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Competiveness of Maize Value Chains for Smallholders in West Africa: Case of Benin, Ghana and Cote D'Ivoire

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Abstract

The paper analyses the entire value chains of the maize food crop in targeted countries. It identifies the maize actors and related business linkages from input supply to product markets, the governance of the chain, mainly the decision making to decrease the transaction costs, the chain performance including efficiency in value-added, gender equity and sustainability and the need for capacity building in various segments along the maize value chains in Benin, Ghana, and Côte d'Ivoire. The main objective of the paper is to contribute to better livelihoods of rural poor through empowerment and gender equitable access to maize value chain opportunities, inputs and product markets through technical backstopping and capacity strengthening so that smallholders understand and participate in the value chains and benefit from it. The following specific objectives are to i) identify the constraints and opportunities and linkages between actors across agro-ecological zones through country and regional level baselines; ii) develop an analytical support toolkit to analyze competitiveness, trends and outlook of maize taking into account climate change and policy shifts at micro, meso and macro level and iii) strengthen the capacity of regional maize value chain actors in the targeted countries. A systematic sampling of one out of every three successive shed was used to select wholesalers whereas snowballing sampling was used to select the assemblers, retailers and processors. The paper informs on the status of technologies application along maize value chains in selected countries and analyzes the economical profitability and/or profit maximization of maize value chains.

Keywords

Value Chains, Cost, Profit Maximization, Competitiveness, Food Security

1. Introduction

About 65% or more of the total labor force is employed in the agriculture sector, which contributes about 32% of Africa's gross domestic product (GDP) [1]. The sector has remained the backbone of Africa's economic development for centuries without having taken on a real structural transformation. Africans consume maize as a starchy base in a wide variety of porridges, pastes, grits, beer, etc. It has accounted for 22 to 25 percent of starchy staple consumption in the continent, representing the largest single source of calories, followed closely by cassava. However, the significance of maize as a staple varies across the continent. The highest amounts of maize consumed are found in Southern Africa at 85 kg/capita/year as compared to 27 in East Africa and 25 in West and Central Africa. Green maize (fresh on the cob) is eaten parched, baked, roasted or boiled and plays an important role in filling the hunger gap after the dry season (Oladejo *et al.* (2012) [2]. Additionally, the predominance of the crop in farming systems in the region and the fact that diets are predominantly crop oriented, led Smale *et al.* (2011) [3] to imply that yield gains in crop farming have the potential to jump-start a Green Revolution in Africa like that experienced in Asia for rice and wheat, as those crops were also both in the center of the farming systems and the diets. Oladejo *et al.* (2012) indicated that growing maize in farms of 1/2 ha to 2 hectares can overcome hunger in the households and the aggregate effect could double food production in Africa. Moreover, maize has been identified as one of the strategic commodities for achieving food security and reducing poverty by the Abuja's summit on food security in Africa in 2006 by the African Head of States [4].

Despite these important economic roles of maize, many African countries have not fully maximized the value added to maize products. The situation is driven by a number of constraints that can be grouped. The different constraints faced by the maize value chain in West Africa can be grouped as those faced during production and transformation and those faced along the chains from marketing to cross-border trade (storage issues, transport, tariffs and non-tariff barriers) according to Bonne *et al.* (2008) [5].

The production constraints include poor access to agro-inputs, adverse weather condition led by climate change, labor issues and milling problem. Farmers in the region have poor access to agricultural inputs such as fertilizer, improved seeds, farm labor, maize herbicides resulting in low productivity. The situation is often exacerbated by limited access to affordable finance. Maize production is labor-intensive, and farmers report increasing difficulties in finding farm workers and/or hiring casual laborers during planting, weeding and harvesting periods. Millers also face high production costs, mainly driven by high energy costs and storage costs. Additionally, the lack of a steady maize supply also creates inconsistencies in supply to buyers. These factors especially affect the competitiveness of products, regarding packaging, branding and market positioning for the majority of maize millers.

Marketing issues and lack of accurate market information, lack of critical mass and uncompetitive maize regional price constitute the *second group of constraints* according to Boone *et al.* (2008) [5]. Market information is important to create transparency and information flows; however numerous stakeholder's involvements have propagated an imperfect maize market and complicated the reliability of marketing information. Farmers are faced with the problem of lack of market information that could enable them to optimize production decision and maximize returns on investments. Information on price, demand, availability of commodity, quality, and general market behavior are lacking. Therefore, the marketing channel involves a number of speculative traders and agents who dominate the current maize value chain and collude to drive down farm gate prices. This is against the smallholders' welfare. Besides, since small-scale farmers only produce small quantities and often fail to aggregate their outputs through commercially oriented farmer-based organizations, or cooperatives, they sometimes appear as not "an interesting trading partners" for large buyers and hence could be missing the opportunities for a better bargain. Despite all the cited constraints, one should highlight that there also are opportunities. As regards to the opportunities, one of the most important throughout the region is the availability of both higher yielding varieties and drought tolerant for farmers. With yields of local varieties at only 1 - 2 MT per hectare and improved varieties showing yields of up to 5 MT per hectare in on-farm trials, there is great upside potential for increased productivity.

Given this background at regional level, the question posed is, what is the situation of the maize sub-sector within the targeted countries? Using the guidelines of value chain analysis, this paper explores the maize sector in Benin, Côte D'Ivoire and Ghana. The tree countries have been chosen for this study based on the decision of their Governments to explore maize as a crop to be supported and expanded for addressing food insecurity and potentially increase income for smallholders through value addition. The paper is organized as followed. The next section presents the framework of the study. Section 3 describes the methodology and data analysis. The state of maize production is discussed in Section 4. The key findings are discussed in Section 5. The country case studies are covered in Section 6. Value Chain Analysis (VCA) and profitability of maize production is discussed in Section 7. The general conclusion is drawn in section 8 and Policy recommendations in Section 9.

2. Framework of the Study

Purpose of the Study:

The purpose of the paper is to carry out a baseline study on integrated maize value chains in targeted countries. The result will be an analytical and informative report on the value chains of maize in West Africa. The study identifies the maize actors and related business linkages from input supply to product markets, the governance of the chain, mainly the decision making to increase production and decrease the transaction costs, the chain performance including efficiency in value added, gender equity and sustainability and the need for capacity building in various segments along the maize value chains in Benin, Cote d'Ivoire, and Ghana. The study shows the available database on maize value chain and the results from analytical models on key indicators such as prices, yield, area and production. The level of adoption and diffusion of the climate smart technologies are also assessed in the study. The model results should provide information to chain actors and policy makers on the trends and outlooks of maize commodity key variables like prices, yield, area and production in a climate change context.

Objectives of the Study

The paper intended to contribute to better livelihoods of rural poor through empowerment and gender equitable access to maize value chain opportunities, input and product markets, by detailing and explaining all the steps of the value chains and through technical backstopping and capacity strengthening. The following specific objectives are to i) identify the constraints and opportunities and linkages between actors across agro-ecological zones through country and regional level baselines; ii) develop an analytical support tool kit to analyze competitiveness, trends and outlook of maize taking into account climate change and policy shifts at micro, meso and macro level and iii) strengthen the capacity of regional maize value chain actors in the targeted countries. The study informs on the status and the promotion of climate-smart technologies along maize value chains in selected countries and analyze the economical profitability of maize value chains.

Expected Outcome:

The paper aims to put together a comprehensive base for a possible regional Value-chain for maize for ECOWAS through the baseline study where comparative advantages of targeted countries are analysed. It also allowed to identify the constraints and opportunities of maize value chain in the three targeted countries, and establish a regional database on maize value chains. It is expected that local platforms in the maize value chains be recognized and considered as entry points on the maize and seed production, associated with other crops or crop trees. The findings of the study are to be considered by decision makers and used by stakeholders, public and private and the in the targeted countries for policy development and investment planning in the maize sub-sectors.

Study Scope and Components:

Creating a value chain requires products to be defined and categorized according to various production processes and procedures that capture all value adding activities associated with a final product. Depending on the complexity of the product and the level of detail required for an analysis, the number of categories of activities along a value chain can range from as few as 5 to as many as 25 or more. For example, depending on the situation, a value chain for coffee can have 15 to 20 process categories clustered under three major value added activities, namely farming, post-harvest, and export processing/administration. For maize we have detailed it for you below.

3. Methodology and Data Analysis

Methodology: The methodology utilized here was to use questionnaires and face to face interviews to identify constraints along the value chains of maize to help define optimal intervention points and activities to increase production and profitability. The questionnaires and interviews helped collecting primary data. This was complemented by extensive literature search and secondary data. Maize farmers, traders and processors in the study areas formed the major source of primary data. These data were collected at the farming communities. The farmers and traders were interviewed with the aid of semi-structured questionnaires[1] and checklists administered in using the service of an interpreter. Secondary data was obtained from FAOSTAT, Ministries of Agriculture and other public sources. The maize farmers were purposively selected from targeted farming communities. A systematic sampling of one out of every three successive shed was used to select wholesalers whereas snowballing sampling[2] was used to select the assemblers, retailers and processors. In each country a total of 52 respondents were interviewed. At the production level, 32 maize farmers were interviewed with the aid of a semi-structured questionnaire though a focus group discussion organized at the community level. At the market level, 20 traders were interviewed comprising of 5 traders at each level of the marketing channel namely assemblers, wholesalers, retailers and food processors. It is worth noting that the study conducted in Ghana was carried out in the Northern Region of Ghana due to the lack of comprehensive study of the maize sub sector in that locality of the country, despite the importance of maize for growers (in the other countries it was nationwide). Primary and secondary data were collected. Primary data collected on a sample of 52 respondents (32 maize farmers), 20 traders (5 assemblers, 5 wholesalers, 5 retailers and 5 processors) using semi-structured questionnaires.

Data Analysis: Data analysis was focused on the cost and return of producing and distributing grain at various levels of the maize delivery channels for the 2014 production season. The total cost of production is decomposed into fixed and variable costs. Fixed costs are the costs that farmers incur even in the absence of production. These are mostly costs associated with capital assets. For this study, the depreciated values of capital assets were computed using the straight line depreciation method without salvage value. Variable costs are the costs that are directly associated with production. Total cost of production is

[1]A semi-structured questionnaire is a mix of unstructured and structured questionnaires. Some of the questions and their sequence are determined in advance, while others evolve as the interview proceed.

[2]Snowball sampling is a non-probability sampling technique that is used by researchers to identify potential subjects in studies where subjects are hard to locate.... This type of sampling technique works like chain referral.

therefore the summation of the fixed and variable costs. Total revenue is simply the income emanating from maize production. The difference between total revenue and total cost is analyzed by the study to judge the level of profitability of maize production (Dogbe *et al.*, 2013) [6].

The mathematically approach used:

$$P_i = TR_i - TC_i$$

where P_i is profit for the i^{th} farmer, TR_i is the total revenue of the i^{th} farmer and TR_i is the total cost incurred by the i^{th} farmer.

Maize production is considered profitable if $P \succ 0$ and vice versa. A P of 0 gives an indication of breakeven.

The marketing margin added by each market participant was computed using the following formulae;

Assembling marketing margin per bag = PA − PF − CA

Wholesaling marketing margin per bag = PW − PA − CW

Retailing marketing margin per bag = PR − PW − CR

Food processor marketing margin per bag = PP − PW − CP

Where, PF = farm-gate price (assembling price), PA = Assemblers selling price, CA = Assembling cost, PW = Wholesaling price, CW = Wholesaling cost, PR = Retailing price, CR = Retailing cost, PP = Processors' price, CP = Processors' cost

The producer-retailer price spread was determined as follows;

$$\frac{PF}{PR} * 100\%$$

Where, PF = Farm-gate price, PR = Retailing price

4. Maize Production

4.1. Maize in the World

Table 1 shows the increase in area harvested in maize, its production, amount seed used and yield over six consecutive years in the world. The table shows an increasing trend in all four variables, except for the yield which remains somehow stagnant at around 5 t/ha. But as we will see below the 5 t/ha is much higher that yield/ha encountered in the three West African countries.

The world's leading producers of maize are USA (32.1%), China (24.4%),

Table 1. World maize production (2009-2014).

Description	Unit	2009	2010	2011	2012	2013	2014
Area harvested	ha	158,615,852	163,936,262	171,272,148	178,571,700	185,599,969	184,800,969
Production	ton	820,237,795	851,300,904	886,921,987	873,151,716	1,014,274,722	1,037,791,518
Seed	ton	5,972,820	6,257,674	6,496,795	6,859,918	6,797,386	
Yield	t/ha	5.2	5.2	5.2	4.9	5.5	5.6

Source: FAOSTAT, http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E

Brazil (8.3%) and the EU (6.4%) while the leading consumers are USA (30.7%), China (24.5%) EU (7.5%) and Brazil (6.5%) based on FAOStat (2015)

4.2. Maize in Africa

Maize is one of the major cereals produced in Africa, covering an average harvested area of 37 million hectares with average production quantity of about 70 million tons per year.

Harvested land and production of maize in Africa grew in tandem, with growth rates of 24% and 30%, respectively, in the period from 2009 to 2014. However, the productivity of maize per harvested area stood at 2 tons per hectare, which is only 39% of the world average (FAOStat, 2015).

Table 2 shows the increase in area harvested in maize, its production, tonnage of seed used and yield over six consecutive years in Africa. The table shows an increasing trend in all four variables, except for the yield which remains stagnant throughout.

4.3. Maize in Côte D'Ivoire

In 2014, maize production was 680,000 tons from a cultivated area of 336,836 hectares. In spite of Côte d'Ivoire's favorable growing conditions for maize, the 2.0 tons per hectare average yield was significantly (39.2%) below the 5.1 tons per hectare global average and slightly below the 2.1 tons per hectare African average.

Table 3 shows the increase in area harvested in maize, its production, amount of seed used and yield over six consecutive years in Côte D'Ivoire. The table shows an increasing trend in all four variables. The yield remains rather stagnant at around 2 t/ha. The government of Côte d'Ivoire has formulated three national

Table 2. Africa maize production (2009-2014).

Description	Unit	2009	2010	2011	2012	2013	2014
Harvested area	ha	29,759,464	31,966,255	33,860,405	34,674,542	35,850,982	37,058,619
Production	ton	59,904,195	66,271,559	65,891,126	70,039,132	70,144,896	78,005,212
Seed	ton	858,894	926,992	982,314	960,756	964,684	
Yield	t/ha	2.01	2.07	1.95	2.02	1.96	2.10

Source: FAOSTAT, http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E

Table 3. Côte d'Ivoire Maize Production (2009-2014).

Description	Unit	2009	2010	2011	2012	2013	2014
Area harvested	ha	319,232	324,045	327,800	308,839	308,776	336,836
Production	ton	637,372	641,610	621,790	654,738	661,285	680,000
Seed	ton	33,000	36,000	36,000	36,000	36,000	
Yield	t/ha	2.0	2.0	1.9	2.1	2.1	2.0

Source: FAOSTAT, http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E development strategies for (i) main food crops, e.g. rice and (ii) for other essentials crops such as maize, cassava, banana/plantain, yam, and (iii) for vegetables a different strategy. These first two types of crops are areas of focus for provision of comprehensive support with the aim of increasing production and productivity in order to achieve the goal of food self-sufficiency and export of surplus with value addition, as well as creation of jobs for the country's increasing population[3] [7].

4.4. Maize in Ghana

Table 4 shows the increase in area harvested in maize, its production, tonnage of seed used and yield over six consecutive years in Ghana. Here too, the yield has been somewhat stagnating at around 1.7 t/ha. The average annual maize production in Ghana has reached nearly 1.8 million tons in 2017, an increase of almost 4% from 2014. The preference in the urban and peri-urban areas, however, is shifting towards rice, even though maize remains one of the major staple foods in the rural areas.

4.5. Maize in Benin

Table 5 shows the increase in area harvested in maize, its production, tonnage of seed used and yield over six consecutive years in Ghana. Here too, the yield has been somewhat stagnating at around 1.7 t/ha. The average annual maize Production in Benin over the same four-year period (2009-2014) was approximately 1.033 million tons[4] [8]. The 2016 aggregate cereal production is estimated at

Table 4. Maize production in Ghana (2009-2014).

Variables	Unit	2009	2010	2011	2012	2013	2014
Harvested area	ha	954,430	991,669	1,023,177	1,042,083	1,023,459	1,019,000
Production	ton	1,619,590	1,871,695	1,683,984	1,949,897	1,764,477	1,762,000
Seed	ton	29,750	30,695	31,262	30,704	30,704	
Yield	t/ha	1.70	1.89	1.65	1.87	1.72	1.73

Source: FAOSTAT, http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E

Table 5. Maize production in Benin (2009-2014).

Variable	Unit	2009	2010	2011	2012	2013	2014
Harvested area	ha	862,283	918,236	820,162	938,846	1,006,289	968,030
Production	ton	1,074,701	1,012,630	1,165,957	1,185,020	1,316,598	1,354,344
Seed	ton	18,365	16,403	18,777	19,469	19,469	
Yield	t/ha	1.25	1.10	1.42	1.26	1.31	1.40

Source: FAOSTAT, http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E

[3]Project of "Stratégie nationale de développement des cultures vivrières autres que le riz" (SNDCV), Ministry of Agriculture, Mr. Haddock, July 2013.
[4]GAIN, "Benin Coarse Grains and Rice Report", USDA FAS, 2013.

about 1.8 million MT, 9 percent above the previous year's output and almost 11 percent above the five-year average. Production of maize for 2017, the main staple cereal, is estimated at about 1.39 million MT, 8 percent below the 2015 production.

5. Key Findings

5.1. In Benin

An analysis of the maize value chain revealed that the keys actors in the maize value chains are the inputs suppliers, producers, wholesalers, retailers and processors. The profitability of maize production depended on the production zone (South, Centre or North) and the production systems in use. In the maize value chain, wholesalers were found to be the actors making more profit than the others. Constraints for effective maize value chains in Benin comprised poor access to inputs and labour; irregularity of supply; use of nonstandard weights and measures; lack of proper storage; limited availability of market information and insufficient access to finance.

5.2. In Ghana

Maize is grown by smallholder farmers and represents the first crop in terms of cultivated area and accounts for 50% - 60% of the cereal production. Maize production is the second largest commodity after cocoa and therefore plays an important role in food security. However, the potential of maize to help reduce poverty is unexploited because of a number of constraints hampering the increase in maize production and productivity such as low soil fertility, drought, lack of access to improved seeds and poor agronomic practices. The analysis of the economic profitability of the maize value chain in the Northern Region of Ghana showed that the maize production was unprofitable with a loss of Ghanaian Cedi GH¢465 (132.85 US dollars) per ha. When considering the whole maize value chains, maize marking was profitable for the wholesalers (with a margin of GH¢5.50 or 1.72 US dollar), for the retailers (with a margin of GH¢1.50 or 0.47 US dollar) and for the processors (with a margin of GH¢11.50 or 3.61 US dollar) per tons.

5.3. In Cote D'Ivoire

Maize occupies the second place after rice. Major producing areas are the North, the Centre and the West-Centre. An analysis of the cereal sector in 2013-14 in Cote D'Ivoire revealed that maize accounts for 29% of the cereal production and 39% of the area under cereal culture. Despite its importance and its rapid development, there are some constraints such as: the low productivity when compared to international standards, the lack of integration of produced maize with the markets systems, a poor processing level and a low value addition of maize-based products. The economic profitability was found to be at the level of actor and zone dependent. For instance, producers obtained a net margin of 21.122 FXOF (40.68 US dollars) per ha in savannah zone against 27.699 XOF (53.36 US dollars) in forest zone whereas intermediaries obtained a net margin of 35.500 FCFA (68.38 US dollars) in savannah zone against 23000 XOF (44.30 US dollars) in forest zone. To improve the maize value chains in Cote D'Ivoire actions should include the improvement of the access to the land, a better organization of the maize production, the improvement of the funding toward maize value chains activities and a better organization of maize commercialization.

5.4. Factors Influencing Maize Yield in Selected Countries: Benin, Cote D'Ivoire, Ghana

- ***Application of fertilizer***: Low level of fertilizer application compared to the regionally recommended rate has been revealed by the VCA study. Interviews suggest the need to ensure appropriate fertilizers are available when needed.
- ***Soil conditions***: Soil conditions are not ideal. In addition to the recommended application of NPK and urea, soil amendments such as lime, manure and other organics may enrich the soil. As was noted above, there does not appear to be application of KCL or K_2SO_4.
- ***Application of agro-chemicals***: Weeds deprive the crops from required nutrients and pests destroy crops through infestations. Hiring extra workers to compensate for the lack of herbicide application is effective yet costly, as seen in the VCA, and pest control is not possible through human labor alone. Agro-chemicals are required in order to quell the ill-effects of pests and weeds. According to the results of the study, 25% of farms used agro-chemicals and, on average, these farms posted yield rates nearly 5% higher than those farms that did not use agro-chemicals. Another 25% are not aware of the benefits or skeptical, this is due mainly to lack of information.
- ***Increased availability and application of improved seed***: Increased access to improved seed, along with education and training to demonstrate the economic advantages of using improved seed, are essential for farms to improve their yields. Unfortunately, more than 66% of the farmers interviewed in Ghana do not apply improved seeds due to availability and /or price issue. The three pillars of good agricultural practices, research based fertilizer application rates, timing, and application of selected improved seed varieties are the keys to achieving higher productivity and production.
- ***Production cycles***: Although yields are reportedly higher from one part of the country compared to others in all the targeted countries, the cycle is limited to one harvest per year. Simple irrigation schemes (small to medium sized earth dams dispersing water through channels for downstream areas and with lifting techniques for upstream fields)[5] may be able to allow for a second season in certain areas.

[5]FAO; Smallholder irrigation technology: prospects for Sub-Saharan Africa; Matching technologies to agricultural regions.

- ***Poor access to mechanization***: Mechanization reduces time and effort required for land preparation and, in the case of Benin, Cote D'Ivoire and Ghana the Value Chain Analysis shows that tractor rental cost is approximately equivalent to the labor cost performing equivalent tasks. Agriculture lending programs, or a matching grants facility may increase purchase, and hence availability, of mechanized tools (particularly tractors and others small machineries used).

6. Country Case Studies

6.1. Case of Benin

Value chain of Analysis: (VCA)

The summary of costs shows in Table 6 that the total cost of production per hectare of maize is XOF126, 444 (USD264). This cost is dominated by two inputs: hired human labor (52.5%) and fertilizer (25.5%). All other costs combined total only 22% of the overall cost. This again draws attention to the labor-intensive nature of maize farming in Benin.

The Value Chains Analysis study revealed that the leading cost contributors to maize farming in Benin are cultivation (41% of overall production cost), land preparation (26%), and planting (12%). The cost components of these three principle processes are further broken down to understand the cost drivers behind each.

Sixty-one percent of *cultivation* cost is attributed to fertilizer. The cost of the actual fertilizers—NPK (46%) and urea (36%)—combine for 82% of fertilizing cost and the additional 18% is contributed by the labor used in applying the fertilizers. Manual weeding, at 33%, is the second cost driver within cultivation followed by spraying, of which 70% of that cost is spent on chemicals.

The second leading cost driver in the maize farming value chain is *land preparation*. As indicated above, land preparation, specifically tilling, in Benin is labor intensive. As such, 89.5% of land preparation is attributed to labor costs with the remaining 10.5% going toward the rental of equipment. The data reveal that 70% of farms are manually tilled while only 13% use a tractor and 18% do not till at all. The largest farms (15 ha and above) use a tractor but tractor usage was not exclusive to larger farms. In some instances, farmers with only 1 ha under cultivation were found to be using tractors for tilling. While not all smallholders may have the means by which to employ a tractor to till a small plot (analysis shows the approximate costs in the range of XOF30,000 (USD60) per hectare), interviews

Table 6. Summary of findings for rain-fed maize farms in Benin.

Yield rate (tons/ha)	1.36
Cost per hectare (XOF/ha)	126,444 (USD264.3)
Cost per production unit (XOF/ton)	109,055 (USD227.9)

Source: Global Development Solutions, LLC/UNECA (2014).

Table 7. Maize production costs along the value chains in Benin.

Variables	Farm-Gate Product ($US/ha)	Collector/ Assembler ($US/Kg)	Wholesaler ($US/Kg)	Retailer ($US/Kg)	Processed Raw Material (Gari) ($US/Kg)
Yield (Kg/ha)	1350.18	–	–	–	–
Unit price ($US/Kg)	0.326	0.279	0.342	0.316	0.413
Gross Revenue	441.418	0.279	0.342	0.316	0.413
Production Cost					
Crop Purchase	–	0.249	0.275	0.278	0.270
Other Variable Costs	179.875	0.027	0.025	0.019	0.115
Investment Costs (equipment amortization)	48.636	0.002	0.003	0.003	0.008
Total Costs	**228.512**	**0.279**	**0.303**	**0.301**	**0.394**
Gross Margin	261.543	0.002	0.042	0.018	0.028
Net Profit	212.906	−0.0003	0.038	0.014	0.019
Rate of return					
Gross margin/TVC	1.454	0.007	0.140	0.061	0.072
Net Profit/TC	0.932	−0.001	0.128	0.047	0.049

Source: International Institute for Tropical Agriculture (IITA): Regional value Chains Support Study for UNECA: Project Number -2013-HDO-7568-6385-0850-1502.

with smallholder farmers suggest that machinery is not available in their villages even for those who have the means to employ a tractor. In fact, the average labor cost to till 1 hectare of land exceeds XOF29,000 (USD61). *Planting* is the third major cost factor in the maize farming value chain and contributes 12% to the overall costs. The cost driver in the planting process is fertilizing (45% of the planting cost), which is 100% attributed to the cost of NPK. Labor represents 40% of planting costs and seed contributes only 15% to the cost of planting.

All the above analysis is to finally evaluate the maize production cost along the value chain in Benin, detailed in Table 7.

Constraints to effective maize value chain in Benin are:

- Poor access to inputs and labour;
- Irregularity of supply;
- The use of nonstandard weights and measures;
- Lack of proper storage;
- Limited availability of market information;
- Insufficient access to finance.

The summary of costs in Table 7 and Table 8 shows that the total cost of production per hectare of maize is XOF126,444 (USD264). This cost is dominated by two inputs: hired human labor (52.5%) and fertilizer (25.5%). All other costs combined total only 22% of the overall cost. This again draws attention to the labor-intensive nature of maize farming in Benin. As a comparison, in Benin

Table 8. Cost of Maize Production per Hectare.

Cost Category	Total (XOF/ha)	Total (USD/ha)	Total (%)
Hired human labor (all stages)	66,408	138.8	52.5
Hired animal labor (all stages)	125	0.3	0.1
Seed	2251	4.7	1.8
Tilling, excluding labor	3417	7.1	2.7
Fertilizer (all stages)	32,260	67.4	25.5
Agriculture chemicals including equip. (all stages)	2669	5.6	2.1
Harvesting, excluding labor	9539	19.9	7.5
Admin & Overhead	9775	20.4	7.7
Total cost per hectare of maize	126,444	264.3	100
Cost per production unit (XOF/ton, US$/ton)	109,055	227.9	
Yield rate (t/ha)	1.36		

Source: Global Development Solutions, LLC (UNECA project 2013).

Table 9. Performance and costs of rain-fed maize farms.

Cost	Total (XOF/ha)	(US$/ha)	Total (%)
Hired human labor (all stages)	33,608	68.6	22.52
Hired animal labor (all stages)	2800	5.7	1.88
Seed	4325	8.8	2.90
Tilling, excluding labor	4250	8.7	2.85
Fertilizer (all stages)	59,450	121.3	39.83
Agriculture chemicals including equip. (all stages)	23,655	48.3	15.85
Harvesting, excluding labor	14,899	30.4	9.98
Admin and Overhead	6282	12.8	4.21
Total	**149,269**	**304.6**	**100.00**
Cost per production unit (XOF (US$)/ton)	60,616	123.7	
Yield rate (t/ha)		2.74	

Source: Global Development Solutions, LLC/UNECA (2013).

the average level of effort is 40.7 man-days per hectare whereas in Côte d'Ivoire the average is 32.7 man-days per hectare. This is an example of comparative and competitive advantage countries might have when compared to each other, and which should be used when doing a regional value chain analysis.

6.2. Case of Cote D'Ivoire: Maize

In Table 9, based on the analysis, the total cost of production per hectare of maize is XOF[6] 149, 269 (US$305)/ton. Out of this cost, fertilizer accounts for 40% followed by human labor cost (22.5%) and the cost of agricultural chemicals (15.8%). The average yield of maize for smallholder and cooperative farms is

[6]XOF is a local currency in Former French Colonies of West and Central African Countries.

about 2.74 t/ha. The cost per unit of product is XOF60, 616 (US$123.7)/t.

The second biggest cost in maize farming is related to hired human labour which amounts to XOF33,608 (US$68.6)/ha. The total average level of effort per farm is equivalent to 16 man-days/ha/season for all maize farming activities along the value chain in Côte d'Ivoire. Representing one-third of all hired labor activities, labor for land preparation requires the highest level of effort. Planting, the second highest labor burden with a 14.4% overall contribution, requires less than half the effort of land preparation. Planting is followed closely by threshing (13.1%). During the field visit, no interviewed farmers applied lime to their field. Literature indicates that soils in the humid zone of Côte d'Ivoire are highly acidic (up to 4.9 PH[7]) which even allowed direct application of phosphate rock with some positive responses [9]. Continuous application of urea decreases the pH of the soil and thereby exacerbates acidity of the soil. Neutral soil pH is more favorable for rice production instead. The most important nutrients are available for plant growth in soils with a pH of 5 to 9 in general, and in the pH range of 6.5 - 7 which is typical of many submerged soils in which rice grows, but not maize [10]. It is therefore suggested that soil profiling is required to ensure a balanced pH to help optimize fertilizer application.

VCA analysis and discussion

The average smallholder or cooperative farm size is 6.45 ha (ranging from 1 ha - 18 ha/farm). Among the interviewed farms, 50% of them harvest once per year while 50% harvest twice per year. The main harvesting season for maize ends in September and the second harvest ends in January. Tillage is done either manually or by tractors depending on the size of farms; farmers with a small area of land tend to utilize manual labor rather than tractors due to financial constraints. Table 10 describes the typical characteristics of a rain fed farm.

Table 10. Characteristics of a typical rain-fed maize farms in Cote D'Ivoire.

Rain fed, 2013	
Harvesting seasons per year	1
Seed	RPMR
Planting method	Sowing
Water regime	Rainfed
Tillage	Till depth < 30cm
Year	2013
Planted area (ha)	6.45
Fertilizer timing	Cultivation
N2 application (kg/ha)	51.16

Source: Global Development Solutions, LLC.

[7]PH: Soil pH is a measure of the acidity and alkalinity in soils. pH levels range from 0 to 14, with 7 being neutral, below 7 acidic and above 7 alkaline. The optimal pH range for most plants is between 5.5 and 7.0; however, many plants have adapted to thrive at pH values outside this range.

The VCA study revealed that the leading cost contributors to maize farming in Côte d'Ivoire are *cultivation* (43% of cost), *land preparation* (18%), and *planting* (15%). *Fertilizing* contributes 56% towards the cost of cultivation. Urea and NPK account for 67% and 28% of the cost of fertilizing, respectively, with the 5% balance being attributed to labor cost. *Spraying* accounts for 38% of the cost of cultivation of which 89% is spent on chemicals. Based on the analysis, the total cost of production per hectare of maize is XOF149, 269 (US$305)/ton. Out of this cost, fertilizer accounts for 40% followed by human labor cost (22.5%) and the cost of agricultural chemicals (15.8%). The average yield of maize for smallholder and cooperative farms is about 2.74 t/ha. The cost per ton is XOF60, 616 (US$123.7) as detailed in **Table 10**.

Fertilizer Application:

With regard to fertilizer application, farmers apply NPK (15-15-15) and urea (46% N) at an average rate of 112.25 kg/ha and 77.5 kg/ha, respectively, whereas the nationally recommended application rates are 150 kg/ha for NPK (specifically, NPKSMg[8] (15-15-15-6-1)) and 100 kg/ha for urea, according to FRICA[9]. Actual application rates are therefore lower than recommended. Moreover, farmers interviewed in Côte d'Ivoire are not applying NPKSMg (15-15-15-6-1) and are therefore foregoing the recommended addition of sulfur and magnesium.

As observed in **Table 11**, Out of the total average cost of XOF59, 450 (US$121.3)/ha spent on fertilizers, NPK and urea account for 59.4% and 40.6%, respectively. Fertilizer cost contributions are broken down by NPK and urea in

The second biggest cost in maize farming is related to hired human labour which amounts to XOF33,608 (US$68.6)/ha. The total average level of effort per farm is equivalent to 16 man-days/ha/season for all maize farming activities along the value chain in Côte d'Ivoire. Representing one-third of all hired labor activities, labor for land preparation requires the highest level of effort. Planting, the second highest labor burden with a 14.4% overall contribution, requires less than half the effort of land preparation. Planting is followed closely by threshing (13.1%), weeding (12.4%) and harvesting (12.3%) as shown in (**Table 12**).

Table 11. Cost of fertilizers per hectare.

Fertilizer (all stages)	Cost		
	Total (XOF/ha)	Total (US$/ha)	Total (%)
Urea	24,163	49.3	40.6
NPK	35,288	72.0	59.4
Total	59,450	121.3	100

Source: Global Development Solutions, LLC.

[8]The fertilizing effect is based on the content of the three macronutrients Nitrogen (N), Phosphorus (P) and Potassium (K), which ensure a balanced fertilization ratio. The fertilizer is enriched with Sulfur (S) and Magnesium (Mg)

[9]FRICA(Fonds Interprofessionnel pour la Recherche et le Conseil Agricoles): (Inter-Professional Fund for Research and Extension)

Table 12. Average man-days of labor on maize farming in Côte d'Ivoire.

Workers for activities per ha	Average workers/ha	Average days	Man-days/ha	Man-day/ha (%)
Land preparation workers/ha	1	5.33	5.4	33.7
Planting workers/ha	1	2.95	2.3	14.4
Water management workers/ha	0	0	0	0
Fertilizing workers/ha	1	1.35	0.2	1.3
Spraying workers/ha	1	1.53	0.2	1.2
Weeding workers/ha	1	2.9	2.0	12.4
Harvest workers/ha	1	2.3	2.0	12.1
Threshing workers/ha	2	1.3	2.1	13.1
Drying workers/ha	2	0.85	1.5	9.1
Transport workers/ha	1	1.15	0.4	2.6
Total man days/ha			**16**	**100.00**

Source: Global Development Solutions, LLC (2013).

The total cost of spraying agrochemicals is XOF24,452 (US$51.11) which contributes 38% to the cost of cultivation, which amounts to XOF63,968 (US$133.7)/ha. Agrochemicals used during cultivation account for 89% of the overall cost of the spraying category and cost on average XOF21, 810 (US$ 44.5)/ha/season excluding labor and equipment costs (operating or rental cost). The costs of labor associated with spraying and equipment contribute 3% and 8%, respectively.

With regard to seed application, the average quantity applied in Côte d'Ivoire is 22 kg/ha which is 10% higher than the nationally recommended 20 kg/ha. The average cost of the recommended seed varieties is XOF 4325 (US$ 8.8)/ha. According to the VCA, farms applied different seed varieties with varied performance. Those who plant GMRP18, an improved maize variety (10% of interviewed farms) registered yields of approximately 5000 kg/ha (5 MT/ha). In general, farms that applied AMT2B-SR-C1, CJB 16, Ferke 7635, EV8728 and RPMR (which are all names of improved maize varieties) registered yield rates above 3000 kg/ha (3 MT/ha).

6.3. Case of Ghana

Maize is the most important cereal crop in Ghana in terms of consumption though its contribution is the 7th largest in terms of the value of agricultural commodities. Root crops such as yam, cassava, cocoyam and plantains are the most relevant in terms of production value due to their importance in the Ghanaian diet. Maize accounts for 55% of grain output followed by paddy rice (23%), sorghum (13%) and millet (9%). Maize is also an important component of the poultry and livestock feed sectors and has some utilization in the brewing industry.

Maize is grown throughout Ghana, however the leading producing areas are mainly in the middle-southern part (Brong Ahafo), Eastern, Western, Volta and Ashanti provinces) where 84% of crop grown are maize. All maize farms interviewed are rain-fed, and rainfall patterns differ across the country. In the southern part of the country, two rainy seasons occur, from April to July, and from September to November. In the north the rainy season begins in April and lasts until September. Bi-modal rainfall allows for two growing seasons in the south regions of the country whereas farmers in the north regions experience uni-modal rain and thus are limited to one growing season [11].

White maize is the type of maize produced in Ghana while yellow maize is imported for use as poultry feed. As seen in Table 13, 2014 maize production in Ghana was 1,762,000 tons from a harvested area of 1.02 million hectares. Production showed a slow but steady 7% increase overall from 2009. The same was observed for yield per hectare which experienced negligible increase, before stagnating at 1.7 t/ha during the four-year span. According to FAO statistics (2014), the yield fluctuated over the period with the low being 1.65 tons per hectare to a high of 1.89 tons per hectare in 2010. Therefore, maize yield in Ghana is approximately two-thirds lower than the global average of 5.1 tons per hectare, and, depending on the year of comparison, 10% to 20% lower than the African average yield of 2.1 tons per hectare.

The average annual maize consumption in Ghana has reached almost 1.8 million tons. The preference in the urban and peri-urban areas, however, is shifting towards rice, even though maize remains one of the major staple foods in the rural areas. The breakdown of maize consumption in Ghana is depicted in Table 14 and Table 15 shows the regional maize indicators with agro-ecological characteristics.

7. Profitability of Maize Production

- Land is acquired through rent, lease or inheritance. Renting was found to be the common way of acquiring land. Land is therefore considered a variable input for this study. Its market value is what is considered for this study.
- Production cost does not vary between open pollinated variety (OPV) maize varieties or maturity groups.

Table 13. Maize production in Ghana (2009-2014).

Variables	Unit	2009	2010	2011	2012	2013	2014
Harvested area	ha	954,430	991,669	1,023,177	1,042,083	1,023,459	1,019,000
Production	ton	1,619,590	1,871,695	1,683,984	1,949,897	1,764,477	1,762,000
Seed	ton	29,750	30,695	31,262	30,704	30,704	
Yield	t/ha	1.70	1.89	1.65	1.87	1.72	1.73

Source: FAOSTAT(2013), http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QC/E

Table 14. Estimated Ghana Maize Market Composition, 2012.

Quantity (MT)	Consumption (%)	Marketed Maize (%)	Description
1,785,00			Total maize consumption
801,000	45		Subsistence consumption by producer. Households and post-harvest loss (does not reach market)
410,000	23	42	Animal feed market (Largely poultry)
328,000	18	33	Human consumption (informally traded)
246,000	14	25	Formally traded for processing (industrial and processed foods)

Source: The Market for Maize, Rice, Soy, and USIDA and EAT, Warehousing in Northern Ghana, January 2012.

Table 15. Regional maize indicators in Ghana.

Region	Predominant maize agro-ecology	Aggregate maize area (Hectares)	Average maize yield (t/ha)
Western	Rain forest	50,120	1.12
Central	Coastal savannah	104,601	1.93
Eastern	Deciduous forest	174,573	2.09
Greater Accra	Coastal savannah	3,931	1.13
Volta	Deciduous forest	53,923	1.81
Ashanti	Deciduous forest	153,936	1.13
Brong Ahafo	Forest-savannah transition	236,651	1.84
Northern	Northern savannah	134,723	1.43
Upper West	Northern savannah	67,350	1.23
Upper East	Northern savannah	43,370	1.74

Source: Ministry of Agriculture of Ghana (2013).

- Price of maize seed or grain does not vary between OPVs.
- Seed or grain is the only part of the crop that is sold.

Maize farmers mostly rely on basic farm implements that may last up to 5 seasons. Their fixed cost was estimated to be GH¢208 (US$71.72). Variable cost of production amounted to GH¢1626 (US$560.68). Total cost of production was estimated to be GH¢1835 (US$632.75).

The average yield of maize at the farm level was found to be 2283 Kg/Ha (2.28 t/ha). After production, the grain is sold at a price of GH¢0.40 to GH¢0.80 per kilogram. Maize production was estimated to be unprofitable with a loss of GH¢465 equivalent of US$160 as presented in Table 16.

VCA for Maize Production

Results from the value chain analysis show that Ghana maize farms are characterized as rain-fed, smallholder plots with moderate level of mechanization

Table 16. Cost and return to maize production in Ghana (1 USD = 2.90 [10]GH¢, rate of June 16 2014).

Fixed Cost			
	Cost (GH¢)	Number of Years	Depreciated value*
Hoe	158.71	2	79.34
Cutlass	31.50	2	15.75
Donkey cart	566.67	5	113.33
Fixed Cost			**208.42**
Variable Cost			
	Quantity	**Unit Price (GH¢)**	**Amount (GH¢)**
Land (Hectare)	1	100	100
Seed (Kg)	45	1	45
Sulphate of Ammonia (50 kg)	3	49	147
NPK (50 kg)	5	51	255
Compost			116.67
Herbicides (Liters)	5	10	50
Land preparation	Contract		251.40
Sowing	Contract		98.54
Labour for chemical applications	Contract		62.30
First weeding	Contract		152.80
Second weeding	Contract		122.40
Harvesting	Contract		137.45
Shelling	Stipend and fuel		87.67
Variable Cost			
Total Cost			
Revenue/Income			
	Quantity	**Unit Price (GH¢)**	**Amount (GH¢)**
Yield (Kg/Ha)	2283	0.60	1369.80
Total Revenue			**1369.80**
Profit (Loss)			**(464.85)**

*Using the straight line depreciation method without a scrap value.

and use of fertilizers and chemicals with scant use of soil amendments. Improved seeds are planted on most of the land under maize cultivation (93%) throughout the country, and average yields are 20% lower than the African average. Farm characteristics as revealed by the VCA are summarized in Table 17.

[10]Exchange rate between the US dollars and the Ghanaian CD was fluctuating a lot during the study: from 2.90 CD to the dollars up to 3.20 CD sometimes, therefore there could be small discrepancy in exchange rate, but not big enough to influence the message we are trying to send.

Table 17. Ghana maize farm characteristics.

Rain-fed, 2013	
Harvesting seasons per year	1 to 2
Seed	**OBAATAMPA**
Planting method	Sowing
Water regime	Rain fed
Tillage	Till depth < 30 cm
Year	**2013**
Planted area (ha)	1.35
Fertilizer timing	Cultivation
N2 application (kg/ha)	32.68

Source: Global Development Solutions, LLC.

Among the farms studied, the average farm size is 1.3 ha (ranging from 0.2 ha - 4 ha/farm). Fifty-four percent of farms are harvested once per year while 46% are harvested twice per year. The main harvest seasons are August/September for the first harvest and November/December for the second harvest. This second harvest is the predominant harvest in the Transition, Rain Forest and Coastal Savannah Zones which practice two harvests per year. The Guinea Savannah zone has only one harvest (in September).[11] However, according to harvest data obtained by interviews in the Volta and Northern regions, harvesting of maize reportedly takes place in all months of the year, except May, with the highest harvest periods being November/December (38% of farms) and August/September (33%).

The VCA study revealed that the leading cost contributors to maize farming in Ghana are: cultivation (68.3% of overall production cost), land preparation (12.6%), and harvesting (7%). The cost components of these three principle processes are further broken down to understand the cost drivers behind each.

Seventy-eight percent of cultivation cost is attributed to fertilizing. The cost of the actual fertilizers—NPK (95.5%) and urea (1.5%)—combine for 97% of fertilizing cost and the additional 3% is contributed by the labor used in applying the fertilizers. Chemical spraying, at 17% of costs, is the second cost driver within cultivation followed by weeding (4.7%). The cost of chemicals accounts for 90.4%, labor contributes 9.2% while equipment rental makes up the remaining 0.4% of the cost of spraying.

The second leading cost driver in the maize farming value chain is land preparation. As indicated below, land preparation, specifically tilling, in Ghana is moderately mechanized and the cost of equipment accounts for 69.6% of land preparation cost while labor accounts for only 30.4%. AMSEC[12] has made it

[11]FAO, http://www.fao.org/agriculture/seed/cropcalendar/cropcalendar.do

[12]http://mofa.gov.gh/site/?p=10003: Ministry of Food and Agriculture in Ghana: In line with the Ministry's policy of increasing farmers access to mechanized services along the value chain in farming communities, the current number of Agricultural Mechanization Services Enterprise Centres (AMSECs) established and operational stands at 89 AMSECs from the previous 86 at the end of 2010.

possible for farmers to utilize mechanization services (*i.e.*, tractors) at a cost of GHC70 (USD24.20) per hectare for tilling. The labor cost for land tilling for farmers who do not use tractors is GHC30 (USD10.37)/ha.

Harvesting is the third major cost factor in the maize farming value chain yet only contributes 7% to the overall cost. The cost driver in the harvesting process is harvesting activity (51.7% of the harvesting cost), which is 100% attributed to the cost of labor. Threshing represents 48.3% of harvesting costs of which 74.9% is for equipment and 25.1% is for labor.

The summary of costs in **Table 18** shows that the total cost of production per hectare of maize is GHC871 (USD301.4). This cost is dominated by two inputs: fertilizer (56.1%) and hired human labor (17.2%). All other costs combined total only 26.7% of the overall production cost. This draws attention to the high cost of fertilizers in spite of the 50% government subsidy in Ghana. For comparison, in Ghana the average cost of fertilizer is USD169.2/ha whereas it is USD121.3/ha in Cote d'Ivoire, yet yields in Ghana are only 1.67 ton/ha compared to 2.74 ton/ha for Cote d'Ivoire. This shows there is room for improvement for increasing productivity. These are parameters which come to play when it comes to regional value chain of maize.

Land preparation and planting are the most labor intensive activities in maize production in Ghana, contributing 51.2% out of the total man-days per hectare. The other labor intensive activities are weeding and harvesting, which take 18.5% and 18.9% of the total 3 man-days per hectare used for maize production in Ghana. This indicates a higher degree of mechanization of maize farming in Ghana compared to Benin where a total of 40.7 man-days are used per hectare for maize production. Notwithstanding the above, the man-days per hectare for Ghana are apparently understated in a similar manner to rice production

Table 18. Performance and costs of Ghana maize farming.

Cost	Total (GHC/ha)	(US$/ha)	Total (%)
Hired human labor (all stages)	150	51.9	17.22
Hired animal labor (all stages)	0	0.0	0.00
Seed	18	6.2	2.07
Tilling, excluding labor	70	24.2	8.04
Fertilizer (all stages)	489	169.2	56.14
Agriculture chemicals including equip. (all stages)	84	29.1	9.64
Harvesting, excluding labor	56	19.4	6.43
Admin & Overhead	4	1.4	0.46
Total	**871**	**301.4**	**100.00**
Cost per production unit (GHC (USD)/ton)	522	180.5	
Yield rate (t/ha)	1.67		

Source: Global Development Solutions, LLC.

Table 19. Hired human labour averaged statistics, Ghana.

Workers for activities per ha	Average workers/ha	Average days	Man-days/ha	Man-day/ha (%)
Land preparation workers/ha	1	0.57	0.6	19.2
Planting workers/ha	1	0.73	1.1	32.0
Water management workers/ha	0	0	0	0
Fertilizing workers/ha	1	0.34	0.2	6.5
Spraying workers/ha	1	0.3	0.1	3.2
Weeding workers/ha	1	0.53	0.6	18.5
Harvest workers/ha	1	0.62	0.6	18.9
Threshing workers/ha	2	0.25	0.0	1.3
Drying workers/ha	2	0.04	0.0	0.1
Transport workers/ha	1	0.09	0.0	0.4
Total man days/ha			**3**	**100.00**

Source: Global Development Solutions, LLC.

man-days due to the culture of shared labor wherein farmers team up to help each other on the farm activities. While other factors mentioned in this report point to a higher degree of mechanization in Ghana than in Benin, the degree to which this is true is distorted by looking at the manpower comparison of only 3 man-days/ha for Ghana against the 40.7 man-days observed in Benin. The labor summary is shown in Table 19.

The most significant input cost identified in Table 18 is fertilizers, which amount to GHC489 (USD169.2)/ha on average. However, farmers who apply urea and NPK (2.6% of farmers) spent GHC861.6 (USD297.9)/ha while those farmers who apply ammonium sulfate and NPK (79.1%) spent GHC377. 2 (USD130.4)/ha; 18.3% of the farmers did not apply any fertilizer. Farmers who applied urea and NPK achieved an average yield of 2694 kg/ha, while farmers who applied ammonium sulfate and NPK achieved an average yield of 1734 kg/ha. Farmers who did not apply any mineral fertilizers achieved an average yield of only 1259 kg/ha. Fertilizer cost contributions are broken down by NPK, urea and Ammonium sulfate.

In conclusion, in Ghana, Maize is the most important food crop and is the most important cash crop in the absence of cocoa. Production of maize has been increasing since the 1990s and is expected to continue to rise in the near future. Dramatic increases in production may be attributable to research (modern technologies) and extension (development interventions). In Ghana, maize is grown in all five agro ecologies (Coastal savannah, Rain forest, deciduous forest, Forest-savannah transition and Northern savannah). Maize production is mainly rain-fed and is dominated by smallholder subsistence farmers. Per capital maize consumption has been increasing steadily since the 1980s with the poultry industry being an important market. Maize production was found to be unprofitable.

Maize marketing and processing was however found to be a profitable venture with processors found to make the highest marketing margin with retailers making the least margin.

Table 20 gives the financial synthesis details for 1ha of maize from farm gate between Cote D'Ivoire and Benin where difference can be seen between regions in the same countries in terms of "net profits". In the same vain Table 21, however, only compares total costs between the three countries, Cote D'Ivoire, Benin and Ghana. Further comparisons of key inputs are unit cost and quantity applied. These are particularly interesting for seed and fertilizer; both subsidized inputs in Benin. Table 21 shows how actual unit costs and applied quantities compare between Benin, Côte d'Ivoire and Ghana. It provides a comparison

Table 20. Financial Synthesis for 1 ha of Maize from farm gate XOF/Kg)[i].

	Côte d'Ivoire		Benin		
	Savana	**Forest**	**Benin South**	**Benin Centre**	**Benin North**
Fix Costs	19.33	21	2.04	6.98	6.43
Labour	35.69	62	33.49	38.28	25.66
Inputs	81.37	97	13.88	26.32	36.84
Production Cost	136.39	180.09	49.41	71.58	68.93
Yield (t/ha)	2.9	3	2.04	1.4	1.94
Average price of maize XOF/Kg			150	150	150
Net Profit	**21.12**	**28**	**100.57**	**78.4**	**81.05**

Source: Global Development Solutions, LLC. [i]XOF/Kg: The exchange rate was vacillating between 1 USD = XOF 459 to 490.

Table 21. Côte d'Ivoire, Benin and Ghana comparative maize production inputs costs.

Cost Category	Total (USD/ha)		
	Cote d'Ivoire	**Benin**	**Ghana**
Hired human labor (all stages)	68.6	138.8	51.9
Hired animal labor (all stages)	5.7	0.3	0.0
Seed	8.8	4.7	6.2
Tilling, excluding labor	8.7	7.1	24.2
Fertilizer (all stages)	121.3	67.4	169.2
Agriculture chemicals including equip. (all stages)	48.3	5.6	29.1
Harvesting, excluding labor	30.4	19.9	19.4
Admin & Overhead	12.8	20.4	1.4
Total cost per hectare of maize	304.6	264.3	301.4
Cost per production unit, US$/ton)	123.7	227.9	180.5
Yield rate (t/ha)	2.74	1.36	1.67

Source: Global Development Solutions, LLC.

between the total costs along the maize production value for these same value added steps. As observed, hired human labor cost in Ghana USD 51.9) is considerably less—almost a third—than that of Benin (USD68.6) but not very far from Côte d'Ivoire (USD138.8). The fertilizer expenditures in Benin, however, are 44% lower than in Côte d'Ivoire (USD121.3 in Côte d'Ivoire versus USD67.4 in Benin), and 60% less than those Ghana (USD 169.2). Although production cost per hectare is 13% lower in Benin (USD264.3 Benin versus USD304.6 Côte d'Ivoire) and 12% lower than Ghana. This is due to the fact that, Benin maize yield rate is half that of Côte d'Ivoire, and a little less than that of Ghana. Furthermore, the cost per production unit in Benin (USD227.9/ton) is 84% higher than in Côte D'Ivoire (USD123.7/ton), and 26% higher than that of Ghana.

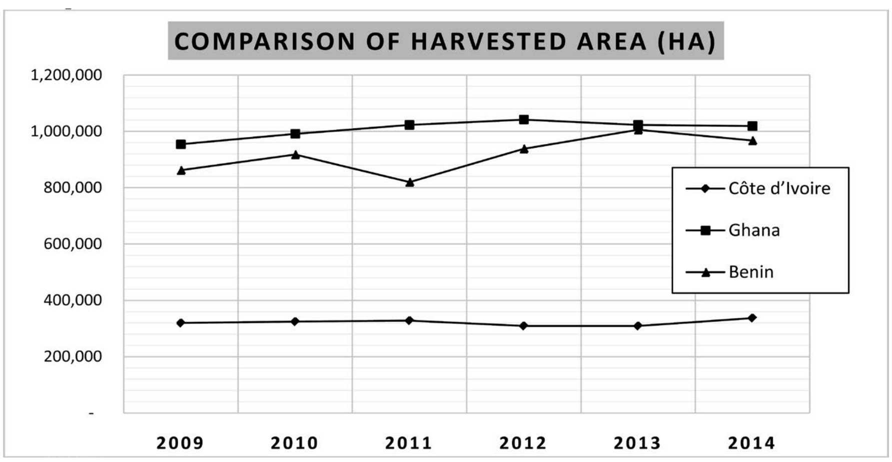
Côte d'Ivoire, Benin and Ghana comparative maize Harvested area Production, Seed availability and Yield (2009-2014) Source, FAOSTAT 2015

Figure 1 shows that the harvested area in the period of six years under consideration, that Cote D'Ivoire remains too far own in amount of harvested areas compared to Benin and Ghana and that Ghana has the most harvested area of the three countries.

Figure 2 shows the difference in production among the three countries. Cote d'Ivoire shows much higher tonnage, followed by Ghana, then Benin has the less amount of production. Although Figure 1 shows less area of production for Cote d'Ivoire, it succeeded to have the higher production tonnage

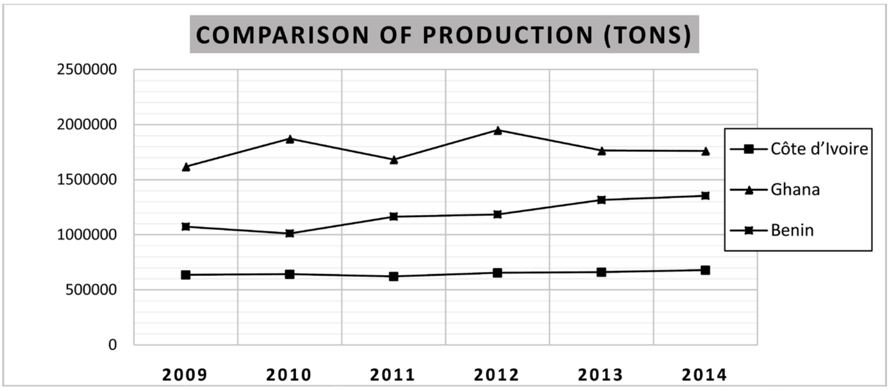
Figure 3 explains the two other figure above as Cote D'Ivoire use the highest amount of seed per hectare than both Ghana and Benin, Ghana being the second highest

In terms of yield/ha showing on Figure 4, Cote D'Ivoire still showed highest yield until up around mid-2013 which correspondent to the beginning of political turmoil in that country. Therefore, up to 2013 Cote D'Ivoire was first in yield followed by Ghana and then Benin. But the three countries performance in yield is far below the world average of 5 t/ha.



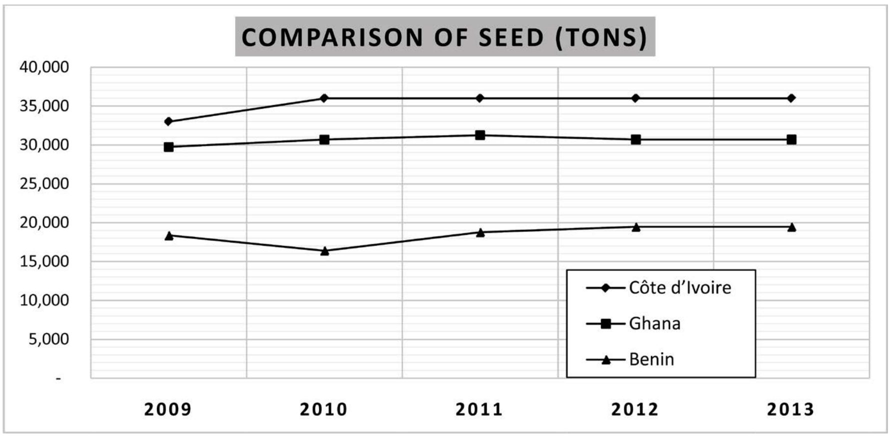
Source: FAOStat 2015

Figure 1. Comparison of Harvested area.



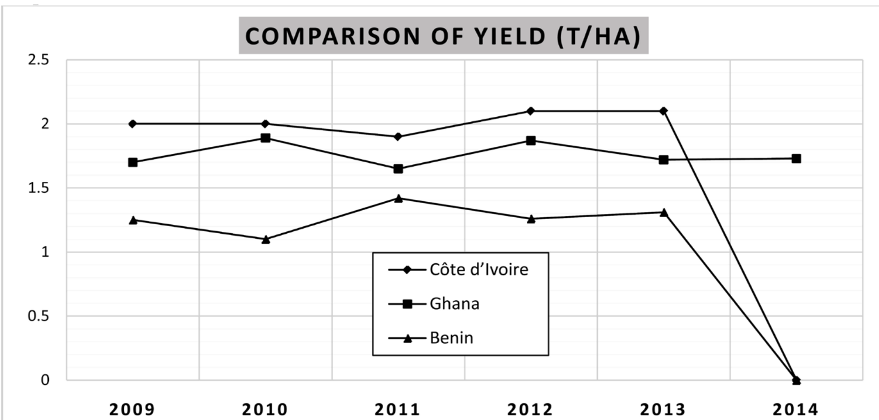
Source: FAOStat 2015

Figure 2. Comparison of Production Areas.



Source: FAOStat 2015

Figure 3. Comparison of Amount of Seeds available.



Source: FAOStat 2015

Figure 4. Comparison of Yields.

8. General Conclusion

The Value Chain Analysis (VCA) study on maize farming conducted for Côte d'Ivoire indicates that the average yield is 2.74 t /ha/season. The average cost of production is XOF149,269 (US$305)/ha and the average unit cost of production is XOF60,616 (US$124)/t. The VCA study revealed that the leading cost contributors to maize farming in Côte d'Ivoire are cultivation (43% of cost), land preparation (18%), and planting (15%). Fertilizing contributes 56% towards the cost of cultivation. Urea and NPK account for 67% and 28% of the cost of fertilizing, respectively, with the 5% balance being attributed to labor cost. Spraying accounts for 38% of the cost of cultivation of which 89% is spent on chemicals.

The VCA study on maize farming conducted for Ghana indicates that the average yield is 1.67 t/ha/season. The average cost of production is GHC872 (US $301.5)/ha, which translates to a production cost of GHC522.1 (US$180.5)/t). It has been estimated at around one million the quantity of maize annually consumed by producer households in Ghana. Of 55% of the produced maize that is marketed, approximately 40%, the equivalent of 400,000 metric tons, serve the animal feed market. About 25% of this marketed maize is sold to industrial maize buyers. Ghana is the second largest maize producers in West Africa after Nigeria (Boone *et al.*, 2008) [5]. Maize production in Ghana primary serves domestic markets. In fact, over the past decade, Ghana has consumed above its maize production level (Boone *et al.*, 2008) [5]. Despite this situation, the country also transact with West African countries of which Cote d'Ivoire is the main importer. For instance, it has been shown that 83% of the Ghanaian's maize export goes to Cote d'Ivoire. Regional demand for maize has been increased over the past decades and will still be over the next decade.

The VCA study on maize farming conducted for Benin indicates that the average yield is 1.36 tons/ha/season. The average cost of production is XOF126,444 (US$264.3)/ha, which translates to a production cost of XOF109,055 (US$227.9)/ton. Data on maize consumption have to be taken with caution. Based on data computed from other studies, it is found that all maize produced in Benin is consumed domestically (e.g., DTMA, 2012; FO, 2013), with consumption sometimes being greater than the total production between 2004 and 2007. Besides human consumption, maize is also used for animal feed, poultry in particular. About 950,000 tons of maize are annually used for poultry feed (Direction Technique/Ministère de Agriculture/Benin, 2012).

Increase in maize demand in sub-Saharan Africa in particular is underway. For example, Pingali (2001) [12] states that by 2020 maize demand will exceed the demands for other cereals. The driven factors are: the increase in per capita maize consumption with a yearly increase of 2.8%, and the increase in demand for feed that augments by 2.2% annually (e.g., Rosegrant *et al.*, 2008) [13]. Broad estimations show that maize supply in the region fails to meet demands, and about 2 to 3 million tons of maize are imported annually (M'mboyi *et al.*, 2010) [14] despite the potential in the region.

These trends in maize demands show that opportunities exist that Benin's maize value chains can benefit from. For example, it is shown that regional demand for maize will be increased by 79% in 2020, reaching about 52 million metrics. As regards exports, Benin saw its exports increase over the last decades. Benin exports have steadily increased from 12,000 tons in 2006 through about 28,000 tons in 2010. These exports, however, have failed to about 4500 tons in 2011 (FAOStat, 2012). The main importing countries of maize from Benin are Cameroon, Cape Verde, Congo, Gabon, Niger, Nigeria, Togo (FAOSTAT 2012). These trends only concern the official exports; most of cross-border trade is informal and not recorded.

9. Policy Recommendations

Competiveness of Maize Value Chains for Smallholders in West Africa should be analysed through many lenses. The comparative and competitive advantages of the targeted countries should be taken in consideration as well as. There is room for economies of complementarity, economies of scale and economies of vertical integration. But in order for the regional value chain of maize to be a reality, member states need to get involved with strong political will.

- ***Application of fertilizer***: Low level of fertilizer application compared to the regionally recommended rate has been revealed by the VCA study. Interviews suggest the need to ensure appropriate fertilizers are available when needed and accessible by smallholders
- ***Soil conditions***: Soil conditions are not ideal in the target countries. In addition to the recommended application of NPK and urea, soil amendments through application of lime, manure and other organics may enrich the soil. As was noted above, application of KCL or K_2SO_4 is minimal and that needs to be corrected.
- ***Application of agro-chemicals***: Weeds deprive the crops from required nutrients and pests destroy crops through infestations. Hiring extra workers to compensate for the lack of herbicide application is effective yet costly, as seen in the VCA, and pest control is not possible through human labor alone. Agro-chemicals are required in order to quell the ill-effects of pests and weeds. According to the results of the study, 25% of farms used agro-chemicals and, on average, these farms posted yield rates nearly 5% higher than those farms that did not use agro-chemicals. Therefore, the use of agro chemicals is recommended.
- ***Increased availability and application of improved seed***: Increased access to improved seed, along with education and training to demonstrate the economic advantages of using improved seed, are essential for farms to improve their yields. Unfortunately, more than 66% of the farmers interviewed do not apply improved seeds. The three pillars of good agricultural practices, research based fertilizer application rates its timing, and application of selected/improved seed varieties are the keys to achieving higher productivity and production. As the study revealed, even though much effort has been exerted and resources made available including significant subsidies, the lack of awareness among farmers and low level of promotion supported by practical

demonstrations is hampering achieving higher productivity*.* However, the yields of these improved seed varieties are still lower than the African average yield. Local seed development is not adequate. Whereas improved seeds are yielding up to 6 tons/ha, seeds.

- ***Production cycles***: to overcome this problem of one harvest per year, simple irrigation schemes (small to medium sized earth dams dispersing water through channels for downstream areas and with lifting techniques for up-stream fields)[13] [15] which may be able to allow for a second season in certain areas, is recommended. This has been used in Mali and Burkina and could be introduces in the targeted countries
- ***Poor access to mechanization***: Mechanization reduces time and effort required for land preparation and, the VCA shows that tractor rental cost is approximately equivalent to the labor cost performing equivalent tasks but reduce time will be the benefit and that time could be used for other things. Agriculture lending programs, or matching grants facility may increase purchase of inputs and technology, e.g. improved seeds, mechanized tools (particularly tractors and other machineries) and this could positively impact yield.

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However, any errors or omissions must be attributed to the author.

[13]FAO; Smallholder irrigation technology: prospects for Sub-Saharan Africa; Matching technologies to agricultural regions.

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Disclaimer

The author stresses that views expressed in this paper are those of the author and should not be attributed to the United Nations or the United Nations Economic Commission for Africa.

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