Growing potatoes: Production and consumption in East Africa

Major MSc Thesis (AEP-80436)

J.C. (Jolien) Witte, BSc
Agricultural Economics and Policy
Wageningen University
The Netherlands
October, 2013

Acknowledgements

This major MSc thesis is written of a result of collaboration with the Dutch Department of Economic Affairs and was supervised by dr. ir. C. (Koos) Gardebroek of the Agricultural Economics and Policy Group (AEP) of Wageningen University and Mr. S.R.R. (Sjoerd) Croqué of the Department of Economic Affairs. I would like to thank both of you for your supervision, support and valuable input in this project.

Furthermore, I would like to thank those who provided me insights and additional background information about the East African countries or the potato sector in general: Mrs. I. Korving and Mr. J. Satter of the Department of Economic Affairs, prof. dr. ir. A.J. Haverkort of Wageningen University, Mr. A. Plomp of HZPC, and Mr. W. van Tilburg and Mr. D. Zelhorst of Aviko Potato B.V.

Finishing this thesis involves the end of more than five years of studying at Wageningen University. A special word of thanks is therefore devoted to Koos, who supervised me in several projects throughout the past years. Thank you for your patience, assistance, education and open office. Finally, I am also thankful to all those I met in Wageningen. I enjoyed every single cup of coffee and relaxing moments we shared. You supported me, together with my family, at all times.

I hope you will enjoy reading my thesis.

Jolien Witte
Wageningen, October 2013

Table of contents

List of figures 5
List of tables 5
Abstract 6
1. Introduction 7
2. Production and marketing of potatoes 12
2.1 Ethiopia 12
2.1.1 Production 12
2.1.2 Marketing 15
2.1.3 Processing 16
2.2 Kenya 17
2.2.1 Production 17
2.2.2 Marketing 20
2.2.3 Processing 20
2.3 Rwanda 21
2.3.1 Production 21
2.3.2 Marketing 23
2.3.3 Processing 24
2.4 Uganda 25
2.4.1 Production 25
2.4.2 Marketing 27
2.4.3 Processing 28
2.5 Synthesis for East Africa 28
3. Consumption of potatoes 33
3.1 Ethiopia 33
3.2 Kenya 34
3.3 Rwanda 34
3.4 Uganda 35
3.5 Synthesis for East Africa 35
4. Modeling potato demand 38
4.1 Ethiopia 39
4.2 Kenya 40
4.3 Rwanda 40
4.4 Uganda 41
4.5 Synthesis for East Africa 42

5. Strategies for East Africa 43
5.1 SWOT analysis 43
5.2 Confrontation matrix 44
6. Conclusions and discussion 46
6.1 Conclusions 46
6.2 Discussion 47
Bibliography 49
Appendices 53
A. Ethiopia 53
B. Kenya 54
C. Uganda 54

List of figures

Figure 1: Global potato production 8
Figure 2: Global potato area 1961-2011 8
Figure 3: Global trade in potatoes in million tons 1986-2005 9

List of tables

Table 1: Average area and share of farms involved in potato production per season 13
Table 2: Production of potatoes in Ethiopia, *Meher* season 14
Table 3: Average production costs and revenues of potato production in in Ethiopia 14
Table 4: Average producer prices in USD and ETB per kg, March 2013 15
Table 5: Marketed potato yield versus home consumption 16
Table 6: Average area and share of farms involved in potato production per season 18
Table 7: Potato production in Kenya 2005-2012 18
Table 8: Average production costs and revenues of potato production in Kenya 19
Table 9: Annual producer prices in USD per ton 20
Table 10: Marketed potato yield versus home consumption 20
Table 11: Area harvested in ha per district 22
Table 12: Costs per ton 23
Table 13: Annual producer prices in USD per ton 23
Table 14: Added value of potato supply chain Musanze - Kigali 24
Table 15: Economic profitability of processing 100 kg of potatoes into French fries in Rwanda 24
Table 16: Average area and share of farms involved in potato production per season 25
Table 17: Average production costs and revenues of potato production in Uganda 27
Table 18: Marketed potato yield versus home consumption 27
Table 19: Estimates of potential French fries production by 2015 in tons 31
Table 20: Consumer price per region in 2009 33
Table 21: Simulated demand scenarios for Ethiopia, in tons 39
Table 22: Simulated demand scenarios for Kenya, in tons 40
Table 23: Simulated demand scenarios for Rwanda, in tons 41
Table 24: Simulated demand scenarios for Uganda, in tons 42
Table 25: Confrontation matrix for East Africa 44

Abstract

In this thesis the organization of potato markets in four East African countries, i.e. Ethiopia, Kenya, Rwanda and Uganda, is surveyed, focusing on both production and consumption characteristics of ware and processed potatoes for the countries separately as well as for East Africa in general. Also, consumption is simulated for 2015 and 2020 according to different scenarios, including population growth, income growth and changes in prices of potatoes and maize. Finally, a SWOT analysis is carried out for East Africa in general and strategies for East Africa's potato sector are given. The study mainly focuses on qualitative information, obtained by a desk study of the four countries and their potato markets. Existing micro datasets are used, to obtain information about recent production circumstances and statistics of East African potato producers. A simulation analysis and a SWOT analysis are carried out to project future consumption and developments of the East African potato sector.

1. Introduction

Potatoes are becoming an international commodity more and more, due to among others the urbanization in developing countries, the increase in incomes in merely Asian countries and the McDonaldization which lead to changes in diets, particularly to consumption of more processed products including potatoes. These have been important considerations in influencing the production and use of potatoes. Following the Food and Agriculture Organization of the United Nations (FAO) (2010), potatoes are ranked as the fourth most important staple food crop, and the number one non-grain food commodity (Thomas and Sansonetti, 2009). In developed countries, potato is regarded as cheap staple food while it is a high-priced vegetable in developing countries (Scott, 2002). Besides that, potato is a source of cash income in both developed and developing countries, and is used in different end products; e.g. fried potato products, table potatoes, mashed potatoes, ingredients for sauces, starch products and seed products.

The relative importance of potatoes has shifted from developed countries to developing countries, in which more than half of the global potato production currently takes place (Walker et al., 2011). In the last fifteen years, potato production in developing countries increased by 25%. It is expected that major potato consuming countries like China and India will meet their demand for food products for the next twenty years by, among others, consuming more potatoes and therefore increasing the planted area of potatoes (Thomas and Sansonetti, 2009).

The global market for potatoes consists of several, mainly unconnected, regional submarkets where trade in potatoes takes place between regional groups of countries. Examples of submarkets are northwestern Europe, South America, and Central Asia. This can also be clearly seen in Figure 1. Potato production in Central Asia covers a chain from northwest China to northern India. In western Europe, potato production as a summer crop is concentrated around the North Sea, where potato yields in tons per hectare are the highest. Furthermore, around 25% of the global potato area is in highland areas, i.e. above 1,000 meters. Global potato area has decreased from 22 million ha in 1961 to 19 million ha in 2011. While the potato area has decreased in Europe in particular, it has increased in Asia and slightly in Africa (see Figure 2).

Considering climatological conditions, it should be noted that potatoes are grown at all latitudes where people live and grow crops. Potatoes are grown in areas with moderate temperatures, i.e. the highlands of the tropical zones, the cool seasons in the subtropical zones and lowlands of moderate zones. The lion's share of the potato distribution is in the northern hemisphere, particularly in Europe. Potato area has increased in tropical highlands and subtropical lowlands of e.g. India, Bangladesh and China (Hijmans, 2001). It is likely that this trend will continue in the future (Walker et al., 1999).

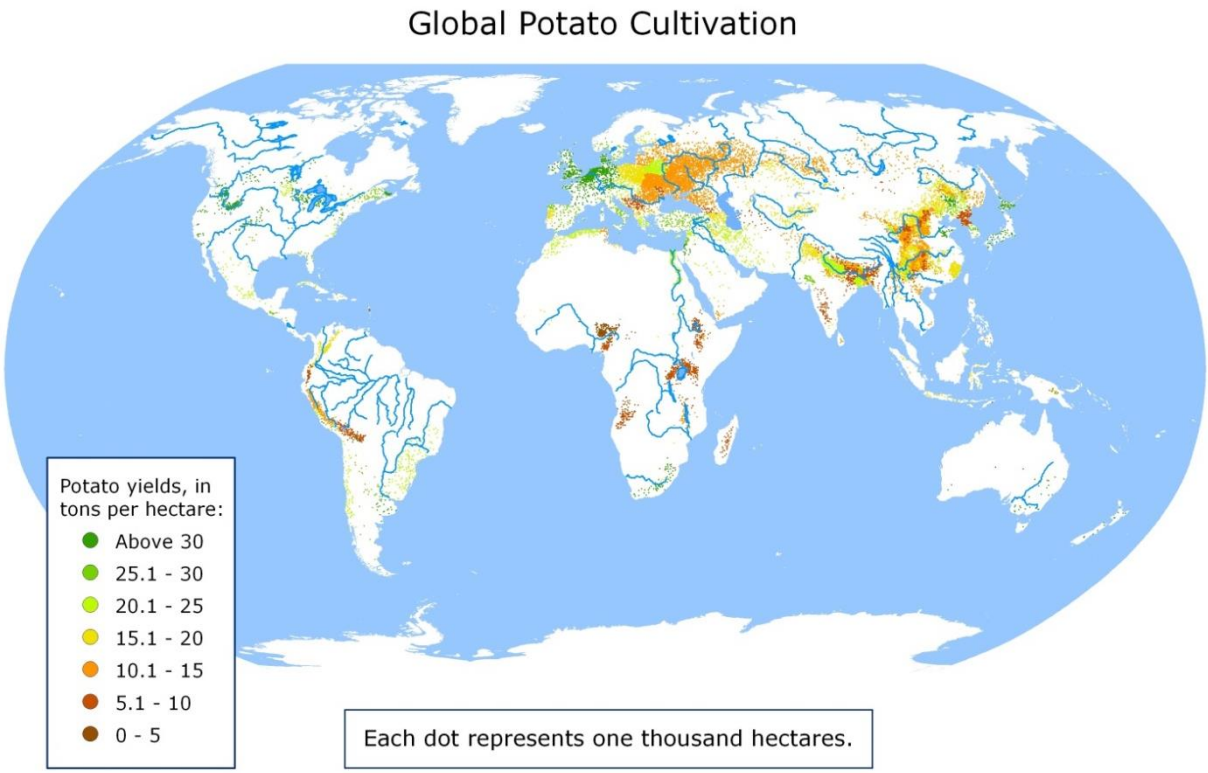

Figure 1: Global potato production
Source: CIP (2009)

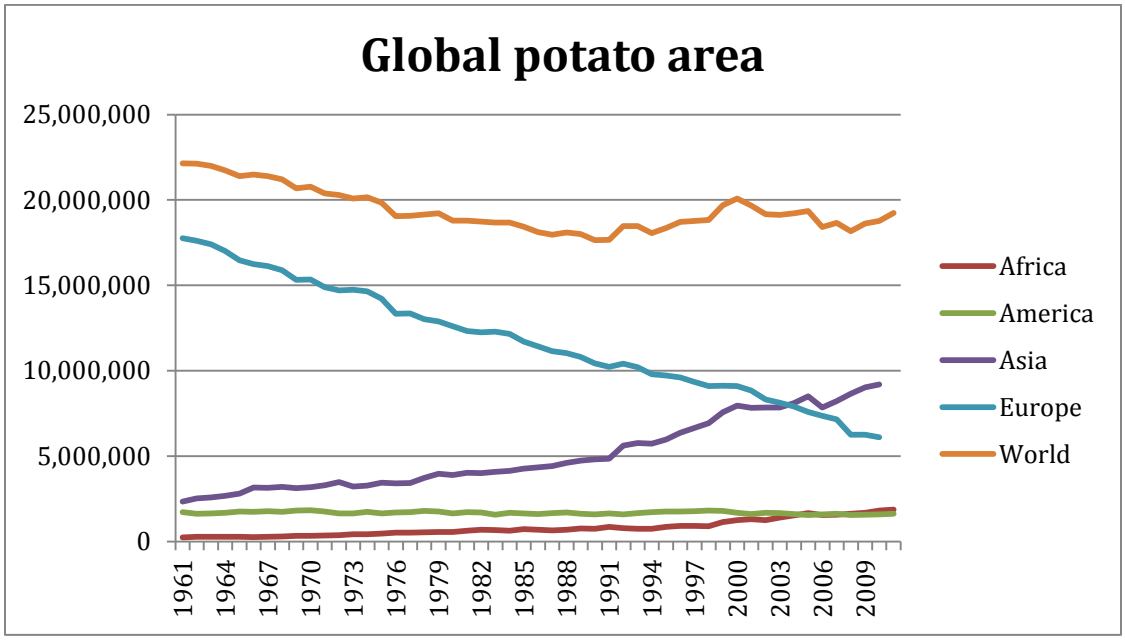

Figure 2: Global potato area 1961-2011
Source: FAOSTAT (2011)

Since the global market for potatoes consists of several regional submarkets, only local production costs and demand determine prices of potatoes and not the impulses of international markets (Thomas and Sansonetti, 2009). Only a fraction of total production is traded internationally. Figure 3 shows the global trade in potatoes over the period 1986–2005, in which the red and yellow bars indicate fresh and processed products, respectively. Here it is seen that overall trade increases slightly, with trade in processed products in particular.

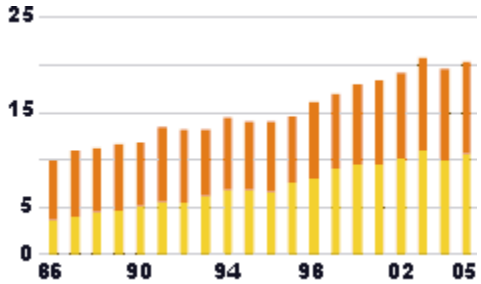

Figure 3: Global trade in potatoes in million tons 1986-2005
Source: FAO (2008)

Since potatoes contain more energy and proteins than cereals and are a much more efficient crop in terms of yield per hectare and water usage (a greater part of the dry matter of potatoes can be consumed, compared to cereals), potatoes can play an important role in the food security for millions of people across the world, mainly in South America, Africa and Central Asia (Scott et al., 2000; Scott, 2002; Thomas and Sansonetti, 2009; Haverkort et al., 2012). In doing so, potatoes can improve health conditions of vulnerable population groups like women and children, and decrease mortality rates in developing countries. Besides, potatoes can provide a means of income and employment since potato production requires more labor than other crops (Scott et al., 2000). Also, potatoes are attractive for developing countries because in many countries potato prices are still determined on a regional or national market, and can therefore be influenced by national policies. Another important element of potatoes for developing countries is the provision of a considerable source of food when adverse climatological conditions or civil unrest threaten basic food supplies. As such, potato cultivation can be considered as a local solution to local disasters (Walker et al., 1999; Scott et al., 2000). Concluding, potatoes are a promising crop for developing countries.

The production of potatoes and food crops in general in Sub-Saharan Africa is far behind that of other countries and regions in the world, although potatoes are an important food and cash crop for Sub-Saharan African countries. Potatoes play an important role in remote areas in particular, where incomes are low and where access to markets and inputs is limited (Scott et al., 2000). Policies in developed countries such as price supports and export subsidies for competing crops have also slowed down potato output in developing countries (Scott, 2002). Examples of potato producing countries in Africa are Nigeria, Tanzania, Rwanda, Malawi, South Africa, Egypt and Algeria, as well as Kenya, Uganda and Ethiopia. In Sub-Saharan Africa, 52% of the area harvested and 45% of the potato production is in East and Central Africa (Scott et al., 2013). Yields per hectare are low in these countries, i.e. less than 10 tons per hectare, but could be increased to above 30 tons per

hectare due to better crop management and practices, availability of appropriate varieties, quality seed, fertilizer and better access to markets (Tesfaye et al., 2010; Haverkort et al., 2012). However, the economies of countries in Sub-Saharan Africa are expected to grow with at least 5% per year (IMF, 2012) and returns to agricultural investments are large and agricultural growth could be extended (Diao et al., 2012). This gives potential for the potato sectors in Sub-Saharan African countries, especially when local producers have access to well organized markets. Through the double purpose of potatoes (both food and cash crop), it is believed that increased productivity of potatoes can improve the livelihood of smallholder potato producers in countries like Kenya, Uganda and Ethiopia and is required to meet the growing demand since populations are doubling every 25 years and urbanization will increase by 13% to the year 2020 for East African countries (Gildemacher et al., 2009; Tesfaye et al., 2010).

Due to economic growth, increased income levels of a growing population and continuing urbanization in the coming decades, it is likely that consumption patterns will change and diets will diversify. According to Pingali and Khwaja (2004), when diet diversification occurs, the traditional food production system has to be transformed since further diet globalization includes a shift from traditional and domestic products to global and more processed products. Therefore, it is expected that the demand for potatoes will increase in the near future.

To meet the increased demand, the traditional food production system in East Africa has to be transformed and requires an increase in the total food supply as well as the existence of large suppliers. In fact, it requires the commercialization and diversification of domestic potato production. It also involves the organization of small-scale producers to become integrated in a larger market instead of being subsistence producers (Pingali and Khwaja, 2004). Consequently, it is expected that production will increase within East Africa and trade of potatoes will be internationalized within East Africa. According to Diao and Hazell (2004), stimulating intraregional trade in Sub-Saharan African countries can also help overall agricultural growth in those countries and is a potential market for Sub-Sahara Africa's products. It is a large and growing market that offers real income opportunities. Since fresh potatoes are very costly in terms of cooling and transport, fresh potatoes are considered to be relatively non-tradable compared to e.g. cereals. Due to this non-tradability, the enlargement of existing market structures, logistic channels and production itself, it is expected that trade of potatoes remains within a regional group of countries in East Africa, i.e. East Africa could develop into an additional submarket for potatoes like the potato market of northwestern Europe at the utmost. It is advocated that Sub-Saharan African farmers have potential to trade food crops in domestic and regional markets. An agricultural policy or strategy to help the most vulnerable people could therefore be based on expanding food crop production, commercialization and trade, instead of traditional subsistence farming (Diao et al., 2012). Based on the expected growth in both production and demand of potatoes, it is expected that price determination of potatoes in Sub-Sahara Africa will be different in the future. Yet, it first should be known how potato markets are currently organized.

Diao et al. (2010) note that increased agricultural productivity will reduce poverty through improving the standard of living of producers and through additional effects such as reducing food

prices for urban consumers, facilitating growth opportunities for rural non-farm activities, and new employment opportunities due to expanded migration. In the long run, increased productivity will also cause the improvement of rural service sectors, the establishment of processing industries and the discovering of new export markets. However, according to Scott et al. (2000), the importance of roots and tubers in general as a source of income for poor farmers and of food for the rural and urban poor is often underestimated in the debate about improving food security and reducing poverty in developing countries. This thesis tries to contribute to that debate in providing some results about the role of one particular tuber, the potato, in the rural livelihoods of farmers in East Africa. The objective of this thesis is threefold. First, the objective is to survey the organization of potato markets in several East African countries and second, the objective is to explore what happens to demand for potatoes when populations and incomes grow and prices change by simulating potato consumption for East Africa. Finally, the objective is to project a future East African potato sector by performing a SWOT analysis of this sector.

To meet these objectives, several research questions are defined:

1. How are potato markets in East Africa organized in terms of production, marketing and trade?
2. What are consumption patterns of potatoes in East Africa?
3. How does consumption of potatoes in East Africa evolve over time?
4. What are strategies for the future of the East African potato sector?

This thesis focuses mainly on qualitative information, which will be obtained by a desk study of four potato producing countries in East Africa and their potato markets. These countries are Ethiopia, Kenya, Rwanda and Uganda, which cover a great part of the potato sector in Sub-Saharan Africa (Gildemacher et al., 2009). Existing micro datasets, initially used for other purposes, will also be used to obtain information about recent production circumstances and their statistics of East African potato producers. Simulations will be conducted to model potato consumption in East Africa and a SWOT analysis will be carried out to project future potato production and trade in East Africa.

The remainder of this thesis is organized as follows. Chapter 2 focuses on production statistics, markets, prices, and trade patterns, whereas chapter 3 considers consumption patterns of potatoes. In chapter 4 potato consumption per country is modeled over time and in chapter 5 a SWOT analysis is performed for East Africa in general, and possible strategies for the East African potato sector are given. Finally, chapter 6 presents some conclusions and a critical discussion of this study.

2. Production and marketing of potatoes

In this chapter, the production and marketing of potatoes in the four study countries is described, in which current processing activities of potatoes are also taken into account. The chapter ends with a description of these activities for East Africa in general.

2.1 Ethiopia

2.1.1 Production

In Ethiopia, potato production mainly occurs in the provinces Amhara, Southern Nations Nationalities and Peoples Region (SNNPR), and Oromiya. Potato production takes place at high altitudes, i.e. above 2,500 meters above sea level (m.a.s.l.) where evapotranspiration is low and rainfall higher than average in the country (Marame and Gelmesa, 2006; Gildemacher et al., 2009). The large range of altitudes within Ethiopia, from below sea level to over 3,000 m.a.s.l., provides a lot of agro-ecological diversity with the cool highlands in particular suitable for potato production (Marame and Gelmesa, 2006; Abebe et al., 2013). In most areas potatoes are grown twice a year during rainy seasons, although it is suitable to have a year-round production. The main *Meher* season takes place in the months June-October, while a shorter *Belg* season takes place in the months February-mid May. The off-season occurs from the start of October to mid-January. The *Belg* season is relatively short and unreliable in most regions, so additional irrigation is required in potato production. Due to the threat of late blight, farmers are shifting their production to other seasons, which, combined with irrigation, is less risky. Also, due to relatively low temperatures and no rainfall during the winter months, producers are able to postpone harvesting for up to five months (Haverkort et al., 2013). The main potato production season depends on the region where potatoes are grown, causing many exceptions to the main potato growing seasons (Gildemacher et al., 2009).

Scott et al. (2013) estimated the number of potato producers to be equal to 1-1.5 million, while the Central Statistical Agency (CSA) of Ethiopia estimated it at 1.3 million for 2012. Most producers grow potatoes in both rainy seasons, on relatively small shares of their arable land per season. In particular, 7%, 8% and 13% of arable land was allocated to potatoes in North Shewa and Awi in Amhara and West Shewa in Oromiya during the *Meher* season of 2006, respectively (Gildemacher et al., 2009). This coincides with the studies by Aviko (2012) and Gildemacher et al. (2009) who reported small farm sizes of about 0.25 ha. Table 1 lists the share of producers involved in potato production, the average size of potato fields and the share of arable land used for potato production for different seasons according to the study by Gildemacher et al. (2009). In the study by Jaleta and Gardebroek (2008) 90.7% of the households in Haramaya in Harari grow potato at an average of 0.21 ha, with a maximum of 1 ha. The average area in hectare is quite small, since farmers in these regions are primarily subsistence farmers who combine potato production with the production of other crops. Jaleta and Gardebroek (2008) also note that the share of land allocated to potato production is larger when the farm size is larger.

Table 1: Average area and share of farms involved in potato production per season

District/season	Farms growing potatoes (%)	Potato fields (ha/farm)	Fraction potatoes (% of farm)
Awi (n=94)			
Belg	84	0.24	29
Meher	40	0.21	21
Off-season	65	0.20	23
North Shewa (n=104)			
Belg	9	0.14	8
Meher	86	0.18	9
Off-season	17	0.16	6
West Shewa (n=138)			
Belg	83	0.27	20
Meher	53	0.43	34
Off-season	7	0.17	13

Note: *Belg* season: February-May, *Meher* season: June-October, off-season: October-January
Source: Gildemacher et al. (2009)

For the *Meher* season of 2012, CSA reported an area of about 59,000 ha, which is an increase of 10.2% compared to the year before (see Table A.1 in Appendix A). Scott et al. (2013) reported an average annual area of 56,000 ha in the period 2008-2010, with an annual growth rate of 1% compared to 1984-1986. These numbers coincide reasonably with the 50,500 ha reported by Aviko for the 2012 *Meher* season. Gildemacher et al. (2009) reported an area of about 160,000 ha for both seasons, which is confirmed by the International Potato Center (CIP) (CIP, 2001). The potato area increased strongly, with an average growth rate of 22% per year in the period 1995-2000 (Gildemacher et al., 2009). Compared to the 1980s, this means an increase of about 400% in potato area (Tesfaye et al., 2010). CSA (2012) further reported a total share of potato area of 28.5% in 2012. There are differences in the area reported since production data is not well documented, or only for the *Meher* season, and potatoes are mainly produced at very small plots in peasant communities scattered throughout the country, although they play a major role in food security issues (see also Table 1, and Tables A.1 and A.2 in Appendix A) (CIP, 2001; Marame and Gelmesa, 2006).

Gildemacher et al. (2009) and CSA (2012) reported an average yield of 7.9 tons per hectare. However, Scott et al. (2013) reported an average annual yield of 10.1 tons per hectare for the period 2008-2010, with an annual growth rate of 1.1% compared to 1984-1986, and so argues yields are stagnating. Average yield per hectare is relatively low, especially when considering the potential of Ethiopia with its favorable climate at higher elevations, soils and irrigation potential (Haverkort et al., 2012).

As with area harvested, total production differs per source, depending on which season is taken into account. Gildemacher et al. (2009) estimate total production at 1.6 million tons annually, Haverkort et al. (2013) estimate it at 2 million tons annually and Aviko (2012) reported 402,500 tons for the 2012 *Meher* season. CSA (2012) reported 475,500 tons for this season, which was an increase of 6.3% compared to the year before. Scott et al. (2013) reported 587,000 tons for the

period 2008-2010, with an annual growth rate of 2.1% compared to 1984-1986. According to FAO statistics, potato production in Ethiopia was unstable in recent years, as can be seen in Table 2.

Table 2: Production of potatoes in Ethiopia, *Meher* season

Year	Tons
2000	385,000
2001	415,000
2002	385,258
2003	509,715
2004	509,716
2005	449,996
2006	449,995
2007	525,657
2008	402,508
2009	384,046
2010	572,332
2011	447,333

Source: FAOSTAT (2011)

The share of potato producers applying inputs is reasonable. In the study by Gildemacher et al. (2009) 26.1% of the potato producers used high average amounts of farm-yard manure on the last production, while 57.2% of the potato producers used low average amounts of fertilizer. Seed stocks were renewed occasionally by 44% of the potato producers, on average after three seasons.

Table 3 lists the average production costs and revenues of 220 potato producers in three major potato production areas studied by Gildemacher et al. (2009) in 2005-2006, with and without opportunity costs for family labor, which equal the average estimated costs of hired labor. For comparison, a daily wage equals about USD 1.75-2.25 (Haverkort et al., 2013). As can be seen, there are large differences across regions in the costs of fertilizers and fungicides, as well as seed potatoes and yields. Potato production is most profitable in North Shewa, which also has the highest returns on family labor and cash investment. Net margins per hectare surveyed by Haverkort et al. (2013) were considerably higher and ranged from USD 462.50 to USD 2,788.75.

Table 4 lists average producer prices in USD and ETB[1] per kg for several regions according to CSA (2013). In the study by Hoddinott and Yohannes (2011), producer prices averaged USD 0.10 in Amhara, USD 0.08 in Oromiya and USD 0.15 in Tigray. As such, producer prices vary between USD 0.08 and USD 0.40 per kg. Potato producers surveyed by Abebe et al. (2013) indicated that potato prices are increasing over time. According to Gildemacher et al. (2009), producers in North Shewa in Amhara receive a relatively higher price for their potatoes, due to both higher yields and low investments in inputs. Prices in the Awi district in Amhara were good but yields were very low and both yields and prices were low in West Shewa in Oromiya, although the latter region is close to Addis Ababa. The difference in profits was also due to limited use of farm inputs, a more extensive farming system with more rotation opportunities and larger farm sizes in North Shewa. Haverkort

[1] Exchange rate August 2013: ETB 1 = USD 0.05

et al. (2013) simulated production costs per kg for different yield levels, which ranges from USD 0.04 to USD 0.10 when yield is 20 tons per hectare, USD 0.03-0.06 when yield is 30 tons per hectare and USD 0.02-0.05 when yield is 40 tons per hectare. These producer prices in Ethiopia are quite competitive since they are comparable to about half of producer prices in northwestern Europe, which ranged from USD 0.14-0.17 in 2010 (AHDB, 2012). These low producer prices are favorable for the competitive trading position of Ethiopia in the long run.

Table 3: Average production costs and revenues of potato production in in Ethiopia

	Awi	North Shewa	West Shewa
Cash investments			
Cost fertilizer (USD/ha)	5.84	4.12	21.12
Cost fungicides (USD/ha)	0.00	2.85	38.57
Hired labor used (USD/ha)	85.51	110.39	120.38
In kind investments			
Cost manure (USD/ha)	1.99	2.42	3.23
Cost seed (USD/ha)	144.10	88.72	65.84
Family labor investments			
Family labor used (days/ha)	149.16	125.99	117.00
Family labor (opportunity cost in USD/ha)	156.27	149.87	116.46
Total cost	393.71	358.37	365.60
Revenues			
Yield (t/ha)	5.14	12.33	7.69
Price (USD/t)	91.22	79.12	62.44
Gross margin (USD/ha)	468.89	975.73	480.09
Net margin (opportunity cost in USD/ha)	75.19	617.36	114.50
Net margin (without opportunity cost)	231.46	767.23	230.96
Return on family labor (USD/day)	1.55	6.09	1.97
Return on cash investment	4.13	7.31	1.67

Source: Gildemacher et al. (2009)

Table 4: Average producer prices in USD and ETB per kg, March 2013

Region	Average producer price		Lowest producer price		Highest producer price	
	USD	ETB	USD	ETB	USD	ETB
Amhara	0.16	3.13	0.10	2.00	0.31	6.25
Dire Dawa	0.17	3.33	-	-	-	-
Oromiya	0.17	3.30	0.11	2.10	0.38	7.68
SNNPR	0.18	3.51	0.07	1.46	0.30	6.00
National	0.16	3.29	-	-	-	-

Source: CSA (2013)

2.1.2 Marketing

Approximately 15-60% of potatoes produced in Ethiopia is marketed, while potato producers keep 15% for seed, 15% is lost in storing and transporting, and households consume the remaining part (see Table 5) (Gildemacher et al., 2009; Haverkort et al., 2012; Scott et al., 2013). In the study by

Hoddinott and Yohannes (2011) an average of 95% was marketed in Amhara, 75.1% in Oromiya and 90% in Tigray. However, the share of potatoes marketed in Oromiya varied from 58.6-84.6%.

Table 5: Marketed potato yield versus home consumption

	Weight in kg per household per season	Percent
Ware sold	528	48
Seed sold	146	13
Total market	*673*	*61*
Ware home	300	27
Seed home	126	11
Total home	*434*	*39*
Total	***1,107***	***100***

Source: Gildemacher et al. (2009)

In the study by Gildemacher et al. (2009), 4% of the producers sell their potatoes at the farm gate to traders or brokers, 88% of the producers sell at village markets and 8% sell through other channels, including roadside sales, farm-gate retailing, producer cooperatives or NGOs. Jaleta and Gardebroek (2008) reported that out of 69 potato producers in Haramaya 15.6% market their potatoes at the farm gate and 84.4% at the local market. They also note that the share of potatoes marketed at the farm gate is lower when the area allocated to potato production is larger. This implies that only large amounts are sold at local or central markets.

Traders or brokers often have an information advantage, since potato producers do not know about the price level. At local village markets, potatoes are sold to wholesalers who sell them to retail outlets such as supermarkets and hotels in major cities. Potatoes at wholesale markets in Addis Ababa are sold for USD 0.10-0.15 per kg depending on the grade, while retail prices are about USD 0.23-0.30 per kg (Haverkort et al., 2012; 2013). Potato producers in Ethiopia are mainly price takers since they receive the residue of the market value received at the end of the value chain, which could be as less as 25% of the price at end markets (Abebe et al., 2013). Also, local traders have strong positions in the value chain because producers mainly want to supply their potatoes in periods of high availability. This causes prices to be higher in periods of short supply (Haverkort et al., 2012).

According to FAO statistics (FAOSTAT, 2010a), potatoes are mainly traded from Addis Ababa to Somalia, Djibouti and the former Republic of Sudan. In 2010, Ethiopia exported about 7,500 tons, 12,500 tons and 1,000 tons, respectively, to these countries.

2.1.3 Processing

Currently, most processing is done by households and restaurants. In the study by Tesfaye et al. (2010) 58% of the sampled hotels and restaurants process potatoes into French fries by themselves at an average of 10.1 tons annually, as well as 77% of high income households and 17% of the low income households, on average of 0.05 tons per year. It is estimated that current processing

practices add about 50% of value to potatoes (Haverkort et al., 2012). Haverkort et al. (2013) calculated the profitability of processing 100 kg of potatoes into French fries, giving a profit of USD 29.28 per 100 kg and assuming one kg of French fries can be sold at an average of USD 0.90. The low production costs presented in previous sections offer a promising scope for improving processing potatoes in the future that compete with imported processed potato products. However, unpredictable weather conditions are a major threat to a stable supply of potatoes, required for the processing industry (Haverkort et al., 2013).

According to Haverkort et al. (2013), less than 25 tons of frozen French fries are imported from mainly Belgium, the Netherlands and Germany annually, in particular to serve two five-star hotels in Addis Ababa. Ethiopia is a favorable environment to import frozen French fries since there are no non-tariff barriers. However, the price difference between domestic processed potato products and imported products is relatively large. Locally processed French fries cost about USD 1.22 per kg, while imported frozen French fries cost about USD 4.00 per kg, resulting in a price difference of 228% (Tesfaye et al., 2010).

2.2 Kenya

2.2.1 Production

Potato production in Kenya is concentrated in the highlands at altitudes ranging from 1,500 to 2,500 m.a.s.l., where potatoes have a comparative advantage over maize and as such being the second most important food crop to this country (Nyankanga et al., 2004; Abong et al., 2010). Major potato producing regions in Kenya are Nyandarua district in Central Province, Bomet district in Rift Valley (Gildemacher et al., 2009), Meru Central district in Eastern Province and Mount Elgon district in Western Province (Nyankanga et al., 2004). Potatoes are mainly grown during two rainy seasons, although there is some minor off-season production in areas higher than 2,000 m.a.s.l. Irrigated off-season production also occurs at the slope of Mount Kenya in Eastern Province. The first rainy season occurs in the months April-July, while the second rainy season takes place from mid-September to mid-January (Gildemacher et al., 2009).

Scott et al. (2013) estimated the number of producers to be about 500,000-800,000. Most producers grow potatoes in both rainy seasons, on an average of 30% of their arable land per season (Gildemacher et al., 2009), while it was just 24.4% in 1998 (Obare et al., 2003). In particular, more than a third of arable land was allocated to potato production in Nyandarua and Bomet in both seasons of 2005 and about 20% in Meru Central, Njabini and Mount Elgon region in 2000 (Nyankanga et al., 2004). Table 6 lists the share of producers involved in potato production, the average size of potato fields and the share of arable land used for potato production for different seasons, in which the average share of potato production is somewhat larger than in the studies by Gildemacher et al. (2009) and Nyankanga et al. (2004). The potato area is almost equal across the main seasons.

The average potato area for the three regions in the study by Nyankanga et al. (2004) was 0.8 ha, while areas were larger in Njabini and Meru. This average area is larger than the area reported in Table 6. Farmers practiced rotation in the production of their crops, although because of limited land available most farmers grow potatoes for three seasons, grow another crop for one season and then grow potatoes again (Nyankanga et al., 2004).

Table 6: Average area and share of farms involved in potato production per season

District/season	Farms growing potatoes (%)	Potato fields (ha/farm)	Fraction potatoes (% of farm)
Meru Central (n=100)			
Season 1	77	0.32	42
Season 2	95	0.34	38
Off-season	9	-	-
Nyandarua (n=151)			
Season 1	93	0.40	35
Season 2	99	0.47	37
Off-season	0	-	-

Note: Season 1 April-July, season 2 October-January, off-season July-October
Source: Gildemacher et al. (2009)

According to the study by Aviko, potatoes were grown at approximately 120,000 ha in 2012, while FAOSTAT reported 143,000 ha in 2012. Scott et al. (2013) reported an average annual area of 143,000 ha in the period 2008-2010, with an annual growth rate of 2.7% compared to 1984-1986. Yields range from 4-10 tons per hectare, with an average of 6.7 tons per ha for the three regions studied by Nyankanga et al. (2004), although 30 tons per ha can be obtained under research conditions. Gildemacher et al. (2009) reported an average yield of 9.1 tons per hectare and Scott et al. (2013) reported an average annual yield of 3.4 tons per hectare over the period 2008-2010, with an annual growth rate of 1.8% compared to 1984-1986. As with yields, total production differs according to different sources. Table 7 lists total production according to FAOSTAT (2012), with a total production of 5.6 million tons in 2012. However, the study by Aviko (2012) reported 850,000 tons in 2012 and Scott et al. (2013) reported an average annual production of 483,000 tons in the period 2008-2010, with an annual growth rate of 0.8% compared to 1984-1986.

Table 7: Potato production in Kenya 2005-2012

Year	Production in tons
2005	2,640,600
2006	2,415,080
2007	2,192,280
2008	2,900,000
2009	2,299,086
2010	2,725,936
2011	2,365,263
2012	5,600,000

Source: FAOSTAT (2012)

The share of potato producers applying inputs is relatively high and ranges from 78-87.8% for fertilizer according to different studies, although very low average amounts are applied (Obare et al., 2003; Gildemacher et al., 2009). In the study by Gildemacher et al. (2009), 45% of the 251 potato producers used farm-yard manure on their last production. Seed stocks were renewed occasionally by 41% of the potato producers, on average after five or more seasons (Nyankanga et al., 2004; Gildemacher et al., 2009).

Table 8 lists the average production costs and revenues of the 251 potato producers in the two major production areas studied by Gildemacher et al. (2009) in 2005-2006, with and without opportunity costs for family labor. Compared to the other countries studied, costs of fertilizer are relatively high in Kenya. As can be seen, there are large differences across regions in costs of manure and seed potatoes, as well as the required amount of labor, labor costs and output prices. Potato production is most profitable in Meru Central, while producers in Nyandarua may even be unwilling to invest since their net return could be negative and returns on cash investments and family labor are relatively low.

Table 8: Average production costs and revenues of potato production in Kenya

	Meru Central	Nyandarua
Cash investments		
Cost fertilizer (USD/ha)	118.40	79.49
Cost fungicides (USD/ha)	33.21	16.22
Hired labor used (USD/ha)	104.34	103.32
In kind investments		
Cost manure (USD/ha)	30.67	5.86
Cost seed (USD/ha)	123.37	72.94
Family labor investments		
Family labor used (days/ha)	97.83	210.57
Family labor (opportunity cost in USD/ha)	100.38	197.04
Total cost	510.37	474.87
Revenues		
Yield (t/ha)	8.83	9.21
Price (USD/t)	80.16	45.10
Gross margin (USD/ha)	707.85	415.34
Net margin (opportunity cost in USD/ha)	197.48	-59.52
Net margin (without opportunity cost)	297.86	137.51
Return on family labor (USD/day)	4.13	0.97
Return on cash investment	1.77	1.09

Source: Gildemacher et al. (2009)

Annual producer prices according to FAOSTAT (2010b) and listed in Table 9 strongly fluctuate, but seem to decline in recent years. Producer prices per district of August 22nd, 2013 (shown in Table B.1 in Appendix B) range from USD 170-385 per ton and so are comparable to those reported by FAOSTAT. In considering trade, it can be noted there is some mutual cross-border trade in fresh potatoes with Uganda due to price differences (Walker et al., 2011).

Table 9: Annual producer prices in USD per ton

Year	Producer price in USD per ton
2005	384.00
2006	267.70
2007	269.80
2008	375.10
2009	291.70
2010	238.10

Source: FAOSTAT (2010b)

2.2.2 Marketing

In Nyandarua potatoes are grown to serve the ware potato market, while in Bomet potatoes are grown to serve the processing industry (Gildemacher et al., 2009). About 80% of potato production is sold to markets (see Table 10), while Nyankanga et al. (2004) reported an average marketed share of 68% and Scott et al. (2013) noted a range of 25-75%. Due to larger average area dedicated to potato production compared to e.g. Ethiopia and Uganda, Kenyan potato producers can sell a larger proportion of their production after satisfying the needs for home consumption and seed potatoes.

Table 10: Marketed potato yield versus home consumption

	Weight in kg per household per season	Percent
Ware sold	2,899	77
Seed sold	165	4
Total market	*3,065*	*82*
Ware home	327	9
Seed home	352	9
Total home	*679*	*18*
Total	***3,743***	***100***

Source: Gildemacher et al. (2009)

In the study by Gildemacher et al. (2009), 87% of the producers sell their potatoes at the farm gate to traders or brokers, 8% of the producers sell at village markets and 5% sell through other channels. Hence, potatoes are often directly sold from the field, without being stored by the potato producer. Traders or brokers sell potatoes to wholesalers in urban markets. It is estimated that about 348 tons of potatoes per day are sold at wholesale markets in Nairobi (Ayieko et al., 2005).

2.2.3 Processing

Potato processing is somewhat more advanced in Kenya, since there already is a processing industry for fresh French fries consisting of four processing companies and a minor one for frozen French fries called Njoro Canning (Höffler and Maingi, 2005; Gildemacher et al., 2009; Tesfaye et al., 2010; Aviko, 2012; Haverkort et al., 2013). There may be more processing companies in Kenya,

since a lot of processing is done informally and unregistered (Tesfaye et al., 2010). Tesfaye et al. (2010) reported that the four fresh French fries companies process an average of 117 tons annually, while two of them process about 183 tons annually and Njoro Canning processes about 144-216 tons annually. This company has set up a contracting scheme with potato producers to supply potatoes.

Also, some processing of potatoes is done by households and retail outlets themselves. 78% of the sampled hotels and restaurants indicated to process 29 tons per year, while the remainder gets fresh supplies on a daily basis. For households, 85% of the high income households and 13% of the low income households indicated to process potatoes, on average an amount of 0.1 ton per year (Tesfaye et al., 2010).

Frozen French fries are also imported from McCain in South Africa and sold in large supermarkets. However, the price difference is very large between domestic produced French fries and imported ones. Whereas domestically produced French fries cost USD 0.77 per kg, imported French fries cost USD 5.64 per kg, resulting in a price difference of 632%. Supermarkets also indicated that domestically processed potato products are sold more often, of which the quality is acceptable (Tesfaye et al., 2010).

2.3 Rwanda

2.3.1 Production

In 2012, potato ranked second of the commodities produced in Rwanda, after cassava (MINAGRI, 2013c). According to Haverkort et al. (2013) and the study by Aviko (2012), in Rwanda potatoes are mainly grown by small-scale family farms at less than 0.5 ha per year. However, in contrast to the other countries studied, Rwanda also has some large commercial producers who grow potatoes at plots up to 10 ha, and national potato production has increased by 70% in the last five years (Haverkort et al., 2013). Scott et al. (2013) estimated the number of producers to be equal to 1 million.

Potato production occurs in all provinces of Rwanda and is relatively concentrated, since the top three producing districts account for one-third of potato production. Those districts are the Ngororero district in Western Province, the Gicumbi district and the Musanze district in Northern Province (Diao et al., 2010). Potato producers in these districts have even set up an efficient input provision network (Haverkort et al., 2013). In most areas potatoes are grown twice a year, while sometimes three times. A third planting season delivers lower yields, but higher prices because of shortages in local markets.

Potato production has increased in northwestern regions recently with volcanic highlands in particular, which have favorable environmental conditions for potato production (Haverkort et al., 2013). Table 11 shows the area harvested over time per province for both seasons. It is clear that

the largest potato area is located in Northern and Western Provinces, although some large areas can be found in the Southern Province. Overall, the potato area is increasing in the first season, while it is decreasing in the second season. For 2012, the Rwandan Ministry of Agriculture reported an area of 165,000 ha (MINAGRI, 2013a). Scott et al. (2013) reported an average annual area of 135,000 ha in the period 2008-2010, with an annual growth rate of 5% compared to 1984-1986. This coincides with the 140,000 ha reported by Aviko in 2012.

Table 11: Area harvested in ha per district

Province	2007		2008		2009		2010
	First season	Second season	First season	Second season	First season	Second season	First season
Eastern	8,061	5,119	5,593	5,542	5,593	6,272	5,602
Kigali	287	142	182	576	182	509	504
Northern	16,336	22,246	24,337	21,057	24,337	21,877	30,224
Southern	21,693	9,695	15,911	9,383	15,630	9,218	19,446
Western	10,907	24,006	22,822	21,821	23,609	19,222	26,919
Total	57,284	69,408	68,845	58,379	69,351	57,098	82,695
Total of both seasons	126,692		127,224		126,449		

Source: Ministry of Agriculture and Animal Resources of Rwanda (2013b)

The average national yield increased from 6 tons per hectare in the 1980's to more than 11-14 tons per hectare a season nowadays. Potato producers in the Musanze district even harvest more than 20 tons per hectare (Haverkort et al., 2013). Scott et al. (2013) reported an average annual yield of 10.5 tons per hectare over the period 2008-2010, with an annual growth rate of 1.7% compared to 1984-1986. Yields are considerably increasing due to a growing use of inputs such as fertilizers, insecticides and fungicides. Total production differs according to different sources. The Rwandan Ministry of Agriculture estimated it at about 2,338,000 tons in 2012 (MINAGRI, 2013a), while Aviko estimated it at 1.3 million tons. Scott et al. (2013) reported an average annual production of 1,413,000 tons in the period 2008-2010, with an annual growth rate of 6.7% compared to 1984-1986.

Haverkort et al. (2013) investigated total production costs of potatoes in the Musanze region, which equal USD 1,811.20 per hectare or USD 90.58 per ton at a yield of 20 tons per ha. Table 12 lists total production costs per ton for different yield levels, which are competitive to production costs in northwestern Europe. Even if yields are lower than 15 tons per ha, production costs will be around USD 130 per ton with a producer price of USD 200 per ton, which is still competitive with the European price level. These relatively low production costs show the profitability of producing fresh potatoes for high-end consumption and processed products.

Table 12: Costs per ton

Variation in yields in tons/ha	15	20	25
Costs per ton in RWF[2]	75,487	56,615	45,292
Costs per ton in USD	126	95	76

Source: Haverkort et al. (2013)

Producer prices are relatively low since potatoes are supplied to the market in a relatively short time frame, i.e. in the period November-March. Consequently, producer prices will be higher during the months August-October. The annual variation in prices is about 35%, ranging from USD 0.19-0.24 per kg (Haverkort et al., 2013). Table 13 lists annual producer prices in USD per ton. In the last five years in particular, producer prices have increased steadily, while there was a drop in prices in 2004-2005. The producer prices are favorable for the competitive position of Rwanda in trading potatoes in the long run.

Table 13: Annual producer prices in USD per ton

Year	Producer prices in USD per ton
2000	94.00
2001	97.10
2002	94.50
2003	102.70
2004	86.70
2005	92.20
2006	171.00
2007	207.20
2008	206.40
2009	240.20
2010	242.90

Source: FAOSTAT (2010b)

2.3.2 Marketing

It is estimated that approximately 30-40% of potatoes produced in Rwanda are marketed, while farmers keep 20% for seed and consume the remaining part. However, farmers in the Northern Province sell a larger share of their production, since they are exclusively market-oriented. Approximately 75% of the sold potatoes are traded using local and rural marketing channels, such that potatoes are exchanged informally with relatives and neighbors but also sold to merchants or itinerant rural traders. Subsequently, potatoes are sold to wholesalers or directly to (sub)urban retailers. Alternative marketing strategies are to sell potatoes to producer cooperatives that transport and sell them to consumer cooperatives, or directly selling to supermarkets in Kigali for which potatoes are washed and packaged by the potato producers. Selling to supermarkets in Kigali

[2] Exchange rate August 2013: RWF 1 = USD 0.0016

could be twice as profitable as selling to traditional markets. From Kigali potatoes are sold to other urban areas as well to rural areas in southern parts of the country. Table 14 presents the value added throughout the supply chain when potatoes are sold from the Musanze region in Northern Province to Kigali. It is estimated that about 80% of marketed potatoes from the Musanze region are sold to Kigali (Haverkort et al., 2013).

Table 14: Added value of potato supply chain Musanze - Kigali

Marketing activity	Price level in USD per kg	Price level in RWF per kg
Production	0.22	140
Collecting	0.23	145
Wholesaling	0.27	170
Retailing	0.29	180
Consumption	0.32	200

Source: Haverkort et al. (2013)

Currently, potatoes are exported to Congo and Burundi, and some minor volumes are imported from Kenya to meet specific demands of supermarkets in Kigali. There is also some unregistered two-way cross-border trade with Uganda because of price differences (Walker et al., 2011; Haverkort et al., 2013). Following a Social Accounting Matrix (SAM) of Rwanda constructed in 2006, total exports of potatoes equaled about USD 1,028,000, which was 0.85% of total exports (Diao et al., 2010).

2.3.3 Processing

There is no processing industry present in Rwanda, although many households, restaurants and hotels process potatoes by themselves. In the study by Tesfaye et al. (2010), 100% of the sampled high income households compared to 72% of the low income households process potatoes, on average 0.7 tons per year, while an average of 6.1 tons annually is processed by retail outlets. Haverkort et al. (2013) calculated the profitability of processing 100 kg of potatoes into French fries, assuming they can be sold at an average of USD 2.40 per kg, giving a profit of USD 111.36 (see Table 15). At the time of the surveys by Tesfaye et al. (2010) and Haverkort et al. (2013), frozen French fries were not imported into Rwanda, although one hotel imported from Belgium before.

Table 15: Economic profitability of processing 100 kg of potatoes into French fries in Rwanda

Activity	Costs in USD	Costs in RWF
Purchase of potato	12.80	8,000
Labor cost	1.60	1,000
Transportation	0.32	200
Additives (e.g. cooking oil)	17.92	11,200
Total cost	*32.64*	*20,400*
Gross benefits	144.00	90,000
Net benefits	111.36	69,600

Source: Haverkort et al. (2013)

2.4 Uganda

2.4.1 Production

Potato production occurs in all provinces of Uganda and is relatively concentrated in some regions. Major potato producing regions in Uganda are Kabale and Kisoro in the southwestern part of the country, as well as Mbale and Kapchorwa in the eastern part of the country (Bonabana-Wabbi et al., 2013) and Mbarara (Okoboi, 2001). It is estimated that in Kabale 50-60% of the annual production is produced. Due to the introduction of new varieties, potatoes are produced in several more regions. In most areas potatoes are grown twice a year during a long and a short rainy season, while sometimes also during a third production season after the short rainy season. The short rainy season takes place in the months February to mid-May, while the long rainy season occurs during mid-August to mid-December.

Scott et al. (2013) estimated the number of potato producers at 800,000. Most producers grow potatoes in both rainy seasons, on an average of 24-32% of their arable land per season. During the short rainy season of 2005, about 24% of arable land was allocated to potatoes in Kisoro and Kabale (see Table 16) (Gildemacher et al., 2009). This coincides with the studies by Aviko (2012), Gildemacher et al. (2009) and Benin et al. (2012) who reported small farm sizes of 1-2 ha for non-export producing farms.

Table 16: Average area and share of farms involved in potato production per season

District/season	Farms growing potatoes (%)	Potato fields (ha/farm)	Fraction potatoes (% of farm)
Kabale (n=169)			
Season 1	91	0.27	25
Season 2	72	0.28	26
Off-season	28	-	-
Kisoro (n=61)			
Season 1	80	0.23	28
Season 2	92	0.25	32
Off-season	8	-	-

Note: Season 1 April – July, season 2 October – January, off-season July - October
Source: Gildemacher et al. (2009)

For 2012, Aviko reported an area of 97,000 ha. Scott et al. (2013) reported an average annual area of 100,000 ha in the period 2008-2010, with an annual growth rate of 6.9% compared to 1984-1986. However, the Ugandan Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) only reported an area of 32,760 ha in 2008. Benin et al. (2012) further reported a total share of potato area of 1.2% in 2004 and estimated it to be equal to 1.3% in 2015. However, according to Gildemacher et al. (2009), the potato area is expected to increase by 7% over time.

Gildemacher et al. (2009) reported a yield of 5.8 tons per ha, although 8.4 tons per ha were achieved in the mid-1990's (Benin et al., 2012). Benin et al. (2012) reported yields of 6.9 tons per

hectare in 2005 with an annual baseline growth rate in the period 2005-2015 of 0.6%, and Scott et al. (2013) reported an average annual yield of 6.8 tons per hectare over the period 2008-2010 with an annual growth rate of 0.2% compared to 1984-1986. Current yields per hectare are low due to low quality of local potatoes since producers use their stock for seed purposes for the last 20 years (Kaganzi et al., 2008). According to a simulation study by Benin et al. (2012), yields could increase to 7.4 tons per hectare in 2015 in their baseline scenario and to about 10 tons per hectare in 2015 when the government invests in agriculture following CAADP[3], with an annual growth rate in the period 2005-2015 of 3.7%. Field trials even show that future yields could be 12.5 tons per ha. However, researchers do not expect Uganda will reach those high yields as well as adopt advanced technologies.

Total production is reasonably identically reported across different studies. The study by Aviko (2012) reported a total production of 670,000 tons in 2012. Benin et al. (2012) reported a total production of 554,000 tons in 2005 and Scott et al. (2013) reported an average annual production of 685,000 tons in the period 2008-2010, with an average annual growth rate of 7.1% compared to 1984-1986. Finally, Bonabana-Wabbi et al. (2013) reported a total production of 695,000 tons in 2010. According to the simulation study by Benin et al. (2012), production could be as high as 973,000 tons in 2015, with an annual baseline growth rate in the period 2005-2015 of 3.2%.

The share of potato producers applying inputs is low since both fungicides and fertilizers are hardly available outside major town centers. In the study by Gildemacher et al. (2009), 17.7% of the potato producers used farm-yard manure on their last production, while only 4.7% of the potato producers used fertilizer. Seed stocks were renewed occasionally by 26% of the potato producers, on average after seven seasons.

According to a Farmer Field School (FFS) study by the International Food Policy Research Institute (IFPRI) (Davis, 2012), in Eastern Province a mono-cropping system of 0.2 ha delivered 350 kg of potatoes after participation in the field school. The producer price was USD 0.20 and total production costs excluding fertilizer were USD 58.50 after participation in the FFS. Table 17 lists the average production costs and revenues of 144 potato producers in the two major production areas studied by Gildemacher et al. (2009) in 2005-2006. There are large differences across regions in the costs of fertilizers and seed potatoes. Potato production is most profitable in Kisoro, which also has the highest returns on family labor.

[3] Comprehensive Africa Agriculture Development Program (CAADP) is an African initiative to stimulate agriculture and accelerate agriculture-led growth and poverty reduction by allocating at least 10% of public resources to the agricultural sector and achieving a 6% annual growth rate for agriculture (Diao et al., 2012).

Table 17: Average production costs and revenues of potato production in Uganda

	Kabale	Kisoro
Cash investments		
Cost fertilizer (USD/ha)	1.81	7.27
Cost fungicides (USD/ha)	25.31	26.34
Hired labor used (USD/ha)	45.61	50.82
In kind investments		
Cost manure (USD/ha)	0.83	1.68
Cost seed (USD/ha)	96.56	72.37
Family labor investments		
Family labor used (days/ha)	227.81	211.59
Family labor (opportunity cost in USD/ha)	107.87	85.63
Total cost	277.99	455.70
Revenues		
Yield (t/ha)	5.25	6.83
Price (USD/t)	88.09	72.06
Gross margin (USD/ha)	462.45	492.14
Net margin (opportunity cost in USD/ha)	184.85	248.04
Net margin (without opportunity cost)	292.33	333.67
Return on family labor (USD/day)	2.08	2.99
Return on cash investment	5.36	4.83

Source: Gildemacher et al. (2009)

2.4.2 Marketing

According to Kaganzi et al. (2008), in Kabale potatoes are grown to serve the ware potato market and as such are of strategic importance in this region. It is estimated that approximately 70% of the production is sold to markets (see Table 18), from which about 25% is sold at village markets, 68% is sold directly from the field to traders and about 8% through other channels (Gildemacher et al., 2009). Alternative marketing channels are wholesale markets and small shops in Kampala (Kaganzi et al., 2008). Traders sell potatoes to higher value outlets such as the Uchumi and Shoprite supermarkets, restaurants and fast-food chains (Bonabana-Wabbi et al., 2013).

Table 18: Marketed potato yield versus home consumption

	Weight in kg per household per season	Percent
Ware sold	753	61
Seed sold	112	9
Total market	*865*	*71*
Ware home	191	16
Seed home	170	14
Total home	*361*	*29*
Total	***1,226***	***100***

Source: Gildemacher et al. (2009)

Prices at local village markets are low, since potatoes are often harvested and sold all at once and all grades and maturities are mixed. Brokers and traders have such a position to negotiate low prices

with potato producers and take a great part of the added value. About half of the traders surveyed by Bonabana-Wabbi et al. (2013) indicated to use a profit strategy or a so-called 'cost-plus' strategy. Moreover, potatoes are traded much more before being sold to the end consumer (Kaganzi et al., 2008). Consequently, there is a relatively strong interaction between different actors in the potato value chain. In general, potato producers source information on prices and marketing mainly from neighboring producers and their own experience. The private sector, including potato traders and agro-input suppliers, do not play an important role in the potato information system (Gildemacher et al., 2009).

The producers of the farmers group studied by Kaganzi et al. (2008) mainly deliver potatoes to a multinational fast-food restaurant in Kampala, Nandos, which demands about 10 tons per month. This pays USD 0.13 per kg after delivery, compared to an average price of about USD 0.10 per kg at the market in Kampala and an average price of about USD 0.08 at the local Kabale market. One bag of 100 kg gives a profit of USD 3.65. Consequently, delivering 50 bags of 100 kg per month gives a profit of USD 182.36 per month (see Table C.1 in Appendix C). In this way, these small-scale producers have established a long-term high value business relationship with Nandos and have changed to a new marketing strategy to deliver bulked and graded potatoes, although this production level is at their upper limit.

Due to price differences and very short-term shortages, there is some mutual cross-border trade in fresh potatoes with Kenya and Rwanda (Walker et al., 2011; Bonabana-Wabbi et al., 2013).

2.4.3 Processing

In Uganda, there is one processing company called Kitty Enterprise, which processes and supplies to supermarkets about 2 tons of French fries per year (Tesfaye et al., 2010; Haverkort et al., 2013). Also, some processing is done by households and retail outlets themselves. In the study by Tesfaye et al. (2010), 80% of the sampled hotels, restaurants and supermarkets indicated to process potatoes on their own, compared to 68% of the high income households and 57% of the low income households. Retail outlets process on average 19.3 tons annually, compared to 0.07 tons by households.

Frozen French fries are also imported from South Africa and sold in large supermarkets. However, as in the other countries studied, the price difference between domestically produced French fries and imported French fries is very large. Whereas domestic produced French fries cost USD 0.84 per kg, imported French fries cost USD 3.37 per kg, resulting in an price difference of 301% (Tesfaye et al., 2010).

2.5 Synthesis for East Africa

In East African countries potato is mainly grown in the highlands, where it is combined with the production of other crops on farms sized less than two hectares, making it a crucial crop in the food

security of highland communities in particular seasons (Thomas and Sansonetti, 2009). Potato production in East Africa is used to prevent hunger in lean seasons between harvests of other local staples. Besides that, potatoes are an important source of cash for small farmers, with which they pay household necessities and generate liquidity for (unexpected) farm operations (Scott, 2002; Gildemacher et al., 2009). Another advantage of potato production is the relatively short growing season, in which most potato production occurs under rainy conditions (Gildemacher et al., 2009).

Scott et al. (2013) reported the differences in production patterns in East and Central[4] Africa. While countries like Ethiopia and Rwanda have seen a strong growth in potato production over the period 1961-2010, a country as Kenya has had a decrease in output in that same period. In general, potato production in East Africa has mainly increased by area expansion, while increase in productivity per unit area was limited. However, in the last decade in particular, growth rates for output, area and yield decreased strongly and contrast with long-term upward trends before.

Total potato area was equal to 621,000 ha per year for East and Central Africa in the period 2008-2010, and grew at an annual rate of 4.7% during 1988-2005. However, the growth rates for Rwanda and Uganda were higher than 5% (Walker et al., 2011; Scott et al., 2013). Further increases in potato production driven by area expansion will become increasingly difficult since that will harm the remaining highland forests and increases the risk of erosion. Especially in Kenya and Uganda there is limited land left for agriculture. As such, it is expected that the area allocated to potato production will remain constant in Uganda (Benin et al., 2012). Also, increasing the share of potatoes within the current rotation is not sustainable due to increasing occurrence of diseases (Gildemacher et al., 2009).

Total production was equal to 4.3 million tons for East Africa during the period 2008-2010, and is on average the highest in Rwanda. Average annual growth rates were 4.6% in the period 1961-2010 while they declined steadily, as with total production itself, over the last twenty years in major producing countries in East Africa. Yields ranged from 3.4 tons per ha in Kenya to 14 tons in Rwanda, with an average of 7.7 tons per ha for East and Central Africa during the period 2008-2010 (Scott et al., 2013). Average annual growth rates were 1.1% in 2008-2010 compared to 1984-1986, and 0.3% for Sub-Saharan Africa in general (Walker et al., 2011). Consequently, future increases in potato production should be in productivity (Diao et al., 2010). Yields have the potential to increase since twice as high yields were surveyed by Gildemacher et al. (2009). According to Scott et al. (2013), Ethiopia in particular has the greatest potential to enlarge its potato production, of all Sub-Saharan Africa.

Potato production patterns for all studied countries seem to be different and irregular across sources and so should be handled carefully. Growth rates for yields and production were volatile during the last half century and some argue figures of yields and production are underestimated since a lot of potato production occurs at small plots and is unregistered, as is the case for Ethiopia. Similarly, the role of a country like Rwanda could be overestimated in total potato production in East Africa (Scott et al., 2013). Area expansion has caused potato production to shift to less

[4] Scott et al. (2013) classify Rwanda as Central Africa

appropriate production zones, which clearly affects yield levels (Emana and Nigussie, 2011) and other seasons where potato producers can have higher prices. Concluding, the exact rate of growth in potato production in East Africa is relatively unclear but is and expected to continue to be larger than growth rates for other major food crops in Sub-Saharan Africa (Diao et al., 2012; Scott et al., 2013).

Total production costs range from USD 244 in Uganda to USD 1,811 in Rwanda. Net margins are comparable for Kenya and Uganda but are the highest in Ethiopia. Returns on family labor and cash investments are all nearly larger than 100%, except for the return on family labor in the Nyandarua region in Kenya. Production costs in East Africa are low compared to other countries, especially due to low labor costs and limited use of inputs. This shows potato production is profitable for (small-scale) producers in East Africa, contributes to employment and incomes (Gildemacher et al., 2009), and gives a competitive position to East Africa. Producer prices range from USD 0.08 per kg in Ethiopia to USD 0.30 in Kenya and Rwanda. A relatively large share is marketed in Kenya, compared to the other countries studied.

While potato production in East Africa is increasing, producers still have to deal with post-harvest constraints in marketing their products. Examples of those constraints are high transaction costs since information is limited, physical losses due to spoilage and lack of cooling facilities, price instability between markets, between seasons and between years, and underdeveloped storage capacities since potatoes are produced and processed on demand (Tesfaye et al., 2010). Furthermore, a lack of reasonable infrastructure in remote areas causes high transport costs, also since potatoes are produced at distance of (urban) markets. Transport costs are particularly high at the start and end of the rainy seasons, which coincide with the harvesting season of potatoes and so makes it difficult to transport surplus production. Consequently, the difference between producer prices and consumer prices is relatively large, and potato producers sometimes only get 10-20% of the market value of potatoes (Diao and Hazell, 2004). This low percentage is also caused by strong negotiation positions of traders, who often have information advantages but are an important link between rural producers and urban wholesalers (Bonabana-Wabbi et al., 2013). Other major constraints for potato producers in Ethiopia and Uganda in particular are the unavailability of high quality seed and the poor management of diseases like late blight (Gildemacher et al., 2009). Obviously, the constraints faced by potato producers in East Africa are interdependent and could only be solved when investments are made in seed potato quality management, disease management and information exchange as well as soil fertility management, irrigation and crop protection. Then potato production will be more profitable (Gildemacher et al., 2009; Haverkort et al., 2013).

Historically few potatoes have been imported or exported in East Africa due to their relatively non-tradability, but they are growing more and more in the interest of national governments and policy makers as a potential exporting material and as a source of hard currency (Scott, 2002).

Emerging markets include fresh potatoes and processed potato products such as French fries and chips, although potato processing is still on a small scale in the tropical highlands of East Africa. Currently, processing occurs merely within wealthy urban households and retail outlets, although

some processing companies exist in Kenya and Uganda to supply fast-food restaurant chains. However, they do not offer reasonable quantities at good prices. To fulfill customers' demand, it is expected that retail outlets in particular will increase processing on their own. Although all the studied countries, except Rwanda where the share of (urban) households processing potatoes is higher, import limited quantities of frozen French fries, retail outlets prefer to process local fresh potatoes whose taste is also preferred by consumers (Tesfaye et al., 2010).

Profitability analyses show that processing potatoes has potential and is a profitable investment in all studied countries, though it gives a better return in Rwanda and Kenya. According to Haverkort et al. (2013), an investor is planning to open a factory in Ethiopia in 2014 and in Rwanda the government is planning to do so in 2015. Potato processing companies would induce a supply chain of graded, washed, packed and branded ware potatoes for supermarkets, and as such creating added value and employment opportunities for the potato sector. Also, post-harvest handling, processing and trade of potatoes in East Africa would be more advanced (Haverkort et al., 2013). Table 19 shows the potential of French fries production for each country separately according to Tesfaye et al. (2010).

Table 19: Estimates of potential French fries production by 2015 in tons

Country	Potential French fries production by 2015
Ethiopia	45,210
Kenya	76,319
Rwanda	64,083
Uganda	52,086
Total	*237,698*

Source: Tesfaye et al. (2010)

There are some major constraints in processing and marketing of French fries in East Africa as well. In short, there are some concerns about a year-round available and sustainable supply of potatoes with the required quality attributes such as high dry matter content and medium to large oval size. Potatoes produced in East Africa do not yet fulfill these requirements and are often of bad quality, which results in losses of about 20% on average. Furthermore, in all countries there is a substantial lack of knowledge about processing, packaging, frying, storage, additives and preservatives. Some actors in the potato value chain even indicated that due to above listed problems they decided not to advance French fries processing in their countries and remain or increase, although on a small scale, importing processed potato products (Tesfaye et al., 2010).

Current trade in processed potato products consists of some cross-border trade between countries and high-value imports from Europe and South Africa. However, price differences between domestic processed products and imported processed products are relatively large due to high transaction costs, which give opportunities to further develop domestic processing industries and establish regional, i.e. between-country, trade in processed potato products. Prices and transaction costs are relatively low and tariff reduction and removal of non-tariff barriers are applied in East Africa, which further show the potential of regional trade in processed potato products within East

Africa over time. Since potato processing is already more advanced in Kenya, there are some chances for this industry to penetrate the markets in Ethiopia, Rwanda and Uganda, and even beyond, when processing practices are improved and upscaled (Tesfaye et al., 2010; Haverkort et al., 2013).

3. Consumption of potatoes

This chapter describes consumption patterns of potatoes in the four study countries. After that, some general conclusions about consumption patterns in East Africa are drawn.

3.1 Ethiopia

For most regions, potatoes and other root crops provide food security during lean months when producers are waiting for the next harvest or when e.g. cereal harvests fail and so, most producers partly depend on the production of potatoes for their daily food intake. Consumption of potatoes is often year-round but still differs per region, depending on when potatoes can be harvested and if potatoes are produced in that region. In the rural household survey by Hoddinott and Yohannes (2011), potatoes are consumed three times a week by about 3-29% of the households in Amhara, by about 22-91% of the households in Oromiya, by about 11-70% in SNNPR and by about 4% in Tigray. In Amhara, about 1.5 kg of potatoes per week is directly consumed from harvest while about 1.4 kg is purchased additionally. In Oromiya, these quantities are 4 kg and 2.5 kg per week, respectively, while in SNNPR about 1.6 kg is purchased per week and in Tigray about 1.2 kg. Table 20 lists average consumer prices in USD and ETB per kg in 2009 for several districts according to Hoddinott and Yohannes (2011). These prices coincide with the average retail price of USD 0.18 per kg reported by Haverkort et al. (2013). Consumption rates of potatoes are the highest in Oromiya and consumer prices of potatoes are the lowest in that region. Moreover, Haverkort et al. (2012) found a price of USD 0.48 per kg for washed and packed potatoes in a luxurious supermarket in Addis Ababa.

Table 20: Consumer price per region in 2009

Region	Average consumer price per kg		Lowest consumer price per kg		Highest consumer price per kg	
	USD	ETB	USD	ETB	USD	ETB
Amhara	0.21	4.17	0.19	3.75	0.25	5.00
Oromiya	0.18	3.50	0.15	3.00	0.20	4.00
SNNPR	0.15	3.00	0.10	2.00	0.18	3.50
Tigray	0.20	4.00	0.20	4.00	0.20	4.00

Source: Hoddinott and Yohannes (2011)

According to Haverkort et al. (2013), average annual consumption of potatoes per capita in Ethiopia equals 17 kg per year while Scott et al. (2013) reported an average annual per capita consumption of about 6 kg per year in 2009, which both are far less than the amounts reported by Hoddinott and Yohannes[5]. In lower market segments, i.e. households, the lion's share of potatoes is traditionally consumed as boiled or mixed in sauces with spices (Tesfaye et al., 2010). In considering processed potato products, according to Tesfaye et al. (2010) 72% of the sampled

[5] Following those consumption rates, annual consumption would be 195 kg per capita.

hotels in Addis Ababa and Nazret in Oromiya buy potatoes from wholesale markets, while the remainder gets potatoes directly supplied to their businesses, sometimes at a daily basis. In 64% of the retail outlets potatoes are sold as French fries, while in the other retail outlets potatoes are also sold in boiled, mashed or other forms. Furthermore, in 88% of the surveyed retail outlets the consumption of French fries is steadily increasing.

3.2 Kenya

Potatoes are broadly consumed in Kenya, in particular in areas where potatoes are produced. In Nairobi, 77% of the households purchase potatoes at an average of 22.7 kg per month, on which on average USD 2.06 per month is spent. It is estimated that households spend more than 25% of fresh vegetables on potatoes annually across all income groups and 2.8% of their total food budget on potatoes (Ayieko et al., 2005). Furthermore, Tesfaye et al. (2010) estimated the consumption growth rate of potatoes in Nairobi at 17% per year. Scott et al. (2013) reported an average annual per capita consumption of about 7 kg per year in 2009, although there was a strong decline in consumption in recent years.

Potato prices per kg were USD 0.09 at open air markets, USD 0.11 at roadside kiosks and street vendors, and USD 0.22 in large supermarkets in the study by Ayieko et al. (2005). This coincides with the study by Janssens et al. (2013), who note that potato prices per kg varied from USD 0.14 at wholesale markets to USD 0.24 in retail outlets.

According to Abong et al. (2010), the most important products for the Kenyan processing industry are chips, and fresh and frozen French fries. According to Tesfaye et al. (2010), most potato processors in Mombasa in Coast Province buy potatoes from nearest markets. In all the surveyed retail outlets, French fries were preferred to other potato products to serve to customers. Furthermore, in 36% of the retail outlets consumption of French fries is steadily increasing, while in 44% consumption is variable but slightly increasing and in 20% demand for French fries is rather stable (Tesfaye et al., 2010). This coincides with the study by Abong et al. (2010), who state that the number of fast-food restaurants in major towns in Kenya is increasing.

3.3 Rwanda

Potatoes are a staple crop for Rwanda and contribute with other root crops most to the daily food intake of Rwandan households and therefore play an important role in food security issues (Diao et al., 2010). According to Haverkort et al. (2013), the average annual consumption by urban Rwandans ranges from 125-140 kg per capita, causing potatoes the second most important source of calories after cassava. Scott et al. (2013) reported an average annual per capita consumption of 110 kg in 2009, which is somewhat lower than the urban average.

It is estimated that households spent in total USD 182.83 on potatoes in 2006 (Walker et al., 2011). Diao et al. (2010) noted that an average rural household spends about 68% of income on food,

whereas an average urban household spends 43% on food and the poorest rural quintile spends 86% on food. They estimated a marginal budget share (MBS), defined as 'the allocation of incremental income spent on a consumption good' (Diao et al., 2010), of potatoes at about 3.6% for rural households and 2.8% for urban households. The national average MBS was estimated at 3.5%. The MBS for food in general was estimated at about 56.7%, for root crops and bananas combined at about 40% for rural households and for high-value food products (processed products included) at about 21%. As such, they argue that at increased incomes Rwandan households will spend more on staple products like potatoes than as they will spend on high-value products.

In considering processed potato products, according to Tesfaye et al. (2010) high star hotels in Kigali get potatoes directly supplied by a few potato producers who select good quality. In all the surveyed retail outlets, French fries were preferred to other potato products to serve to customers. Furthermore, in 45% of the retail outlets consumption of French fries is steadily increasing, while in 55% of the retail outlets consumption is variable but slightly increasing.

3.4 Uganda

Scott et al. (2013) reported an average annual per capita consumption of 14 kg in 2009. Household expenditures on potatoes were the highest in southwestern production zones and urban areas in recent years, emphasizing the role of potatoes as food security crop in production zones and as high-value product in urban areas (Ferris et al., 2001).

Most households in the study by Tesfaye et al. (2010) indicated to eat mainly boiled potatoes, while French fries and fried potatoes were also preferred. Also, 70% of the households preferred French fries to other potato products due to children. In hotels, restaurants and other retail outlets, potatoes are mainly consumed as French fries or boiled, and served as either main dish or side dish. High income class consumers in Kampala indicated to buy potatoes in supermarkets, while low income class consumers indicated to buy small quantities of potatoes at retail markets. Supermarkets offer a better quality but also higher prices, which shows that high income class consumers are willing to pay more for a better quality of (processed) potatoes, although consumption of French fries is increasing at all socio-economic levels. Furthermore, in 65% of the surveyed retail outlets French fries were preferred to other potato products to serve to customers.

3.5 Synthesis for East Africa

Scott et al. (2000) estimated consumption of potatoes in Sub-Saharan Africa equal to 1.9 million tons in 1996 and per capita consumption equal to 4 kg, while Keijbets (2008) estimated per capita consumption for Africa in general at 14.1 kg in 2005. It is expected that potato consumption will increase in coming years due to higher incomes and urbanization. As such, the relative importance of potatoes in urban diets is increasing (Scott et al., 2013).

Since about 85% of a single potato can be used as food, potatoes are important in providing micronutrients such as vitamins, minerals, carbohydrates, proteins, nutritional fibers and antioxidants. One potato contains 50% of the daily recommended intake of vitamin C (Keijbets, 2008; Thomas and Sansonetti, 2009). According to Scott et al. (2000), roots and tubers in general provided about 20% of calories and 8% of proteins of a daily intake in Sub-Saharan Africa in 1996. Therefore, potatoes play a major role in health issues in East Africa.

Consumption of potatoes in households in East Africa is related to income, age and family size. Traditional low income households mainly consume boiled potatoes in their cultural dishes, while larger households with children, in particular in higher income classes living in urban areas, demand more popular and western potato products such as French fries, chips and salads (Tesfaye et al., 2010). Also, the food preferences of older people tend to be more static over time, while younger people are more influenced by advertising campaigns of popular food (Pingali and Khwaja, 2004).

Inferring from the consumption patterns of the countries studied, consumption of potatoes in Ethiopia can be characterized as traditional and occurring between harvests of other crops, while potatoes are clearly a staple food crop in Rwanda. Consumption of potatoes in Kenya and Uganda is more modern and focuses slightly more on consuming processed products. However, in all studied countries there is potential for higher consumption rates in the near future.

Processed and fresh potatoes are increasingly consumed in hotels, restaurants and other retail outlets and are an important part of the meals served. French fries are preferred over other potato products in retail outlets. Yet many retailers indicated quality of potatoes is less than expected, although the quantity of potatoes consumed by restaurants grew by 16.7% in the period 1997-2004 due to increases in incomes and urbanization (Tesfaye et al., 2010). This trend, combined with the increasing launches of bars, hotels, restaurants, supermarkets and franchised fast-food restaurants clearly indicates a growth in demand for potatoes in East Africa, with processed potato products and French fries in particular. This was also indicated by the lion's share of the surveyed retail outlets by Tesfaye et al. (2010).

Demand for potatoes is particularly increasing because of high urbanization rates and the resulting growth in economic sectors in urban areas. It is estimated that 60% of populations in Africa are living in urban areas by 2025, which corresponds to an average annual growth rate of the urban population of about 5%. However, for East Africa the growth rate of the urban population is about 13%. Moreover, 70% of this urban population will be younger than 30 years and so create an additional demand for processed products such as French fries due to their different lifestyles. Young people favor French fries because of its affordability and popular image compared to other food products. Tourism also plays a role in the increasing demand for potato products. While the global tourism industry increased by 5.5% in 2004, in Africa it increased by 10% in that period. Kenya in particular is a growing popular tourist destination. Retail outlets adapt their menus to the preferences of visitors and as such, contain French fries (Tesfaye et al., 2010).

Both urbanization and the growth in tourism are closely related to economic growth and increasing incomes of Africa's urban populations. As such, value added and convenience products become increasingly preferred by consumers and urban markets will become larger and more important (Keijbets, 2008; Tesfaye et al., 2010). According to Pingali and Khwaja (2004), economic growth will lead to changes in diets in two stages. In the first stage consumers change to superior food products in western diets while still consuming traditional food products, whereas in the second stage consumption of more western-style products as highly processed convenience food products readily available in supermarkets and fast-food restaurants will strongly increase. This globalization of diets will be largely irreversible and so have large consequences for the growth in demand for processed potato products. Furthermore, economic growth will cause a higher participation of women in the labor force, which also increases the demand for processed and convenience food products. However, it should be noted that consumption patterns in urban slums will change less since supermarkets and fast-food restaurants target higher income classes.

According to Scott (2002), total per capita consumption of fresh potatoes will decline when incomes increase, but will be compensated by the increased demand for processed products. However, Horton (1987) argues this not to be necessarily true as this mainly depends on the relative price of potato and the level of income. According to Diao et al. (2010), substitution effects will occur between different staple crops when incomes increase.

4. Modeling potato demand

In this chapter simulations are conducted to analyze future potato demand for the four countries separately. The final paragraph aggregates the results for East Africa.

Future consumption of potatoes in East Africa is simulated using a potato demand equation (see Equation 1). As there is limited data about the share of processed potatoes compared to the total amount of potatoes consumed, this future consumption is only about fresh potatoes.

$$\ln C_t = \alpha_0 + \alpha_1 \ln pop_t + \alpha_2 \ln inc_t + \alpha_3 \ln p_t + \alpha_4 \ln pmaize_t \quad (1)$$

Consumption of potatoes in tons (C_t) is assumed to be a function of population in million persons (pop_t), income or GDP in USD (inc_t), price of potatoes in USD per kg (p_t) and the price of maize in USD per kg ($pmaize_t$). The price of maize is included to capture substitution effects since maize is an important staple food crop in East Africa and potatoes are often consumed between the harvests of maize. All variables are transformed into natural logarithms such that the coefficients of $\ln pop_t$, $\ln inc_t$, $\ln p_t$ and $\ln pmaize_t$ represent the population elasticity, the income elasticity of demand, the own price elasticity of demand and the compensated cross-price elasticity of demand, respectively. The elasticities reflect the percentage change in total consumption of potatoes per country when population, income, the price of potatoes or the price of maize increases by 1%, with other things remaining equal. Tafere et al. (2010) estimated the cross-price elasticity of root crops in general with maize at 0.021 for Ethiopia, but it is assumed this cross-price elasticity holds for the other countries as well due to lack of data about cross-price elasticities. In doing so, it is assumed the substitution rate of potatoes and maize is equal across the study countries. This may be different in reality since e.g. Rwanda is more potato-oriented than other countries. Consequently, it is assumed total consumption of potatoes will rise by 0.021% if the price of maize increases by 1% in all countries. The population elasticity is also assumed equal across all countries. The intercept of the demand function is calibrated for all countries separately for the base year 2009. Next, the demand function is used to simulate potato demand for the years 2015 and 2020, for the four countries separately and for different scenarios. A caveat of this simulation analysis is the use of general income or price elasticities instead of potato-specific elasticities. This obviously affects the accuracy of the estimated quantities.

The base scenario estimates total consumption of potatoes when population and incomes grow at a specific rate, varying per country. In Diao et al. (2012) it is estimated that potato prices will have increased by 5% in 2015 in Rwanda when agriculture is stimulated under CAADP[6], compared to the base year 2006. Similarly, for Uganda it is estimated that potato prices will have declined by 15% in 2015 under that program, compared to the base year 2005. In simulating future consumption of potatoes in East Africa, alternative scenarios, so-called low and high demand scenarios, are

[6] To recall, CAADP stands for Comprehensive Africa Agriculture Development Program and is an African initiative to stimulate agriculture and accelerate agriculture-led growth and poverty reduction by allocating at least 10% of public resources to the agricultural sector and achieving a 6% annual growth rate for agriculture (Diao et al., 2012).

assessed in which these changes in potato prices are taken into account for all countries, resulting in applying an annual growth rate of 0.56% and −1.5%, respectively. A fourth scenario is calculated in which prices of maize will have declined by 4% in 2015 under CAADP, compared to the base year 2006 (Diao et al., 2012), resulting in applying an annual growth rate of −0.45%. It turns out that in all countries total potato consumption hardly changes when maize prices decline. Both potatoes and maize are staple food crops for East Africa, but because they are harvested at different times of the year and the cross-price elasticity is very small, changes in maize prices hardly affect potato consumption.

4.1 Ethiopia

For Ethiopia, Muhammad et al. (2011) estimated the income elasticity of demand for a rest category of food products at 0.622 and the own price elasticity at −1.669. Furthermore, population equaled 82.8 million in 2009 (Scott et al., 2013), the average consumer price of potatoes equaled USD 0.18 in 2009 (Hoddinott and Yohannes, 2011), average per capita consumption of potatoes equaled 17 kg in 2009 (Haverkort et al., 2013) and the average national price of maize equaled USD 0.18 per kg in 2009 (WFP, 2010). As such, the potato demand equation for Ethiopia is calibrated as:

$$\ln C_t = 3.12 + 0.01 \ln pop_t + 0.622 \ln inc_t - 1.699 \ln p_t + 0.021 \ln pmaize_t \qquad (2)$$

As is clear from the above equation, total consumption of potatoes in Ethiopia increases by about 0.62% and decreases by about 1.7% when income and the price of potatoes increase by 1%, respectively. To capture all effects at once, the demand equation for Ethiopia is simulated for upcoming years, whereby it is assumed that annual population growth equals 2.5% and annual GDP growth equals 7.3% (World Bank, 2012). Table 21 presents total demand for potatoes in tons according to different scenarios for the years 2015 and 2020.

Table 21: Simulated demand scenarios for Ethiopia, in tons

Year	Base scenario	5% price increase	15% price decline	4% maize price decline
2015	1,744,000	1,650,000	2,028,000	1,743,000
2020	2,173,000	1,965,000	2,868,000	2,171,000

The simulation predicts a total growth of 23% in aggregate consumption of potatoes for Ethiopia in the base scenario, compared to a level of about 1,408,000 tons in the base year 2009, which means an average annual growth rate of about 4.5%. This annual growth rates coincides reasonably with the annual growth rate estimated by Scott et al. (2000) for Sub-Saharan Africa in general, i.e. 3.1%. When prices have increased by 5% by 2015, total consumption of potatoes will be slightly lower than in the base scenario, involving a per capita consumption of about 18 kg in 2015. Per capita consumption will be about 19 kg in 2020 in this scenario, showing Ethiopians will remain consuming potatoes in coming years even if prices increase, which indicates that potatoes are substantial in Ethiopian diets.

4.2 Kenya

For Kenya, the income elasticity of demand for a rest category of food products and the own price elasticity are 0.559 and −1.069, respectively (Muhammad et al., 2011). This income elasticity coincides with the elasticity found by Ayieko et al. (2005), i.e. 0.53. Furthermore, population was equal to 39.8 million in 2009 (Scott et al., 2013), the average consumer price of potatoes was USD 0.17 (Ayieko et al., 2005), average per capita consumption of potatoes was 7 kg in 2009 (Scott et al., 2013) and the average national price of maize was USD 0.34 per kg (USAID, 2010a). As such, the potato demand equation for Kenya is:

$$\ln C_t = 3.87 + 0.01 \ln pop_t + 0.559 \ln inc_t - 1.069 \ln p_t + 0.021 \ln pmaize_t \qquad (3)$$

Total consumption of potatoes in Kenya increases by about 0.56% or declines by about 1.07% when income and the price of potatoes increase by 1%, respectively. In combining all effects to simulate for upcoming years, it is assumed that annual population growth equals 2.7% and annual GDP growth equals 4.4% (Thurlow et al., 2012; World Bank, 2012). Total demand for potatoes in tons according to different scenarios is presented in Table 22.

Table 22: Simulated demand scenarios for Kenya, in tons

Year	Base scenario	5% price increase	15% price decline	4% maize price decline
2015	324,000	313,000	357,000	324,000
2020	366,000	343,000	437,000	365,000

The base year presumes an aggregate consumption of potatoes of about 278,600 tons. Consequently, the base scenario involves a total growth in consumption of about 2.7% per year to 324,000 tons in 2015 and 366,000 tons in 2020. The alternative scenarios involve a consumption growth rate of about 2.1% and 5%, respectively. These growth rates are lower than the one estimated by Scott et al. (2000) for Sub-Saharan Africa, except the high demand growth rate. Per capita consumption will stay equal at 7 kg per year for both years in the base scenario, will be about 6.5 kg in the low demand scenario and will be about 8.0-8.3 kg in the high demand scenario. The increase in consumption due to population growth, income growth and a price decline is less than in Ethiopia, which indicates potatoes are less important in diets for Kenyans than they are for Ethiopians.

4.3 Rwanda

An income elasticity of 0.591 and an own price elasticity of −1.209 are used for Rwanda (Muhammad et al., 2011). Other used values are a population of 10 million for the base year, an average per capita consumption of potatoes of 110 kg (Scott et al., 2013), an average consumer price of potatoes of USD 0.22 per kg and an average price of maize of USD 0.37 per kg (NISR, 2010). Consequently, the potato demand equation for Rwanda is calibrated as:

$$\ln C_t = 5.61 + 0.01 \ln pop_t + 0.591 \ln inc_t - 1.209 \ln p_t + 0.021 \ln pmaize_t \quad (4)$$

A 1% growth in incomes and potato prices causes total consumption of potatoes in Rwanda to increase by about 0.59% or decrease by about 1.21%, respectively. To further simulate total consumption, it is assumed population will grow at 3% annually and GDP will grow at 8.3% annually (World Bank, 2012). Table 23 presents the results of this simulation for the different scenarios.

Table 23: Simulated demand scenarios for Rwanda, in tons

Year	Base scenario	5% price increase	15% price decline	4% maize price decline
2015	1,492,000	1,434,000	1,665,000	1,491,000
2020	1,892,000	1,759,000	2,313,000	1,890,000

Total consumption of potatoes is equal to 1,100,000 tons in the base year 2009. In the base scenario, consumption in Rwanda will rise to about 1,492,000 tons in 2015 and 1,892,000 tons in 2020 at an average rate of about 6.0-6.5%. Obviously, growth rates are lower in the higher price scenario, i.e. about 5.0-5.5%, and higher in the lower price scenario, i.e. ranging from 8.5-10.0%. In the base scenario per capita consumption will be about 121 kg in 2015 and about 132.5 kg in 2020. The second scenario predicts about 116.5 and 123 kg and the last scenario predicts 135 and 162 kg for 2015 and 2020, respectively. These simulated quantities are fairly higher than a consumption of 90 kg per capita in 2020 expected by Haverkort et al. (2013). As in Ethiopia, potatoes are a basic element of Rwandan diets, although in Rwanda consumption per capita decreases when prices rise.

4.4 Uganda

The income elasticity and own price elasticity used for Uganda are 0.581 and −1.177, respectively (Muhammad et al., 2011). Furthermore, population was equal to 32.7 million in 2009, average per capita consumption of potatoes was equal to 14 kg in 2009 (Scott et al., 2013), the average consumer price of potatoes was equal to USD 0.09 per kg (Kaganzi et al., 2008) and the average national price of maize equaled USD 0.35 per kg (USAID, 2010b). The potato demand equation for Uganda is then:

$$\ln C_t = 3.27 + 0.01 \ln pop_t + 0.581 \ln inc_t - 1.177 \ln p_t + 0.021 \ln pmaize_t \quad (5)$$

A 1% growth in incomes and potato prices causes aggregate consumption of potatoes in Uganda to rise by about 0.58% or decline by about 1.18%, respectively. To simulate consumption using population growth, income growth and price changes, it is assumed annual population growth is 3.2% and annual GDP growth is 5.1% (Benin et al., 2012). Table 24 presents simulated total demand for potatoes in tons according to different scenarios.

Table 24: Simulated demand scenarios for Uganda, in tons

Year	Base scenario	5% price increase	15% price decline	4% maize price decline
2015	548,000	527,000	610,000	548,000
2020	662,000	617,000	806,000	662,000

The base year presumes an aggregate consumption of potatoes of about 457,800 tons. Consequently, the base scenario involves an average growth in consumption of about 3.5% per year to 548,000 tons in 2015 and 662,000 tons in 2020. The alternative scenarios involve an average consumption growth rate of about 3% and 6%, respectively. These growth rates fairly coincide the one estimated by Scott et al. (2000) for Sub-Saharan Africa, except the high demand growth rate. Bonabana-Wabbi et al. (2013) estimated a demand of 850,000-1,000,000 tons per year by 2015, which is much higher than the quantities simulated above. Per capita consumption will stay equal at 14 kg per year for both years in the base scenario and high price scenario (i.e. 13.5 kg per year), while it slightly rises to about 15.5 kg per year in 2015 and 17.5 kg per year in 2020 in the low prices scenario. This indicates that potatoes are a basic element of the Ugandan diet as well and Ugandans still remain consuming potatoes even if prices increase.

4.5 Synthesis for East Africa

Consumption of potatoes in East Africa will increase substantially due to increases in population and income. When they grow by 1%, total demand for potatoes will increase by 0.01% and by about 0.55-0.62%, respectively. Average annual growth rates range between 3 and 5% for Ethiopia and Uganda, while they are lower for Kenya and higher for Rwanda. Per capita consumption will be rather stable across years and scenarios, indicating potatoes are substantial in East African diets. However, the increase in total potato demand is less in Kenya than in Ethiopia and Uganda, while in Rwanda consumption per capita also decreases when prices rise. An increase in maize prices hardly has any effect on total demand for potatoes.

5. Strategies for East Africa

In this chapter a SWOT analysis is carried out for East Africa in general, where sometimes specific references to individual countries are made. The chapter ends with a confrontation matrix in which the elements of the SWOT analysis are matched in order to provide possible strategies for East Africa as an additional regional submarket for potatoes. The focus is on both production and consumption characteristics, as well as the simulation analysis of potato demand in chapter 4.

5.1 SWOT analysis

A SWOT analysis is an instrument developed for strategic analysis, and consists of a confrontation between external developments (opportunities or threats) and internal capabilities (strengths or weaknesses) of an organization or sector. Based on this confrontation, which is described in more detail in the next section, strategic options for the future can be identified (Johnson et al., 2010). The analysis is carried out for the East African potato sector in general.

Strengths of the East African potato sector include favorable climatological conditions and a short growing season, the importance of potatoes in lean seasons, a large number of producers, low production costs (for processed products in particular), low input use, low wages, source of cash income, an abundant labor force, and the launch of new processing factories in Uganda, Ethiopia and Rwanda. A strength of the potato sector in Kenya in particular is the already more advanced and growing processing industry, which delivers acceptable quality. Strengths of the Rwandan potato sector consist of high yields and being the largest potato producer within East Africa.

One major weakness of the East African potato sector is the poorly organized supply chain, which places potato producers in a weak negotiating and so price-taking position, particularly in Ethiopia and Uganda. This causes low prices for potato producers. Other weaknesses include the small areas dedicated to potato production, low yields compared to other production regions in the world, and high transaction costs implied by high-post harvest losses, which are due to bad infrastructure and lack of storage facilities. Shortages of quality seed and prevalence of pests and diseases, which result in not achieving full yield potential, are also major weaknesses of the East African potato sector, as well as the high transport costs involving only local trade. Finally, the lack of techniques in processing, packaging and storing of processed potato products is also considered as a weakness. Weaknesses in Kenya and Uganda specifically include a volatile production and being expected not to adopt advanced technologies to achieve high yields, respectively.

Opportunities for the East African potato sector include the growing labor force, a strong overall growth in potato production in recent years, access to other Sub-Saharan African markets, the increase in demand due to a larger role of potatoes in (urban) diets and the emergence of fast-food restaurants, urbanization, economic growth and so rising incomes. Furthermore, the relatively large price difference between imported potato products and domestic potato products provides an opportunity to develop future regional trade within East Africa. Also, per capita consumption of

potatoes is relatively stable even if potato prices and maize prices change, indicating potatoes are substantial in East African diets and demand for potatoes will increase when populations grow. Ethiopia has the largest potential to expand its potato production, while for Rwanda other opportunities are the highest economy-wide returns on investments in potato production compared to other crops and the high consumption rates compared to the other countries studied.

A major threat to the development of the competitive trading position of East Africa in general is the chance of political instability. For Rwanda, low direct investment is considered as a threat to its potato sector.

5.2 Confrontation matrix

The confrontation matrix in Table 25 lists the most important elements of the SWOT analysis carried out in the previous section and so combines strengths with opportunities, strengths with threats, weaknesses with opportunities and weaknesses with threats in order to give some projections of a future East African potato market.

Table 25: Confrontation matrix for East Africa

<table>
<tr><th></th><th colspan="5">Opportunities</th><th colspan="2">Threats</th></tr>
<tr><th></th><th>Growing labor force</th><th>Strong growth in production</th><th>Access to markets</th><th>Increasing demand</th><th>Price differences</th><th>Political instability</th><th>Low direct investment</th></tr>
<tr><td>Strengths:
Favorable climatological conditions
Large number of producers
Low production costs
New processing factories</td><td colspan="5">Exploit strengths and opportunities:
- Expanding production strategy
- Upscaling processing strategy
- Exporting potato products strategy</td><td colspan="2">Emphasize strengths to offset threats:
- Promotion strategy</td></tr>
<tr><td>Weaknesses:
Poor organized supply chain
Small areas
Low yields
High post-harvest losses
Shortages of quality seed
Pests and diseases</td><td colspan="5">Improve weaknesses to meet opportunities:
- Investment strategy</td><td colspan="2">Encounter weaknesses and threats:
- Prevention strategy</td></tr>
</table>

The strategies generated from the confrontation matrix can be classified in four overall approaches, i.e. exploiting strengths and opportunities, emphasizing strengths to offset threats, improving weaknesses to meet opportunities and encountering weaknesses and threats.

The East African potato sector could be further strengthened in exploiting and utilizing both strengths and opportunities. One strategy arising from that focuses on expanding potato production, being realized by the favorable climatological conditions, low production costs and the large number of potato producers available in East Africa. By increasing production to meet future demand, the traditional potato production system has to be transformed into an efficient, professional and commercial sector. This involves the organization of small-scale producers in producer associations to reinforce their trading position and to become integrated in the market. This strategy will help the most vulnerable population groups and causes traditional subsistence potato production to be reduced. Another strategy focuses on upscaling the processing industry, in which part of the growing labor force could be commissioned in new processing factories. Low production costs will also favor the development of the processing industry. It should be clear that expanding production will also support the expansion of processing potatoes, ensuring a year-round and sustainable supply. Both strategies however, are required to meet future demand for ware potatoes as well as for processed potato products, and eventually cause East Africa to be able to export potato products to other Sub-Saharan African markets; a final strategy.

The strategy arising from offsetting possible threats is a so-called promotion strategy, in which all strengths and advantages of potato production in East Africa are promoted in order to avoid low direct investment in this sector, and even generate more invested capital. This promotion strategy could also be used to increase foreign direct investment, instead of only generating national investment.

The East African potato sector could also be strengthened when weaknesses are improved. One strategy arising from dealing with weaknesses is an investment strategy. Investments in seed quality management and disease management will increase yields, and investments in information exchange will improve the potato supply chain. Investments in further research, as well as training material for potato producers to increase their organizational and marketing capacities, would also benefit the East African potato sector. As such, this strategy supports the transformation of the potato production system into an efficient sector, stimulates a further growth in production, and causes the East African potato sector be able to satisfy increasing demand.

The strategy arising from combining weaknesses and threats is a so-called prevention strategy, since this combination could harm the East African potato sector, i.e. when investments cannot be made to improve weaknesses.

However, it should be noted all strategies are interdependent and required to have an efficient and professional East African potato sector. For example, the promotion strategy is required in order to improve the weaknesses in the investment strategy, and the prevention strategy also has an impact on the investment strategy. As such, these three strategies affect the quality of results emerging from the expanding production and upscaling processing strategies. Therefore, in fact all strategies should be prioritized.

6. Conclusions and discussion

This chapter first gives the conclusions of this study in paragraph 6.1. A discussion of this study is presented in paragraph 6.2.

6.1 Conclusions

This thesis aimed to survey the organization of potato markets in four countries of East Africa, i.e. Ethiopia, Kenya, Rwanda and Uganda, thereby focusing on production as well as consumption characteristics. Also, this thesis aimed to project consumption by simulating future demand for potatoes and finally to provide some strategies for the future of the East African potato sector. The main conclusions with respect to the research questions can be found below.

1. *How are potato markets in East Africa organized in terms of production, marketing and trade?*

Potato production in East Africa has seen a strong growth in recent years, although Kenya has experienced an output decline in the late 2000's. Yields are low since growth was mainly driven by area expansion, and also due to lack of quality seed and diseases. The exact rate of growth in potato production is not very clear, though is and expected to continue to be larger than growth rates for other major food crops in Sub-Saharan Africa. Production costs of potatoes are low, especially because of low labor costs and limited use of inputs. This shows potato production is profitable for (small-scale) producers, contributes to employment and incomes and gives a competitive position to East Africa. Therefore, increased productivity and production can improve the livelihoods of potato producers in East Africa. Ethiopia in particular has the highest potential to expand its potato production. Price determination still occurs at merely regional markets since the potato supply chain is fragmented, which also causes potato producers to be price takers. Marketing costs are relatively high due to post-harvest losses and lack of reasonable infrastructure. Historically few potatoes have been traded in East Africa due to their relatively non-tradability, although there is some cross-border trade between countries and processed potato products are imported from Europe and South Africa. Emerging markets are those for fresh and processed potatoes, which is profitable in East Africa. Processing potatoes gives the highest returns for Rwanda and Kenya, but new factories are planned to be launched within a few years in all study countries.

2. *What are consumption patterns of potatoes in East Africa?*

Potatoes provide a lot of micronutrients and so play an important role in health issues in East Africa. Potatoes are traditionally consumed in Ethiopia, between harvests of other crops, and Rwanda, where consumption rates are the highest. In Kenya and Uganda, consumption of potatoes is more modern and includes more processed products. Also, consumption of potatoes is related to income and age. In all countries there is potential for higher consumption rates of fresh and processed potatoes in the near future due to economic growth, urbanization and tourism.

3. *How does consumption of potatoes in East Africa evolve over time?*

Consumption of fresh potatoes will increase substantially due to population and income growth. Average annual growth rates range between 3 and 5% for Ethiopia and Uganda, while they are lower for Kenya and higher for Rwanda. Changes in potato prices affect aggregate demand as expected. The increase in total potato demand is less in Kenya than in Ethiopia and Uganda, while in Rwanda consumption per capita also decreases when prices rise. Per capita consumption in the other countries studied will be rather stable across years and scenarios. An increase in maize prices hardly has any effect on total demand for potatoes.

4. *What are strategies for the future of the East African potato sector?*

Strategies for the East African potato sector include expanding potato production to meet future demand and to transform to a commercial sector, upscaling processing activities, exporting potato products, promoting the advantages of potato production in East Africa to generate investments, investing in seed quality management and disease management to improve yields, investing in information exchange and marketing capacities of potato producers to improve the potato supply chain, and finally preventing investments cannot be made to not further harm the East African potato sector. However, all strategies are interdependent and required to have an efficient and professional potato sector, and as such should all be prioritized.

6.2 Discussion

As in every research project this thesis has its limitations, which should be noted. First, this thesis is limited in its scope since it excludes the East African seed potato sector. Seed potatoes in East Africa are often not officially registered, many times just produced by the potato producers themselves and even used for several production seasons. Traders in seed potatoes are restricted in their operations and seed production systems are not yet quite advanced, which is however an important part in solving problems in the fresh and processed potato chains. Also, the scope of this thesis is limited since it does not take a broader perspective and so, it does not include policies about the development of agriculture in East Africa or the development of the root crop sector in very detail. A broader perspective could also be obtained by comparing the development of the East African potato sector to other somewhat more advanced potato sectors in the world, e.g. those in Central Asia or South America.

Limited available data also prevent further specificity of this thesis. Considering production characteristics, data was often fragmented, dated or inaccurate since potatoes are produced at small, eventually unregistered, plots and throughout the year instead of being strictly per season harvested. Also, some data was available for only a few regions within countries or only for one or two countries, which restricted a systematic and comprehensive assessment of the studied countries. Furthermore, production statistics about yields, areas and quantities were often conflicting across sources. Also, the literature cited in this thesis focused on potato producing regions in particular, while production statistics could be different in non-potato oriented regions. Considering consumption characteristics, data was hardly available about prices and quantities consumed, as well as the share of processed potato products compared to the total amount of

potatoes consumed. This obviously reduces the quality and accuracy of the simulation analysis conducted in chapter 4, which focused on fresh potatoes only. Therefore, the hypothesis of Scott (2002) stating total consumption of fresh potatoes will decline when incomes increase but will be compensated by the increased demand for processed products, could not be verified. Other caveats of this simulation analysis include the use of general income or price elasticities instead of potato-specific elasticities, the assumption of equal cross-price elasticity of maize across the studied countries, and the used consumption rates as starting points. Others, e.g. Janssens et al. (2013), found higher consumption rates. This explains why total production and total consumption of the studied countries and described in chapter 2 and 4, respectively, do not match.

At the end of this thesis, some strategies for the future are provided. However, these strategies should be considered as interdependent to really improve East Africa's potato sector. Also, it is questionable whether returns from investing in potato production will be evenly distributed among regions and (rural) households, since potato production is more intensive in some regions than others. According to Diao et al. (2012), growth, whether it concerns general economic growth or growth of a particular sector, may not equally benefit households.

However, despite these limitations it is clear that demand for potatoes is increasing in the next decade in East Africa and that increased potato production could benefit potato producers in this region. Therefore, growing potatoes in East Africa has an additional meaning since this potato sector certainly will expand in the future.

Bibliography

Abebe, G.K., J. Bijman, R. Kemp, O. Omta and A. Tsegaye (2013). *Contract farming configuration: Smallholders' preferences for contract design attributes*. Food Policy 40 (2013): 14-24.

Abong, G.O., M.W. Okoth, J.K. Imungi and J.N. Kabira (2010). *Consumption patterns, diversity and characteristics of potato crisps in Nairobi, Kenya*. Journal of Applied Biosciences 32 (10): 1942-1955.

AHDB (2012). *Potato: Cost of production for processing potatoes in NW Europe.* Kenilworth, UK, Agriculture and Horticulture Development Board (AHDB).

Aviko (2012). *Locating a French fries factory in Africa, based on the potato supply chain*. Dronten, Aviko Potato. Personal communication.

Ayieko, M.W., D.L. Tschirley and M.K. Mathenge (2005). *Fresh fruit and vegetable consumption and trade in urban Kenya: Implications for policy and investment priorities.* Food Security Collaborative Working Papers. East Lansing, Michigan State University, Department of Agricultural, Food, and Resource Economics.

Benin, S., J. Thurlow, X. Diao, A. Kebba and N. Ofwono (2012). *Uganda*. In: X. Diao, J. Thurlow, S. Benin and S. Fan (2012). *Strategies and priorities for African agriculture: Economy-wide perspectives from country studies*. Washington, D.C., International Food Policy Research Institute (IFPRI).

Bonabana-Wabbi, J., S. Ayo, B. Mugonola, D.B. Taylor, J. Kirinya and M. Tenywa (2013). *The performance of potato markets in South Western Uganda*. Journal of Development and Agricultural Economics 5 (6): 225-235.

CIP (2001). *World potato atlas: Ethiopia.* Lima, International Potato Center (CIP).

CIP (2009). *Global potato cultivation.* Lima, International Potato Center (CIP).

CSA (2012). *Area and production of major crops.* Addis Ababa, Central Statistical Agency (CSA).

CSA (2013). *Producer price index March 2013.* Addis Ababa, Central Statistical Agency (CSA).

Davis, K. (2012). *Assessing the potential of Farmer Field Schools (FFS) to fight poverty and foster innovation in East Africa*. # http://hdl.handle.net/1902.1/17988, version 6. Washington, D.C., International Food Policy Research Institute (IFPRI).

Diao, X., S. Fan, S. Kanyarukiga and B. Yu (2010). *Agricultural growth and investment options for poverty reduction in Rwanda.* Washington, D.C., International Food Policy Research Institute (IFPRI).

Diao, X. and P. Hazell (2004). *Exploring market opportunities for African smallholders.* Issue briefs 22. Washington, D.C., International Food Policy Research Institute (IFPRI).

Diao, X., J. Thurlow, S. Benin and S. Fan (2012). *Strategies and priorities for African agriculture: Economywide perspectives from country studies.* Washington, D.C., International Food Policy Research Institute (IFPRI).

Emana, B. and M. Nigussie (2011). *Potato value chain analysis and development in Ethiopia: Case of Tigray and SNNP Regions.* Addis Ababa, International Potato Center (CIP) and United States Agency for International Development (USAID).

FAO (2008). *International Year of the Potato - Global potato economy.* Retrieved 15-02-2013.

FAO (2010). *Strengthening potato value chains: Technical and policy options for developing countries* Rome, Food and Agriculture Organization of the United Nations (FAO) and Common Fund for Commodities (CFC).

FAOSTAT (2010a). *FAO Detailed trade matrix*. Rome, Food and Agriculture Organization of the United Nations.

FAOSTAT (2010b). *FAO Price Statistics*. Rome, Food and Agriculture Organization of the United Nations (FAO).

FAOSTAT (2011). *FAO Production Statistics*. Rome, Food and Agriculture Organization of the United Nations (FAO).

FAOSTAT (2012). *FAO Production Statistics*. Rome, Food and Agriculture Organization of the United Nations (FAO).

Ferris, R.S.B., G. Okoboi, C. Crissman, P. Ewell and B. Lemaga (2001). *Uganda's Irish potato sector*. Prepared for Uganda's conference on competitiveness of selected strategic exports.

Gildemacher, P., W. Kaguongo, O. Ortiz, A. Tesfaye, G. Woldegiorgis, W. Wagoire, R. Kakuhenzire, P. Kinyae, M. Nyongesa, P. Struik and C. Leeuwis (2009). *Improving potato production in Kenya, Uganda and Ethiopia: A system diagnosis*. Potato Research 52 (2): 173-205.

Haverkort, A.J., M.J. van Koesveld, H.T.A.M. Schepers, J.H.M. Wijnands, R. Wustman and X. Zhang (2012). *Potato prospects for Ethiopia: On the road to value addition.* Lelystad, PPO-AGV.

Haverkort, A.J., G. Woldegiorgis, M.J. van Koesveld, S. Ntizo and R. Wustman (2013). *On the road to potato processing in African tropical highlands.* Wageningen, Plant Research International Wageningen UR. Unpublished.

Hijmans, R. (2001). *Global distribution of the potato crop*. American Journal of Potato Research 78 (6): 403-412.

Hoddinott, J. and Y. Yohannes (2011). *Ethiopian Rural Household Surveys (ERHS)*. # hdl: 1902.1/15646, version 7. Washington, D.C., International Food Policy Research Institute (IFPRI).

Höffler, H. and G. Maingi (2005). *Rural-urban linkages in practice: Promoting agricultural value chains*. Entwickling und Ländlicher Raum 5: 26-28.

Horton, D.E. (1987). *Potatoes: Production, Marketing, and Programs for Developing Countries.* Westview Press.

IMF (2012). *World Economic Outlook, October 2012: Coping with high debt and sluggish growth.* Washington, D.C., International Monetary Fund (IMF).

Jaleta, M. and C. Gardebroek (2008). *Crop and market outlet choice interactions at household level*. Ethiopian Journal of Agricultural Economics 7 (1): 29-47.

Janssens, S.R.M., S.G. Wiersema, H. Goos and W. Wiersma (2013). *The value chain for seed and ware potatoes in Kenya: Opportunities for development.* Den Haag, LEI Wageningen UR.

Johnson, G., K. Scholes and R. Whittington (2010). *Exploring Corporate Strategy.* Pearson Education.

Kaganzi, E., S. Ferris, J. Barham, A. Abenakyo, P. Sanginga and J. Njuki (2008). *Sustaining linkages to high value markets through collective action in Uganda: The case of the Nyabyumba potato farmers.* CAPRi Working Paper No. 75. Washington, DC, Collective Action and Property Rights initiative (CAPRi) of the International Food Policy Research Institute (IFPRI).

Keijbets, M.J.H. (2008). *Potato processing for the consumer: Developments and future challenges*. Potato Research 51 (3): 271-281.

Marame, F. and D. Gelmesa (2006). *Review of the status of vegetable crops production and marketing in Ethiopia*. Uganda Journal of Agricultural Sciences 12 (2): 26-30.

MINAGRI (2013a). *Area harvested*. Kigali, COUNTRYSTAT Rwanda.

MINAGRI (2013b). *Area harvested per district*. Kigali, COUNTRYSTAT Rwanda.

MINAGRI (2013c). *Production quantity of primary crops*. Kigali, COUNTRYSTAT Rwanda.

MOA (2013). *Wholesale commodity prices*. Ministry of Agriculture (MOA).

Muhammad, A., J.L. Seale, B. Meade and A. Regmi (2011). *International evidence on food consumption patterns: An update using 2005 International Comparison Program Data.* Technical Bulletin 1929. Washington, D.C., United States Department of Agriculture (USDA) Economic Research Service.

NISR (2010). *Statistical Year Book 2010.* Kigali, National Institute of Statistics of Rwanda (NISR).

Nyankanga, R.O., H.C. Wien, O.M. Olanya and P.S. Ojiambo (2004). *Farmers' cultural practices and management of potato late blight in Kenya Highlands: Implications for development of integrated disease management*. International Journal of Pest Management 50 (2): 135-144.

Obare, G.A., S.W. Omamo and J.C. Williams (2003). *Smallholder production structure and rural roads in Africa: The case of Nakuru District, Kenya* Agricultural Economics 28 (2003): 245-254.

Okoboi, G. (2001). *The marketing potential of potatoes in Uganda and market opportunities for Rwanda.* Draft report. International Institutie of Tropical Agriculture.

Pingali, P. and Y. Khwaja (2004). *Globalization of Indian diets and the transformation of food supply systems.* ESA Working Paper No. 04-05. Rome, Food and Agriculture Organization of the United Nations (FAO).

Scott, G.J. (2002). *Maps, models, and muddles: World trends and patterns in potatoes revisited*. Potato Research 45 (1): 45-77.

Scott, G.J., R. Labarta and V. Suarez (2013). *Booms, busts, and emerging markets for potatoes in East and Central Africa 1961–2010*. Potato Research: 1-32.

Scott, G.J., M.W. Rosegrant and C. Ringler (2000). *Roots and tubers for the 21st century: Trends, projections, and policy options.* 2020 Vision Briefs No. 66. Washington, D.C., International Food Policy Research Institute (IFPRI).

Tafere, K., A.S. Taffesse, S. Tamru, N. Tefera and Z. Paulos (2010). *Food demand elasticities in Ethiopia: Estimates using Household Income Consumption Expenditure (HICE) survey data.* Ethiopia Strategy Support Program II Working Paper 11. Addis Ababa, International Food Policy Research Institute (IFPRI).

Tesfaye, A., B. Lemaga, J.A. Mwakasendo, Z. Nzohabonayoz, J. Mutware, K.Y. Wanda, P.M. Kinaye, O. Ortiz, C. Crissman and G. Thiele (2010). *Markets for fresh and frozen potato chips in the ASARECA region and the potential for regional trade: Ethiopia, Tanzania, Rwanda, Kenya, Burundi and Uganda.* Working Paper No. 2010-1. Lima, International Potato Center (CIP).

Thomas, G. and G. Sansonetti (2009). *New light on a hidden treasure: International Year of the Potato 2008, an end-of-year review.* Rome, Food and Agriculture Organization of the United Nations (FAO).

Thurlow, J., J. Kiringai and M. Gautam (2012). *Kenya*. In: X. Diao, J. Thurlow, S. Benin and S. Fan (2012). *Strategies and priorities for African agriculture: Economy-wide perspectives from country studies*. Washington, D.C., International Food Policy Research Institute (IFPRI).

USAID (2010a). *Kenya monthly price bulletin January 2010.* Washington, D.C., United States Agency for International Development (USAID).

USAID (2010b). *Uganda monthly price bulletin January 2010.* Washington, D.C., United States Agency for International Development (USAID).

Walker, T.S., P.E. Schmiediche and R.J. Hijmans (1999). *World trends and patterns in the potato crop: An economic and geographic survey*. Potato Research 42 (2): 241-264.

Walker, T.S., G. Thiele, V. Suarez and C. Crissman (2011). *Hindsight and foresight about potato production and consumption.* Working paper No. 2011-5. Lima, International Potato Center (CIP).

WFP (2010). *Ethiopia Monthly Market Watch April 2010.* Rome, World Food Programme (WFP).

World Bank (2012). *World Development Indicator*. Washington, D.C., World Bank.

Appendices

A. Ethiopia

Table A.1: Area, production and yield for private peasant holdings, *Meher* season 2011-2012

Region	Number of producers	Area in ha	Production in tons	Average yield in t/ha
Amhara	521,571	21,353	185,101	8.7
Benishangul-Gumuz	5,192	-	-	-
Dire Dawa	526	5	-	-
Harari	497	18	-	-
Oromiya	402,544	28,167	200,534	7.1
SNNPR	332,911	8,978	80,938	9.0
Tigray	60,810	661	5,376	8.1
Total	1,324,051	59,181	471,949	-

Source: CSA (2012)

Table A.2: Potato area per region in Ethiopia, sampled survey

Region	Number of producers	Average area in ha	Smallest area in ha	Largest area in ha
Amhara	39	0.06	0.015	0.2813
Oromiya	79	0.1339	0.000013	0.5
SNNPR	25	0.037	0.0033	0.125
Tigray	1	0.0156	0.0156	0.0156

Source: Yohannes and Hoddinott (2011)

Table A.3: Economic profitability of processing 100 kg of potatoes into French fries

Activity	Costs in USD	Costs in ETB
Purchase of potato	6.38	127.55
Labor cost	1.50	30.00
Transportation	0.42	8.31
Additives (e.g. cooking oil)	2.58	51.52
Depreciation	0.13	2.50
Frying fuel	1.13	22.50
Total cost	*12.12*	*242.38*
Gross benefits	41.40	828.00
Net benefit in local currency	29.28	585.62

Source: Haverkort et al. (2013)

B. Kenya

Table B.1: Wholesale commodity prices in KSH[7] per bag of 110 kg, August 22nd 2013

Region	Red-fleshed potatoes	White-fleshed potatoes
Nairobi	3,300	3,600
Mombasa	1,700	2,250
Kisumu	3,500	1,800
Nakuru	3,300	3,300
Eldoret	2,000	1,800
Malindi	-	3,850
Kisii	3,300	-
Average	2,850	3,050

Source: MOA (2013)

C. Uganda

Table C.1: Profitability analysis for delivery of 50 bags of 100 kg every 2 weeks in Uganda

Production costs	USD per bag	UGX[8] per bag
Total, including seed, fertilizer, pesticides and labor	4.68	12,000
Grading, packing, sewing	0.04	100
On-loading	0.08	200
Off-loading	0.12	300
Bags	0.20	500
Book keeping and accounting	0.02	40
UNSPPA charge	0.39	1,000
Transport to Kampala	2.34	6,000
Escort cost	0.31	800
Rental of store / bad roads	0.04	100
Subtotal	3.53	9,040
Other costs (bank fees, depreciation, etc.)	0.71	1,808
Total cost	*8.91*	*22,848*
Net profit 1 bag	3.65	9,352
Net profit 50 bags	182.36	467,600

[7] Exchange rate August 2013: KSH 1 = USD 0.011
[8] Exchange rate August 2013: UGX 1 = USD 0.00039