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Competitiveness of the Ghanaian Vegetable Sector

Findings from a Farmer Survey

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ABSTRACT

This study looks broadly at the state of vegetable competitiveness in Ghana; focusing on trade, production, profitability, and marketing. Ghana is dependent on imports to meet its vegetable consumption requirements. While Ghana has the potential to meet local vegetable demand because of its diverse agro-ecological zones, currently production is highly seasonal and yields are significantly lower than in neighboring countries. Large urban markets are restricted by networks of traders and, while farmers can get higher prices through these networks, many farmers lack market power and struggle to access the marketing networks. This may lower incentives for vegetable farmers to increase their production. However, despite these challenges, vegetable production is profitable and there is potential for significant expansion. Strategies to improve yields as well as measures to remove restrictions on entry to major markets should be considered to provide increased opportunities for import-substitution of profitable vegetables in Ghana.

Keywords: Ghana; vegetables; production; marketing

1. INTRODUCTION

Vegetables, including tomatoes, onions, carrots, and chilies, are widely consumed in Ghana. The latest consumption estimates from the 2012-2013 Ghana Living Standards Survey (GLSS) show that household spending on vegetables was 12.8 percent of total food expenditure. Spending on tomatoes made up the highest share of total vegetable expenditure (35.2 percent), followed by onions (19.0 percent), chilies (9.7 percent) and carrots (1.3 percent). Despite the importance of these vegetables in the local diet, much of the demand is met by imports, especially from neighboring countries. There is a widely held perception that Ghanaian farmers do not attain the productivity levels needed for the vegetables to compete in the regional market.

In this study, we look broadly at the state of vegetable competitiveness in Ghana. We focus on tomatoes, onions, carrots, and Scotch bonnets, a variety of chili pepper.[1] We examine competitiveness by focusing on trade, production, profitability, and marketing. First, we focus on Ghana's ability to meet local demand by looking at import dependence and seasonality. Second, we look at vegetable production and the causes of low vegetable yields in Ghana. Next, we study profitability by examining gross margins per hectare (ha) and costs of production per metric ton (mt). Finally, we look at the structure and efficiency of the marketing system.

Three surveys were conducted to supplement the limited data available on vegetables from official and secondary sources: a key informant survey, a wholesaler survey, and a producer survey. In the key informant survey, seven traders identified key production regions, production characteristics, and estimated vegetable imports and exports to specific markets. In the wholesaler survey, 82 wholesalers at Agbogbloshie (Accra), Tudu (Accra), Abinkyi (Kumasi), Bolaho (Kumasi) and Market Circle (Takoradi) markets were asked to recall information from the past 12 months on the source, variety, and quantity of the selected vegetables they brought to their respective markets. Additionally, a representative of the Ghana National Tomato Trader and Transport Association was asked to provide information on tomato trade and prices.

Table 1.1. Producer survey sample, by region and production system

	Tomato		Onion		Carrot		Scotch bonnet	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
Ashanti	15	21	4	8	19	9	5	9
Northern	7	2	0	0	0	0	29	7
Upper East	11	1	32	1	1	0	24	5
Volta	14	0	3	0	2	0	13	0
Total	47	24	9	39	22	9	71	21

Source: Authors' calculations from the 2017 producer survey
Note: This table includes more than 199 observations because 44 farmers interviewed planted two vegetables.

In the producer survey, 199 producers of the selected vegetables were surveyed in August 2017 in six districts across four regions (Mampong Municipal and Offinso North in Ashanti region; Tolon Kumbugu in Northern region; Bawku Municipal and Kassena Nankana East in Upper East region; and Keta Municipal in Volta region) (Table 1.1). Respondents were asked to recall their vegetable production and marketing practices, including quantities, costs, and sale prices, for up to two of the selected vegetables harvested in either the rainy or dry season in the last 12 months. The districts sampled in the producer survey were informed by a literature review, the key informant survey, and interviews with officials at selected district offices of the Ministry of Food and Agriculture (MOFA).

[1] Because we cannot obtain production and trade data for Scotch bonnets alone, in our analysis of marketing and trade in chili peppers, we use data on "green chilies and peppers".

Within the districts, four communities were randomly selected for each vegetable and stratified by production system, i.e., rainfed or irrigated.

This paper is organized as follows: section 2 presents an overview of vegetable production and trade, including seasonal patterns and price trends; section 3 provides a detailed look at domestic production of selected vegetables and yields; section 4 focuses on vegetable profitability; section 5 gives an overview of the market structure and marketing system; and section 6 draws conclusions and makes policy recommendations.

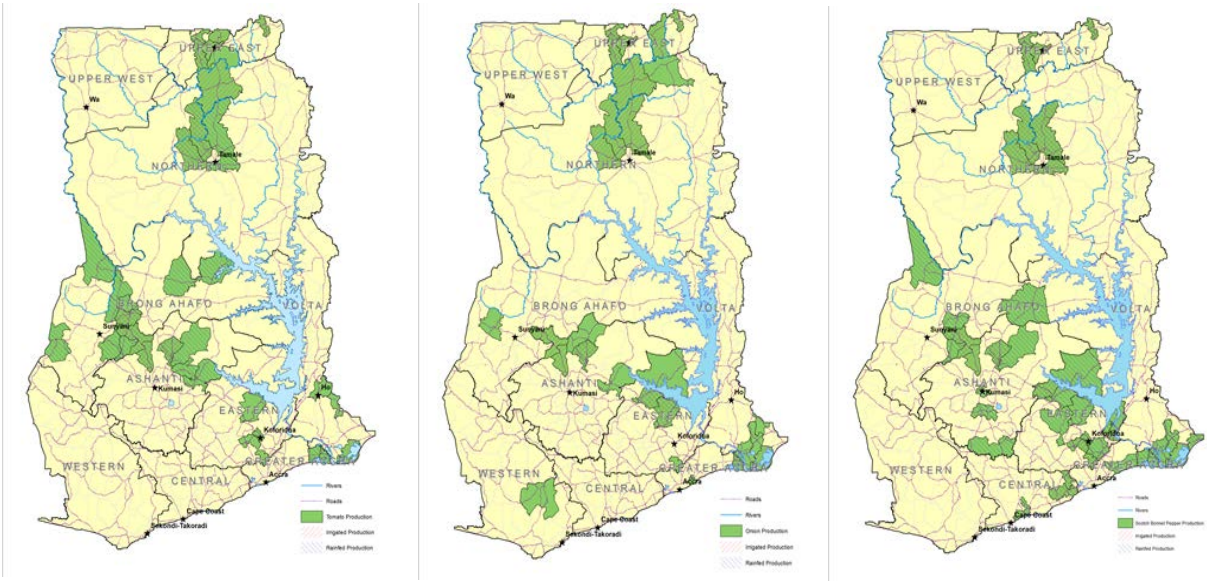
2. IMPORT DEPENDENCE AND SEASONALITY

2.1. Production and trade

As is typical in sub-Saharan Africa with the dominance of field crops, production of tomatoes, onions, and chilies, expressed in terms of area planted, is not widespread in Ghana. In 2015, tomatoes were planted on approximately 48,000 hectares, green chilies and peppers on 14,000 hectares, and onions on 8,500 hectares. Together, the three crops were planted on less than 1.5 percent of the estimated 4.7 million hectares of cultivated land (MOFA 2015). Moreover, production only occurs in concentrated belts in Upper East, Northern, Brong Ahafo, Ashanti, Eastern, and Volta regions (GSS 2012; Saavedra et al. 2016; Attoh et al. 2014; Robinson and Kolavalli 2010a) (Figure 2.1).

The majority of vegetable farmers are smallholders, with average landholdings of less than two hectares. Vegetables are usually cultivated on plots of less than one hectare – the average tomato plot is 0.66 hectares, the average onion plot is 0.42 hectares, and the average Scotch bonnet plot is 0.36 hectares. There is little regional variation in the scale of operation. GLSS data indicates that most tomato and onion farmers, irrespective of if they are irrigated producers in the north or rainfed producers in the south, only plant in one season. In the other season, vegetable farmers will plant other vegetables, starches, or may leave their lands fallow.

Figure 2.1. Maps of tomato, onion, and Scotch bonnet growing areas



Source: Authors' estimates from authors' scoping trips, literature review, and the 2017 key informants survey

Because of limited local production, vegetable imports are necessary to meet Ghanaian consumption demand. Table 2.1 presents official estimates of Ghanaian imports of tomatoes, onions, carrots, and chilies over the period 2013 to 2015. The size of vegetable trade is difficult to

estimate, as Ghana trades mainly with its neighbors, and this regional trade is not well monitored. Therefore, we present estimates from four sources: Ghana's Ministry of Trade and Industry (MOTI), the UN Comtrade database, the Base pour l'Analyse du Commerce International (BACI), and Eurostat.

Table 2.1. Average annual imports, 2013 to 2015

	Source	Tomato	Onion	Carrot	Chili
Quantity, mt	MOTI	6,341	52,799	800	26
	BACI	7,025	26,615	845	30
	Eurostat	--	--	870	28
	Authors' estimates	101,640	862,190	--	--
Value, '000 USD	MOTI	1,262	9,301	253	65
	BACI	1,498	5,257	375	116
	Eurostat	--	--	267	71
	Authors' estimates	8,702	52,935	--	--

Source: Authors' estimates based on Ghana's Ministry of Trade and Industry (MOTI), Base pour l'Analyse du Commerce International (BACI), Eurostat, and authors' estimates from the Ghana National Tomato Trader and Transport Association and Wholesalers' Survey data (MOTI 2013; BACI 2010, European Union 2017; Ghana National Tomato Trader and Transport Association 2017)
Notes: MOTI figures reported as CIF. BACI and Eurostat figures reported as FOB.

Over the period 2013 to 2015, Ghana's Ministry of Trade and Industry (MOTI) valued average tomato imports at US$1.2 million annually. Onion imports were substantially larger, averaging US$9.3 million annually over the period. Chili imports on the other hand, were relatively small, valued at only US$65,000 annually. Compared to the MOTI values, BACI values tomato imports slightly higher at US$1.6 million, while onion imports are lower at US$5.7 million and chili imports are almost double at $116,000 annually.

Although, these inconsistences are an example of trade data quality issues, our findings suggest that there is much more significant underreporting. Large trade volumes go unreported because of porous borders, poor border enforcement, and illicit trading practices. Further, export data from neighboring countries cannot fill this knowledge gap, since not every partner country reported data annually and export data are often just as poorly monitored. Therefore, there is significant missing trade information.

A recent study by Saavedra et al. (2014) found anecdotal evidence that suggests the value of onion imports from Togo and Burkina Faso is more than US$120 million for the Accra and Kumasi markets alone. Moreover, Josserand (2013) estimated onion imports from Niger and Burkina Faso to be 215 percent higher than official figures on average between 2008 and 2011. We estimate, from the wholesaler survey, that the value of onion imports could be as high as US$52.9 million per year. This is 470 percent higher than the official figure suggests. The Ghana National Tomato Trader and Transport Association reports that its members imported 101,640 mt of tomato, valued at US$8.7 million, from Burkina Faso annually between 2011 and 2016. These estimates suggest that official data for tomato and onion may only account for around seven percent of actual imports.

Table 2.2 shows quantity estimates of production, net imports, and consumption from various sources. While official estimates suggest that in 2013 tomato imports made up only 2 percent of total tomato consumption in Ghana, chili imports made up less than 1 percent of consumption, and onion imports accounted for 34 percent of consumption, evidence from traders suggest that imports are much more essential than these official data suggest. These estimates show that imports could account for as much as 30 percent of tomato consumption and 90 percent of onion consumption.

Table 2.2. Production, net imports, and consumption, selected sources

	Tomato	Onion	Chili
Production 2013 ('000 mt)			
FAO estimates	340,218	138,188	116,690
Net Imports 2013 ('000 mt)			
MOTI estimates	6,337	52,462	(18)
BACI estimates	6,989	26,300	(1,307)
Authors' estimates	101,640	861,875	
Consumption 2013 ('000 mt)			
MOTI estimates	346,555	190,650	116,672
BACI estimates	347,207	164,488	115,383
Authors' estimates	441,822	1,000,063	116,690

Source: Authors' estimates based on FAOSTAT, MOTI, BACI, Eurostat, Ghana National Tomato Trader and Transport Association and Wholesalers' Survey data (FAOSTAT 2017; MOTI 2013; BACI 2010, European Union 2017; Ghana National Tomato Trader and Transport Association 2017)
Notes: MOTI figures reported as CIF. BACI and Eurostat figures reported as FOB.

Official import and export data only illustrate part of Ghana's regional integration story. For tomatoes and onions, while official data indicates that Burkina Faso and Niger are Ghana's most important trading partners, respectively, we know the quantities are grossly underestimated (Table 2.3). For carrots, official trade data show that most imported carrots come from the Netherlands. However, according to the wholesalers' survey, traders reported a higher concentration of carrots from Burkina Faso in the market in all months than carrots from the Netherlands. Moreover, carrots from Togo were roughly as large a share of imports as those from the Netherlands from April to December. Finally, although we did not collect information on chilies in the wholesalers' survey, preliminary market studies indicate that in the off-season chilies from Burkina Faso and Togo supplement local production, and during the primary harvest season chilies from Cote d'Ivoire also supply the local market. These import sources for carrots and chilies are not in the official estimates.

Table 2.3. Average share of imports, by vegetable and trade partner, 2013 to 2015

Vegetable	Trade Partner	Quantity (mt)	Value ('000 US$)	Share (%)
Tomato	Burkina Faso	6,319	1,212	99
	Netherlands	8	37	0
Onion	Niger	37,422	6,387	69
	Burkina Faso	12,962	2,145	23
	Belgium	1,506	469	5
Carrot	Netherlands	665	208	82
	South Africa	110	33	13
Chili	Netherlands	11	51	79
	Belgium	11	5	8
	Egypt	2	4	6

Source: Authors' estimates based on Ghana Ministry of Trade and Industry data (MOTI 2013)

Unfortunately, since our wholesalers' survey focuses on local markets only, we do not know the extent of Ghana's informal exports. Presenting informal import estimates without informal export estimates can skew the extent of Ghana's reliance on imports and confuse overall import dependence with seasonal dependence and regional integration. Because of this, tomato, carrot, and chili trade stories are still unclear. For example, during the peak tomato harvest season in Ghana, tomato production exceeds demand (Awo 2010). Tomatoes are primarily exported to Togo, Cote d'Ivoire, Niger, and Burkina Faso. We do not know the extent of these exports, because of the

same issues discussed above with trade data collection. Therefore, Ghana's tomato import dependence may be a result of seasonal deficits rather than an overall production gap.

For chilies, the story is even more unclear. Official import and export figures show that Ghana is a net exporter of chilies. Exports averaged US$5.7 million annually between 2013 and 2015, mainly to the United Kingdom (Table 2.2). However, all exports of capsicum (chili) to the EU were banned in October 2015 due to failure to comply with sanitary and phytosanitary (SPS) measures. This ban has now been lifted. Nonetheless, it is unclear if Ghana was ever a net exporter of chili. Preliminary work on chili markets already shows large unaccounted-for imports from neighboring countries. More research is needed to figure out Ghana's true net trade figures for chili.

In sum, current data shows that Ghana cannot meet local demand year-round and regional integration is important for meeting vegetable demand in Ghana. Furthermore, it is important to note that this import dependence is not per se negative: it may signal that the economy is leveraging the benefits of non-overlapping seasons through trade integration.

2.2. Seasonality

Vegetable production in Ghana is highly seasonal. Vegetables in the north are produced under irrigated conditions, whereas southern production is mainly rainfed, except in the Volta region, where most farms are irrigated. A bi-modal rainfall pattern in the south allows for a long farming season from May to November. Table 2.4 shows the cropping calendar for rainfed and irrigated tomato, onion, carrot, and Scotch bonnet chilies. Since vegetable production is spread across the country and Ghana benefits from having several climatic zones, Ghana could supply most vegetables year-round.

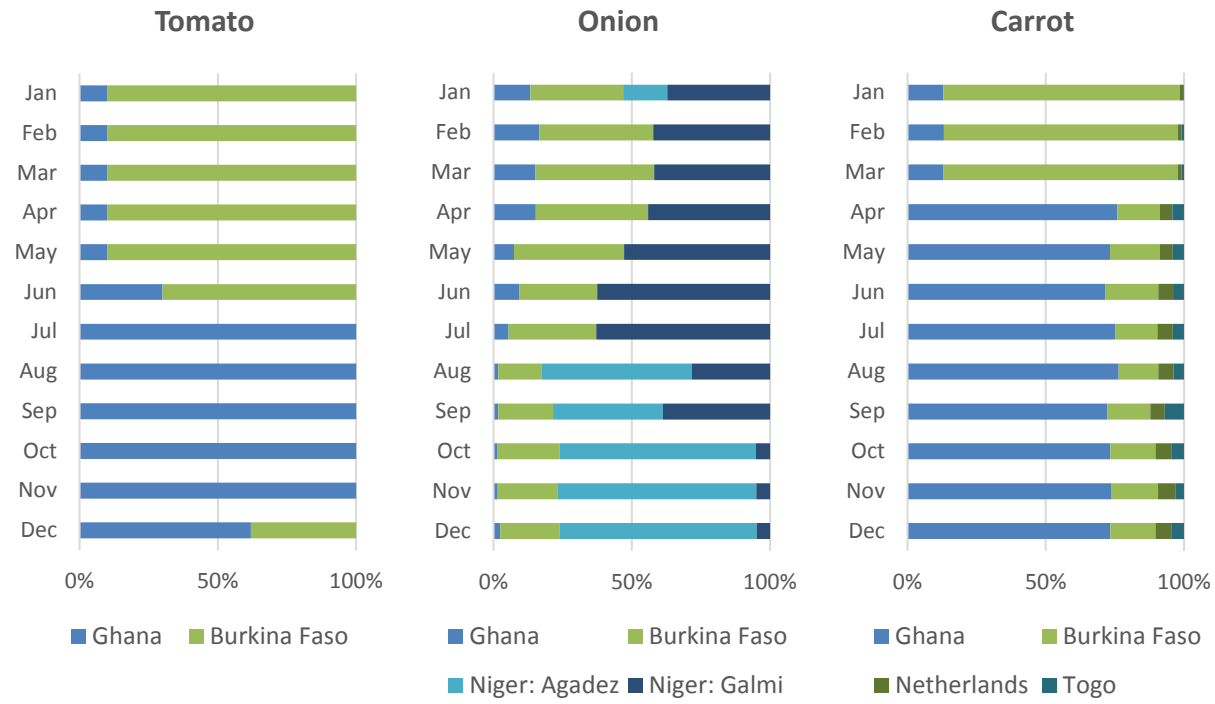
Table 2.4. Months of harvest by vegetable and production system

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tomato												
Irrigated	■	■	■	■				■	■	■	■	■
Rainfed					■	■	■	■	■	■		
Onion												
Irrigated	■	■	■	■				■	■	■	■	■
Rainfed						■	■	■	■			
Carrot												
Irrigated	■	■	■	■				■	■	■	■	■
Rainfed					■	■	■	■				
Scotch bonnet chilies												
Irrigated	■	■	■	■	■						■	■
Rainfed					■	■	■	■	■	■	■	■

Source: Authors' estimates based on authors' scoping trips and literature review

Tomatoes are a good example of this potential year-round production, with harvests from Upper East, Northern, Ashanti, and Volta regions supplying markets at different points of the year. From late December through April, Upper East supplies the market with tomatoes from irrigated plots. From May onwards, the harvest picks up in rainfed areas, with a longer season through October in the Brong Ahafo and Ashanti regions. Tomatoes from the Northern region enter the market in early June and are supplied until October. In Volta, with irrigated production, tomatoes are mainly harvested August through December.

Figure 2.2. Monthly share of tomatoes, onions, and carrots, by source for all of Ghana, 2016



Source: Authors' estimates based on Ghana National Tomato Trader and Transporter Association and the 2017 wholesaler survey (Ghana National Tomato Trader and Transport Association 2017)

Although this seasonality could allow for year-round production, with limited off-season production, certain regions struggle to produce enough to supply the markets. Most farmers do not plant tomatoes in both growing seasons. According to GLSS 2012-2013 data, only 57.5 percent of tomato farmers in Upper East plant tomato in the second growing season. In Volta, where farmers also plant irrigated tomato, only 38.2 percent of the farmers grew tomato in the second season. In rainfed production areas, such as Ashanti and Brong Ahafo, less than 36.0 percent of farmers plant a tomato crop in the second season. Farmers instead plant other vegetables, such as chili, okra, and eggplant, or maize. Because there is hardly any second season production in the rainfed south, Upper East is the only region supplying the market from January to April. Since, production in the region is small compared with demand, most tomatoes are imported from Burkina Faso at this time (Figure 2.2).

Onion production is smaller than tomato production and is spread over a smaller area with fewer distinct climates. Therefore, at present Ghana cannot supply the market with onions year-round. Most local production occurs between January and April, with almost no production in the rest of the year. Moreover, as demonstrated by the large quantities of imports, even during peak production periods, local production is not enough to meet demand. Instead Niger and Burkina Faso dominate the onion market year-round, with Ghana only having a small share of the market from January to July (Figure 2.2). Although onions could be profitably grown in the Northern and Upper East regions from June through October, field crops are grown instead.

Scotch bonnet chili production in Ghana is year-round. In irrigated areas, Scotch bonnets can be harvested throughout the year, while in rainfed areas, two rainfall peaks make growing chilies possible in two seasons. In the first four months of the year, Scotch bonnets from Upper East region are offered in the markets. However, these Scotch bonnets cannot meet demand, and chilies are also sourced from Burkina Faso and Togo (Figure 2.2). Around June, Scotch bonnets from Volta,

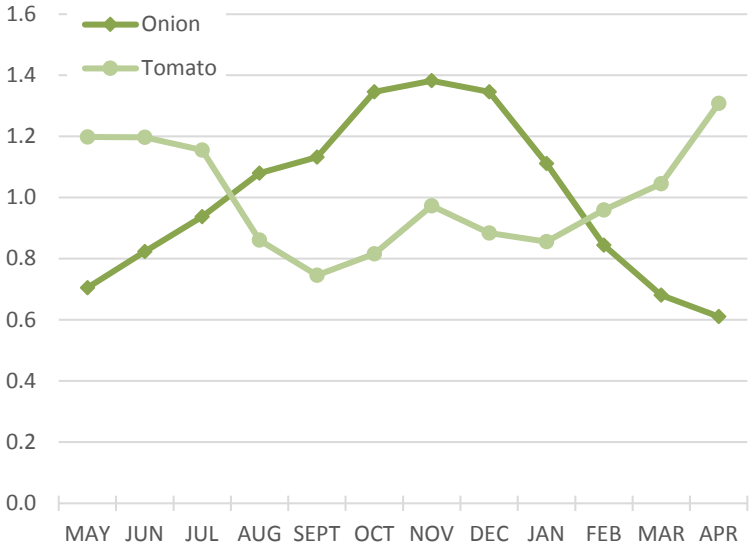
Ashanti, and Brong Ahafo enter the market. Scotch bonnets from the Northern region are available from June to November. Imported Scotch bonnets from Côte d'Ivoire are also sold from May to October, coinciding with Ashanti and Brong Ahafo peak harvest seasons (IFPRI 2017; Saavedra et al. 2016; NEPAD and FAO 2005; Centre National de Recherche Agronomique 2009).

2.3. Prices

This seasonal distribution of production has an important effect on average domestic and regional prices. Furthermore, trade patterns also have a significant effect on price. Vegetable prices in Ghana follow seasonal patterns; prices are lowest when local production permeates the market, except for onions, where local production does not meet a significant portion of the demand.

In May, when tomato harvest begins in the South, prices are high. As harvests increase, prices fall (Figure 2.3). Tomato production peaks in September, with harvests in Brong Ahafo, Ashanti, Greater Accra, Eastern and Volta regions. By November, most local production subsides, and the price increases. Price changes from November through June reflect the seasonality of tomato production in neighboring countries, rather than in Ghana. From November to April, Ghanaian production makes up less than 20 percent of tomatoes in Ghana. Low prices in December and January, reflect low prices in Burkina Faso, Niger, and Côte d'Ivoire, Ghana's three largest tomato trading partners.

Figure 2.3. Seasonality of wholesale tomato and onion prices in Ghana



Source: Authors' calculations based on Ghana Ministry of Food and Agriculture data (MOFA 2015)

Onion prices are also highly seasonal, but appear to be primarily driven by prices in neighboring countries rather than by local production. Primary harvests in Upper East and Volta are from November through April, with a second, smaller season in June through October. Despite this production pattern, over the period 2005 to 2015, average onion prices were at a low in May and rose steadily to a high in November and then slowly decreased (Figure 2.3). Low onion prices reflect seasonality of production in Niger and Burkina Faso.

3. YIELDS AND PRACTICES

3.1. Yields

Yield estimates for vegetables in Ghana vary between sources. MOFA estimated that in 2013 the average tomato yield was 7.5 mt/ha, the average onion yield was 15.1 mt/ha, and the average chili

yield was 8.3 mt/ha. The literature on vegetables has also estimated different yields. Robinson and Kolavalli (2010) found that rainfed tomato yields in Brong Ahafo were 14 mt/ha and irrigated yields in Upper East were 15 mt/ha. They found much lower yields of 5.0 mt/ha on average in the Greater Accra region, both in irrigated and rainfed conditions. Ayerh (2015), in a recent survey of mainly rainfed tomato farmers in Ashanti region, found that yields averaged 7.0 mt/ha, with maximum yields of 11.8 mt/ha. DAI (2014) in their report on the onion value chain found that Bawku Red onion yields are around 10 mt/ha. Akrofi (2016) found that onion yields under rain-fed conditions on farms in Eastern region were between 5.2 and 7.4 mt/ha if transplanting took place at the appropriate time.

Table 3.1. Vegetable yields, by production system, mt/ha

	Tomato		Onion		Carrot		Scotch bonnet	
Region	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated
Overall	4.2	5.2	2.6	3.9		10.0	6.0	4.3
Ashanti	6.2		2.7			10.0		
Upper East		4.6		4.6				3.8
Upper East (IWMI)		5.2		9.0				5.5
Northern		4.2						7.5
Northern (IWMI)		7.9		6.4				5.6

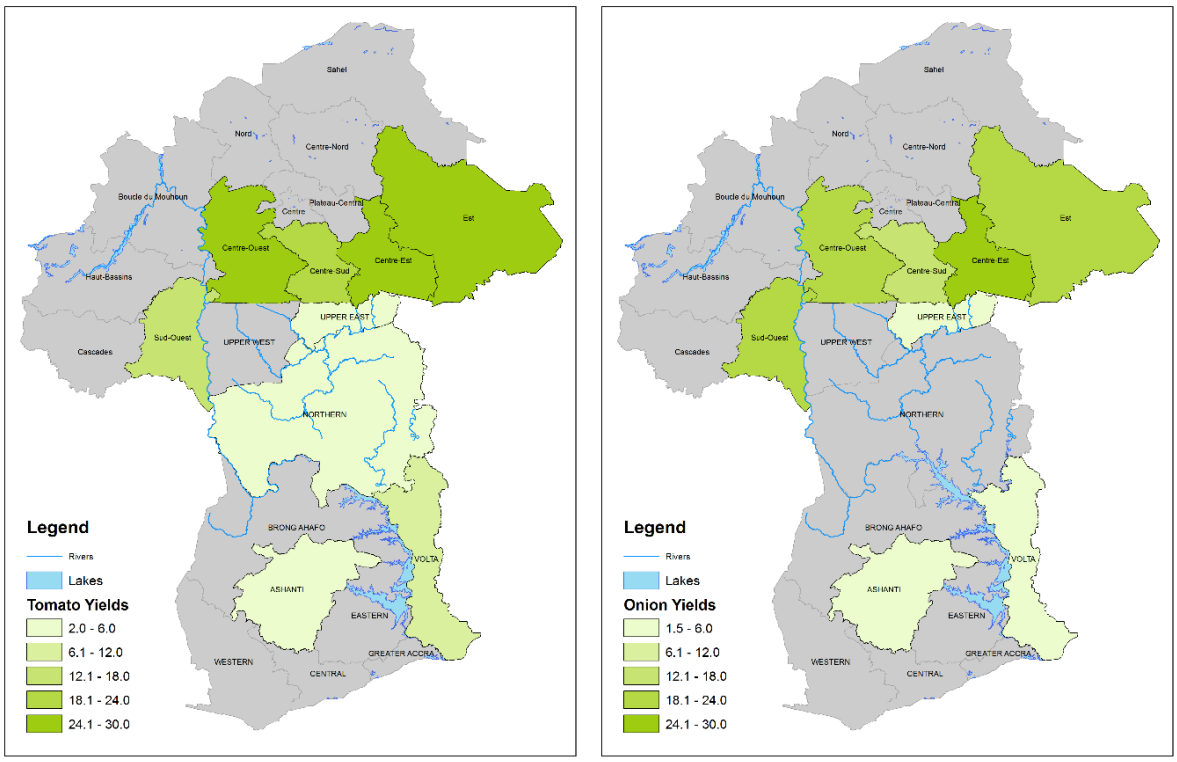
Source: Authors' calculations from the 2017 producer survey.
Note: IWMI estimates are from Bwaku West in Upper East and West Mamprusi in Northern region.

In our survey, we found an average tomato yield of 5.2 mt/ha on irrigated plots and 4.2 on rainfed (Table 3.2). The International Water Management Institute (IWMI), in their study of irrigated vegetables also found similar yield ranges for tomato. Our onion yield estimate is very low at 3.7 mt/ha (Balana 2017). IWMI estimates show higher yields of 9.0 mt/ha in Bawku West**,** Upper East. Finally**,** in our survey, we found Scotch bonnet chili yielding on average 4.7 mt/ha, ranging from 4.3 mt/ha under irrigation to 6.0 mt/ha when rainfed. The IWMI data shows similar yields.

Regardless of the source, vegetable yields in Ghana are much lower than vegetable yields in neighboring countries. Tomato yields in Burkina Faso are more than three times higher than in Ghana (Figure 3.1). Further, tomato yields in Mali and Niger are more than double Ghanaian yields and in Cote d'Ivoire yields are slightly higher. On the other hand, tomato yields in Benin and Togo are comparable to those in Ghana. Onions yields are 1.5 times greater in Burkina Faso than in Ghana and double in Niger. In Cote d'Ivoire, Benin, and Togo, yields are similarly low as in Ghana.

One possible reason for low yields is the varieties and seed used in vegetable production. Ghanaian vegetable famers still depend on several old vegetable varieties (Saavedra et al. 2016). The Council for Scientific and Industrial Research (CSIR) has not developed any tomato, onion, or carrot varieties (CSIR 2018). There is no systematic program to conduct trials of vegetable varieties and release them with area-specific recommendations (Robinson and Kolavalli 2010d). Most vegetable varieties currently farmed were introduced more than a decade ago. For example, the most common onion cultivars grown in Ghana are the local red cultivars, Bawku Red, 'Malavi', and Red Creole (Alidu 2013, Akrofi et al.2016). Bawku Red was introduced to Ghana as long ago as 1930 (Sinnadurai and Abu 1977).

Figure 3.1. Tomato and onion yields in regions of Ghana and Burkina Faso



Source: Authors' estimates based on FAOSTAT and Burkina Faso Ministère de l'Agriculture et de l'Hydraulique data (FAOSTAT 2017; Ministère de l'Agriculture et de l'Hydraulique 2011)

Some varieties are informally imported from neighboring countries to fill the void of local high-yielding varieties. New onion and tomato varieties enter through Burkina Faso and Niger. During field visits to the Keta Municipal district, farmers reported that seed to grow the Galmi variety of onion was informally imported from Niger in small bottles. If the seed did not arrive, then onions were not grown. Likewise, in Upper East region, tomato seed is obtained across the border in Burkina Faso. However, it is unclear if these varieties are high performing in Ghana.

In Ghana, many vegetables farmers use recycled seed – seed recycling may account for between 85 to 90 percent of seed supply (Orchard and Suglo 1999; Horna et al. 2006). Vegetable farmers, however, compared with cereal farmers, purchase a larger percentage of their seed. Monney et al. (2009) suggest that only 33 percent of farmers use recycled seed exclusively. Likewise, Robinson and Kolavalli (2010a) suggest that only 20 percent of farmers use recycled seed only, the others combine recycled and purchased seed or use only purchased seed. In our producer survey, we found that tomato and Scotch bonnet seed was either recycled (54 percent) or purchased from the local market (42 percent), while onion seed was mainly obtained from the local market (64 percent). Carrot was the exception, as 82 percent of the seed was purchased from private input dealers.

Even though the seed they used was not all recycled, most tomato, onion, and Scotch bonnet farmers could not name the variety they planted. Farmers who got their seed from the local market were not more likely to know the name of the variety than those who recycled their own seed. Most farmers who obtained seed from private input dealers, however, could name the variety or a local name. Carrot farmers knew their variety, maybe because carrots are a relatively new crop in Ghana. As a significant share of vegetable farmers purchase their seed, rather than recycle, it is unfortunate that there is no focus on vegetable varietal development in Ghana.

Of the tomato farmers interviewed, 29 percent planted a local variety they could not name, 15 percent planted Power Rano, 12 percent planted Konkon, and another 20 percent planted other local varieties. The remaining farmers either planted Pectomech (14 percent) or other improved varieties (8 percent). Yields varied hugely by variety: local unknown varieties had yields of 5.7 mt per hectare, lower than for Pectomech (8.2 mt/ha), and Power Rano (8.4 mt/ha) (Table 3.2). Robinson and Kolavalli (2010a) also found that Power Rano and Pectomech outperformed other varieties in yield.

Most onion farmers (42 percent) also planted a local variety they could not name, followed by Gaabu (29 percent), and Alata (20 percent). There was regional variation in the variety of onion planted. All the Alata onions were planted in Ashanti, whereas all the Gaabu onions were planted in Upper East. Both Alata yields and Gaabu yields were extremely low, 2.5 mt per hectare and 3.9 mt per hectare, respectively. Only 12 percent of carrot farmers could not name the variety they planted; the rest of them planted Tokita (82 percent) or Golden Bob (6 percent). Scotch bonnet farmers were not familiar with the variety they planted – 86 percent of farmers could not name the variety they planted. The remaining 14 percent listed a local variety that we could not identify from the literature.

Table 3.2. Tomato and onion yields, by variety

Tomato			Onion		
	Observa-tions	Yield (mt/ha)		Observa-tions	Yield (mt/ha)
Akukor	3	2.9	Alata	10	2.5
Akumada	4	4.8	Anago	1	3.0
Burkina	1	20.4	Bawku Red	2	0.8
Konkon	9	9.3	Gaabu	14	3.9
Maacoli	1	5.9	Niger White	1	5.8
Other	5	8.1	Unknown (Local)	20	4.3
Pectomech	10	8.2			
Pertinent	2	14.1			
Power Rano	11	8.4			
Rasta	4	2.4			
Unknown (Local)	21	5.7			

Source: Authors' calculations from the 2017 producer survey

3.2. Production practices

Vegetables production is generally irrigated in Upper East, Northern, and Volta regions. In Ashanti, on the other hand, the selected vegetables are produced under rainfed conditions. Most farmers irrigate their plots using gravity-fed systems, whereas farmers in Upper East use irrigation pumps. Tomato, onion and Scotch bonnet farmers in Kassena Nankana have access to an irrigation scheme. Few vegetable farmers owned irrigation assets. Twenty-three percent of farmers interviewed owned motor pumps – 17 percent of tomato and onion farmers and 25 percent of Scotch bonnet farmers. Motor pump ownership was much more common among carrot farmers – 61 percent of carrot farmers owned pumps.

Access to water for irrigation was an important issue for farmers in Upper East. Forty-five percent of tomato farmers, 85 percent of onion farmers and 29 percent of Scotch bonnet farmers in Upper East felt that not having enough water for watering was their largest hindrance to vegetable production. Flooding was also an issue. Both rainfed and irrigated farmers lost crops to flooding. For tomato farmers, 15.6 percent of irrigated tomato farmers and 11.5 percent of rainfed farmers lost some crops to floods. Similarly, 10.1 percent of irrigated Scotch bonnet farmers and 15.0 percent of

rainfed farmers lost produce to floods. While flooding was not an issue for irrigated carrot and onion farmers, over twenty percent of rainfed farmers from both groups suffered losses from floods.

Fertilizer use varied by value chain. Nearly all vegetable farmers surveyed used fertilizer – 99 percent of tomato farmers, 98 percent of onion farmers, 100 percent of carrot farmers, and 95 percent of Scotch bonnet farmers. Tomato farmers applied on average seven 50-kg bags of fertilizer per hectare, with significant differences between value chains. Onion farmers applied 10.2 bags. Carrot farmers in Mampong used 15.5 bags per hectare on average. Scotch bonnet farmers in Kassena used 18.1 bags per hectare on average, eight more bags then farmers in Tolon. Use of manure and mulch were much less common – only 4.9 percent of farmers used manure and only 6.5 percent used mulch. The use of manure and mulch was most common among tomato farmers.

Pests and plant diseases are an important issue for Ghanaian vegetable farmers. In the producer survey, farmers were asked to list any problems that they faced during vegetable production. The biggest issue identified by farmers was pests and diseases – 68 percent of survey respondents reported that they struggled with pests and diseases. Thirty-three percent of farmers' fields were affected by pests in the most recent growing season. These farmers reported that the pests damaged on average 17.4 percent of their crop. Questions about post-harvest loss from pests were not included in the survey.

Table 3.3. Farmers affected by pests and pesticide use

	Overall			Fields not damaged by pests		Fields damaged by pests	
	Pest damage (% of farmers)	Herbi-cides (%)	Pesti-cides (%)	Pesti-cides used (#)	Use pesti-cides (%)	Pesti-cides used (#)	Use pesti-cides (%)
Ashanti rainfed tomato	36	4	96	2.4	94	3.3	100
Keta irrigated tomato	35	36	79	3.0	85	1.0	100
Upper East irrigated tomato	64	55	91	2.0	75	1.9	100
Bawku irrigated onion	41	44	81	1.1	88	1.2	73
Mampong irrigated carrot	30	25	95	3.5	100	3.6	83
Kassena irrigated Scotch bonnet	45	24	81	3.0	82	3.1	78
Tolon irrigated Scotch bonnet	14	10	41	1.3	36	1.0	75

Source: Authors' calculations from the 2017 producer survey

Table 3.3 shows the percentage of farmers who were affected by pests in each value chain. Irrigated tomato farmers in Upper East struggled the most with pests, 63.6 percent of farmers there stated that their fields were damaged by pests. Farmers commonly use pesticides to protect their crops. Of the producer survey respondents, 90.9 percent of carrot farmers, 86.1 percent of tomato farmers, 81.3 percent of onion farmers and 64.1 percent of Scotch bonnet farmers used pesticides.

While most farmers used pesticides, pesticide use was not tailored to the crop or the pest. First, most pesticides used were preventative not curative (77 percent) – there was no statistical difference in the amount of pesticide used between farmers whose fields were affected by pests and those farmers whose fields were not. Second, 59.4 percent of the farmers surveyed applied more than one type of pesticide on their fields. The farmers combined the pesticides and applied them together roughly one month after their vegetables sprouted. Third, very few farmers could name the brand or type of pesticide they used. Of the 39 onion farmers surveyed that used pesticides, only three could give a name for the pesticide they used. Only two carrot farmers could do so. Slightly more tomato and Scotch bonnet farmers could come up with names, around 11 percent of tomato famers and 20 percent of Scotch bonnet farmers.

The most common types of pesticides cited were Dursban 4E, Topsin, and Sulfur 80. At the same time, however, very little was known about the application of these pesticides. Both Dursban 4E and Sulfur 80 are curative pesticides, however, only one farmer used either of them after their crops showed signs of disease. Moreover, Topsin is a fungicide, but all farmers but one using Topsin identified it as an insecticide. Increased knowledge of pesticides is necessary to battle specific crop blights on vegetables.

The application of herbicide was less common than pesticide. Twenty-two percent of farmers applied herbicides – 16.3 percent of Scotch bonnet farmers, 16.7 percent of tomato farmers, 27.3 percent of carrot farmer, and 37.5 percent of onion farmers. The use of herbicide was far more common among farmers who used irrigation – 23.9 percent of irrigated tomato farmers used herbicide versus only 3.9 percent of rainfed tomato farmers; and 18.3 percent of irrigated Scotch bonnet farmers against 9.5 percent of rainfed Scotch bonnet farmers.

Another issue farmers faced in addition to pests and plant diseases is crop destruction by animals. In Northern Ghana, animals are traditionally allowed to roam freely during the dry-season, and, since vegetable are produced in irrigated conditions in the dry season, they are at risk of being eaten. Farmers therefore build makeshift fences or sleep on their plots to scare off the animals. In Bawku, large dirt walls are constructed around plots. Farmers reported that these measures help reduce the losses from small animals eating their crops, but are not enough to prevent large animals, like cows, from entering their farms, which could result in their losing their entire harvest. In addition, farmers mentioned that the presence of animals limited the area they could plant to vegetables.

Onion and chili farmers in Upper East as well as tomato farmers in Mampong reported that animals were a problem. Only 23.7 percent of the farmers surveyed used a barrier, such as a fence or a wall, to protect their crops from animals. Ninety-two percent of these farmers used irrigation in Upper East or Northern region. The remaining farmers were irrigated farmers in Volta. Almost all the fences were makeshift, constructed each season. Most tomato, Scotch bonnet, and carrot farmers did not fence their farms, because they did not feel it was necessary. Around 10 percent of onion and Scotch bonnet farmers thought it was necessary, but could not afford it. Many onion farmers (35.4 percent) protected their plots by staying and sleeping on their field. Of the farmers who reported that their yields were affected by animals, 76.9 percent did not protect their fields with a wall.

The use of hired labor differed by crop and value chain. To measure hired labor, farmers reported for which farming tasks they used hired labor and for which tasks they used family labor. Overall, the use of hired labor was most common among carrot farmers – 87.5 percent hired outside labor – and tomato farmers – 84.5 percent hired outside labor. Further, carrot and tomato farmers used hired labor to preform 53.0 and 50.3 percent of their farming tasks, respectively. The use of hired labor was common among tomato and carrot farmers for land clearing, tilling/ploughing, and harrowing/leveling – tasks for which hired labor was used by 80.0 percent and 69.3 percent of tomato and carrot farmers, respectively. Hired labor was also used for bedmaking and weeding for these two crops, 63.5 percent of tomato farmers and 68.8 percent carrot farmers used outside labor for these tasks. Input use, such as fertilizer and pesticide application, was mainly done by family labor. Planting/transplanting was mainly done by outside labor for carrot farmers (70.6 percent), while it was done by family labor for tomato farmers. Harvesting, on the other hand was mainly done by outside labor for both crops.

Onion and Scotch bonnet farmers used less hired labor – only 74.4 percent of onion farmers used hired labor and 76.4 percent of Scotch bonnet farmers. However, onion farmers only used

outside labor for 31.8 percent of their tasks and Scotch bonnet farmers for 33.9 percent of their tasks. Unlike carrot and tomato farmers, onion and Scotch bonnet farmers did not use outside labor for land preparation or weeding. Nor did they use outside labor for fertilizer and chemical application. In fact, none of the onion famers interviewed hired outside labor for fertilizer application. Instead, onion farmers mainly used outside labor to build protection walls and bedmaking. Scotch bonnet farmers used outside labor mainly for harvesting.

Capturing the effect of different practices on yields is difficult using our producer survey data. First, it is very possible that yields are lower than IWMI and MOFA estimates because vegetable farmers over-estimate their plot size. Only 5.4 percent of survey respondents reported planting less than half an acre in vegetables. Most respondents either planted half an acre (29.2 percent) or one acre (29.6 percent). Anecdotal evidence suggests that these estimates are high. Second, although our survey asks about the quantity of inputs applied, it does not include information on the specific type of fertilizer, pesticide, or soil type. Finally, we do not know whether best practices are followed in terms of timing of input application and irrigation or for practices such as row planting, bedmaking, or the seeding rate.

Nonetheless we have attempted to understand the relationship between the vegetable farming practices we captured and the quantity of vegetables harvested. In Table 3.4 we have divided irrigation and input use into groups to observe whether yields are statistically different under different conditions.

Table 3.4. Vegetable yields by irrigation, fertilizer use, and pesticide use, mt/ha

		Tomato		Onion		Carrot		Scotch bonnet	
		Obs.	Yield	Obs.	Yield	Obs.	Yield	Obs.	Yield
Irrigation	No irrigation	26	4.2	9	2.6	10	7.4	20	6.0
	Motor-pump	13	4.3	7	2.8	23	7.9	24	3.7*
	Gravity-fed	33	5.2*	32	4.2*	-	-	27	4.5*
Fertilizer use	< 2 bags	39	5.3	17	2.7	7	0.2	43	2.8
	2 to 4 bags	22	7.3*	15	3.1	11	8.3*	20	2.6
	> 4 bags	11	9.1*	16	4.7*	15	10.3*	29	3.6*
Pesticide use	None	17	4.5	14	2.8	14	0.4	37	3.8
	1 to 5 kg	38	6.7*	18	3.4	7	5.7*	19	2.2*
	5 to 10 kg	17	5.8*	16	4.1*	12	10.3*	36	2.9

Source: Authors' calculations from the 2017 producer survey
Note: T-tests are relative to no irrigation, fertilizer less than two bags, or no pesticides, * represents a significant differences at the at p = .05.

Looking at our three key inputs, irrigation, fertilizer and pesticides, we can see in Table 3.4 that there are significant differences in yields. The use of irrigation did not increase yields. Tomato and carrot farmers had only marginally higher yields under irrigated conditions and irrigated Scotch bonnet farmers had lower yields. Onion yields only increased with the use of gravity-fed irrigation in Bawku East. However, irrigated onion yields were still extremely low compared with other estimates. Yields may have been lower with motor-pump irrigation because of limited water supplies – 45 percent of tomato farmers in Upper East, 85 percent of onion farmers, and 19 percent of Scotch bonnet farmers complained that there was inadequate water for watering.

Increased use of fertilizer contributed to higher yields. Tomato yields increase incrementally by about 2.0 mt per hectare for every two 50 kg bags of fertilizer added. Carrot farmers reported very low yields with low fertilizer use. Scotch bonnet farmers saw a much smaller increase in yield with higher levels of fertilizer application. Although pesticide use was not well targeted, increased

pesticide use did contribute to increased yields, except among Scotch bonnet farmers suffering from pest outbreaks.

4. PROFITABILITY

Despite low yields, vegetable production is profitable in Ghana. Our survey data show that gross margins for tomato, onion, carrot, and Scotch bonnet are high and much larger than the gross margins for staples such as maize and rice. Our survey indicates that average gross margins for tomato range from GHc 2,339/ha in irrigated Keta (Volta) to GHc 9,565/ha in rainfed Ashanti, and GHc 8,113/ha in the irrigated Bawku (Upper East). Onion farmers in Upper East had lower gross margins on average, GHc 4,171/ha, but still high compared with staple farmers. Moreover, carrot farming is very lucrative with average gross margins for irrigated production around GHc 13,756/ha in Mampong (Ashanti). Finally, Scotch bonnet also has high returns; average gross margins ranged from GHc 20,926/ha in Kassena Nankana East (Upper East) to GHc 4,928/ha in Tolon (Northern).

Surveys of irrigated vegetable production conducted by International Water Management Institute (IWMI) in 2017 also show that vegetable production is profitable. Their data also reveals a wide range of average gross margins for tomato growers, from GHc 10,488/ha in West Mamprusi (North) to GHc 5,892/ha in Talensi (Upper East), and GHc 5,449/ha in Bawku West (Upper East). Their data however, shows much higher gross margins for onion production than our data, GHc 7,526/ha in Bwaku West, GHc 10,355/ha in Talensi, and GHc 8,315/ha in West Mamprusi. Further, their data also shows a range of gross margins for Scotch bonnet farmers, from GHc 5,066/ha on average in Bwaku West to GHc 9,173/ha in West Mamprusi.

Gross margins for vegetable farming in Northern Ghana are much higher than gross margins for maize and rice production there. Estimates from Innovation for Poverty Action (IPA) data in Northern Ghana show that in 2016 gross margins for maize were GHc 264/ha in Upper East, West, and Northern regions. Ragasa, Chapoto, and Kolavalli (2014), estimate that the returns to rice farming in Northern Ghana in 2013 were GHc 1,214/ha for irrigated rice and GHc 415/ha for non-irrigated rice – higher than maize, but much lower than for vegetables.

Table 4.1. Average gross margins for vegetable farmers, by gross margin tercile, district, and production system, GHc/ha

	Observations	Bottom third	Middle third	Top third
Ashanti rainfed tomato	23	(106)	6,231	24,429
Keta irrigated tomato	12	(2,160)	1,194	7,984
Upper East irrigated tomato	11	(1,619)	2,099	29,108
Bawku irrigated onion	27	1,469	3,700	7,344
Mampong irrigated carrot	20	2,126	12,232	29,103
Kassena irrigated Scotch bonnet	20	5,726	14,834	45,766
Tolon irrigated Scotch bonnet	29	750	3,594	11,051

Source: Authors' calculations from the 2017 producer survey

Although vegetables were generally more profitable than staple farming, gross margins ranged considerably at each site. While all onion, carrot, and Scotch bonnet farmers reported positive gross margins, tomato farmers at all three sites struggled with low-profitability (Table 4.1). To try and understand some of the reasons behind these differences in profitability, we break each value chain into three quantiles (terciles) of gross margins. Table 4.2 presents these quantiles for all values chains.

First, we see that the most significant difference between farmers with low gross margins and high gross margins is yield. Farmers in the first tercile, with average gross margins of GHc 1,218/ha,

obtained yields of 3.0 mt/ha for their crop, while farmers in the most profitable quantile had yields of 8.5 mt/ha. Farmers in the most profitable tercile also received better prices. Costs per hectare were fairly consistent across the terciles with the most profitable farmers spending the most. There was also little variation in farm size. The most profitable growers used more fertilizer and herbicide, but less pesticides. They were also more likely to own a motor pump. Finally, it seems that while age did not play a role in increasing profitability, years or experience did – farmers in the third most profitable tercile had an average of seven more years of experience than those in the first.

Table 4.2. Gross margins for vegetable production, by farmer characteristics and gross margin terciles

	Bottom third	Middle third	Top third	Mean
Farmgate price	2.2	3.2	3.8	3.0
Cost, GHc/ha	4,085	3,718	4,474	4,078
Yield, mt/ha	3.0	4.3	8.5	5.1
Use hired labor, %	90	76	80	82
Own motor pump, %	26	22	44	30
Know variety, %	49	53	57	53
Fertilizer, kg	259	207	343	267
Herbicide, kg	0.4	0.5	1.0	0.6
Pesticide, kg	5.8	5.2	3.7	4.9
Loss to pests, %	7	4	7	5
Vegetable farm size, ha	0.5	0.5	0.6	0.55
Age, years	40	42	43	42
Years of experience	16	18	23	19

Source: Authors' calculations from the 2017 producer survey
Note: The vegetables examined are tomatoes, onions, carrots, and Scotch bonnet chilies. The types of vegetables are distributed evenly across the terciles, with the same amount of each vegetable in each tercile. Farmers for each vegetable were first grouped into terciles and then combined for the table.

Ghanaian farmers produce vegetables at a cost of less than 1,000 GHc per mt (Table 4.3). As shown above, costs per mt were not a major driver of differences in gross margins, but some value chains faced higher costs than others, particularly those in Kassena and Keta. Two broad patterns emerge from the cost of production data. First, in some cases, input use intensification did not increase yields, which resulted in high per mt costs. In Kassena, Scotch bonnet farmers in the lower two gross margins quantiles had high input costs, GHc 640/mt, because of very high pesticide use. Farmers in the first quantile reported that pests consumed on average 18 percent of their Scotch bonnet fields.

Table 4.3. Breakdown of production costs, by district and production system (GHc/mt)

	Observa-tions	Total costs	Inputs	Hired labor	Machin-ery	Infra-structure
Ashanti rainfed tomato	23	380	161	155	22	41
Keta irrigated tomato	14	841	282	323	39	198
Upper East irrigated tomato	11	396	111	118	108	59
Bawku irrigated onion	27	622	397	106	12	107
Mampong irrigated carrot	20	786	214	225	158	189
Kassena irrigated Scotch bonnet	21	1,537	640	358	351	188
Tolon irrigated Scotch bonnet	29	302	172	39	49	42

Source: Authors' calculations based on Producer Survey, 2017
Note: production costs have been estimated without including the value of family labor

Second, it is expensive to irrigate a plot, and in some areas irrigation did not sufficiently increase yields, so production was less profitable. An excellent example of this is Keta (Volta) tomato. Infrastructure (irrigation) costs tomato were GHc 41/mt for Ashanti rainfed tomato and GHc 59/mt for Upper East irrigated tomato, but GHc 198/mt for Keta irrigated tomato. Among the Keta farmers, yields were consistent across gross margins terciles, but costs per mt were double in the first tercile, so tomato farmers in Keta in the first tercile were estimated to have negative gross margins.

Finally, because of low yields in Ghana, costs per mt are higher than in neighboring countries. In Maradi, Niger, costs of production for onion were 192 GHc/mt, while tomato costs were GHc 225/mt (Chambre Régionale d'Agriculture de Maradi 2017). Moreover, in Mali, the AFC Consultants International (2015) estimate the cost of onion production at GHc 415/mt, also lower than our estimate for Ghana. While costs are higher in Ghana, total onion costs of production in Ghana are much lower than in Niger or Mali. For onion, we estimate costs at GHc 2,816/ha, while in Niger costs were GHc 6,142/ha and in Mali, GHc 9,132/ha. Spending on infrastructure, such as irrigation and fencing, was almost four times greater in Niger than in Ghana. For tomato, per hectare costs were similar in Maradi and in Upper East, Ghana at around GHc 4,000/ha. Distribution of spending, however, was different. In Ghana spending on infrastructure and hired labor made up a larger portion of total spending at 38 percent and 28 percent, respectively, while in Niger 52 percent of costs were for inputs.

5. MARKETING

Efficient marketing systems are essential for incentivizing production. Ability to market produce and negotiate a fair price affects whether a farmer will choose to produce the crop and whether the farmer will make investments to increase productivity. There are several studies that detail the vegetable marketing structure in Ghana. They explain that large markets are controlled by associations of traders. These associations include both wholesaler and retailers and are controlled by a female leader called 'Queen Mothers' or 'Market Queens' (Robinson and Kolavalli 2010c). These associations exist for all major commodities, though Peppenelenbos (2005) asserts that the associations are strongest in the vegetable sector, specifically for tomato.

These associations limit vegetable supply in the markets. First, in some markets, traders are required to register to sell in the market. If they are not registered, they must sell through a registered wholesaler. Second, once traders control access to the market, they control the quantity supplied by limiting the number of trucks that enter the market (Robinson and Ngeleza 2011; Awo 2012; Robinson and Kolavalli 2010b). Networks that give farmers access to these markets therefore are extremely important.

Traders travel to farms to purchase vegetables. We found in our producer survey that more than 50 percent of the farmers surveyed sold their produce at the farmgate. There are two types of farmgate buyers: local market buyers who may retail and sell to retailers in nearby markets; and traders or agents of traders who transport the produce to major markets. Farmers who do not sell at the farmgate sell to retailers at local markets or bring their produce to the market themselves. Most farmers only sold to one buyer per harvest.

Farmers who sold at the farmgate received higher prices on average than farmers who sold their produce at the market. Tomato prices were nearly GHc 80 greater on average per crate if the sale was made at the farm as opposed to off-farm (Table 18). Likewise, onion prices were GHc 40 greater per maxi bag if the sale was made at the farm. Scotch bonnet farmers in Kassena received GHc 50 more per maxi bag for an on-farm sale. In Tolon, however, there was no statistically significant difference between prices for on-farm and off-farm sales, but this appears to be a result of a

shortage of buyers in Tolon. Again, this suggests that access to trader associations is important for successfully marketing vegetables.

Table 5.1. On-farm and off-farm sale prices, by district and production system,

	On farm	Off farm
Ashanti rainfed tomato, GHc/crate	227	124
Keta irrigated tomato, GHc/crate	226	142
Upper East irrigated tomato, GHc/crate	139	115
Bawku irrigated onion, GHc/maxi-bag	145	106
Kassena irrigated Scotch bonnet, GHc/maxi-bag	207	166
Tolon irrigated Scotch bonnet, GHc/maxi-bag	30	39

Source: Authors' calculations from the 2017 producer survey.

Wholesalers aggregate vegetables from nearby communities. By aggregating vegetables and selling to larger urban markets, traders' lower transportation costs per unit and can sell at a premium. In some cases, traders obtain their produce requirements by contracting farmers and supplying them with credit or inputs for a guaranteed purchase at farmgate.

Our survey data indicates that farmers in each of the districts and production systems we studied had varying access to these trader networks. For example, most Ashanti tomatoes were sold to wholesalers selling to Accra and Kumasi, while most Upper East tomato farmers sold to retailers who sold in local markets. Onions from Upper East also were bypassed by traders and sold locally in the region. Carrots, on the other hand, were either transported to Accra, Kumasi, or Mampong. Scotch bonnet from Kassena that were not sold in Kassena were transported to Navrongo and Kumasi, while those from Tolon were sold to traders who transported their Scotch bonnets to Accra and Tamale. This suggests that traders in certain areas may bypass locally produced vegetables and rely on imports.

Tomato production in Upper East region overlaps with peak production in Burkina Faso. Ghanaian traders, who control access to major markets, prefer to obtain tomatoes from Burkina Faso (DAI 2014). Traders claim that the tomatoes from Burkina Faso are of higher quality than those from Upper East, particularly in that they last longer and travel better, reducing the risk of loss to the trader. The association of tomato traders who import from Burkina Faso also claimed that locally produced tomatoes do not keep as well as those that they import. In addition, traders prefer to source tomatoes from a consistent source, with a concentration of farmers that are able to supply sufficient quantities and are easily accessible from major roads (Robinson and Ngeleza 2011). The result of these marketing patterns appears to be a decline in tomato production in Upper East.

For onions from Upper East, this appears to be an issue as well. None of the onion farmers we interviewed had produce that they knew was being transported to Accra. Instead, their onions were staying in local markets. It seems that onion wholesalers bypass Upper East onion farmers and mainly bring imported onion into Accra (DAI 2014). More research would be needed to see if this was indeed the case.

Although, farmers within these market networks garner higher prices than farmers who are excluded, this marketing system may not encourage investment in agriculture. First, these farmers must wait for a buyer to come to their farm, which reduces their bargaining power. Second, farmers outside of the system do not have steady access to markets and, therefore, have limited incentives to increase production. Third, even farmers within the system may have a limited desire to increase production because, if farmers are not guaranteed access to this marketing system, they will receive

different prices from harvest to harvest, depending on whether they must bring their produce to the market.

The market power of farmers also is weak because farmers are unable to store their harvests before selling. In our survey, we found that tomato and Scotch bonnet farmers, regardless of their location, do not store their crops for more than a day before selling. This implies that most Scotch bonnet farmers chose to sell their Scotch bonnets fresh instead of boiling and drying them. While carrot farmers do not store their carrots for more than three days, onion farmers, on the other hand, store their onions for 19 days on average. However, onions are stored on the ground at the farm. In fact, every farmer interviewed who stored their crops, stored them either at home or on their farm.

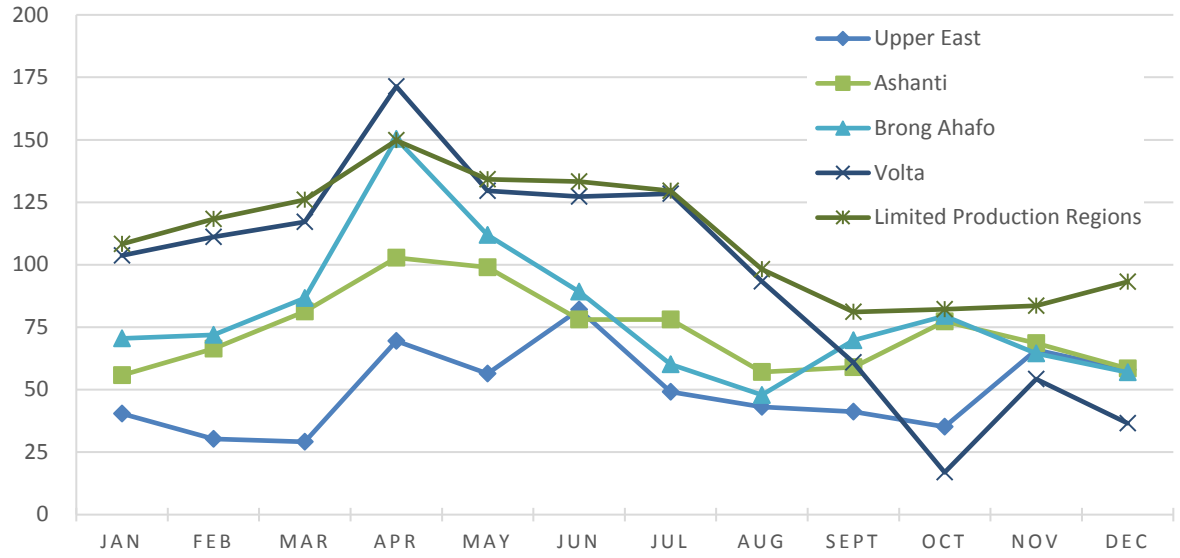
This is in part because there are no major storage facilities for vegetables in Ghana. While onions can be stored for nearly six months if they are adequately cured and stored in the right conditions – in a cool, dry, and well-ventilated building – without appropriate storage, onions will rot in high temperatures or sprout in humidity. Emmanuel (2011) reports from a small survey that farmers who participated in an inventory credit program benefitted from being able to safely store their onions for three months.

Finally, there are other limitations to marketing for farmers, such as the wide range of buying units. Different units used by different buyers, at different levels of the value chain makes it hard for farmers to determine if they have received a fair price for their goods. Marketing practices, such as using the crates in which tomatoes are transported also as units of exchange, have made traders resist any innovations in packaging. Therefore, traders may be unwilling to adopt a new system, although current packaging leads to high levels of post-harvest loss and, therefore, lower prices for farmers.

Transportation is also an issue. Perishables undergo considerable damage during transport because of poor roads and the use of inappropriate vehicles and packaging. The bulk of vegetables and fruits may be taken from farms to nearby markets in taxis. Between markets in Ghana there is significant spatial variation in vegetable prices. Although we do not have the means to tease out the causes of the price differences, it is possible that in many cases, the price difference is simply transportation costs.

As shown in Figure 5.1, over the period 2005 to 2015 the average price of a crate of tomatoes was GHc 35 greater in non-producing regions than in producing regions. This could be a result of transportation costs. Moreover, in each region, prices reached a low during the respective peak harvest period: March in Upper East, August in Ashanti, and October in Volta. Prices in Upper East, however, were consistently lower than prices in all other regions, which reflects the counter-seasonal nature of their primary production season as well as their proximity to Burkina Faso. Prices in Ashanti also stayed below prices in non-producing regions. This is driven in part by the prolonged production season and because Kumasi is the center of tomato marketing. Over the period considered, the average price of a crate of tomatoes in the Greater Accra region was consistently GHc 30 higher than the average price across the country. Further, research is needed to understand to what extent these higher prices reflect road conditions or other marketing costs.

Figure 5.1. Average tomato wholesale prices by region and month, 2005 to 2015, GHc/crate



Source: Authors' estimates based on Ghana Ministry of Food and Agriculture data (MOFA 2015).

Most vegetable farmers in Ghana only sell to one buyer, which decreases their marketing power. With access to few buyers and limited or no storage, vegetable farmers are forced to sell their crops at the price set by the wholesaler. Further as discussed, certain value chains benefit from having several wholesalers who sell to a variety of markets, while others have only one or two buyers. Low farmgate prices and weak marketing power reduce farmers' incentives to increase productivity. If vegetable production is to increase in Ghana, improving marketing incentives is key.

6. CONCLUSION

Ghana depends on imports to meet total consumption requirements of essential horticultural foods such as onion, tomato, Scotch bonnet, and carrot because domestic production does not meet demand. Quantifying the trade in vegetables is difficult because the bulk of it takes place informally across borders. However, discussions with traders in major markets suggest that imports are significant. Nearly 90 percent of the tomatoes coming into major markets from January to May are imported. For onion and carrot, import dependence is far greater.

Seasonality is one reason that vegetable production cannot meet local demand. Although several production systems under the diverse agro-ecological conditions in Ghana can supply vegetables year-round, vegetables are produced in significant quantities in just one season. In agro-ecological terms, a much larger area is suitable for vegetable production. GLSS data that shows the number of households growing vegetables at the non-commercial level reveals that Western and Upper West regions are suitable for production, as well as broader areas in current production zones.

Low-yields are another important reason for limited supply response. Although farmers cultivate vegetables intensively with applications of significant quantities of inorganic fertilizers and plant protection chemicals, yields are significantly lower than in neighboring countries.

One possible reason for low-yields is the varieties used. Little research is being conducted on vegetables in Ghana. Varietal development and release has been neglected for some time. There is no systematic program to conduct trials of vegetable varieties and release them with area-specific recommendations – as evidence of this, a large segment of growers interviewed did not know the

name of the varieties they had planted. Making suitable varieties available is an important avenue for increasing productivity. Locally suitable Galmi onion varieties, for example, could encourage greater production even in rainfed conditions.

Plant protection is also an important aspect of vegetable production. While vegetable farmers use chemicals, their knowledge of the chemicals and their proper use is limited. Farmers must use chemicals safely and adopt integrated pest management practices. Research is also needed to help farmers address pest outbreaks. Some areas that have historically produced vegetables, such as Upper East region, are affected by disease complexes that can only be eliminated through research and changes in vegetable cultivation practices. There is also a need to improve soil management through crop rotation and application of both organic and inorganic nutrient sources. Importantly, because vegetables are grown in different conditions in the country, area-specific technologies need to be developed.

Despite low yields, average gross margins for the selected vegetables are much higher than can be obtained from the cultivation of crops such as maize and rice. (Note, however, that these gross margins do not take into consideration value of household labor.) But returns are heterogeneous. Nearly 25 percent of tomato growers in some production systems incur losses, while producers of other vegetables make attractive returns. The variation in returns is explained by differences in yields and prices obtained.

Unlike the farmers, traders are well organized. Wholesalers who take produce to major markets such as Kumasi, Accra and Takoradi have organized themselves into associations, which exercise control to various degrees. In the case of tomato, they effectively control the number of truckloads that go to major markets. These quantitative restrictions can be a significant problem for producers seeking a market. In smaller markets, the queen may even have control over who retails in the market (Schipmann 2006). Farmers who do gain access to markets end up receiving slightly higher prices than they would have otherwise received (Robinson and Ngeleza 2011).

While, imports usually meet the excess demand for vegetables in Ghana, there is some evidence that imports curtail domestic production. Apart from meeting the seasonal deficits, imports may be encouraged for network, quality, or convenience. Tomato production in Upper East region overlaps with peak production in Burkina Faso, and Ghanaian traders, who control access to major markets, prefer to obtain tomatoes from Burkina Faso. The association of tomato traders who import from Burkina Faso claims that locally produced tomatoes do not keep as well as the imports. The result appears to be a decline in production in Upper East (Robinson and Kolavalli 2010a). Carrot traders may prefer imports because of convenience, traders in Accra's Agbogbloshie market find it more convenient to sell packaged carrots from a cold house established by importers, rather than organize procurement from numerous domestic farmers. This may be the case for onion traders as well.

Although in agro-ecological terms, vegetables can be grown more widely than at present, expansion of production may require improvements in both production conditions and marketing. First, irrigation makes year-round production feasible. If Ghana were to supply vegetables year-round, farmers either need to expand production in the north of the country, which requires irrigation, or grow vegetables in the second season in the south, which also requires irrigation. At the same time, however, we have found that irrigation does not necessarily improve yields or gross margins. This is in part because of issues with accessing ground water and with the quality of ground water available. Further, since irrigation increases costs considerably, other changes such as the use of improved varieties and better practices may be necessary to make farming vegetables under irrigated conditions profitable.

For marketing, the essential challenge is to overcome the fact that producers of perishables must wait at their farm for buyers to pick up their output. This is an area that deserves further research. The physical infrastructure for marketing of perishable crops, such as fruits and vegetables, is nearly non-existent in Ghana at both farm and market levels. Smallholders rarely have structures on farms to store and sort the harvested produce in shade, let alone store them at cooler temperatures in dry conditions to delay deterioration. Perishables also undergo considerable damage during transport because of poor roads and the use of inappropriate vehicles and packaging.

In sum, import-substitution of vegetables offers higher-return cropping opportunities for Ghanaian producers under both rainfed and irrigated conditions. Some of the strategies that need to be considered to develop these opportunities are:

- Improve yields under different conditions to encourage vegetable production.
    - Make suitable improved varieties more widely available, which would require systematic trials to assess performance of available varieties;
    - Develop area-specific production practices;
    - Improve guidance to overcome pest and disease outbreaks and promote safe pesticide use; and
    - Increase opportunities for irrigation, including supplemental irrigation.
- Initiate measures to overcome trader-organized restrictions on entry to major markets.
    - Establish auction markets in urban centers; and
    - Encourage larger buyers to source vegetables from these auction houses.

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