world fertilizer prices, and iv) improved training and extension services.

[10] *Pers. Comm. with a retailer in Makueni, 14/11/2013 and with KARI Seed Unit*



Fertilizer is mainly imported, with state agencies and the private sector playing major roles. Out of the 10 fertilizer importers in Kenya, four firms control over 85 percent of the market. Public sector institutions, such as the NCPB, KTDA and sugar companies/outgrower schemes are major players in the market. While KTDA fertilizer is for tea production and those of sugar companies target sugarcane production, these specialty fertilizers often find their way into maize production through diversion and misuse. Excluding imports by the public sector and small amounts by donors, Yara International East Africa Ltd alone controls about half the market for imported fertilizers, with MEA Limited controlling another 25 percent of the market. Other secondary importers include Supplies & Services Ltd., Shah Khanji Lalji & Sons, Scotts Company Kenya Ltd., Omnia Fertilizer, and Devji Meghji & Bros Ltd. The Fertilizer Association of Kenya (FAK) represents the largest importers and traders.

According to Mathenge (2009), local fertilizer manufacturing is estimated at 10,000 MT. MEA Ltd has installed blending/mixing capacity of 300,000 MT per annum but currently utilizes only a small fraction of this capacity (estimated 60,000 MT) because of a thin market for blended fertilizers.[11] Fertilizer importers distribute directly to large farmers and retailers/stockists, and through wholesalers/distributors who sell on to stockists or agrovets. An estimated 500 wholesalers and distributors and 8,000 retailers and agrodealers are involved in fertilizer supply (Mathenge, 2009).

Cost of fertilizer remains a big challenge to smallholder farmers, and has contributed to low input use by most smallholder farmers. For example, a study by Barnett et al., 2011 found that smallholder farmers faced a number of challenges accessing fertilizers, which include high cost (53.8 percent), lack of finance (28.2 percent), long distance to source (15.4 percent) and lack of information. Combined, 82 percent of the responses identified an "affordability problem" as the key constraint in using fertilizers (Dorward, 2009). The distance to the suppliers also adds to the cost due to higher transportation rates.

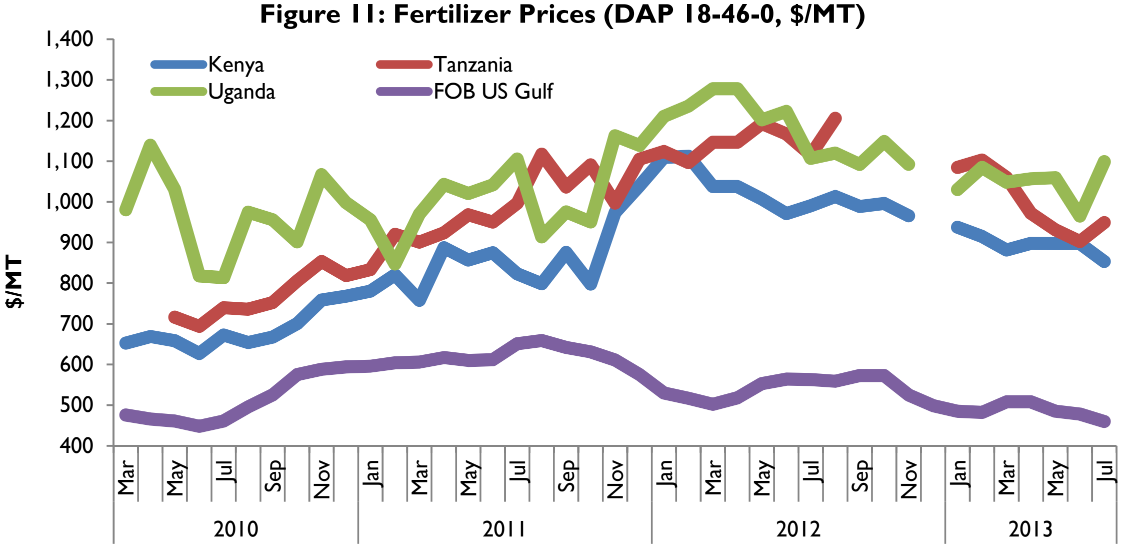
Key Issues Related to Fertilizer Accessibility in Kenya

- *Fertilizer price gaps:* Significant domestic-international price gaps, ranging from $480 to $661, are indicative of excessive procurement costs (with some also claiming, without supporting evidence, excessive margins).
- *High cost of fertilizer:* High cost of fertilizer is among the leading constraints to use by small-scale farmers. In an effort to improve affordability, the Kenyan Government is providing limited fertilizer subsidies. Understanding the cost structure of fertilizer in Kenya and factors contributing to the high cost could be the starting point towards developing strategies to lower the cost of fertilizer.
- *Low coverage:* Lack of incentives by agrodealers to penetrate some remote areas due to low returns and low demand for fertilizer. The average distance to a fertilizer store is greater in low potential areas.

[11] Interviews with the Managing Director, MEA Ltd, in November 2013.

While Kenyan fertilizer prices compare favorably against those of its East African neighbors, it is well above FOB prices from major exporters such as the US Gulf (see Figure 11) and the price differential has increased significantly since late 2011 (from roughly $200 to $400 per MT) illustrating the impact of high transport costs (both sea freight and internal land) on fertilizer prices in Kenya and throughout East Africa. While there is little control over sea freight charges, the costs of inland freight are changeable in a context of improved infrastructure – decreasing those costs could have a significant impact on fertilizer prices but would require extensive investments in port, road and rail infrastructure, as well as policies that reduce lengthy delays and high fees/charges (inclusive of bribes).[12] The planned new rail line from Mombasa to Nairobi (expected completion in 2017) with eventual expansion onwards to Kisumu should dramatically reduce internal transport time and costs for fertilizer and other freight.

Figure 11: Fertilizer Prices (DAP 18-46-0, $/MT)



Source: indexmundi.com (FOB US Gulf), AMITSA (others)

To address the affordability problem, the Kenyan government initiated the National Accelerated Agricultural Input Access Program (NAAIAP) in 2008 to help farmers access subsidized fertilizer by organizing them into groups, especially in remote areas. These are ostensibly areas where incentives to develop private sector distributorships are low as a result of low demand and lack of purchasing power by poor farmers (IFDC, 2012). Targeting beneficiaries of subsidized fertilizer has been a challenge and some of the subsidized fertilizers have ended up with unintended beneficiaries. In 2012, the Government provided subsidized fertilizer (about 60,000 MT) to about 250,000 maize farmers. In 2013, subsidized fertilizer supplies amounted to 60,000 MT for the long-rain season, and another 42,000 MT was expected for the short-rain season. For the 2014 growing cycle, the Agriculture Cabinet Secretary, Mr. Felix Koskei, has indicated that the government plans to procure and distribute 100,000 MT during the long-rain season (Kipsang, 2013). USAID-KAVES estimates that subsidized fertilizer accounts for about 20 percent of fertilizer for maize and about 8 percent of the total national fertilizer market.

In July 2012, subsidized fertilizer was retailing for KSh2500 per 50-kg bag, compared to commercial sale prices of KSh3000-3500 per bag. At the time the world market price was $563.13/MT or $28.15 per 50 kilograms (equivalent to KSh2365 per 50-kg bag at an exchange rate of KSh84 to the dollar). Therefore, the Government was distributing the fertilizer at a price slightly above the spot world

[12] The estimated cost of transporting a 20-foot container from Mombasa to Nairobi is $9,174 – of which only 14 percent (or $1,300) is the actual transportation cost. Indirect and hidden costs of delays account for the the balance of the total logistical cost. (Analytical Comparative Transport Cost Study Along the Northern Corridor Region, CPCS Transcom Limited, June 2010).

market price but well below local private sector prices. According to the Agriculture Cabinet Secretary, the fertilizer is distributed at prices that are 57-65 percent of the prevailing market prices[13]. For the 2011/2012 season subsidies totaled about $75 million.

4.1.3 Provision of Mechanical Equipment and Services

The provision of mechanical tillage, planting, and fertilizer application services is important to any maize value chain development initiative. In rain-fed environments where timeliness of operations can be the difference between good and bad yields, the availability of faster tillage methods is key to increased farm productivity. In Bungoma district, for example, Agwara (2005) found farmers oftentimes prepared their land late and therefore preferred faster but affordable tillage methods just at the onset of rainfall; availability and affordability were key factors. Depending on the size of their farm, smallholder farmers may hire manual labor, animal draft power or tractors for land preparation and limited harrowing with payment based on land area. Other machinery used on maize includes planters, threshers, and dryers, but their adoption on smallholder farms is limited.

Nationally, the level of adoption of mechanical methods of agriculture remains low. According to the Ministry of Agriculture, Livestock and Fisheries (MoALF), approximately 30 percent of primary tillage in Kenya is done using motorized power, 20 percent by animal draft power, and 50 percent manual labor.[14] The majority of small farmers rely on manual and animal draft power for tillage operations, while a majority of medium and large farmers operate its own machinery. The market for mechanical farm services remains underdeveloped and unorganized in most parts of the country. Farm families are generally unable to invest in mechanical equipment on their own and thus must rely on private providers, other farmers, or communal groupings. With increased pressure on land, availability of grazing land for draft animals has diminished, making oxen ownership for untenable in many areas. This trend coincides with increasing rural labor shortages and wages, critical constraints in maize production.

The CGA has identified high labor costs as a key constraint in maize production and increasing farmer margins. For example, Agwara (2005) found primary tillage in Bungoma using hired manual labor was 60 percent and 25 percent more expensive per unit area than animal draft and tractors, respectively, despite taking nine to ninety times as long to till an acre. On farm and post-harvest operations will therefore require labor saving innovations, including i) improved technology such as minimum tillage, integrated mechanical planters and fertilizer dispensers, and equipment for harvesting, shelling, drying and transport; ii) better market organization for collective marketing of inputs and outputs, shared mechanical services, and small-scale irrigation services, and iii) capacity building for agro-dealers and service providers to improve supply and efficiency of services, and support to develop simple standard weights and measures for output marketing.

Increasing adoption and utilization of mechanical services will require concomitant investments in support infrastructure and businesses. Agwara (2005) found poor rural access infrastructure that make farm accessibility difficult, especially for motorized tillage, was the main hindrance to the provision of mechanical services. In addition, because only primary farm operations are mechanized, there is suboptimal use of equipment, which forces providers to charge higher fees because of low equipment utilization after land preparation. More contractors and/or providers are required in rural areas to increase competition, supply, and act as price regulators. Recently, a number of organizations including the GoK have invested in tractor hire services and grain drying technologies. For example, most County Governments across Kenya have invested in tractor hire services for primary tillage. Additionally, Lesiolo (recently acquired by Cargill) operates mobile dryers in the main maize and wheat growing areas. These services are still inadequate and yet to reach smallholder farmers. In most cases demand far outstrips the capacities of service providers, leading to significant delays in farm operations.

[13] "Our prices are also fair. Subsidized DAP fertilizer costs KSh2500 compared to KSh3900 in shops. CAN goes for KSh1600 per bag compared to KSh2800." (Kipsang, 2013)
[14] See "MoALF Achievements Under the Jubilee Government's One Year in Offfice," 2014.

Agwara recommended that mechanization strategies should aim at reducing the cost of acquiring or leasing new machinery and equipment through expanded fabrication, relaxed tax regime, and affordable, reliable spare parts and energy supply systems. Furthermore, these should be accompanied by the promotion of better animal nutrition and healthcare, and increased adoption of alternatives to oxen to increase accessibility to animal draft power. Finally, proper regulatory and contract enforcement frameworks are required to encourage private hire services and improve service delivery; this would mean creating an enabling environment for service providers to increase their market capacity to supply tillage services.

There is also the need to invest in mechanical technology research and extension services focusing on improving the efficiency of mechanical equipment and services for timely land preparation. This will involve R&D work on appropriate equipment and machinery designs and the provision of maintenance services to improve power capacity. Plow designs suitable for an ox or two can alleviate the problem of increasing oxen shortages. The Rural Technology Development Centers (RTDC) and demonstration units (RTDU) should be strengthened to undertake some of this research and extension. Support from USAID-KAVES could catalyze the process.

4.1.4 Other Farm Inputs

Other farm chemicals (pesticides, herbicides, fungicides) are widely available through stockists and all major leading manufacturers are represented in Kenya. Annual imports of pesticide products are estimated at 9,000 MT ($50 million). Selection, safe use, and appropriate disposal remain serious issues. The Agrochemicals Association of Kenya (AAK), affiliated with CropLife International is the umbrella organization for 48 Kenyan pesticide manufacturers, formulators, re-packers, importers, and distributors. The Pest Control Products Board (PCPB) is responsible for product registration (about 200 products currently registered), and provides inspection services to identify improperly repacked, unregistered, counterfeit, mislabeled, or adulterated product.

Small agrodealers and stockists are the primary source of inputs for smallholder farmers, many of which also carry other items (hardware, general wares, etc.). Their numbers have increased substantially over the last decade – estimated at 8,000 to 10,000 nationwide (Mathenge, M. et al August, 2009) – which resulted in better access to primary inputs by farmers (although average distances for farmers to the nearest seed or fertilizer supplier remains high in certain districts). Agrodealers are required to have a license from local government authorities, as well as receive certification from the Pest Control Products Board (to sell pesticides and other farm chemicals) and KEPHIS (to sell seeds). In reality, however, not all agrodealers register with PCPB and KEPHIS.

4.1.5 Input Use and Effect on Productivity

Research shows that, under current conditions, increased soil fertilization provides the biggest "bang for the buck" for Kenyan smallholders, although this may well be a proxy for poor agricultural practices that do not capture the potential of hybrid varieties. Kamau et al. (2012) evaluated the impact of inputs on maize yields, as shown in Table 19. Estimated costs, revenue and gross margins are calculated using USAID-KAVES average crop budgets from the Baseline Survey 2013. The evidence suggests that a combination of fertilizer and local seed would be the most profitable for maize farmers using normal practices. It shows a farmer who uses fertilizer only increases yield 9 percent by switching from local (OPV or retained) to hybrid seed – but would see a 61 percent reduction in profit due to the additional cost accompanying the use of the seed. However, a farmer who uses local seeds would see a 59 percent increase in yield by applying fertilizers and an 80 percent increase in profit. In Western Kenya, farmers who did not use fertilizer were found to obtain 45 percent more yield with hybrid seeds than with local varieties (Ayieko and Tschirley, 2006, cited in AGRA, 2013). Overall this emphasizes the point that farmers can only become competitive if they adopt a full package of appropriate agricultural practices, a change that would require major investments in extension and training to achieve at a national scale.

Table 19: Household Maize Performance Comparison with Various Input Combinations (per acre)

Farming system	Yields (kg)	Production Costs (KSh)	Unit Cost (KSh/kg)	Sales (KSh)	Gross Margin (KSh)
Fertilizer + hybrid seeds	980	26,000	26.53	29,400	3,400
Fertilizer + local seed	892	18,000	20.18	26,760	8,760
No fertilizer + hybrid seed	727	20,000	27.51	21,810	1,810
No fertilizer + local seeds	458	12,000	26.20	13,740	1,740

Source: Kamau et al. (2012) for yield data; USAID-KAVES for production cost and sales estimates

Kamau et al. identified three categories of smallholder maize farmers, based on their use of fertilizers and hybrid seed: (i) consistent users; (ii) inconsistent users; and, (iii) consistent non-users. Nationally, only 41 percent of all smallholders use fertilizers and hybrid seed consistently, but the distribution varies across agro-regions (see Table 20). A majority of farmers in the Lowlands and Marginal Rain Shadow regions are either inconsistent users or non-users, while most farmers in the High Potential, Western Highlands, and Central Highlands consistently use fertilizers and hybrid seeds.

Table 20: Households Use of Fertilizer and Hybrid Maize Seed Across Four Panel Surveys (2000-2010, in Percent)

Agro-Ecological Zone	Consistent Users	Inconsistent Users	Consistent Non-Users
Coastal Lowlands (CL)	-	37.7	62.3
Eastern Lowlands (EL)	3.5	52.8	43.7
Western Lowlands (WL)	0.0	13.5	86.5
Western Transitional (WT)	38.9	49.3	11.8
High Potential (HP)	69.2	26.0	4.8
Western Highlands (WH)	58.7	33.3	8.0
Central Highlands (CH)	59.0	35.1	5.9
Marginal Rain Shadow (MRS)	-	20.0	80.0
Overall	**41.0**	**33.3**	**25.8**

Source: Kamau et al. (2012)

Interventions should be structured to conform to the unique profiles and challenges of each agro-region. For instance, promoting a more consistent application of soil fertilization (i.e. reducing the number of consistent non-users) would have greater impact in the Lowlands than in the High Potential and Highlands regions. In both cases, however, reducing the number of inconsistent users would have the greatest immediate impact on production and productivity. Alternatively, targeting the Lowlands with high-input interventions may not guarantee enough tangible benefits to the households and the program. In the High Potential and Highlands regions, attention should be paid to problems of fertilizer misuse and/or overuse that have compromised soil fertility and health. Years of abuse and overuse of urea and DAP fertilizers in these areas have depleted soil nutrients and elevated acidity levels. The seriousness of the problem was recently demonstrated by the new requirement by the Kenya government that farmers must submit results of soil tests to access subsidized fertilizers (Mureithi, 2013). Soil rehabilitation, nutrient replenishment and conservation must therefore form a key pillar of all interventions.

Combining the categories of farmers in Table 19 and agro-ecological zone profiles in Table 20, we build the following intervention scenarios:

1. Users of certified seed adopt fertilizer

2. Users of local seed adopt certified seed, with fertilizers
3. Users of local seed adopt certified seed, without fertilizers
4. Consistent nonusers apply fertilizer on local seed

The potential effect of these intervention scenarios is estimated in Table 21. All else equal, gains from adoption of hybrid seed among farmers already using fertilizers with local seed are negligible. In fact, such an outcome would lead to large declines in average gross margins. Instead, helping this group to improve their local seed selection and preservation would have greater impact. Getting users of local seed to adopt fertilizers, followed by more users of hybrid seed apply fertilizers, can attain the greatest impact. Adopting hybrid seed alone will have little impact.

Soil fertility depletion, specifically low soil organic matter (SOM) content and soil acidity is a key driver of productivity. Recent survey work in Kenya demonstrates that appropriate use of fertilizers is the single most important driver of yields and gross margins. With only 41 percent of maize farmers using fertilizer on a consistent basis, there is clearly substantial room for growth. The SOM content however is key determinant of the efficacy of fertilizer use. Maize response to fertilizers was found to be poorest on soils with low SOM (Marenya & Barrett, 2009). Moreover, soil acidity is a major threat to the high potential maize regions, particularly in the North Rift.

USAID-KAVES interventions that target integrated soil fertility management would have the biggest impact on productivity, even among consistent users of hybrid seed. Interventions could include: soil nutrient amelioration and management; soil testing and mapping; and fertilizer blending to meet nutrient requirements of various soils.

By adopting and applying fertilizer efficiently, users of hybrid seed could increase yields per acre by 26 percent (with an increase in gross margin of KSh1590), and users of local seed could increase yields per acre by 95 percent (with an increase in gross margin of KSh7020, see Table 21). Of course, hybrid seed users could also increase their returns more if they adopted better all-round practices. Overall, adoption of a suite of technologies around IFSM, seed, and agronomic practices may have the greatest impact, as shown by Teklewol, Kassie, Shiferaw, & Köhlin (2013) for Ethiopia.

Table 21: Intervention Scenarios

Scenarios	AEZ of interest	Yield increase (kg)	Change in Yield	Change in Gross Margin (KSh)	Remarks
1. Users of hybrid seed adopt fertilizer	CL (38%), EL (53%), WT (49%), WH (33%)	253	26%	1,590	*Second biggest impact*
2. Users of local seed and fertilizers switch to hybrid seed	CL (38%), EL (53%), WT (49%), WH (33%)	88	9%	-5,360	*Intervention may reduce household income*
3. Users of local seed without fertilizers adopt hybrid seed only	CL (62%), EL (44%), WL (87%), MRS (80%)	269	59%	70	*Increases productivity but income gain is marginal*
4. Consistent nonusers apply fertilizer on local seed	CL (62%), EL (44%), WL (87%), MRS (80%)	434	95%	7,020	*Greatest impact*
Overall impact*		**270-344**	**60%**	**4,305**	

*Source: USAID-KAVES calculations. Notes: * Refers to scenarios 1 & 4 only.*

In terms of agro-ecological zones, the greatest potential for yield increase is found in the Coastal Lowlands, Eastern Lowlands, Western Lowlands, Western Transition, and Marginal Rain Shadow. The main conclusion from this analysis is that a focus on soil fertility improvements, including the use of fertilizer, offers the greatest opportunity for increasing smallholder yields and incomes.

Our conclusions are supported by Duflo et al. (2008), who conducted a series of six field trials (over six crop cycles during a 3-year period) to ascertain the profitability of fertilizer on farms in Busia District of Western Kenya. They were interested in investigating the possibility that, while fertilizer and hybrid seed increased yields on model farms, they may not be profitable on many small farms where conditions are less than optimal. In the first few trials, one plot was randomly assigned to receive Calcium Ammonium Nitrate (CAN) fertilizer to be applied as top dressing. On the second plot, the full package recommended by the Ministry of Agriculture was implemented.[15] The third plot was a comparison plot on which farmers farmed as usual with traditional seed and without fertilizer. They found mean yield increases due to fertilizer use within the range of yields recorded on model farms, and the mean rate of return to using the most profitable quantity of fertilizer was 36 percent over a season (or 70 percent on an annualized basis). Importantly, other levels of fertilizer use, including the combination of fertilizer plus hybrid seed recommended by the Ministry of Agriculture, were found not to be profitable for the sampled farmers.

4.1.6 Input Affordability

Adoption of improved seeds, new varieties, and improved technologies has either been slow or stagnant recently, largely due to increasing cost of inputs, particularly fertilizer. Despite increasing fertilizer use among farmers, consumption remains low nationally and depends on the size of farm and the maize growing season. The national average cost of producing an acre of maize is about KSh30000 (Kamau et al., 2012), one-third of it spent on fertilizers. This is equivalent to $355 per smallholder household, and amounts to more than a year's income for most rural households. These households simply do not have the necessary capital to meet the recommended high-input "best practices" farming systems – the phenomenon Dorward (2009) refers to as the "affordability problem."

Dorward identifies credit constraints, imperfect competition, and risk of crop failure as the leading factors influencing input use. Since maize production is rain fed and the poorest smallholders are vulnerable to poor harvests and may not be able to absorb the sunk costs of inputs, they may choose not to purchase inputs and instead opt for a smaller but more stable output. Because the production season also coincides with the hunger season and high rural unemployment, smallholders find it difficult to raise the production capital. Without alternative sources of financing, most farmers opt for low or inadequate input techniques or resort to fertilizer types that are unsuitable for maize and damaging to the soil.

Potential Interventions to Address Input Use Constraints

- Work with fertilizer manufactures and farmer groups to increase the uptake of blended and customized fertilizer suitable for various regions;
- Increase level of soil testing through cooperation with private sector providers;
- Develop partnerships with input suppliers to reduce soil acidity;
- Promote fertilizer purchases immediately after harvesting through training and extension;
- Help develop informal seed systems through training and extension.

An alternative theory however contends that input use constraints are less about cost than farmer procrastination. Simple interventions related to the timing of inputs procurement can lead to significant increases in input use. Randomized experiments by Duflo *et al.* (2007) show that encouraging farmers to buy fertilizers immediately after harvest increases fertilizer use by 33 percent. It is also important to note that fertilizer market prices tend to be about 50 percent cheaper when purchased immediately

[15] Hybrid seeds were used in place of traditional varieties and Di-Ammonium Phosphate (DAP) fertilizer was supplied for planting along with CAN for use as top dressing.

after harvest as opposed to the start of the next planting season. One challenge to this intervention is the proper and safe storage of fertilizers.

4.2 FARMERS

4.2.1 Smallholder Farmers

We define smallholder farmers as those that cultivate less than 10 acres of land largely for subsistence, although some produce surplus for sale. Maize is grown by an estimated 97% of the 3.5 million smallholder farmers in Kenya, which translates to some 3.4 million farmers (Kirimi et al 2011). They operate in low-inputs and low yields systems but produce about 70 percent of the national maize output. Because of the small per capita volumes of maize produced by this category of farmers, they have limited access to important services such as finance, warehousing and drying services. Kirimi et al. (2011) found only 2 percent of small-scale farmers accounted for 50 percent of national maize marketed by smallholders. The vast majority of smallholder maize producers are actually net buyers.

Smallholder maize sales go largely to small-scale assemblers or brokers, who collect and bulk for onward sale to large wholesalers. Most small-scale farmers sell their maize at low prices immediately after harvest to meet immediate cash demands, such as school fees, health and other household requirements. Many also lack storage facilities that would enable farmers to *potentially* obtain higher prices during the off-season. Warehousing has been proposed as a potential solution, but the majority lack quantities to utilize this opportunity (the minimum receipt is available at 10 MT). This raises the potential to identify storage alternatives suitable to the small-scale farmers.

Less than one-quarter of maize farmers sell maize commercially. Farmers predominantly sell small amounts of maize in the village to many small-scale under-capitalized traders, making aggregation time consuming and costly and, hence, contributing to relatively high consumer prices.

4.2.2 Medium-Scale Farmers

Medium-scale farmers produce for home consumption as well as surplus for sale. They cultivate between 10 to 25 acres of maize, and are responsible for about 5-10 percent of Kenya's total maize output. Medium scale farmers sell about 46 percent of their production, while the rest is consumed at home (44 percent), stored as seed or lost (10 percent) (Kirimi et al. 2011).[16] They tend to be better capitalized than small-scale farmers, use a combination of both family and hired labor, and source their inputs more from agrodealers. These farmers can generally access financial services, warehousing facilities and can negotiate better prices for their maize depending on the volume on offer.

4.2.3 Large-Scale Farmers

Large-scale farmers cultivate for commercial purposes and are heavy users of commercial inputs such as fertilizer, improved seeds, chemicals and machinery. They rely more on hired labor and cultivate over 25 acres and account for the remaining 20-25 percent of national maize production. Most are found in the main maize producing areas of Rift Valley. Large-scale farmers are able to minimize their inputs cost by purchasing from wholesalers or distributors and are better placed to access financial services, warehousing facilities, and negotiate direct sales to large millers because of their large volumes. According to Kirimi et al (2011), large-scale farmers sell 99 percent of their maize output to both large-scale maize millers and the NCPB. The benefits of such economies of scale and the attendant market power are immense, and include better prices for maize. These farmers form a powerful political lobbying group and are the main drivers of government maize policies, specifically those related to NCPB and international trade policy. Together with medium-scale farmers, they are also the main proponents and the largest beneficiaries of the government-subsidized fertilizer strategy.

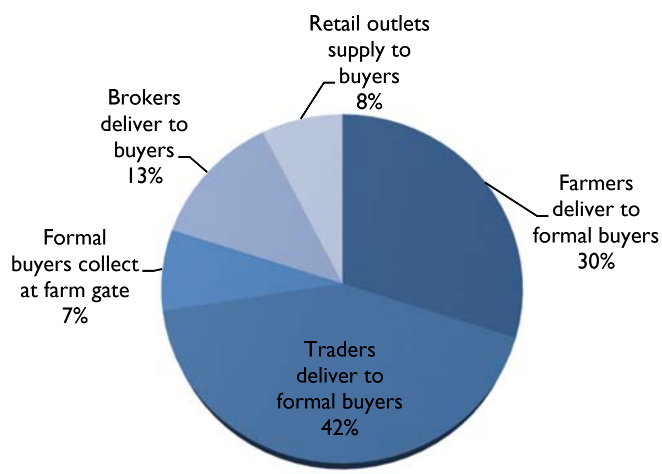
[16] USAID-KAVES calculation based on data presented in Table 7, page 46 in Kirimi et al, 2011.

4.3 MARKETING ACTORS

Maize marketing in Kenya is a complex, unorganized system consisting of thousands of small assemblers, brokers, medium-scale wholesalers, large wholesalers, transporters, and retailers. Wholesalers are traders that buy maize from assemblers and also directly from farmers, usually those in surplus areas for resale in deficit areas, to larger market centers and to millers. The NCPB is among the largest bulk buyers of maize, together with large- and medium-scale millers. For the period 2005/2006 NCPB purchased an average of 5.7 percent of national maize output (Kirimi et al. 2009). A few large trading companies and medium and large-scale farmers sell directly to NCPB, or millers.

Primary and secondary traders buy maize from large wholesalers and assemblers and sell it to smaller-scale retailers and final consumers. Secondary traders are also retailers in small market places where maize is stocked and sold in small volumes. KAVES field surveys found formal buyers procure maize through a number of channels; 42 percent from deliveries by local traders, 30 percent via direct deliveries from farmers, 13 percent from farmers through brokers, and 7 percent directly from the farm-gate (see Figure 12). Interestingly, approximately 8 percent of maize comes from retailers.

Figure 12: Supply Chain Allocation for Formal Maize Buyers in Surveyed Regions



Source: USAID-KAVES

4.3.1 Small-Scale Assemblers

Smallholder maize sales go largely to small-scale assemblers[17] or brokers. These are the first commercial purchasers of maize from the farm-gate. They buy maize directly from several farmers in bulk to capture economies of scale in transport to local markets, and sell it to wholesalers and retailers, and sometimes directly to consumers. In some cases, they also act as purchasing agents of large commercial millers.

The assembler (usually an under-capitalized small enterprise) turns over their stock as quickly as possible to release working capital and avoid storage costs. In general, local assemblers change their buying and selling practices in response to the seasonal agricultural cycle. During the harvest period, local buyers are busy assembling maize from small-scale farmers. Small-scale assemblers, itinerant traders, and small millers in the informal marketing channels are less active in drought years because they depend almost entirely on small-scale farmers for their supplies.

There are substantial costs associated with assembly, handling and grading of maize. Rural-based traders suffer low margins, poor access to credit, and inadequate storage facilities. More efficient aggregation by better-organized farmer groups can have an immediate impact on margins and incomes at the village level.

Kirimi et al (2011) found that maize wholesalers operate in the main urban centers in the maize growing areas and are the primary market channels for the village level maize assemblers. Due to a lack of suitable storage facilities (and working capital), village assemblers do not store grain but transport and sell quickly to wholesalers. Most small traders, like farmers, are interested in quick turnover, not storage. Results of Sitko and Jayne (2014) showing postharvest storage does not rank high among constraints identified by these traders provides support for this claim. Competition is strong within counties among small-scale assemblers whose turnover depends on day-to-day cash availability. Rural assemblers sell their grain to brokers, local cereal storeowners or maize

[17] Small scale assemblers operating at the village level are the most important market channels utilized by small scale maize farmers. (Kirimi et al., 2011)

wholesalers in district or local markets and also directly to retailers in the urban centers depending on the region. Farmer-village assembler relationships tend to favor the village assembler in terms of price and purchasing conditions, specifically weighing of produce. Interventions to promote weight standards and dissemination of price information will help level the playing field for farmers.

Because most assemblers do not store maize for any significant amount of time and sell quickly to wholesalers, they tend to not be very concerned with issues of maize quality and moisture content. Indeed, from a small-scale farmer's perspective, assemblers' willingness to buy most any product is considered a main advantage (Kirimi et al. 2011). However, assemblers use measurement units that result in the farmer being paid for less maize that s/he actually sells (see text box). As the first point of contact for farmers and their primary source of market information, rural assemblers wield a lot of power over farmers, especially those in remote areas.

Maize Assembling in Bungoma

Interviews by USAID-KAVES with local maize assemblers in Bungoma County revealed that assemblers get orders from brokers and purchase maize using gorogoros (tin). While gorogoros are meant to be equivalent to 2.25 kilograms, actual weight is more around 3 kilograms. However, when the assemblers/traders deliver to the local stores or brokers, the maize is weighed using a calibrated scale. Thus, the assembler/trader receives payment for roughly one-third more produce than s/he paid the farmer. Stiko and Jayne (2014) corroborate this finding. Since quality is difficult to ascertain at the farm gate, the assemblers could be insuring themselves against quality uncertainties and moisture content risk (i.e. maize with high moisture content weighs much less after further drying). For example, the FAO estimates that, to avoid the burden of extra drying, farmers give away an extra kilogram of maize per bag for every 1% increase in moisture content above 13.5%.

The assemblers in Bungoma use various means of transport to assemble maize, including donkeys, motorcycles and even bicycles. The assemblers use their own funds or advances from local maize traders to purchase maize from farmers. The local storeowner either uses his funds and/or is pre-financed by a wholesaler who comes to collect maize from him/her. The local storeowners in this region only sell their maize in bulk.

4.3.2 Wholesalers

Maize wholesalers are the main link between rural assemblers, local urban center cereal dealers and millers. The wholesalers are well capitalized and can command large volumes of grain. A majority also uses their own transport, while others use hired transport to deliver grain to distant customers. Maize is purchased either through brokers, local assemblers, or directly from farmers. Sorting and grading takes place mainly at this level, incurring significant handling costs and requiring space, facilities and equipment. 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. In maize deficit areas, "disassemblers" purchase larger quantities from wholesalers and others and repackage in smaller lots for sale to kiosks and small shops. Maize grades and quality is not an important consideration by either wholesalers or assemblers. The quality burden is therefore shifted to the end users, like millers, hence raising marketing costs and prices of final products.

4.3.3 Warehousing and Storage Service Providers

Kenya is among several East African countries that have embraced or are in the process of embracing warehousing receipts systems. Some of the major players in the provision of warehousing receipts system include Lesiolo (in Nakuru), Export Trading Company (in Kitale), and NCPB (in Narok South and Eldoret). NCPB warehouse charges are given in Table 22. The warehouses provide a number of services, including drying, bagging, fumigation, cleaning, storage, and links with buyers. A receipt requires a minimum of 10 MT of maize. The NCPB storage charges per month increase with the length of storage. Other charges include bagging, cleaning, drying, and fumigation. Drying costs KSh28 for every 1% above the minimum 13.5%; maize delivered with moisture content of 18%, for example, would attract an additional KSh126 per bag. Loading and off-loading services cost another KSh50 per bag, and transportation charge averages KSh100 per bag.

Participants in the warehousing receipts system can use the receipt to get credit from several participating banks. Small-scale farmers can only participate in the warehousing receipts system through group aggregation to attain the minimum volume requirement. Such adaptations are already occurring in different parts of the country; for example, MDG Yala which operates more like a cooperative with farmers organized into groups, supplying them with subsidized farm inputs on credit and then receiving repayment through crop harvests. The harvest is then bulked for storage at local NCPB warehouses. Farmers are free to supply quantities just enough to repay their loans or release own stock for storage, at rates slightly higher than NCPB's.

NCPB is the only Government parastatal involved in maize purchase. It has a dual purpose of stabilizing prices through market interventions and purchasing/building a strategic reserve. NCPB usually purchases maize at a price higher than the prevailing market price. The stored maize is usually off-loaded to the market through millers or through other channels for relief purposes, often at prices lower than the purchase price. It also manages the distribution/marketing of Government-subsidized fertilizer.

Table 22: Summary of Monthly Storage Charges by NCPB (KSh)

Month	Days	Per MT
1	0-30	833.25
2	31-60	1,022.10
3	61-90	1,211.00
4	91-120	1,399.85
5	121-150	1,588.70
6	151-180	1,777.60

Source: NCPB (cited in Mbwika, J. FAO 2012 pg. 45)

4.3.4 Transporters

Maize transportation takes a number of forms; at the village level the main modes of transport include bicycles, ox/donkey carts, small trucks (pick-ups) and lorries. From the district level transportation assumes high volume means, such as lorries (either own or hired) and in some cases rail. Some means of transportation is illegal – i.e. where drivers heading to the coast from western Kenya for example are hired by maize traders to transport maize without the knowledge of the trucks' owners – and often happens when the vehicle is empty and heading to the coast to collect imported cargo. Some wholesalers operate their own transport. Transportation is normally charged per bag and in consideration of the distance to be covered. For example, a bag of maize cost KSh150 to transport from Eldoret to Nairobi in 2010 (Mbwika, 2010). Kilometer based costs is estimated at $0.113 per ton (CPCS Transcom Ltd, June 2010)

4.4 PROCESSORS

Milling for maize meal is the primary source of value addition component of the Kenyan maize value chain. Other processed products include cooking oil and animal feed. About 19 large-scale millers do milling with a total milling capacity of 1.6 million tons per year (about 90% capacity utilization), while medium scale operators achieve 0.2 million ton annually:

- Twenty or so **medium- to large-scale millers** producing sifted maize meal or flour under their own brands (capacity averaging 200 MT per day, with ranges of 100-600 MT per day). These processors deal with large volumes of maize and do their own packaging. The millers are capital intensive and use roller-milling technology that produces a more refined meal. They acquire maize from wholesalers, NCPB stores, and large farmers.

- Fifty to 75 **smaller-scale millers** producing sifted maize meal and other processed maize products, often in their own brand consumer packaging, but at much smaller volumes (annual capacity average under 360 MT).

- Thousands of **posho millers** producing un-sifted flour using hammer mills with capacities of 10-50 bags per hour.

The large millers are members of the cereal millers association (CMA), while the small- and medium-scale millers belong to United Grain Millers and Farmers Association (UGMFA). Millers produce sifted maize meal and generally sell them under their own brands in 1-kg and 2-kg consumer packs (5-kg, 10-kg, and 50-kg bags are also produced). There have been innovations in the past to diversify maize meal brands by medium to large-scale millers through milling of composite flours and also fortification with minerals. Most of the composite flours are milled by small- and medium-scale millers and are targeted for porridge consumers.

Medium- and large-scale mills account for 90 to 95 percent of the total installed milling capacity (estimated at 1.4 million MT per year) and are located primarily in Nairobi and Mombasa (each with roughly 30 percent national capacity), followed by Eldoret (15 percent), Thika, Kisumu, and Kitale. Mombasa Maize Millers has increased its market share to more than 30 percent through recent acquisitions of other millers (i.e. Milly Grain Millers, Mazeina Millers, Kabansora Mills, Swan Millers, Grain Milling Corporation) and now has eight mills nationwide. Other major players include Unga Limited (35 percent owned by Seaboard and with mills in Eldoret, Nakuru, and Mombasa), Pembe Group, and Eldoret Grains. Combined, these top four milling companies account for nearly 70 percent of total milling capacity. The majority of millers also own livestock feed mill lines.

Most of the milling firms have a business line that deals with distribution of their products (e.g. Mombasa Maize Millers, Kitui Maize Millers), while others (e.g. Unga Millers) contract distributors to move most of their products. The distributors are the main link between the millers and the supermarkets and retail shops. While large millers are able to build stock of maize supplies to cushion themselves during the low supply season, and are also able through connections to get formal imports of maize whenever there is shortage in the country, small-scale millers who have limited capital and cannot build sufficient stocks to cushion themselves during the off-season.

4.5 RETAILERS

Maize flour is bought daily by the majority of urban Kenyans, from roadside kiosks, market stalls, small shops and supermarkets, or directly from small scale milling enterprises and posho mills. Distributors and, in some cases, millers supply retailers with maize flour at their point of operation. In rural areas, where motor vehicle transport is difficult, some retailers purchase maize meal in urban centers and transport on bicycles or motorcycles to remote market centers. The product is packaged in various containers, including 1kg, 2kg, 5kg, and 10kg bags. Some milling enterprises also pack maize mill in 90-100 kg bags, which are mainly sold to institutions. Some posho mills usually sell maize in smaller quantities, 0.5 kg or 0.25 kg, and usually have increased business when the prices of sifted maize meal sold in shops or super markets increase significantly.

Maize grain retailers on the other hand source their supplies from a number of sources; direct from farmers, from village assemblers, as well as wholesalers. They combine maize grain trade with other cereals such as dry beans, cowpeas, sorghum, millet, pigeon peas, etc. Retail outlets include open-air markets, kiosks, shops, cereal stores as well as supermarkets. Due to the significant vertical integration within the maize marketing chain, wholesalers and assemblers are also involved in maize retail sales to consumers. The retailers operate at low margins of 5-10 percent, depending on the source of their stock and the transport costs incurred.

4.6 SUMMARY OF FINDINGS

The maize value chain is complex, with a high number of interconnected actors. Our analysis has highlighted the opportunities for reaching farmers through multiple potential entry points, including input suppliers, village traders, extension service providers, and rural brokers. Our analysis shows that precision fertilizer usage provides the biggest 'bang for the buck' in terms of investment in inputs. A farmer that uses local seeds would see a 59 percent increase in yield by using fertilizer and an 80 percent increase in profit. However, the cost of inputs, particularly fertilizer, as a result of high freight costs, has contributed to low input use by most of the smallholder farmers. USAID-KAVES can help to reduce fertilizer costs by improving linkages between smallholder groups and input providers, experiment with smart subsidies for the most needy smallholders, and promote links to other rural agriculture finance initiatives.

Given the significant role of informal seed systems in maize production, USAID-KAVES should also focus on improving seed selection, preservation and the marketing systems to ensure farmers access to appropriate high quality seed. Results of the USAID-KAVES Baseline Survey show minimal yield differences between hybrid and local seed in most FTF counties which is almost certainly due to poor weed control and water stress in many areas. For some farmers, the local seed apparently performed better than its hybrid counterparts. By implication, proper selection and preservation of local seed could improve yields substantially, although performance issues are also a result of hybrid users not utilizing other required good agricultural practices that would increase yields.

5. MARGINS ANALYSIS

In this section we look at gross margins along the value chain. In order to do this, we conducted rapid rural appraisal (RRA) surveys of producers, assemblers, wholesalers, and retailers, and used data collected for farmer respondents of the USAID-KAVES Baseline Survey (2013). The surveys considered a number of variables in calculating cost of production for maize, including inputs, labor, processing, and transport.

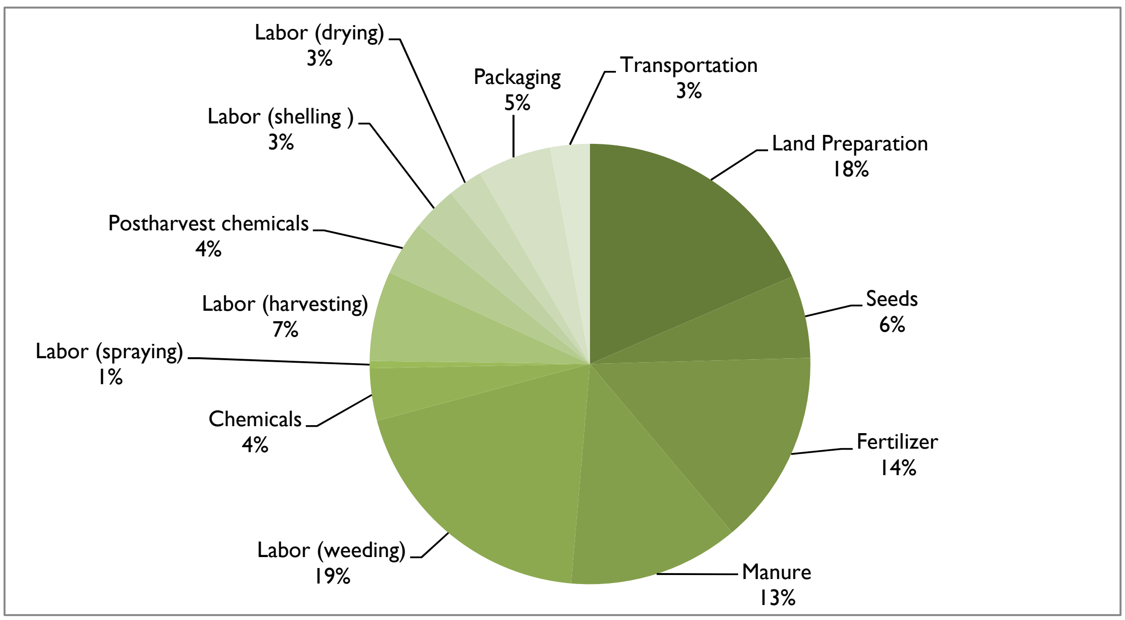
5.1 FARMERS

We have utilized the USAID-KAVES Baseline Survey to derive crop budgets and conduct margins analysis for small-scale maize farmers, cultivating 1 acre, on average, and ranging from 0.1 to 10 acres. The survey considered a number of variables in calculating cost of production for maize, including land preparation, seeds, fertilizers, weeding, application of chemicals at farm and in storage, cost of labor for fertilizer and chemical application, and harvesting.

5.1.1 Farmer Gross Margins

Our analysis reveals that the leading drivers of maize production costs are labor (33% of total production costs), fertilizer/manure (27%), land preparation (18%), and seeds (6%) as detailed in Figure 11. The average cost of production per acre is estimated at KSh17755 in Trans Nzoia, compared to KSh16492 in Migori and KSh15628 in Kakamega (see Table 23). Bomet had the lowest cost of production (KSh10726 per acre), however the county's crop was affected by the outbreak of the MLND that led to poor yields of only five bags per acre compared to normal yields of 22 bags.[18] The average cost of production per bag in the four counties was estimated at KSh1700, with the Trans Nzoia average of KSh1268 more than 40 percent lower than the Migori average of KSh1649.

Figure 13: Main Production Costs for Maize



Source: USAID Kenya Agricultural Value Chain Enterprises Survey (KAVES), 2013

[18] Personal communication with USAID-KAVES Maize Specialist for West Kenya Region, November 2013

Labor cost constitutes the biggest proportion of production cost across the four counties. It constitutes a significant upfront investment allocation beyond the reach of most smallholders, particularly those with a limited supply of family labor. The consequences include cutbacks on farm size, delayed field operations, skipping of critical operations, and poor husbandry practices. These lead to lower productivity and production.

The average farm gate price per 90-kg bag across all counties surveyed was KSh2179, generating an average gross margin of KSh480. Average gross margins varied by county, with Trans Nzoia reporting KSh732, followed by Migori (KSh691), Bomet (KSh286, despite MLND infestation), and Kakamega (KSh264). These margins translate to annualized return on investment of approximately 100%, 70%, 24%, and 21% for Trans Nzoia, Migori, Bomet and Kakamega, respectively (Table 23). In terms of household (5 members) income, they average to about KSh264 per person per month in Trans Nzoia, KSh131 in Migori, and KSh34 and KSh38 in Bomet and Kakamega, respectively. Assuming a rural poverty line of KSh1900 per adult equivalent per month, the Table further shows that maize income is less than 10% of total household expenditure requirements. If all the maize produced were consumed at home (at prevailing retail prices), households would meet between 4.2 percent (Bomet) and 26 percent (Trans Nzoia) of their total annual consumption expenditure requirements.

5.1.2 Economic Viability of Maize Production

In terms of economic viability of maize enterprise, Table 24 computes the minimum number of acres required to meet annual household consumption requirements. Assuming maize is the only source of income, the Table indicates that for households to meet their consumption expenditures at current production levels, they need at least 11 acres in Trans Nzoia, 16 acres in Migori, and 48 acres in Kakamega. Even with a 30% increase in productivity, households would still need 6, 8, and 15 acres respectively. These land sizes are not available among households in the FTF counties. **This report, therefore, concludes that maize cannot constitute the only source of livelihoods for smallholders in the target counties. Income and enterprise diversification must form an integral part of USAID-KAVES intervention package**.

For households to meet their consumption expenditures at current production levels, they need at least 11 acres in Trans Nzoia, 16 acres in Migori, and 48 acres in Kakemega.

Based on our analysis, key interventions to further increase farmers' returns should target reduction in per unit costs of production, specifically focusing on more expensive inputs such as fertilizer, labor and land preparation costs. Access to financial services for purchase of inputs is also an important consideration to ensure that farmers are able purchase inputs on a timely basis.

Table 23: Typical Gross Margins obtained by Smallholder Maize Farmers in four Counties (KSh per acre)

Item	Trans Nzoia		Migori		Bomet		Kakamega	
	Amount	% Total	Amount	% Total	Amount	% Total	Amount	% Total
Cost:								
Land preparation	2,293	13%	2,651	16%	2,203	21%	2,594	17%
Fertilizer purchase	4,812	27%	2,979	18%	2,984	28%	4,468	29%
Fertilizer application	627	4%	833	5%	600	6%	1,764	11%
Seed	2,140	12%	1,699	10%	1,559	15%	1,908	12%
Weed control	1,505	8%	1,855	11%	1,492	14%	1,344	9%
Pesticides	581	3%	700	4%	360	3%	388	2%
Pesticide application	427	2%						
Materials	1,104	6%	640	4%				
Harvesting	2,121	12%	2,013	12%	1,073	10%	1,710	11%
Storage chemicals	611	3%	821	5%	251	2%	711	5%
Marketing	192	1%	667	4%			300	2%
Transport	1,343	8%	400	2%	200	2%	440	3%
Other			1,233	7%				
Total production cost	**17,755**		**16,492**		**10,722**		**15,628**	
Yields (bags)	14		10		5		9	
Cost per bag	1,268		1,649		2,144		1,736	
Revenue and Returns:								
Price per bag	2,000		2,340		2,430		2,000	
Gross income	***28,000***		***23,400***		**12,150**		**18,000**	
Gross margin	10,245		6,908		1,428		2,372	
Gross margin per bag	732		691		286		264	
Percent gross margin	37%		30%		12%		13%	
Return on investment (ROI)	58%		42%		13%		15%	
Real ROI (assumes 8% annual inflation rate)	53%		39%		12%		14%	

Source: Calculations from data obtained from USAID-KAVES Baseline Survey(2013)

Table 24: Financial Viability of Maize as a Smallholder Crop Enterprise

County	Trans Nzoia		Migori		Bomet		Kakamega	
Item	**Amount**	**30% Yield Increase**	**Amount**	**30% Yield Increase**	**Amount**	**80% Yield Increase**	**Amount**	**30% Yield Increase**
Total production cost (KSh)	17,755	17,755	16,492	16,492	10,722	10,722	15,628	15,628
Yields (bags)	14	18.2	10	13	5	9	9	11.7
Cost per bag (KSh)	1,268	1,268	1,649	1,649	2,144	2,144	1,736	1,736
Price per bag (KSh)	2,000	2,000	2,340	2,340	2,430	2,430	2,000	2,000
Gross income (KSh)	28,000	36,400	23,400	30,420	12,150	21,870	18,000	23,400
Gross margin per acre (KSh)	10,245	18,645	6,908	13,928	1,428	11,148	2,372	7,772
Percent gross margin	37%	51%	30%	46%	12%	51%	13%	33%
Return on investment (ROI)	58%	105%	42%	84%	13%	104%	15%	50%
Real ROI (at 8% inflation rate)	53%	97%	39%	78%	12%	96%	14%	46%
Production cycle (8 mos = 240 days)	0.658	0.658	0.658	0.658	0.658	0.658	0.658	0.658
Annualized ROI	100%	198%	70%	154%	21%	196%	24%	85%
Average maize farm size (acres)	1.03	1.03	0.76	0.76	0.94	0.94	0.97	0.97
Total maize enterprise earnings (KSh)	10,552	19,204	5,250	10,585	1,342	10,479	2,301	7,539
Consumption expenditure saved by own production (at retail price = KSh3300)	29,831	44,107	8,588	16,112	4,788	17,196	13,181	21,824
Maize earnings per person per month	264	480	131	265	34	262	58	188
Annual rural HH consumption expenditure, at poverty line (KSh1900 PAE per month)	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000
Contribution of maize to consumption requirements	9.3%	16.8%	4.6%	9.3%	1.2%	9.2%	2.0%	6.6%
Contribution of saved (maize) expenditure in total annual consumption expenditure	26.2%	38.7%	7.5%	14.1%	4.2%	15.1%	11.6%	19.1%
Number of acres required to meet household needs (if maize is the only enterprise)	**11.1**	**6.1**	**16.5**	**8.2**	**79.8**	**10.2**	**48.1**	**14.7**

Source: Calculations from data obtained from USAID-KAVES Baseline Survey (2013)

5.2 VILLAGE ASSEMBLERS

The village assemblers are the universal links to markets given their ability to penetrate remote areas in search of maize. The assemblers purchase direct from farmers and sell in rural urban centers either to wholesalers or retailers. They operate with low capital and therefore sell their purchases as soon as possible to wholesalers or retailers in the local market centers. Others operate on agency basis for major buyers. USAID-KAVES conducted unrepresentative small RRA surveys to estimate cost and margins of village assemblers. Results show assemblers bought a bag at KSh2656 with an average margin of KSh305 in the three counties surveyed. This margin is in line with Kirimi et al. (2011) that found village assemblers made gross margins of between KSh100 and KSh400 per bag. Kakamega had the highest return of KSh316 per bag and Wote (Makueni) the lowest at KSh160 (Table 25). The key challenge facing village-level assemblers is access to capital, with the respondents reporting that they relied on daily turnover to re-capitalize their operations.

Table 25: Gross Margin Analysis for Village Level Assemblers (KSh per 90-kg bag)

	Wote (n=1)	Kakamega (n=2)	Trans Nzoia (n=1)
Purchase price	3,000	1,950	1,900
Transport bulking	100	0	0
Bagging cost	5	45	40
Bag cost	30	10	10
Loading cost	10	10	10
Offloading cost	10	10	0
CC levy	20	30	30
Storage	12	10	20
Drying	20	15	20
Losses/Bag	33	0	0
Cost per bag	3,240	2,080	2,030
Sale price	**3,400**	**2,400**	**2,200**
Gross margin per bag	**160**	**320**	**170**
Gross margin as % of sale price	**5%**	**13%**	**8%**

N=number of people surveyed per location *Source: USAID-KAVES RRA surveys (November 2013)*

5.3 WHOLESALERS

Maize wholesalers purchase maize from a number of sources: direct from farmers, village assemblers and brokers. Wholesalers are also involved in the importation of maize grain especially from regional markets. Gross margins for the 11 wholesalers surveyed are contained in Table 26.

Table 26: Wholesale Gross Margin Analysis (KSh per 90-kg bag)

Cost Item	Migori (n=5)	Trans Nzoia (n=3)	Wote (n=2)	Bomet (n=1)
Transport bulking		100	88	
Purchase price	2,844	2,233	2,850	2,500
Bag cost	45	40	30	25
Bagging Cost	15	10	10	10
Loading cost	16	10	10	10
Weighing	0	10	0	0

Transport selling			1	300
Offloading	10	10	10	20
County levy	10		20	4
Storage	10	20	6	40
Drying	29	40	20	
Total cost	2,979	2,473	3,044	2,909
Sales Price	**3,236**	**2,950**	**3,325**	**3,040**
Gross margin	**257**	**477**	**281**	**91**
Gross margin as % of sales price	**8%**	**16%**	**8%**	**3%**

Source: USAID-KAVES RRA surveys (November 2013)

5.4 RETAILERS

Grain retailers obtain their supplies from a number of sources, from village assemblers, brokers, wholesalers and also informal importers. Table 27 contains the gross margins for the 15 retailers surveyed.

Table 27: Maize Retailer Gross Margins (KSh per 90-kg bag)

Cost Item	Wote (n=5)	Machakos (n=4)	Migori (n=3)	Trans Nzoia (n=3)
Purchase price	3,080	2,900	2,790	2,350
Offloading	10	10	15	10
County levy	0	4	28	10
Storage	0	0	0	0
Labor	0	0	0	15
Losses per bag	30	49	154	93
Other costs	0	10	0	0
Total cost	**3,120**	**2,973**	**2,986**	**2,488**
Sale Price	**3,400**	**3,350**	**3,320**	**3,150**
Gross margin per bag	**280**	**377**	**334**	**662**
Gross margin as % of sales price	**8.2%**	**11.2%**	**10.1%**	**21%**

Source: USAID-KAVES RRA surveys (November 2013)

5.5 MILLERS

Four millers were interviewed within Nairobi in November 2013 to gather information on milling costs, purchase prices of maize and revenues from the sale of maize meal and byproducts. One miller was large-scale (30,000 bags per month), one was medium-scale (6,000 bags per month) and two were small-scale (600 and 1,400 bags per month). The medium-scale miller reported a maize meal recover rate of 80 percent, compared to the 75 percent reported by the large-scale miller. The cost of purchased maize grain constituted 96 percent of the production cost for the millers, with a reported gross margin of KSh 101 per bag milled (Table 28).[19] Gross margins are quite thin (an average of 4 percent and derived mostly from byproducts sales. Without revenues from byproducts, the millers

[19] In a different study conducted by KARI/MoA (2011), it was found that cost of maize contributed to 85% of cost of maize meal processing.

interviewed for this report are losing on average about 8 percent per bag of maize milled. Those millers who do not have markets for their byproducts are therefore at a great disadvantage, which partly explains why most large-scale maize millers also operate mixed animal feed processing plants.

Table 28: Gross Margin Analysis for Millers in Nairobi

	Small-1	Small-2	Medium	Large
Cost of maize	2,950	2,850	3,000	2,900
Offloading cost	20	15		10
Overheads	55.56	20.83	8.6	10.56
Electricity/diesel	13.89	3.27	7.50	33.33
Repairs		2.98	8.33	26.67
Taxes	15.00	1.49		
County levy	13.89	17.86	16.67	0.28
Labor	6.94		33.33	3.33
Losses per bag			26.00	10.00
Distribution			10.00	13.89
Packaging			60.00	40
Total cost of milling	3,075.28	2,911.43	3,170.44	3,048
Bags milled per month	**600**	**1,400**	**6,000**	**30,000**
Total monthly milling cost	1,845,166.67	4,076,000	19,022,667	91,440,000
Maize meal monthly revenue	1,620,000	3,675,000	17,520,000	92,250,000
By-products revenue	310,500	567,000	2,160,000	165,000
Total revenue	1,930,500	4,242,000	19,680,000	92,415,000
Gross income	85,333	166,000	657,333	975.000
Gross margin per bag	142.22	118.57	110.00	32.50
Average gross margin per bag				**100.82**

Source: USAID-KAVES RRA Surveys, November 2013

5.6 SUMMARY OF FINDINGS

At an average cost of production of KSh1700 per 90-kg bag, and additional KSh1603 is added in value or earned in gross margins by the various value chain actors. The farmers' maize selling price of KSh2179 accounts for 66 percent of the final retail price, with value addition and gross margins by assemblers, wholesalers and retailers accounting for 14 percent, 15 percent, and 5 percent respectively of the final retail price. Table 29 provides a summary of the cumulative value addition and gross margins for maize grain along the value chain. Contrary to popular belief, the average gross margins for each post-farm actor are not high. In fact, farmers have the highest gross margin with 22 percent margin. Village assemblers and wholesalers obtain 10 percent and 11 percent gross margins (after accounting for costs), respectively, while retailers have the lowest margin of 5 percent.

The relatively small margins achieved by traders, coupled with high risks of wastage and other forms of loss, leave little room for increasing farm gate prices by squeezing other actors' margins. These thin margins are indicative of the high cost of doing business along the maize value chain, starting with the cost of assembly and transportation. Increased margins would be best obtained by reducing per unit production costs (particularly at the farm level through increased productivity) and through increased efficiencies of scale through better aggregation.

Table 29: Illustrative Gross Margins of Maize Value Chain Actors (KSh per 90-kg bag)

Value Chain Actor	Gross Margin (KSh)	Sales Price (KSh)	Gross Margin (%)
Producer	480	2,179	22%
Assembler	260	2,656	10%
Wholesaler	339	3,136	11%
Retailer	163	3,303	5%
Total	**1,242**	**3,303**	**38%**

Source: USAID-KAVES 2013

6. BUSINESS ENABLING ENVIRONMENT

6.1 SUPPORTING ORGANIZATIONS AND INSTITUTIONAL ACTORS

Kenya has several ministries handling agriculture-related issues, including the State Departments of Agriculture, Lands, Housing and Urban Development, Environment and Mineral Resources, and Devolution and National Planning, among others. The Agricultural Sector Coordination Unit (ASCU) and the National Stakeholder Forum played a crucial inter-ministerial role in formulating maize-related policies in consultation with various stakeholders, but their roles have now been absorbed in the new Agriculture, Fisheries and Food Authority (AFFA). The Ministry of Agriculture provides most of the extension and training services. It also generates market information through the Agricultural Information Resource Center (AIRC).

Public regulatory institutions are regarded as weak because of limited resources and low credibility. Their ability to regulate and enforce quality standards is limited. The legal institutions regulating rural commerce are weak and thus make for less efficient markets. Additionally, difficulties in contract enforcement pose a major problem through the value chain and have specifically hindered the growth of contract farming, where side selling is common.

6.1.1 Research, Extension and Information Institutions

Kenya has the most developed network of public and private maize research institutions in Africa, with12 percent of the national research budget allocated to maize, supplemented by several donor-funded national and multinational breeding and research programs, including:

- *Kenya Agriculture and Livestock Research Organization (KALRO) Food Crops Research Institute (formerly KARI)* – responsible for research and seed multiplication.
- *Kenya Plant Health Inspectorate (KEPHIS)* – coordinates response to crop pests and disease control.
- *International Maize and Wheat Improvement Center (CIMMYT)* – breeding and technology transfer
- *Local universities, primarily Egerton University, the University of Nairobi, and Jomo Kenyatta University of Agriculture and Technology (JKUAT)* – research on plant breeding and protection, mechanical technology research, and training in agronomy and farm management.
- *Tegemeo Institute of Agriculture Policy and Development* – maize policy, value chain analysis.
- *Private agribusiness companies, including regional centers for multinationals such as Monsanto and Syngenta* – foreign seed variety testing, agrichemical development, research and extension.
- *Private and public institutions laboratories* – testing of maize and maize products for aflatoxins and other quality parameters

While there is no shortage of research institutions, technology transfer to smallholders has been slow, particularly in the customization, promotion, and adoption of long and short-cycle hybrid maize varieties available for different ecological conditions. KARI and other crop breeders have supported maize crop development and currently have over 215 varieties suited to various agro-ecological zones. Some of these are not only tolerant to drought but also can withstand *striga* infestation, especially in western Kenya regions. KARI is presently the main player in research and technology transfer for maize.

The latest addition is the Kenya Agricultural Information Network (KAINet) set up to promote information exchange among stakeholders in the agricultural sector. KAINet was established with financial support from the Department of International Development through FAO and implemented through collaboration between KARI, the Association for Strengthening Research in Agriculture in East and Central Africa (ASARECA) and CAB International. KALRO currently hosts the KAINet with participating of universities, research institutions, and Government ministries such as JKUAT, Kenya

Forestry Research Institute and the Ministry of Agriculture. Private sector technology companies, such as M-Farm, are emerging as players in market information services through mobile technology.

6.1.2 Financial Service Providers

Financial institutions are important players in the maize value chain, financing of a number of activities, including farm inputs, trading and processing. Smallholders' access to financial services is affected by a number of factors. Some find the loan application process tedious, while others fear the consequences of defaulting. Since most smallholder farmers can only access loans as a group, one farmer defaulting has consequences for all group members. Financial institutions are also reluctant to lend to agriculture in general, which they perceive to be risky, and to small farmers in particular due to lack of collateral and the high cost of servicing small loan amounts.

Although access to financing by smallholders is extremely limited, the Kilimo Biashara is an example of one initiative that is financing small-scale farmers, farmers groups/self-help groups, and cooperatives and farming companies for purchase of farm inputs; fertilizers, chemicals and seeds (up to KSh150000). Grain traders can also access loans for purchasing maize and other farm produce. The fund does not advance cash to farmers but pays directly to input suppliers. It is a $5 million dollar facility financed by IFAD and AGRA to cushion banks against risks of lending to the agriculture sector (participating Banks include Equity and Family Bank). To date, the project has loaned KSh7.1 million to just 250 farmers growing maize on 497 acres.[20]

Other financial products for the sector include facilities provided under the warehousing receipt system. The warehousing receipt system comes with a number of benefits but has proven elusive for small-scale farmers due to the minimum requirements of 10 MT per receipt, a volume impossible for individual farmers unless they deposit their grain as a group. Even when farmers work as a group, they can encounter complications related to diverse financial needs and interest. Lesiolo Grain Handlers Ltd has partnered with Chase bank to offer warehouse Receipt Financing product to grain traders and farmers. They qualify for loans of up to 65 percent of the total value of maize stored in a certified warehouse (Business Daily, September 17, 2013, p.1). Lesiolo can store up to 50,000 MT of maize at any given time in its silos. The loan comes with a commitment fee of 1.5 percent and is repayable at one percent monthly interest rate for six months.

Smallholders' access to financial services is affected by a number of factors. Some find the loan application process tedious (e.g. in the case of Kilimo Biasara facility), while others fear the consequences of defaulting. Since most small farmers can only access loans as a group, one farmer defaulting has consequences for all group members. Financial institutions are also reluctant to lend to agriculture in general, which they perceive to be risky, and to small farmers in particular due to lack of collateral and the high cost of servicing small loan amounts.

Commercial bank lending to agriculture is nearly exclusively to large-scale farmers. The GOK's Agricultural Finance Corporation provides both individual and group loans to farmers, but it has high default rates. Microfinance institutions have not traditionally penetrated the smallholder agriculture sector nor designed appropriate financial products for producers, but this is improving with SACCOs 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 will provide inputs on credit (deducting the price of the inputs from the sales price paid to the farmer upon delivery of product). A pilot crop insurance program for small-scale maize growers began in 2010 and shows promise, but coverage area and utilization remains low.

[20] Bob Koigo, at www.farmbizafrica.com. Accessed October 30th 2013

6.1.3 County Governments

Emerging county agriculture policies and regulations will significantly reshape Kenya's agricultural policy regime.[21] The emergence of these devolved units will change the organization of local agricultural sectors, particularly in the areas of extension and education, inputs marketing policies, and production support strategies. Of specific importance will be production and marketing levies already being proposed across the country. The impact of these policies will vary depending on whether a county is a net producer or net consumer of maize. County government policies/strategies, institutions, levies and taxes, priority value chains and facilitation of value chain actors must be understood within the broad legal framework established to support county governments. The legal framework consists of the County Government Act of 2012 and the Public Financial Management Act (2012). These call for the preparation of County Integrated Development Plans (CIDPs). The CIDPs must be aligned to the Kenya Vision 2030 and the second MTP 2013-2017 to align County development with National goals.

Concerns have been raised about the potential influence of devolution on the maize industry with respect to County government policies/strategies, regulations, and institutions, and concurrence of county priorities and goals with those of the central government. A number of functions formerly in the domain of the Ministries or state corporations have now been devolved per the constitution. In practice, however, confusion reins about the impact of some policy reforms (such as the AFFA) and their implementation and coordination arrangements. Based on rapid appraisal surveys of ten counties, the following picture emerges:

- *Prioritization of value chains yet to be rationalized:* Progress toward establishing working structures, institutional framework, policies and operational procedures, and initiating stakeholder forums varies depending on when County Ministers and Directors of Agriculture were appointed. Most counties have not designated priority value chains to be promoted.
- *Resource allocation for agriculture is inadequate:* Specifically, deployed staff is well below the required numbers. Amounts of funds allocated to agriculture depend on the agricultural potential of a County. Thus Kirinyaga and Kisii have relatively higher agricultural budgets (as a percentage of the total budget) compared to Machakos and Makueni.
- *Coordination mechanisms characterized by mistrust:* In all the counties there is low level of communication, mutual understanding, and cooperation between national government units and the county ministries and officers. It was observed that county ministers involved the ASDSP and Liaison Officers of the national government only to a limited extent.
- *Revenue collection and regulation of trade causing concerns among traders:* The need for devolved governments to raise local revenue is one of the greatest challenges facing county governments. So far, most counties have targeted various areas of trade and production as sources of revenue. In most counties, cess and market charges are received at source and destination of commodities traded or transported. The taxation rates vary across counties and commodities. No additional charges are imposed when crossing county boundaries except for numerous traffic police roadblocks that charge unofficial "facilitation" fees.

[21] Five Acts and Bills on devolution related to agriculture are either operational or pending before Parliament. They include: (a) the Agriculture, Fisheries and Food Authority Act (No. 13 of 2013) that commenced on 17th January, 2014 and created the Agriculture, Fisheries and Food Authority (AFFA); (b) Kenya Agricultural and Livestock Research Act (No 17 of 2013), which commenced in January 2013 and created KALRO as the successor to the Kenya Agricultural Research Institute (KARI), the Kenya Marine and Fisheries Research Institute (KEMFRI), the Kenya Trypanosomiasis Research Institute (KETRI), the Kenya Forestry Research Institute (KEFRI), the Coffee Research Foundation, the Tea Research Foundation of Kenya, the Kenya Sugar Research Foundation (KESREF), and all livestock research institutes; (c) Crops Act (No. 16 of 2013), assented to in January 2013 but no commencement date yet and seeks to regulate the Scheduled Crops sector, maize included; and, (d) The Kenya Plant Health Inspectorate Service (KEPHIS) Act No. 54 of 2012, assented to in December 2012 but yet to commence due to conflicts with the AFFA Act. Some of these laws remain contentious and currently under review, specifically those related to KEPHIS and the Pests Control Products Board (PCPB).

- *Investment priorities identified but no incentives and links with potential investors:* Most counties recognize the need for investments in value addition, processing, storage, and marketing. However, there are no clear plans, strategies for investment, or partnerships that would lead to the realization of these goals; nor are there any clear statements on the nature of support and incentives to be offered by the county governments.

USAID-KAVES could play an important role in working with county governments in the target regions to help shape agriculture policy. The following cost items will prove particularly important for any interventions: storage/rental fees and charges; transportation charges; county cess; and roadblocks and weighbridges. Intervention projects must be tailored to the unique needs of the devolved units and collaboration must be cultivated to ensure buy in. Capacity building to establish well-functioning governance structures will be necessary to support the agriculture development needs of the counties.

6.2 REGULATORY AND POLICY ENVIRONMENT

Policy uncertainty is a major limiting factor for maize production. Given the importance of maize, governments often justify intervening in the markets to ensure food security. This can be in the form of export or import bans, purchases for national food reserves, or punitive import duties. Furthermore, government and donor interventions can also cause uncertainty and provide market advantages to private sector traders who gain contracts to supply public entities with maize (import licensing and NCPB allotment letters).

6.2.1 Policy Regime

At the national level, policy reforms and interventions relevant to the maize industry include the following:

Agricultural Sector Development Strategy, ASDS (2010-2020), which focuses on: enhancing access to inputs and credit; increasing productivity; improving land use and management; strengthening enabling and support institutions to improve service provision; and, promoting commercialization and competitiveness. The strategy has also prioritized organization of smallholder horticulture producers and building of their capacity at all levels, e.g. through horizontal and vertical linkages. The main challenges likely to hamper implementation of ASDS are as follow:

- It is largely aligned to the priorities of previous line ministries in the agriculture sector;
- It was launched before promulgation of the Constitution of Kenya 2010, thus there is a lack of harmonization at national and county levels;
- Restructuring of the national government through consolidation of ministries, from ten to four, has caused a lot of confusion in the sector;
- Most of the substantive activities proposed in the strategy have since been devolved to the counties, whose investment priorities may not converge. This could create difficulties in management and inter-ministerial coordination of crosscutting functions.

The National Agriculture Sector Extension Policy (NASEP) (2012) provides a sector-wide approach to providing extension services. Since its enactment, the policy has faced numerous implementation challenges, including:

- Extension is one of the functions that has been fully transferred to the county governments; horticulture production by smallholder farmers is likely to bear the brunt of interruption in service provision due to transition mechanisms;
- Continued overreliance on programs and projects by development partners' that do not cover the majority of smallholder horticulture farmers;
- Lack of skills and financial resources may force service providers to continue focusing on production aspects rather than commercialization, value addition and marketing;

- There is no regulatory authority to control the quality of services provided by extension service providers.

National Agricultural Research System Policy (2012) provides for the enactment of the Kenya Agricultural Research Act, which consolidates all agricultural research institutions in the country under one umbrella organization, the Kenya Agricultural and Livestock Research Organization (KALRO). The implications of the policy must be evaluated in the context of ASDS, NASEP, AFFA, interventions proposed in the National Horticulture Policy and the devolution of agricultural functions. There is ongoing debate on whether or not KALRO should retain the current decentralized structure of KARI, along county and agro-ecological zones, or centralize into a national research agenda.

The National Agribusiness Strategy (2012) proposes to use a value chain development approach to facilitate productivity increases, commercialization and competitiveness through removal of barriers and creating incentives for the private sector to invest in agribusiness and related opportunities. It also seeks to invest public resources more strategically to trigger growth in agribusiness and make agribusiness systems more competitive and easily adaptable. It is complementary to ASDS and the National Horticulture Policy in terms of building capacities of market actors and promoting linkages.

The National Seed Policy (2011) has prioritized a number of interventions, including increased financial support to research, extension, variety and species development and technology transfer, strengthening coordination of public and private research and extension services, sourcing and developing variety germplasm to broaden the genetic base, support to domestication and conservation of biodiversity, and facilitating self-regulation of seed industry through authorization of institutions with expert knowledge and appropriate facilities to undertake seed certification services. The policy is a critical ingredient to both ASDS and the National Horticulture Policy. Although there are many players in the seed industry, their core business remains in cereals (mainly maize and beans). Horticulture producers rely on either local informal seed or imported seeds thus raising concerns about accessibility by smallholders.

6.2.2 Policy Intervention

> There is a high level of political sensitivity of maize prices, leading to attempts to support, suppress, or stabilize prices, creating uncertainty within the sector.

Government intervention in the maize market to support domestic production and manage imports is common. In 2008, Kenya followed other African countries, such as Malawi, Nigeria, Zambia, Tanzania, and Ghana to introduce new production subsidy programs. These actions influence maize prices and change market dynamics, specifically the conduct of the various actors along the value chain. The government uses the National Cereals and Produce Board (NCPB) to influence producer prices. For example, for the 2010 harvest, NCPB increased its buying price from KSh1600 (in July) to KSh2300 (in August/September) and later reduced it to KSh1850 for the October-December period (Kamau et al., 2012). These prices were 33 to 49 percent higher than prevailing wholesale prices in Eldoret. For 2011, NCPB raised the buying price by 62 percent to KSh3000 from August to December. The analysis by Tegemeo found that this action reversed the decline in wholesale prices and only stopped in January 2012 when wholesale prices decreased markedly after NCPB stopped buying maize. While the price support program seems effective in boosting producer prices, it raises prices for maize consumers, including a majority of smallholder maize farmers who are net purchasers of maize themselves.

The National Cereals and Produce Board (NCPB) has a grain storage capacity of 28 million bags, but this remains largely under-utilized, currently at about 13 percent. In 2008, after the food security crisis, the Ministry of Finance was asked to allocate more funds to increase the Strategic Grain Reserve from the 4 million bags (or one and half months of the national requirement) to 8 million bags (or three months of the national requirement). However, the reserve has never surpassed 3 million bags.

Since 2008, the government has been importing over 60,000 MT of fertilizers annually through the NCPB, in a bid to boost food security in Kenya through increased fertilizer use. The fertilizer is sold to farmers in major producing regions at subsidized prices, between 30 percent and 41 percent lower than commercial fertilizer. Through this policy the GOK controls approximately 20 percent of maize fertilizer market and about 8 percent of the total 1.2 million MT for all agriculture.

6.2.3 Grades and Standards

Grades and standards of local maize are rarely adhered to, as quality does not seem to be a major concern for the wholesale and retail traders at the surveyed markets. Large cereal trading enterprises and millers indicated that local maize often has a lot of impurities (soil and other foreign matter), which increases unit costs by having to carry out cleaning processes before milling and reducing revenue through weight loss. Maize is often not fully dried or fumigated at the farm, resulting in the need for further dying and sometimes fumigation by traders and millers. Poor drying can also result in high levels of aflatoxins.

The absence of standardized grades requires the quality of produce to be manually checked. As a result, maize is repeatedly packed and unpacked during marketing, creating additional labor costs and inefficiencies in the market chain. Although Kenya has grades and standards for maize, these are mainly applied for formally imported maize, but mechanisms for enforcement on domestically procured maize are lacking. KEBS has the regulatory mandate to ensure compliance to the maize standards but lacks capacity to undertake this mandate on domestically procured maize. The agency suffers chronic capacity constraints and political patronage characterized by the high turnover of its senior management.

Under Article 81 of the EAC Treaty, the Partner States enacted the East African Standardization, Quality Assurance, Metrology and Test Act 2006 (EAC SQMT Act 2006) to harmonize requirements on quality of products and services and reduce trade barriers. The SQMT Act regulates trade in products produced or originating in a third country to facilitate industrial development and trade as well as promote health and safety and environmental protection. The maize value chain is governed by the EAS 2:2013 (maize grain) and EAS 44:2011 (maize flour).

Kenya's regulatory institutions are not adequately developed to provide effective support to the maize value chain. Public institutions suffer from limited resources (financial, infrastructure, and human) and low credibility. Their ability to regulate and enforce marketing and quality standards is limited. Two institutions critical to the maize value chains are briefly highlighted below.

Kenya Plant Health Inspectorate Services (KEPHIS) was established through the Legal Notice No. 305 of 18th October 1996 pursuant to the State Corporations Act Cap 446 to undertake quality control services of agricultural inputs, plant variety protection and plant health. The strengths of KEPHIS include:

- Local and internationally recognized accreditation and certification
- Availability of infrastructure
- Good corporate governance
- Competent and committed staff
- International recognition and membership to international organizations
- Advanced laboratories and inspection service
- Decentralized services for ease of access
- Enhanced collaboration with all stakeholders
- Ability to form and maintain linkages with collaborators and donors

Weaknesses include: limited resources; lack of specialized capacity in specific disciplines; inadequate visibility and awareness about some institutional services; inadequate procedures for implementation of existing legal framework; inadequate internal legal capacity; and weaknesses in succession planning.

Pest Control Products Board (PCPB) was established in 1985 under the Pest Control Products Act (Cap 346). Its functions are to regulate the importation, exportation, manufacturing, distribution and usage of pesticides. Broadly, the Board derives its strength from internal resources and capabilities that enable it to accomplish its mandate and achieve the strategic objectives. The specific strengths include:

- Good collaboration with public and private organizations, academia, and with the government extension service providers;
- Nationally, regionally and internationally recognized standards
- A state of the art operational and well maintained website and database accessible to the public for information and awareness creation
- Internal quality control analytical laboratory
- An enabling legal framework with trained prosecutors
- Highly technical and competent staff

The main weaknesses identified were: limited capacity to conduct post registration verification tests, monitor cross border trade, ensure that pesticides are used for recommended and registered uses; low capacity for assessment and evaluation of products and enforcing compliance with ratified international conventions; and, limited physical facilities and resources including office space, human resources, technological and ICT infrastructure.

6.2.4 Trade Policy

Due to Kenya's reliance on maize imports from Uganda and Tanzania, policies and government action in these countries influence maize market dynamics, specifically in regions nearer the borders. The regular bans on maize imports from Tanzania, for example, has significant impact on Kenya's maize markets, especially in eastern and southern maize deficit areas. Uganda's increasing exports to South Sudan and sales to international humanitarian relief organizations greatly affect local and national price trends. Since market liberalization, tariffs have been a principal policy instrument with tariffs shifting between 0 and 50% in response to changes in domestic production levels (Short et al. 2012). Imports from Uganda and Tanzania, however, are subject only to 2.75 percent inspection fee since 2005 due to an agreement amongst members of the East African Community.

The Kenya Cabinet Secretary for Agriculture has ruled out issuing duty-free import licenses, arguing, "the gaps…can be closed, although not fully, by cross-border trade…we resolved the issues with Tanzania and now the borders are open" (Mbogo, 2013). This was after Tanzania lifted her 2011 ban on food exports. The licenses are only issued during food emergencies and, according to the World Bank, cost Kenya an estimated $280 million in lost revenue. Tanzania has already expressed willingness to sell maize to Kenya and has reportedly exported the first 850,000 bags (Mbogo, 2013).

The impact from the effects of the duty waiver/imposition during normal or shortfall periods may be seen through the wholesale (and retail) prices of maize in the domestic market – comparatively lower when an import duty waiver is in force than when it is not (Kamau et al., 2012). When Kenya waived the tariff on non-EAC maize imports in 2009, as a result of shortfalls in domestic supply, millers and wholesalers were able to directly import approximately 1.6 million MT of maize to meet supply, amounting to about 50 percent of the normal annual national production, at an average price below $300 per ton.[22] Moreover, maize prices are relatively more stable during periods of low maize supply from domestic production. Therefore the tariff on maize imports increases uncertainty on maize supplies and speculation in the Kenyan maize market, which exerts upward pressure on prices. Apparently, even when the country does not need to import maize, imposing duty creates an artificial environment that tends to increase domestic maize prices even without the accruing benefits in terms of revenue collection.

[22] Short et al. (2012)

6.2.5 Price Controls and Taxation

The Price Control (Essential Goods) Act No. 26 of 2011, an Act of Parliament, commenced on 19th September 2011 and aims to provide regulation of the prices of essential commodities in order to secure their availability at reasonable prices.. The Minister from time to time may determine the maximum prices of the commodities with consultation with the industry. The list of the prices for the essential commodities was never announced. In addition, the Consumer Protection Act of 2012 came into force on March 14, 2013 and provides for punishment of businesses that knowingly sell sub-standard goods and lie on pricing, prohibits the use of misleading information to sell goods and services.

Under the new Value Added Tax Act of 2013 (CAP 476) that commenced in September 2013, cereals of Chapter 10 (that include maize flour, maize seed, fertilizers, agricultural pest control products, and agricultural services) have been reclassified as exempt from tax. Maina (2013) analyzes the differences between exempt and zero-rated status, and concludes that the difference in the price of exempted supplies and those charged 16 percent VAT is negligible, and prices of zero-rated supplies are the lowest. This is a result of the fact that businesses supplying exempted goods/services have no mechanism to claim back input VAT, which then must be converted into a cost, while those under the 16 percent VAT category do. For instance, while farm inputs, agricultural services, and output are exempt from VAT, other services such as transportation and distribution are not.

The 16 percent VAT on distribution will increase the cost of production inputs, transportation costs, and ultimately maize prices. Since maize grain constitutes over 85 percent of the cost of maize flour, millers' costs of purchasing grain will rise, which will be transferred to consumers in the form of higher flour prices. Gitau et al. (2012) estimate that the new law would increase cost of production by approximately 5 percent and may lead to a decline in fertilizer demand of 17–23 percent. The effect on yield and production levels could be substantial and in turn affect the supply and price of maize. As such, maize grain prices may increase by over 5 percent.

6.3 INFRASTRUCTURE

The infrastructure needed for value addition includes energy, transport, communications, and physical marketing facilities. Storage and transport infrastructure, including roads, rail and port facilities, are major price and quality determinants in the maize industry. Most Kenyan households are inadequately served by such facilities.

6.3.1 Transport Infrastructure

The maize value chain is heavily dependent on rural accessibility through transport infrastructure, from the distribution of bulky inputs like fertilizers and seed, provision of mechanical services, to moving output to markets. The availability and condition of access roads and transportation systems are key factors influencing the structure and performance of the maize value chain. Poor roads, for example, increase transportation costs and lead to higher inputs and services prices, lower producer returns, and higher consumer prices. Banful (2011), for example, estimates around 50 percent of market fertilizer prices across SSA can be attributed to transaction costs (including transportation) compared with only 20 percent in Thailand. In Kenya, Short et al. (2012) estimated transport costs constituted up to 50 percent of the market access costs to Nairobi and approximately 15 percent of the wholesale price of maize produced and shipped from Western Kenya.

In 2010, Kenya's transport infrastructure consisted of about 62,000 kilometers of road network and 1,917 km of largely dilapidated railway lines (World Bank WDI). Only about 14 percent of the roads are paved. According to the World Bank Logistics Performance Index (LPI) 2012, Kenya's ports and rail are considered of lower quality and more expensive than the average for Sub-Saharan Africa and Low Income Countries (LICs). Planned investment in the new Mombasa-Nairobi-Kisumu (and beyond) rail line may improve the situation. Kenya's logistics problems are however less about the gauge or state of the railways than inefficiencies related to mismanagement, inadequate investment in rolling stock, and corruption. How the proposed new rail system will change these is unclear.

6.3.2 Electricity

Kenya does not generate enough electricity to meet demand, neither does the national monopoly, Kenya Power and Lighting Co. (KPLC) distribute the available electricity efficiently. National electric grid coverage remains woefully low and most rural areas are hardly covered. In most rural areas, frequent power shortages and outages is the norm and, wherever available, electricity is too expensive for most households and businesses. The Kenya Rural Electrification Program was supposed to alleviate some of these bottlenecks but, due to financial constraints and inefficient power distributor, progress has been slow. Without adequate and reliable electric power, agro-processing and value addition in most rural areas will remain difficult and expensive.

6.3.3 Rural Market Facilities

Rural market facilities are predominantly open air or semi-permanent buildings. Approximately 67 percent of maize produced is stored on-farm either for home consumption or for sale at a later date. Because of insecurity and investment capital considerations, the temporary storage facility is oftentimes a room reserved in the main house or a separate house in the homestead. These structures tend to be humid and thus provide perfect conditions for mold growth and aflatoxin contamination. While improved granaries built from wooden walls and iron roof are more cost-effective and efficient for short- and medium-term storage, less than 15 percent of smallholders use them or other improved storage technologies.

The growing debate of rural accessibility on maize markets

In a recent paper on the impact of assembly traders on maize markets in East and Southern Africa, Sitko and Jayne (2014) seem to suggest that the effect of rural accessibility could be exaggerated. First, the authors estimate that 96 percent of maize transactions in Kenya occur within five kilometers of the farm gate (73 percent at the farm gate, and 23 percent within five kilometers). Given this result, if rural accessibility was a factor, then we should expect farmers in less accessible areas to attract fewer assembly traders. However, when the authors tabulated the numbers of visits assembly traders made, they found no significant difference between accessible and remote villages. About 93 percent of farmers in each reported being visited by at least sixteen assembly traders every harvest season, irrespective of their degree of remoteness.

Contrary to popular perception, Sitko and Jayne (2014) conclude that remoteness does not seem to have adverse effects on competition for maize grain and on the farm-gate prices offered by assembly traders. Examining the ratio between the average farm-gate prices in isolated and accessible villages, they found that farmers in the former received on average 96 percent of the farm gate prices in more accessible regions of Kenya. These ratios mirror Yamano and Arai (2010), cited by Sitko and Jayne (2014), and suggest a modest decline in the prices received by farmers with distance from urban markets. Yamano and Arai (2010) found a 2 percent increase in farm-gate to wholesale maize price spreads for every additional hour drive from the wholesale market in Kenya and Uganda. Assembly therefore appears to offer competitive market access to farmers at their doorsteps, even in remote regions. In most cases, the prices offered were far better than what farmers would receive were they to arrange their own transport to the nearest wholesale or retail market.

Small intermediate traders and millers use various facilities but mostly for short-term storage. A preference for quick turnover among traders makes storage a temporary need. Sitko and Jayne (2014) suggest that storage is not a major constraint among rural traders and assemblers (see text box). Existing purpose-built warehouse capacity for long-term storage is adequate. For example, most NCPB storage and warehousing facilities across the country are currently underutilized, besides being inaccessible to smallholders.

6.3.4 Irrigation Infrastructure

Only 103,000 hectares of Kenya's land area (2 percent of total arable land and 5 percent of total maize area) is equipped with irrigation infrastructure and irrigated maize production is uncommon. In the Vision 2030 development plan, Kenya plans to expand the area under irrigation to 300,000 hectares through rehabilitation of dysfunctional irrigation schemes and construction of dams and small-scale water pans. Although new funding toward this initiative has been included in annual fiscal budgets since 2008, historical experience gives little confidence that irrigated area, especially for maize, will expand significantly in the foreseeable future. Also, the availability and cost of water will significantly increase production costs. The demand on water especially for the population will hinder irrigation demand.

Overall, the poor state of storage facilities and roads contributes to high production costs and low sale prices, and high post-harvest losses. The decline in investment in rural infrastructure after trade liberalization, such as rural access roads, has affected rural marketing organizations and limited the ability of smallholder farmers to negotiate better market prices.

7. USAID-KAVES UPGRADING INTERVENTIONS

The overall goal of USAID-KAVES is to increase the productivity and incomes of smallholder households and other participants along selected value chains, thereby enhancing food security and improving their nutritional status.

Based on the information and analyses provided above, this section recommends three strategic components for KAVES, eight strategic interventions and twenty upgrading objectives for the maize sub-sector that will increase on-farm productivity, streamline and commercialize crop aggregation, and improve storage and postharvest systems. Interventions have been selected that will contribute directly to the goals and objectives of the project and are highly scalable through private sector partnerships, usually with some level of public sector support.

The interventions all rely heavily on the mass adoption of new technologies, supported with specialist training and extension; new sources of investment and credit to unlock value chain constraints; and engagement of private sector partners for market development and sustainability. These are cross-cutting implementation activities that apply to all value chain upgrading interventions and are taken as given.

Recommended intervention	Specific upgrading objectives	Challenges	Expected outcomes
Strategic component 1: Increase Productivity			
9. Promote reduction in average area of maize planted per household by smallholder farmers	21. Farmers will focus more on increasing yield per unit area by optimizing use of inputs 22. Greater use of irrigation for mixed horticulture and maize production systems	• On-time availability of inputs • Traditional low input approach to maize production • Weak input distribution systems	• Increased yields • Higher farm incomes • Increase in county and national production
10. Support application of integrated soil fertility management systems (ISFM)	23. Site specific soil analysis and fertilizer selection 24. Precision application of fertilizer 25. Increased use of lime, blended and customized fertilizer	• Cost of extension to reach 500,000 farmers • Finance for farmers to buy inputs. • Finance for stockists to supply inputs. • Fertilizer suppliers lack capacity to serve smallholder sector	• Increased yields • Lower costs per unit of production • Higher gross margins • Increase in total production
11. Increase availability of labor-saving technologies	26. Distribution networks improved for small-scale technologies 27. New rental businesses established at village level for cultivation, harvesting, shelling and drying equipment 28. Widespread adoption of herbicides and foliar feeds	• Capital cost of equipment • Land size limits range of equipment that is cost-effective • Environmental objections to herbicide use	• Reduced cost of production • Higher yields • Higher margins • Progressive farming systems • Youth participation • Less farm and more productive work for women

12. Introduce precision selection of varieties	29. Greater adoption of location-specific varieties with optimum yield potential 30. Increased availability and adoption of "water efficient maize for Africa" (WEMA) varieties and striga resistant seed	• Cost of hybrid seed • Weak outreach of seed suppliers • Regulatory bottlenecks	• Reduction in crop failure • Less financial risk • Higher yield potential
Strategic component II. Strengthen Marketing and Aggregation			
13. Promote collective marketing	31. Greater on-line access to market information 32. Marketing agreements and contracts between farmer groups and buyers 33. Well-managed collection centers	• Traders slow to adopt new business models • Side selling	• Increased smallholder bargaining power • Lower costs • Higher quality • Less wastage
14. Stimulate new investments in equipment and facilities	34. Minimal wastage 35. Cost and quality efficient logistics	• Availability of capital • Lack of volume to justify investments	• More competitive prices and quality • Less wastage
Strategic component III. Reduce Postharvest Losses			
15. Facilitate new investments in household and commercial storage systems	36. Cost-benefit analyses of on-farm and aggregated bulk storage systems 37. Widespread adoption of cost-effective hermetic bags for household storage 38. Investment in silos and storage structures by aggregators	• Cost of systems • New technology • Lack of competition between suppliers	• Reduced value of wastage • Increased availability of maize at household level • Safer products, better nutrition
16. Provide training to raise quality standards	39. New grading systems introduced 40. Adoption of digital scales and moisture meters by aggregators and traders	• No price/quality incentives • Cost of equipment	• Higher quality grain • Safer maize products • Higher net returns

ANNEX I: REFERENCES

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ANNEX II: LIST OF ACRONYMS

AAK	Agrochemicals Association of Kenya
ADC	Agriculture Development Cooperation
ADSP	Agribusiness Development Support Project
AFFA	Agriculture, Fisheries and Food Authority
AI	Artificial Insemination
AIRC	Agricultural Information Resource Center
ASAL	Arid and Semi-Arid Lands
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASCU	Agricultural Sector Coordination Unit
AU	African Union
CAGR	Compounded Annual Growth Rate
CH	Central Highlands
CIF	Cost Insurance and Freight
CIMMYT	International Maize and Wheat Improvement Center
CL	Coastal Lowlands
CMA	Cereal Millers Association
COMESA	Common Market for Eastern and Southern Africa
DAP	Diammonium Phosphate
DRC	Democratic Republic of the Congo
DSL	Dryland Seed Company Limited
EABL	East African Breweries Limited
EAC	East African Community
EAGA	East African Growers Agriculture
EASEED	East African Seed Company Limited
EL	Eastern Lowlands
FAK	Fertilizer Association of Kenya
FAO	Food and Agriculture Organization
FAQ	Fair Average Quality
FCI	Farm Concern International
FEWSNET	Famine Early Warning Systems Network
FPEAK	Fresh Produce Exporters Association of Kenya
FTF	Feed the Future
GCI	Global Competitiveness Index
ha	Hectare
HCDA	Horticultural Crops Development Authority
HP	High Potential
HQCF	High Quality Cassava Flour
HRI	High Rainfall I
ICBT	Informal Cross-Border Trade
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics

IFPRI	International Food Policy Research Institute
IPM	Integrated Pest Management
IPDM	Integrated Pest and Disease Management
ISFM	Integrated Soil Fertility Management
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KAINet	Kenya Agricultural Information Network
KALRO	Kenya Agricultural and Livestock Research Organization
KARI	Kenya Agricultural Research Institute
KDB	Kenya Dairy Board
KEBS	Kenya Bureau of Standards
KEFRI	Kenya Forestry Institute
KEMFRI	Kenya Marine and Fisheries Research Institute
KEPHIS	Kenya Plant Health Inspectorate Services
KESREF	Kenya Sugar Research Foundation
KETRI	Kenya Trypanosomiasis Research Institute
kg	Kilogram
KHE	Kenya Horticultural Exporters
KNBS	Kenya National Bureau of Statistics
KPLC	Kenya Power and Lighting Company
KSC	Kenya Seed Company
KSh	Kenyan Shilling
KSU	KARI Seed Unit
KTDA	Kenya Tea Development Agency
KVC	KAVES Value Chain
LIC	Low Income Country
LPI	Logistics Performance Index
MCMV	Maize Chlorotic Mottle Virus
MDMV	Maize Dwarf Mosaic Virus
MLND	Maize Lethal Necrosis Disease
MoA	Ministry of Agriculture
MRS	Marginal Rain Shadow
MT	Metric Ton
NAAIAP	National Accelerated Agriculture Input Access Program
NCPB	National Cereals and Produce Board
NEPAD	The New Partnership for Africa's Development
NGO	Non-governmental organizations
OPV	Open Pollinated Varieties
PCPB	Pest Control Products Board
PHL	Postharvest Losses
PMG	Producer Marketing Group
ppb	Parts Per Billion
ppm	Parts Per Million
PSDA	Promotion of Private Sector Development in Agriculture

RRA	Rapid Rural Appraisal
RTDC	Rural Technology Development Center
RTDU	Rural Technology Demonstration Unit
SA2	Semi-Arid 2
SACCO	Savings and Credit Cooperative Society
SC	Sub-Corridor
SMV	Sugarcane Mosaic Virus
SSA	Sub-Saharan Africa
STAK	Seed Trade Association of Kenya
UGMFA	United Grain Millers and Farmers Association
USAID	United States Agency for International Development
USAID-KAVES	Kenya Agricultural Value Chain Enterprises
USAID-KHCP	Kenya Horticulture Competitiveness Project
VAT	Value Added Tax
WH	Western Highlands
WHSL	Wholesale
WL	Western Lowlands
WSC	Western Seed Company Ltd.
WT	Western Transitional