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Ghana Food Manufacturing Industry Report

An Analysis of Ghana's Aquaculture, Fruits & Vegetable, and Poultry Processing Sectors

Contents

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The Ghana Food Manufacturing Sector Development Report is an initiave financed by The Kingdom of Netherlands Embassy in Accra and the The Netherlands Enterprise Agency. The report presents nuanced analysis of three food processing value chains—tilapia, poultry, tomato and mango—highlighting the sectors' developmental tracjectories, structural impediments and emmerging opportunities.

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INTRODUCTION

In the last decade, Ghana's economy and population has grown rapidly. Between 2008-2018, the country recorded average economic growth of 6.5%. This growth has brought about a sharp expansion of Ghana's middle class. The African Development Bank estimates that 20% of Ghanaians fall within the middle-income bracket. In the same period, Ghana has recorded a population growth rate of 2% per annum, with current population size of 28.1 million. A total of 51% of Ghana's population live in urban areas, with the urban population expected to increase at 3.1% per annum in the coming years.

The convergence of the above-mentioned economic and demographic shifts has set in motion a transformation in the dietary preferences of Ghanaian consumers: increasing demand for processed food. Indeed, given time demands and need for convenience, the growing urban population is replacing consumption of foods with long preparation times with (semi) processed foods. Similarly, with rising incomes, middle class consumers are prioritizing diversity, nutrition and safety in their food purchases. These developments are spurring a growing demand for processed foods and thus present an opportunity for suppliers of processed foods.

Notwithstanding growing demand from consumers, Ghana's food processing sector remains underdeveloped. As of 2017, a mere 200 agro processing firms had registered and received certification to operate by the Ghana's Food and Drugs Authority. Although, retail shops stock vast variety of processed foods, the local processing industry accounts for only 20% of processed food on the market.

The local industry's inability to adequately leverage the growing domestic demand for processed food is the starting point of this report. In light of this, the report's objectives are to identify the critical challenges impairing the sector's growth and outline key potential solutions to resolving such challenges. The report is structured into three parts. The first part is concerned with Ghana's aquaculture sector. In chapter 1, a general analysis of Ghana aquaculture sector is presented; whereas Chapter 2 presents an in-depth value chain analysis of the tilapia processing sector; with the final chapter of Section 1 detailing the critical challenges and opportunities of the tilapia processing industry. Section 2 of the report pertains to the poultry industry. In Chapter 4, a sector overview is presented, charting the broad trends in production, consumption and trade. Chapter 5 offers an analysis of primary production sub-sectors, by mapping out the characteristics of day-old-chick production, and commercial layers and broiler rearing as well as the accompanying critical challenges. In Chapter 6, analysis of the broiler processing sub-sector is discussed along with critical challenges and opportunities. The final Section pertains to the fruits and vegetable industry. Here, Chapter 7 offers a general overview of the vegetable processing industry, with Chapter 8 presenting in-depth analysis of the tomato processing sub-sector. Chapters 9, 10 and 11, offers in-depth analysis of the fruits processing industry, with particular emphasis on mango processing.

SECTION 1: AQUACULTURE SECTOR

Executive Summary Aquaculture Sector

Fish-holding systems commonly used in Ghana include floating cages, earthen ponds, and concrete tanks. Of all farmed fish in Ghana, between 75 per cent and 93 per cent are derived from floating cages, while the remaining are harvested from ponds. Tilapia (Oreochromis niloticus) is the predominant and preferred fish species for farming, marketing, and consumption in Ghana, and it accounts for over 80 per cent of farmed fish harvest. Under MOFAD's policy for sustainable development of aquaculture, fish production from aquaculture has grown over the past decade, from a paltry 6,514 MT in 2008 to 76,620 MT in 2018. However, in recent times, the emergence of issues relating to fish health has stressed the industry to a significant extent leading reduction in production levels.

A total of about 12 policies are in existence to regulate the aquaculture sector in Ghana. There are also about 11 institutions in the country playing various roles that contribute to sustaining the sector with the Ministries of Fisheries and Aquaculture Development exercising oversight responsibility.

Some 849 primary actors were identified to be involved in the aquaculture value chain nationwide. However only 297 (35 per cent) were listed as active, 23 per cent as inactive with the rest not having their status indicated. Of the active actors 30.9% are classified as small-scale, 44. per cent as medium scale and 24.3 per cent as large scale, based on their installed capacities. About 20 value chain actors in the sector were interviewed on their operations. These included 3 hatcheries, 2 feed producers/suppliers, 8 grower processors and 7 processors.

Profitability calculations indicated that Fingerling production yields a profit of 138 per cent whilst Growers make a profit of 1,306% with the Processors (grillers) making a profit of 208 per cent - implying that the industry is very profitable.

Some recommended measures to mitigate the constraints outlined include; streamlining and enforcing Ghana Aquaculture Standards, enforcement of the fish movement certification and provision of technical support/assistance to the growers to overcome challenges related to high mortality. The key constraints identified across thee value chain were high mortality, limited funding, high cost of inputs, lack or inadequacy of equipment/technology and insufficient supply of inputs

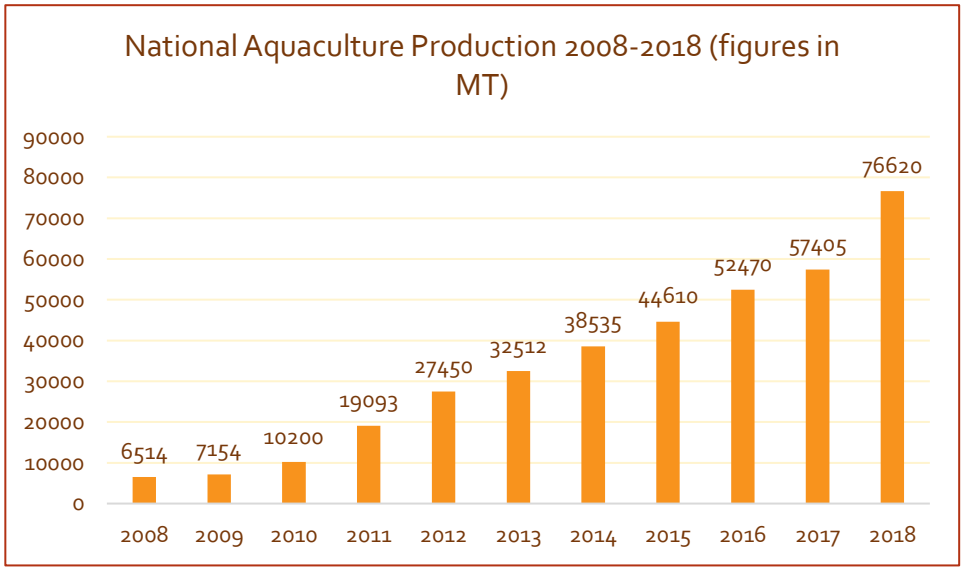
The study comprised a data review as well as primary data collection through semi-structured interviews and direct observations were also made during field visits. A stratified sampling method was used to select the actors to be interviewed and sites to visit. Primary data gathered was analysed using the ESSEC Value Chain Analysis Methodology, and conclusions drawn. Per the initial secondary information obtained, a population size of 97 functional Actors was identified, out of which a sample size of 25 actors was used for the study. For primary data collection, a total of 18 Value Chain Actors (VCAs) were interviewed. These comprised of 3 Hatcheries, 2 Feed Producers, 8 Grower-Processors and 7 Processors. Eighteen of the companies were privately owned, whilst two were publicly owned. Companies sampled are located in four regions, namely: Central, Eastern, Greater Accra and Volta regions. Further details on the VCAs interviewed may be found in Appendix 4

1. OVERVIEW OF AQUACULTURE SECTOR IN GHANA

Aquaculture and Ghana's economy

Ghana's economy is led by the agriculture sector including the production of cash and food crops, livestock, and poultry, as well as fisheries. The fisheries sector is made up of both capture fisheries and aquaculture sub-sectors which contribute substantially to Ghana's economy through employment, Gross Domestic Product (GDP), foreign exchange earnings, food security and poverty reduction. It provides livelihoods and employment opportunities for an estimated 10 per cent of the Ghanaian population representing about 2.6 million people and contributing 1.5 per cent to the nation's GDP with an annual revenue of about 1 billion to the national economy in 2017 (MOFAD, 2018). The fisheries sector share of agriculture GDP is 5 per cent with the aquaculture industry playing a significant role as it currently contributes about 10 per cent to fisheries production and expected to continue to rise in tenfold in subsequent years.

Figure 1: National aquaculture production source



Source: Fisheries Commission, 2018

Across Africa, Ghana is recognised as a major aquaculture producer. According to FAO, in 2015, Ghana was the second largest producer on the continent, and the 13th largest producer in the world. As a lower middle-income country with an expanding middle-class population, the market for high value-added products, such as tilapia, is growing rapidly. Daily consumption per capita in Ghana is approximately 28 kg representing one of the highest consumption rates globally and in Africa (IFPRI, 2018). Fish accounts for 60 per cent of the national dietary intake of animal protein in Ghana (Rurangwa et al. 2015), about four times higher than the global average (Hishamunda et al. 2009).

However, Ghana's dwindling fish supply from capture fisheries—both in marine and inland--are inadequate to satisfy growing demand for affordable protein for a growing population. Natural water bodies such as Lake Volta, River Bosomtwi and River Pra which have also been instrumental in fish production are facing their share of challenges, ranging from pollution due to mining to the reduction of water levels that compromise fisheries. In the face of these problems, it will suffice to say the Ghanaian consumers' demand for fish will be met through aquaculture.

Sector performance

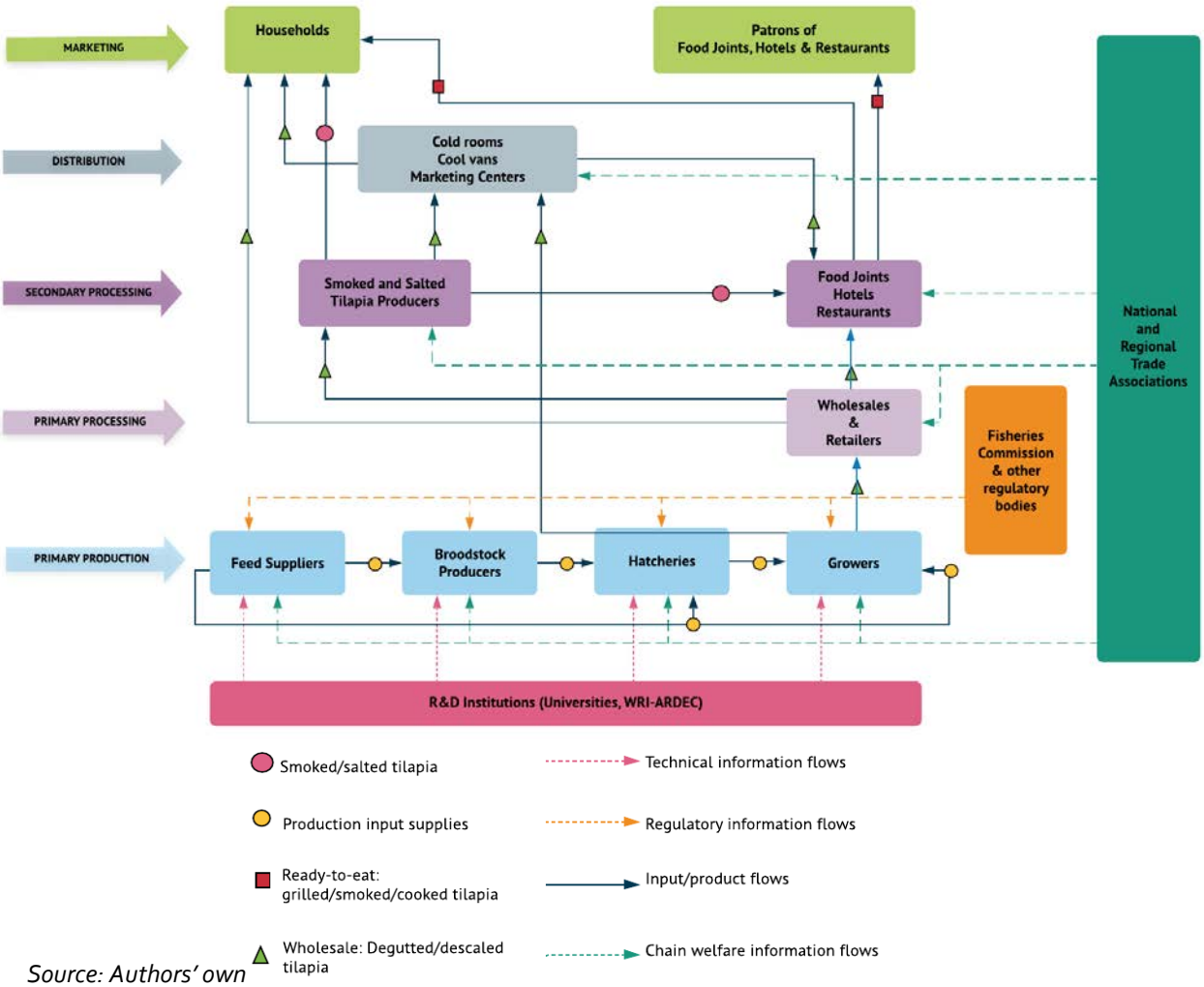
Ghana is home to one of the largest man-made lakes in the world, serving as an ideal resource for cage aquaculture. Indeed, the sector has seen significant growth in the past decade. Fish production from aquaculture increased from over 32,512 metric tonnes (MT) in year 2013 to 76,620.00 MT in year 2018 representing about 42.4 per cent of the national fish production. Aquaculture is increasingly seen as a key resource for bridging the gap between annual average demand (900,000 MT) and annual average supply of fish (400,000 MT) (MOFA, 2018).

The major cultured fish species in Ghana presently are the Nile tilapia (Oreochromis niloticus), the African catfish, (Clarias gariepinus) and the African arowana (Heterotis niloticus). Tilapia species account for over 80 per cent of the farmed fish harvest in Ghana. Ghana has about 5,000 fish farmers operating approximately 19,000 fishponds and cages. The aquaculture output for 2013 was a little over 30,000 MT of fish, out of which nearly 88 per cent came from cages. Presently, production of cultured tilapia is approximately 76,620 metric tonnes (MoFAD 2018). The subsector has majority of its farmers farming on a subsistence level, primarily on a small-scale using semi-intensive systems to culture fish in floating cages, earthen ponds, dugouts, and reservoirs, with few commercial fish farmers (investors) employing intensive culture systems to farm from circular cages, floating cages, earthen ponds and concrete tanks. The commercial farmers - though are in the minority - produce about 75 per cent of Ghana's total aquaculture production.

2. VALUE CHAIN ANALYSIS: TILAPIA PROCESSING

In Ghana, the tilapia value chain from inputs to final product (processed tilapia) is relatively short and simple. The value chain begins with hatcheries, feed producers, primary producers who also double as primary processors and the market operators. This section discusses how the chain is constituted and functions.

Figure 2: Tilapia Processing Value chain



Source: Authors' own

2.1 Fingerlings Production

Tilapia productions starts and depends on the availability of quality fingerlings. Presently, there are 24 hatcheries, of which three are public hatcheries namely, the Ashaiman Aquaculture Demonstration centre in Greater Accra, the Pilot Aquaculture Centre (PAC) in Kumasi in Ashanti Region, and the ARDEC in Akosombo, Eastern Region. The widespread tilapia breed farmed in Ghana is the local Akosombo strain. Incidentally, Akosombo is the only breed permitted to be farmed by local regulators. Although not permitted, it was noted that Genetically Improved Farmed Tilapia (GIFT) strain is slowly being adopted by some hatcheries. According to local hatcheries, GIFT reduces maturing time by four months, and, according to anecdotal evidence, is less susceptible to bacterial infections and disease.

The subsector as observed consists of two types of producers: 'Specialist Hatcheries' are those companies dedicated to the exclusive production of fingerlings; whereas 'Integrated Hatcheries' are entities that produce fingerlings to stock their own commercial tilapia farms, mostly large and medium-scale commercial farms. Notwithstanding, numerous Specialist Hatcheries, low supply of quality fingerlings to feed commercial tilapia farms has been a major bottleneck among farmers, especially small farmers. Indeed, due to the rapid growth of cage farming, coupled with difficulty in accessing fingerlings, several medium-large scale cage farms have resorted to producing their own fingerlings and selling to other farmers when they have surplus.

Private hatcheries depend on ARDEC at Akosombo for technical advice for their production. Annual fingerling production was 504.7 million as at August 2018 due to the rehabilitation of three public hatcheries. The highest numbers of fingerlings are produced in hatcheries located in the Greater Accra (39 per cent) and the Eastern (24 per cent) regions to supply cage farms with stocking material; and their number keeps growing each year. Of the six hatcheries sampled, three are integrated producers accounting for 26 per cent of fingerlings output within the sampled population. As Table 1 illustrates, Integrated Hatcheries tend to have modest installed capacities hence the cost of production is higher relative to Specialist Hatcheries. Nonetheless, it was observed both hatcheries sold fingerlings within range GHS 0.24-0.30.

Image 1: Facility of specialist hatchery in the Eastern Region

Source: Authors' own

It was noted that, strain enhancement and conditioning along with growing sound management of hatcheries in recent years have brought about increased productivity and profitability of tilapia

farming. Indeed, the profit margin of hatcheries across the country is estimated at 515 per cent (Anani and Agbo, 2018); whereas 128 per cent is the average profit margin recorded among hatcheries sampled

Table 1: Operational Details of Sampled Hatcheries[1]

Company	Type	Region	Installed capacity	Output per annum (pieces)	Feed utilized
A	Hatchery	Eastern Region	5,460,000	5,460,000	0.64
B	Integrated	Eastern Region	20,000	20,000	2.64
C	Integrated	Eastern Region	4,000,000	4,000,000	8
D	Hatchery	Eastern Region	3,000,000	3,000,000	1.2
E	Integrated	Eastern Region	720,000	720,000	108
F	Hatchery	Central Region	4,800,000	4,800,000	1.44

Source: Authors' own computation

Table 2: Cost Composition Fingerlings Production of Sampled Hatcheries

Item	Cost (in GHS)
Feed Cost	21,480
Fertiliser (Urea)	-
$CaCO_3$	-
Harvesting cost	-
Contingency (4%)	873.6
Employment (17.5%)	3.822
Total Cost	22,713.60
Output (pcs)	270,000
Unit cost per kg/pc	0.30
Revenue	54,000

Source: Authors' own computation

2.2 Fish Feed

Although supply of fingerlings and improved strain quality are essential for productivity, feed is key to cost effectiveness and competitiveness. Until recently, farmers had difficulty in accessing quality fish feed and were locally producing their own self-compounded, non-extruded fish feed from available materials. The quality floating feed were all imported by the few large farms and it was comparatively expensive. Consequently, some farmers produced their own feed with some local ingredients. The major local ingredients for fish feed include corn, fishmeal, animal by-products and wheat bran. All commercial fish feed was imported into the country until year 2011. With the establishment of a feed mill in 2011 (Raanan feeds) producing 30,000 MT annually and other major importers like Aller aqua, Multifeed, Coppens, Skretting, and Cargill, coming on board, most farmers were relieved as fish feed could easily be accessed.

Notwithstanding the growth in feed producers, the cost of fish feed is still high. Indeed, feed cost constitutes 70 per cent of the total production cost, and the imported feeds are mostly about 30 per cent more expensive than the locally manufactured feed. The high cost of raw materials is the main issue facing fish feed producers. Feed raw materials include maize, soybean, fish oil, fish meal, groundnut cake, cotton cake, premix, wheat bran, and vegetable oil. Maize makes up 20 per cent of

[1] The names of companies not revealed to protect their identities.

feed; soybean, 30 per cent; and, depending on the feed formulation, fish meal, between five and 10 percent of feed. The tedious and costly process of acquiring certification for fish feed production or for importing raw materials is another challenge highlighted by feed producers and importers. High import tariffs and taxes and other fees, estimated at between 20 and 30 per cent of feed costs, as well as the depreciation of the Ghanaian currency have made imported ingredients more expensive, resulting in tilapia farmers facing higher costs for fish feed. Large-scale farmers like Vision 2000 still import commercial feed because local production is not able to meet their demand vis-a-vis the high price offered on the market. Small-scale farmers unable to afford the high cost of commercial feed have resulted to using alternative feed resources like feed provided by ARDEC.

This is one significant reason why serious attention should be paid to the improvement of pond aquaculture as that can reduce the feed-conversion ratios obtained in cage culture by 50 per cent. In addition, tilapia grown in ponds through grow-out and fattening can do well on extruded feed with 25 per cent crude protein, the cheaper and most common type of feed used in Egypt but completely missing from the feed market in Ghana. Farm experiments conducted recently in Ghana showed that productivity of 10,000-14,000 kg/ha is easily attainable with fertilization and supplementary extruded feed – and without the need for aeration.

2.3 Tilapia Primary Production

2.3.1 Scale of production

The scale of production ranges from small (≤2 cages or 1 pond), medium (3-6 cages or 2 ponds) to large-scale (≥ 7 cages or ≥ 3 ponds) fish farming. Although the number of small-scale producers surpass others, medium-large-scale tilapia producers account for 75 per cent.

Majority of medium and large producers were noted to operate one form of integration or the other. Affluent large and some medium-scale producers have integrated fingerlings production into their activities; similarly, most have ventured into feed production, mainly milling and formulation. It was observed that, irrespective of scale of operation, all producers engaged in some form of primary processing. Whereas only large producers have invested in commercial cold storage facilities.

2.3.2 Production systems

Cage-based culture system

Of all farmed fish in Ghana, between 75 per cent and 93 per cent are derived from floating cages, while the remaining are harvested from ponds. The cage farming of tilapia is concentrated in Lake Volta and has developed fast as a business activity at an annual growth rate of 73 per cent between 2009 and 2014 (FAO, 2018).

Image 2: Circular Cages for Tilapia Production at Volta Rapids
Source: Authors' own

About 90 per cent of farmers use the cage culture system and mostly on the Volta Lake with the rest using pond culture system especially in the southern part of Ghana. A dominant 89 per cent of the cage farms are currently concentrated around the Eastern and Volta regions, specifically around the Kpeve, Akosombo to Kpong stretch of the Volta Lake where infrastructure such as roads and electricity are available. A survey in 2013 counted 70 cage fish farms in the Asuogyaman stretch of the Volta Lake alone (Nunoo & Asase, 2014). Majority of these cage farms situated particularly in the Asuogyaman District between Akosombo dam and Kpong dam account for about 2 per cent of the total number of farms using small to medium-sized cage farms. Many of such small to medium-sized cage farms can also be found in areas such as Kpeve in South Dayi District of Volta Region, Akuse in Lower Manya Krobo District and Akuse in Upper Manya Krobo District of Eastern Region. Aquaculture in the North of Ghana is mostly done in extensive or culture-based fisheries at irrigation sites, reservoirs, and dams.

Pond-based culture system

Pond-based culture system is the dominant production system in the southern and central belts of Ghana and is mainly small scale and semi-intensive in nature. Under MOFAD's policy for sustainable development of aquaculture, fish production from aquaculture has grown over the past decade: from a paltry 6,514 MT in 2008 to 76,620 MT in 2018 (Fisheries Commission data). MOFAD has prohibited the importation of farmed fish, particularly frozen tilapia, and has set up the Ghana National Aquaculture Development Plan (GNADP) with an ambitious production target of 100,000 metric tonnes of fish at the end of 2016; which was however not achieved. There has however been tremendous growth in the sector.

Table 3: Tilapia Production: Cage and Pond Culture[2]

Item	2010	2011	2012	2014	2015	2016
No of ponds	4,288	4,560	4,749	4,872	3,915	4,132
Total surface of pond-based aquaculture (Ha)	617	680	704	711	815	833
Production of pond-based farm (MT)	1,093	1,469	1,772	2,912	2,410	2,714
No of cages	1,148	1,525	2,278	2,562	7,607	8,415
Total volume of cage-based farms ('ooo M^3)	166	234	280	311	1,699	1,081
Production of cage-based farms (MT)	7,581	16,245	24,249	33,075	40,15	47,172

Source: IFPRI, 2018

Table 4: Operational Details of Sampled Primary Producers[3]

Company	Company	Type	Region	Installed capacity (cubic meters)	Fingerlings utilized (pieces)	Feed utilized (in MT)	Output per annum (pieces)
A	UG Cage Fish	Integrated	Akosombo	6250	4,000	2	144
B	Gadason	Integrated	Senchi	-	-	2.64	36
C	WRI	Integrated	Akosombo	-	-	8	-
D	Grace Farms	Integrated	Akwamufie	6048	34,000	3.2	6
E	Volta Rapids	Integrated	Akwamufie	-	200,000	6	21
F	Vision 2000	Integrated	Asuogyaman	56,160	-	37.5	3,360
G	Lee's Farm	Integrated	Asuogyaman	18,7500	420,000	108	600
H	Bosco	Integrated	Kpeve	34,128	10,000	480	1,106

Source: Authors' own computation

Table 5: Cost Composition Tilapia Production (Sampled Hatcheries)

Item	Cost (in GHS)
Fingerlings	60,000
Feed Cost	81.600
Fertiliser (Urea)	2,160
$CaCO_3$	1,188
Harvesting cost	430.81
Contingency (4%)	5,815.15
Employment (17.5%)	25,441.29
Total Cost	176,635.25
Output (pcs)	270,000
Unit cost per kg/pc	9.20
Revenue	2.843,000
Profit margin	1306%

Source: Authors' own computation

[2] The names of companies not revealed due to protect their identities.

[3] The names of companies not revealed due to protect their identities.

2.4 Processing

Fish is a highly perishable commodity and therefore requires some degree of processing to preserve and extend its shelf life and thus allowing for extended distribution and marketing opportunities. In Ghana, processed fish products include salted and dried, or smoked tilapia but this only constitutes a small part of total output. At present, Ghana does not have any industrial aquaculture processing factory to boast of, though there are two large tuna canneries: Pioneer Food Cannery, and Seaboard of Ghana, formerly Ghana Agro-Food Company Ltd. Farmed fish like tilapia is preserved principally through primary and secondary processing techniques by traditionally salting, drying, smoking, grilling and fermenting or a combination of two of these.

Primary processing involves sorting, descaling, degutting, and icing prior to being sold, especially if it has to be moved from one town to the other. Primary processing is normally done on the farm for a fee borne by the buyer before it is sold. Fish purchased from the farms are often sorted, descaled, degutted, and iced. Secondary processing is where the descaled and degutted fish are grilled, smoked or salted for consumption. It is difficult to establish trends of output and value of processed fish because there are no available data on the quantities of fish sold that have been processed into smoked, grilled or salted & dried. Both the primary and secondary processing are vital for the women who are normally involved in post-harvest activities including trading, whilst the men are engaged in the main culturing activities.

2.4.1 Smoking

Traditionally processed fish is widely patronized by many Ghanaians due to their affordability and good taste. Smoking is however the most used method, with about 70 – 80 per cent of the domestic marine and freshwater catch consumed in smoked form (Asamoah, 2018). It is common to encounter smoked fish which has been stored for between 3-8 months in the urban markets in Ghana. In Ghana smoking technology is rudimentary with a focus on economising on fuel use. The technologies used in fish smoking in Ghana are improved types of conventional fish smoking ovens.

Chorkor oven

The Chorkor oven is the most used technology among large volume fish smokers. The oven was developed by CSRI in 1970 as an improvement of the traditional smoking oven. It consists of a combustion chamber and a smoking unit with a set of trays. The combustion chamber is rectangular, twice as long as it is wide, divided by a wall down the middle and with two stoke-holes in front. A set of 10-15

Image 3: Chokor oven
Photo credit: E. Kwartneg

smoking trays of the same size and shape of the combustion chamber, is stacked on top of the oven—trays constructed out of wooden frame and wire mesh.

Frismo oven

Frismo oven is a slightly enhanced version of the Chorkor oven by reducing fuelwood consumption and limiting processor to smoke exposure. Frismo stove has two burning chambers located at the lower corners of the stove and a door that prevents smoke escape during smoking, and a chimney that penetrates through a roof. It has eight metallic trays where fish are arranged for smoking. Notwithstanding the health benefits and fuel economy, the adoption of Frismo is not as pervasive as the Chorkor. According to one smoker, the cost of construction and the share size of the Frismo renders it less preferred to the Chorkor.

Image 4: Frismo oven
Photo credit: USAID

Ahotor oven

The Fisheries Commission in collaboration with SNV Ghana have introduced the Ahotor oven, an improvement on the traditional Chorkor oven. The oven comprises of a combustion chamber fitted centrally to a Chorkor-like outer shell, with fish processing trays above as in a normal traditional oven. Above the combustion chamber, a fat collecting tray is fitted that allows hot gases to flow up through to the fish while preventing any fat from dropping down onto the fire. The Ahotor oven is energy efficient (reduces fuelwood consumption by 32 per cent), emits less smoke compared to the Chorkor and produces smoked fish

Image 5: Ahotor oven developed by SNV Ghana
Photo credit: Ghana districts

with low PAH levels of 10.93µ/kg which is less than the EU standard of 12 µ/kg. Notwithstanding the resource efficient and health benefits, adoption level of Ahotor oven remains low.

2.4.2 Salting

Fresh tilapia, when marinated with salt and dried for days, becomes salted tilapia, known is Ghanaian parlance as "Koobi". Salting is one of the alternative methods of preserving fish in Ghana. It is based on the penetration of salt into and extraction of water from the fish muscle, thereby lowering water activity and ph. Traditionally, salting is performed either by dry salting, or brining. The salting process employed depends mainly on the size of the fish. Small fish can be salted whole (no gutting) as the skin is a poor barrier to salt penetration in this situation. Bigger fish must be gutted and perhaps split open to encourage salt penetration because the thicker skin (and scales) is a major barrier to penetration. Brine salting has become popular for processing salted fish as a pre-salting step, followed by dry salting.

Image 6: Salted Tilapia displayed at Asikuma Tilapia Market

Credit: Authors' own

2.4.3 Drying

Image 7: Dried fish
Credit: Authors' own

Open-air sun drying is the most widespread method of drying fish used by artisanal fishermen in Ghana. It is the most convenient and the most cost-efficient processing technique to preserve fish and fish products, given the abundance of solar radiation. Here, it was observed that, salted fish is placed on either poly-sheets straw mats or trays to dry. At the initial stages of drying, the high levels of moisture contained in the fish and smell attracts flies and insects, increasing risk of contamination. However, a major problem of open sun drying is the loss of quality due to contamination with dust and excreta from birds and animals. Moreover, it is difficult to control the drying process and the drying parameters in the open air due to weather uncertainties and also a large drying area is required. Further, it was observed, a minor class of commercial farmers-cum-processors have adopted enclosed solar dryers. Solar drying has proved to be an energy efficient system for drying fish as it can be controlled and occupies a smaller drying area.

2.4.4 fermentation

In addition to salting and drying, fermentation is another traditional technique for preserving fish in Ghana. Fermentation preserves fish by curbing the ability of microbials-induced decay. The process involves increasing acidity contained in fish muscles through salting. After salting the fish is left for a number of days for chemical and bacterial breakdown to occur. Following disintegration, the fermented fish is sun-dried. This form of preservation is prevalent in areas where there is seasonal abundance of fish and scarcity of cold storage facilities.

Fermented fish, known in local parlance as *momone*, is commonly used as condiments for spicing stews, sauces, and soups. The strong aroma and flavour of the fermentation makes this product highly desirable as a seasoning for many of Ghanaian dishes.

Table 6: Operational Details of Sampled Processors[4]

Company	Region	Type	Tilapia utilized (MT)	Output per annum (MT)	
				Primary Processed Fish	Secondary Processed Fish
A	Eastern Region	Producer-Processor	144	144	0
B	Eastern Region	Producer-Processor	36	36	0
C	Eastern Region	Producer-Processor	6	6	0
D	Eastern Region	Producer-Processor	21	21	0
E	Eastern Region	Producer-Processor	3,360	3,360	
F	Central Region	Specialist Processor	9,600	9,600	6.067
G	Eastern Region	Producer-Processor	600	600	0
H	Greater Accra	Specialist Processor	130	0	130
I	Greater Accra	Specialist Processor	3	0	3
J	Greater Accra	Specialist Processor	20.1	0	20.1
K	Greater Accra	Specialist Processor	50.4	50.4	0
L	Greater Accra	Specialist Processor	7.2	7.2	7.2
M	Volta Region	Producer-Processor	1,106	1,106	0

Source: Authors' own computation

[4] The names of companies not revealed due to protect their identities.

2.5 Marketing and Trade of Tilapia

2.5.1 Domestic trade

Structure of domestic trade

Fish farmers are generally responsible for marketing their produce, except in the Eastern region of Ghana where the Fisheries Commission is piloting a project that buys fresh fish from farms for processing, packaging, and sale to consumers. There are no price control restrictions on farmed fish, market forces determine price. Fish is sold fresh directly at fish farms, and any unsold stocks are fried or salted and dried and sold later. Fish 'mummies' and other middlemen may also buy the fresh fish in bulk from the farms and retail it either fresh or processed in the major towns. Various Fish Farming Associations (FFA) scattered around the country sell fish directly to retailers or consumers. These direct sales of fish by the associations are attempts to cut out the fish 'mummies' who make a huge profit by buying the fish very cheaply from the farmer and selling at a high mark-up to the public. A few commercial farms such as Tropo Farms, Lee farms and Vision 2000 have cold vans and sales outlets in the major cities where they sell directly to buyers.

Pricing and packaging

Presently, farmed fish in Ghana is neither labelled nor certified, hence their prices depend on the species, the size and location of the market. For most small-scale pond farms, fish buyers tend to sort, select, and negotiate the prices, but for large commercial farms, the fishes are graded at harvest and priced by size and sold per kg with prices set by large scale farms.

Image 8: 50kg Crate Loaded with Size 2 Tilapia
Credit: Authors' own

There are different sizes or grades of tilapia i.e., economy (250g) and regular (350g), sizes 1, 2, 3, & 4 (450g to >800g). The fish are normally packed in 25kg cartons or plastic crates, or in 50kg polypropylene sacks or 100kg plastic drums. The price per 25kg is fixed irrespective of the size of fish. A wholesaler would normally buy fish from the producer's site using the 25kg crate as the unit of measurement, and after primary processing, transfer the fish into polypropylene sacks or plastic drums where icing is done simultaneously , after which they are loaded into a cold van or truck that transports them to their destinations. It is mostly the relatively high to middle income earners who can afford tilapia at current retail prices. Also, the absence of cold storage facilities at strategic places in the aquaculture industry in Ghana restricts the distribution and marketing of fresh Tilapia.

2.5.2 International trade

Currently there are no importation of tilapia into Ghana as the GoG intends to protect the local industry from imports. However, interaction with some hatcheries indicated some export of fingerlings to neighbouring countries like Benin, Nigeria, and Burkina Faso. Information gathered from the Fisheries Commission indicated that in June 2018, the GoG banned the importation of Tilapia (including eggs and fingerlings) into Ghana in response to fears over Tilapia Lake Virus (TLV) which caused significant deaths in farmed tilapia species. The ban notwithstanding, Genetically Improved Farmed Tilapia (GIFT) strain is illegally imported into the country from China, resulting in high mortality rates of fingerlings.

With average breakeven production cost of more than $2/kg, Ghana's tilapia production industry is not competitive on the international or local markets. Comparing Ghana's tilapia retail prices to those in Egypt, China and the Philippines, a study in 2011 found out that, prices were four to six times higher in Ghana than in the other countries. Notwithstanding the ban on tilapia importation, frozen tilapia imported from China enters Ghana along its border with Togo[5]. The illegally imported tilapia retails at $1.50/kg. The proximity of the heart of Ghana's aquaculture activity—the Volta Lake—to the Togolese border provides an opportunity for exporting tilapia to Togo, however the issue of high cost of production remains a hurdle.

2.6 Structure and Operation of the Tilapia Processing Value Chain

Ghana tilapia processing value chain is rather short. It consists of four value-additions segments. At the "input production" segment, feed producers and importers supply starter feeds and grower feeds to the hatcheries and primary producers. Whereas hatcheries cultivate and supply fingerlings to primary producers. A large portion of private hatcheries operate their mature tilapia farms, therefore produce to primarily stock their farms before supplying other producers. At the "primary production" segment, farmer cultivate mature tilapia for a diverse market. However, given the lack of specialized commercial-scale tilapia processing industry in Ghana, all primary producers engage in primary processing and preservation, mainly descaling, degutting, and icing or freezing. In addition to farmer-processors, a separate class of processors engage in secondary processing, mainly drying, salting, smoking, and grilling. Lastly, the distribution and marketing segment ensure the variety of tilapia produce reach the appropriate markets. The distribution and marketing segment is highly concentrated with blurry distinctions. In that, although 'bulk distributors' and 'retailers' specialise in distribution and marketing, 'primary producers' and 'processors' are increasingly distributing their produce at fish depots in order to secure high prices.

Outlined in Table 7 is the operational structure of the four value-addition segments.

[5] As Togo has no ban on Tilapia importation.

Table 7: Tilapia Value-chain Operations

Value adding activities	Chain actors	Categories of chain actors	Output	Off-taking groups	Output channels
Fingerlings production		Specialist hatcheries	Fingerlings	- Small and medium-scale farmers	
		Integrated hatcheries		- Medium and large -scale farmers	Farmgate
Matured tilapia production	Primary producers	Small-scale hatcheries	- Whole undressed - Dressed	- Traditional traders ('fish mommies')	Farmgate
		Medium-scale farmers		- Wholesalers - Traditional traders - Supermarkets & Cold stores - Commercial caterers	- Farmgate - Fish depot
		Large-scale farmers			
Processing	Primary processors	Small-scale processors	Dressed fish	- Wholesalers - Traditional traders	Farm/processing gate
		Medium-scale processors			
		Large-scale processors	- Dressed fish - Dressed frozen fish	- Wholesalers - Traditional traders - Supermarkets - Commercial caterers	Own outlets
	Secondary Processors	- Farmer-processor - Informal processors - Small-scale processors - Commercial caterers	- Grilled tilapia - Dried tilapia - Salted tilapia - Smoked tilapia	- Wholesalers - Traditional traders - Supermarkets - Commercial caterers - End consumers	
Distribution	Bulk distributors	- Wholesale associations - Cold stores	- Frozen tilapia - Dressed tilapia - Grilled tilapia - Dried tilapia - Salted tilapia - Smoked tilapia	- Traditional traders - Supermarkets	- Fish depot - Fish market - Own outlet
	Retailer	- Traditional traders - Supermarkets - Cold stores		- Commercial caterers - End consumers	

3. CONSTRAINTS AND OPPORTUNITIES TILAPIA VALUE CHAIN

3.1 Critical Constraints to Market Growth

3.1.1 High cost of inputs

One of the most important inputs for farming tilapia is fish feed. It is very essential for the survival and growth of the fish. However, until recently, all fish feed was imported into the country. Exchange rate volatility of the local currency ensured feed was awfully expensive. Meanwhile, feed forms about 70 per cent of the production cost, hence making domestically farmed fish using imported feed expensive and uncompetitive. Local feed production on the other hand is about 30 per cent cheaper, but also depends on imported ingredients as access to local ones are unreliable. So, in the long run, locally produced feed tends to be costly, although less so than imported feed. For domestic production, ingredients are sourced partly locally and partly imported as mentioned above. Proteins, premixes, and amino acids are imported from Italy, Netherlands, and Israel, respectively. Also, the feed supplied per annum cannot meet the growing trend of the tilapia production as more fingerlings are being produced hence the need to upscale feed production to meet demand. As COVID 19 has now set in, it is even going to be more expensive than before. This constraint was expressed by all the actors' i.e., fingerling producers, growers, and processors alike. None of the feed producers indicated this as a challenge. In all there were 6 actors who indicated this as a constraint.

3.1.2 Fingerlings high mortality rate

Another challenge that the value chain faces is the high mortality rate of the fingerlings. The Akosombo strain of the Nile Tilapia Oreochromis niloticus had always been what was cultivated in the past. Recently, there was an illegal introduction of an Asian strain, the Genetically Improved Farmed Tilapia (GIFT), which according to most farmers was initially performing well, but at a point could not withstand the climatic conditions. Besides, some farmers were crossing the GIFT with the Akosombo strain and that has resulted in increased mortalities being recorded amongst fingerlings. Mortality rates increased from 75 per cent to 97 per cent, leading to farmers losing a lot of money as they had already invested in feed purchases. About nine of the actors indicated this as affecting their business operations. Some feed producers indicated this as a constraint because it affected the operational capacity of fingerling producers as well as growers and therefore limited the volume of feed they purchased.

Also, contributing to the mortality rates is the up swirling of the water at certain periods of the year, leading to contamination of the environment. This contamination happens during the period of February to March each year when, as a result of the up swirling of the water, debris from the riverbed is swirled up to the surface resulting in high mortality of the fish. Whilst some actors are of the view that the illegal introduction of the GIFT is the principal cause of high mortality being experienced, others felt the high mortality was a result of the Tilapia Lake Virus. Studies by the World Bank and other agencies however cleared the TLV as the cause of mortalities. Some of the secondary processors of tilapia (grillers) also indicated the spread of information about a tilapia virus as a constraint because the news of the virus scared customers from patronising grilled tilapia and thus affected their sales. For fingerling producers, growers and primary processors, the high mortalities meant loss of money and inability to meet the demand of their customers due to reduced low outputs.

3.1.3 Insufficient supply of full-grown tilapia to secondary processors

This constraint was indicated only by three primary and secondary processors. The challenge confirms the effects of the constraint of high mortality being experienced by the growers. As more investment into fingerlings dwindled, as a result of the mortality rate coupled with the inability to produce the expected volumes, the number of grown cultured fish dropped by more than half of the expected volume. Lee Farms' production level dropped by about 50 per cent as a result of the high mortality rate of the fingerlings. The same applied to most of the farmers interacted with. A number of small-scale farmers had folded up due to same reasons. Looking at the demand trend of full-grown tilapia, there is definitely going to be insufficient quantity to supply to the market.

3.1.4 Weak access to finance

Funding has been a major constraint especially amongst the small to medium scale farms. This constraint was indicated by the 6 out of the 18 actors interviewed. Whilst some needed funds to expand their facilities – like cages and nets, or grilling facilities, others needed funds to purchase new equipment to facilitate work. Some of this equipment included filtration equipment, technology to transport nursery size fishes: and others needed funding to purchase inputs like feed and fingerlings in the case of growers of cultured tilapia. The larger farms on the other hand are foreign owned and have a higher ability to access funding, so have limited funding need. Generally, local banks are adamant to supporting aquaculture start-up businesses. They claim that the sector has little knowledge of their potential cash flows and lack good management hence the risk level is high. Though some financial houses like Stanbic Bank, Prudential Bank, and Merchant Bank had expressed interest in supporting the sector, the support never materialised, it was only Agricultural Development Bank who provided support to some farms but had to stop along the line due to a high rate of default (Kaunda et al., 2010). The government of Ghana has shown interest in supporting small and medium scale farms and has channelled funds through the Skills Development Fund (SDF) that provides support with training and equipment for their operations.

3.1.5 Lack or inadequacy of equipment

As indicated above, the equipment or technologies in question included filtration equipment, technology for transporting nursery size fishes, grilling equipment, cold vans, etc. Technologies used by small -medium scale farms are outmoded. Meanwhile these farms form about 80 per cent of the sector. It is however prudent that they receive the appropriate technology to ensure quality and volume production.

3.2 Critical Opportunities for Market Growth

3.2.1 Export to ECOWAS market

It is estimated that tilapia production in Lake Volta can increase about 25 per cent from its current level, based on the lake's estimated biophysical carrying capacity. This expansion presents tangible export potential for the sector. However, the cost of production in Ghana is higher relative to global competitors. As such, Ghana may not be competitive in the global tilapia export market. However, there is an opportunity to export fresh tilapia to ECOWAS countries. In that, Ghana is strategically located in the centre of West Africa and the presence of Lake Volta gives Ghana a natural comparative advantage as a regional supplier of fish.

3.2.2 Supply of technical services

Access to technical expertise is available at the Ashaiman Aquaculture Demonstration Centre operating under the Fisheries Commission of MOFAD. The Centre focuses on practical trainings for

farmers and the supply of fingerlings at a lower cost than that of the private hatcheries. The hatchery focuses 95 per of its efforts on Tilapia and 5 per cent on Catfish production. Government has also created opportunities for small and medium scale businesses, by harnessing competitive funding facilities such as the Skills Development Fund (SDF) to either upgrade or acquire technology or skill to enhance efficiency and improve productivity. Technical advice and training support have also been readily available from the WRI-ARDEC. The reach and capability of these institutions is limited, the gap in supply of technical service represents an opportunity for service providers.

3.2.3 Improving feed quality and lowering cost

It was noted, both hatcheries and mature tilapia cultivators placed a premium on high quality. Notwithstanding present commercial-scale quality feed production is under par, due to inadequate supply of maize and soy. To this, the expanding of local production of maize and soya purposely for animal feed as well as developing alternative sources will bolster the sector's growth. As such, the supply of quality maize and soya and alternatives sources of protein to commercial feed producers represents a tangible opportunity.

3.3 Market Opportunities for the Dutch Private Sector

From analysis of challenges and potential in the Ghanaian sector, we have identified opportunity areas for Dutch companies to offer their goods and services. These include supply of technical services; supply of high-quality inputs; guidance in securing local and international certification; better fish grading system; supply of research and product development services; improved hatchery equipment.

Although the amount of fish produced from farming in the Netherlands is low, the sector is a global leader in producing aquaculture related inputs. Some of the products produced by these companies can benefit the sector in Ghana as well. Almost all companies interviewed are open to doing business in Ghana, they indicate it is an interesting market although some of them are a bit hesitant of actively pursuing business in the country since the fish production is decreased. Mortality mostly caused by the TLV is brought up as the main cause for the lower production.

Through stakeholder engagement sessions with the Dutch sector about the above-stated opportunities, a several *addressable*[6] market opportunities were identified. These are presented below:

3.3.1 Supply of feed

Feed is produced by three companies in the Netherlands. All three have been interviewed for this study. All producers observed opportunities in Ghana for their produce. All companies indicated that are able to offer a higher quality product compared to the local market. The improved quality of feeds produced in the Netherlands is suitable for addressing the challenge of high mortality rates for fingerlings. Particularly, Dutch starter-feed of sizes smaller than 2mm which are given to the young fish render them less susceptible to diseases such as the TLV. Furthermore, the higher quality feeds produced by the Dutch companies also have a lower FCR which implies less feed is needed.

Presented are offerings by the Dutch companies suitable for addressing challenges and opportunities identified in Ghana.

[6] Addressable implies those opportunities which the Dutch sector is able and willing to pursue.

Table 8: Context-relevant Services and Products Offered by Dutch Feed Manufacturers

Relevant products/services	Challenges addressed	Companies offering
Starter-feed[7] Low FCR-feed[8] Low FCR-feed[9]	Fish are susceptible to diseases Nutrients polluting the lake High-cost price	1. Alltech Coppens 2. Koudijs 3. Skretting

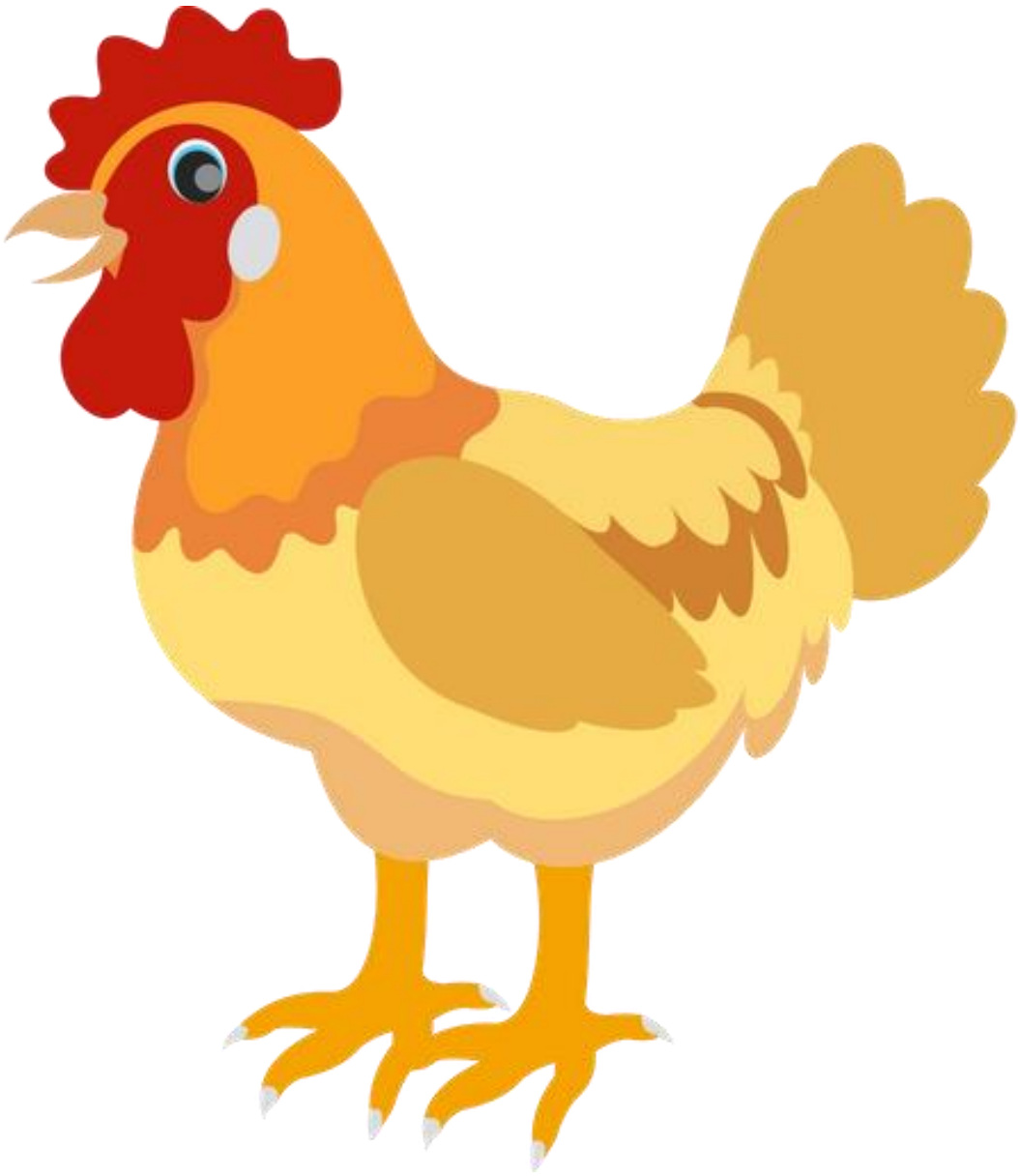
3.3.2 Supply of culturing systems

The equipment used in fish farming can make the production process more sustainable and efficient. Various types of equipment are produced by Dutch companies. Main equipment relevant for the Ghanaian aquaculture sector produced by these companies is the Recirculatory Aquaculture System (RAS). These systems can work with various kinds of filters which allows farmers to reuse water in land-based systems. RAS hatchery systems—such as flow through systems, incubation systems, aeration material, and water quality testing kits—are also relevant for the Ghanaian sector. RAS systems reduces the risk of juvenile mortality as well as render hatchery operations efficient and reduce cost.

Table 9: Context-relevant Services and Products Offered by Dutch Feed Manufacturers

Relevant products/services	Challenges addressed	Companies
• Closed-hatchery and Flow-through systems with filtration[10] • Closed systems[11] • Recirculation systems[12]	High mortality rate among fingerlings and juvenile fish High-cost price of production Nutrients polluting the lake	Aquaculture ID Catvis Landing aquaculture

[7] Boost the immune system of fishes.
[8] Reduces the amount of nutrients excreted from the fish.
[9] Reduces feed costs and mortality during the production cycle.
[10] Can reduce the risk for juvenile fish to come in contact with diseases during the early life phase where they are more vulnerable to diseases.
[11] Provide optimal conditions for the fish to grow in leading to reduced mortality and growth time, therefore reducing the cost price.
[12] Ensure water can be used for a longer period of time and therefore reduce the amount of polluted water.



SECTION 2: POULTRY SECTOR

Executive Summary Poultry Sector

Poultry produce is the most affordable source of animal protein in Ghana. However, the domestic poultry industry's development has not followed the steady growth of consumption; the sector's high productivity of the 1980s gave way to dismal performance from 1990s to 2015. Though, the past five years has seen nascent revival of layer and broiler production sub-sector to meet increasing demand. Yet, owing to socio-economic developments, demand has shifted from primary to processed poultry produce. The poultry processing sub-sector's underdevelopment threatens the overall viability of the poultry industry, in that, the domestic industry's failure to meet demand will further strengthen importation. At the same time, increased demand represents an opportunity for local actors to evolve a processing industry peculiar to their local context.

Of the several challenges observed, two were identified as critical. First, the absence of effective coordination of upstream and downstream activities represents a critical challenge to the processing sector's operational efficiency. Operational efficiency in broiler processing requires continuous band operation from entry of live birds to exit of chilled or frozen produce. Maintaining uninterrupted operation requires effective synchronisation of upstream and downstream activities: from provision of DOCs, production on farms, as well as marketing and distribution. To resolve this challenge, a shift from 'transactional approach' to 'collaborative approach' is needed. Collaborative approach entails a working relationship where a processor enters into a long-term commitment with suppliers and buyers. A situation whereby, processors reconfigure their operations and make investments in order to deliver products according to specifications and conditions of off-takers, as well as offering advance payment or support primary producers to secure high-quality inputs (DOCs and feed).

Secondly, the processing industry is noted to be acutely hampered by the weak capital goods position observed throughout the industry. In the hatcheries, commercial production and processing sub-sectors, majority of companies were observed to utilise outmoded industrial equipment or new equipment with narrow performance capabilities. Underpinning his challenge is weak access to capital goods finance, and the growing dominance of Chinese and Turkish suppliers in Ghana. The solution to these lies with: (i) provision of structural support to poultry companies to access existing credit facilities provided by ADB, Ghana Exim Bank and Stanbic Bank; and (ii) given that the Dutch manufacture high quality poultry equipment, the Dutch Embassy should develop a one-stop portal where information on the long-term competitive benefits of their products as compared to equipment from Turkey, China and India is presented. Indeed, information contained in such a portal will aid poultry companies assess the value of an equipment based on multiple variables other than price alone.

Two main data collection approaches were adopted for this study. The first approach consisted of a literature review which entailed review of Ghanaian government policy and project documents, reports, and news articles. The second approach entailed a series of semi-structure interviews with key actors. A total of 26 interviews were conducted with representatives of the Ministry of Food and Agriculture, hatcheries, feed producers, primary producers, broiler processors, among others. Companies interviewed are located in the Ashanti, Brong Ahafo, Bono, Greater Accra and Eastern regions. Further details on the VCAs interviewed may be found in Appendix 5.

4. OVERVIEW OF POULTRY SECTOR IN GHANA

4.1 Poultry Produce Production

Rapid Expansion of National Poultry

Since suffering heavy losses arising from the 2007 H5N1 avian influenza, Ghana's poultry bird[13] population has expanded significantly. As Figure 3 illustrates, in 2017, the bird population was estimated at 50.2 million birds compared to 24 million in 2007, representing an average growth rate of 7.08 per cent per annum (FAOStat, 2019).

This expansion is driven by high productivity growth in the layer sector. Indeed, in the period under consideration, the layer sector accounts for up to 75 per cent of growth with the broiler sector accounting for the rest. Equally, in measuring growth in terms of output, the layer sub-sector outperforms the broiler subsector. According to Food and Agriculture Organization's (FAO) estimate, at the end of 2017, total output for the layer sub-sector was 46,000 metric tonnes (MT) compared with 33,655 MT a decade earlier, in the same period the sub-sector grew by 3.08 per cent per annum. The broiler sub-sector's trajectory is less rosy. In 2013 output is estimated at 47,385 MT up from 42,335 MT in 2007. Moreover, between 2007 and 2013, average per annum output for broiler sub-sector grew by 0.9 per cent, compared to 3.5 per cent recorded by layer sub-sector.

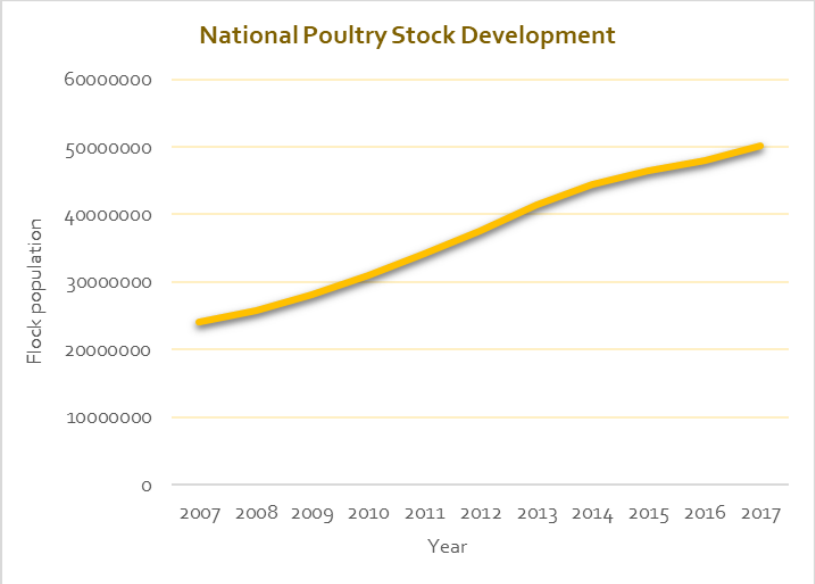


Figure 3: National Poultry Stock Development

Source: FAOStat, 2019

[13] Poultry as used in this report refers exclusively to chicken.

Non-linear growth

The sector's growth in the past two decades, as illustrated in Figure 4 has been non-linear. For example, output in the layer sub-sector ('chicken eggs') grew 8.2 per cent in 2009, then dipping to zero per cent in 2010, only to rise to 7.6 per cent in 2011, and once again declining to 0.6 per cent in 2012. Whereas the broiler sub-sector output ('chicken meat') declined by -28 per cent in 2009, then increased by 7.4 per in 2010, rising another 3.6 per cent in 2011, and then accelerating by 13.5 per cent in 2012.

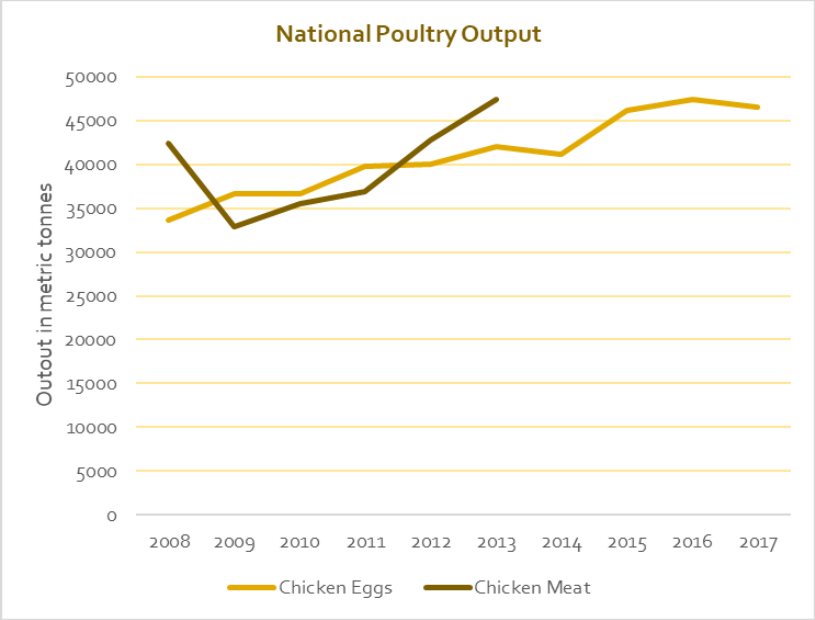


Figure 4: National Poultry Output 2008-2017

Source: FAOStat, 2019

4.1.1 Consumption

In recent years, consumption of poultry produce has risen steadily. In 2018, AMPLIFIES Ghana estimates per capita egg consumption stood at 7.2 kg (128 eggs), on par with South Africa the largest consumer in sub-Sahara Africa . The growth in consumption is driven by 'table eggs', which accounts for over two-thirds of egg consumption. Use of egg produce in non-industrialised bakery confectionery and dairy produce manufacturing—a rapidly growing sector—accounts for close to a third of egg consumption.

Equally, consumption of poultry meat has increased. According to the FAO, poultry meat consumption per capital reached 7.24 kg in 2017, representing a 34.3 per cent increase from the previous year. In 2018, consumption of poultry meat reached 238,000 MT, up from a 193,00 MT in the previous year. It must be noted that, the recorded growth is artificially low, in that MOFA reports an overall supply deficit of 163,129 MT of poultry meat in the same year.

4.1.2 Trade

Although the consumption of poultry meat has risen, the growth in demand does not benefit local producers. Of the 238,000 MT of poultry meat consumed in Ghana 25 per cent was supplied by domestic producers with the remainder satisfied through imports. Combining the supply deficit of 162,129 MT in 2018—and, assuming sustained increase in consumption—with weak capacity of domestic producers, the trend of high rate of importation is likely to continue unabated in the foreseeable future, in the absence of direct government intervention.

Emerging developments suggests that, although supremacy of imports might continue, it will occur in a context of increasing competition from domestic suppliers. One of such signals lies in the growth of share markets captured by domestic suppliers. Although the year-on-year growth of imports, as measured, in volumes has risen, growth in terms of market share per centage has declined. In 2011, imports accounted for 80 per cent of poultry meat consumption, in 2018, it accounted for 75.6 per

cent (MOFA, 2019; USDA, 2017). In this light, one can assert, with caution that, the end of the dominance of cheap imports is not yet in sight, rather we are witnessing the beginning of a domestic sector reasserting itself. Just as the layer sub-sector has significantly boosted productivity and annihilated the market for imported table eggs from Cote d'Ivoire, possibly a revival of a competitive broiler industry might be on the horizon. For this to occur, the emergence of an efficient poultry processing sub-sector is essential.

5. SUB-SECTOR ANALYSIS: PRIMARY PRODUCTION

5.1 Day-old Chicks Industry

5.1.1 Domestic production

Presently, all genetic strains of broiler day-old chicks used in commercial farming are imported[14]. Domestic DOC production is dominated by vertically integrated and commercial hatcheries. Vertically integrated hatcheries are linked to primary production and/or to poultry processing operations. Whereas commercial hatcheries specialise in parent stock breeding and production of day-old chicks with no forward-integrated operations. Both classes of hatcheries operate breeding farms where parent stocks are raised and operate feed mills. These two classes represent the "formal domestic DOC production segment".

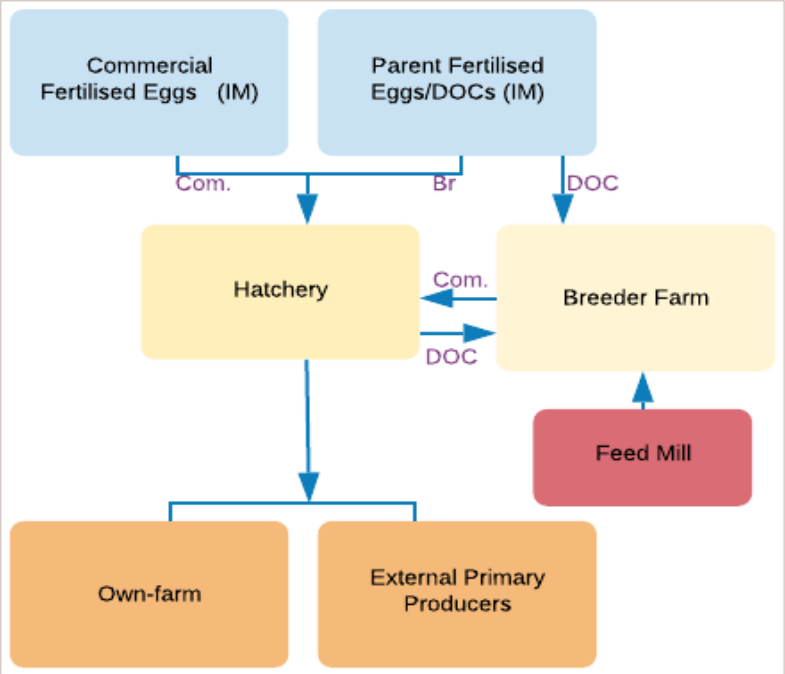


Figure 5: Structure of Formal Domestic DOC Production

Source: Authors' own

Vertically integrated and commercial hatcheries obtain parent-stock by importing either fertile eggs and/or day-old chicks from breeding companies in Europe. On hatchery-owned breeding farms, broiler breeder chicks are reared for a period of six months to the start of laying. Fertile eggs are collected and incubated on premises for a period 21 days to produce commercial day-old chicks, which are then supplied to production farms. In the formal segment, Bovans and Lohman are the dominant breeds.

[14] Akate Farms in partnership with KNUST Olympio Hatchery are engaged commercial trails of new breeds developed by the latter.

Production by vertically integrated and commercial hatcheries aside, Service Hatcheries in conjunction with Artisanal DOC Producers engage in commercial day-old chick production. Service Hatchery is a standalone hatchery (without own parent stock) providing artificial brooding services to artisanal DOC producers/breeders[15]. Artisanal breeders represent a class of small, but enterprising, primary producers that have succeeded in producing their own stock of broiler breeders through crossing commercial mature birds (purchased as DOCs from the formal sector).

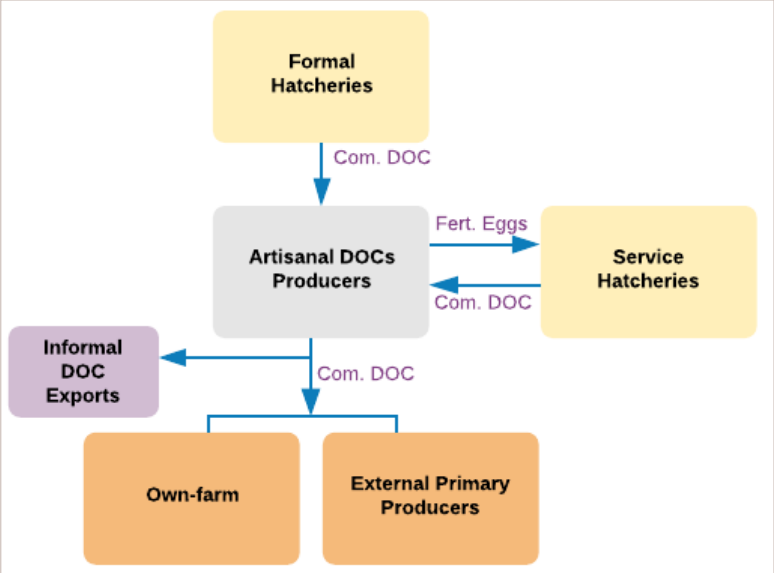


Figure 6: Structure of Informal Domestic DOC Production

Source: Authors' own

Artisanal breeders are primary producers with an average commercial bird population of between 3000-5000 birds. The minuscule size of their individual DOC demand in tandem with weak purchasing power exclude small-holder farmers from obtaining DOCs through the conventional channels. Therefore, they pursue forward integration by stealth, producing commercial DOCs out of necessity—and, in so doing, satisfy their demand and that of other small-holding farmers

Table 10: Production Figures of Sampled Hatcheries[16]

Hatchery	Capacity	Utilization (month)	Utilization (%)	Incubation system[17]
A	38,000	30,000	78	Multi-stage
B	410,000	41,000	10	Multi-stage
C	410,000	41,000	10	Multi-stage
D	100,000	10,000	10	Multi-stage
E	350,000	55,000	15.7	Single stage
F	400, 00	20,000	5	Multi-stage
G	691,000	360,000	52	Multi-stage
H	100,000	10,000	10	Multi-stage

Source: GPP, 2017; Author's primary data 2020

[15] The operations to service hatcheries are vital to the functioning of the small-holding primary production tier of broiler sector. Owing to inadequate domestic DOC production and the prohibitive cost of obtaining imported DOCs from resellers, small farms would be unable to restock commercial bird population where not for brooding services provided by service hatcheries. See section on Supply Deficit for further discussion.

[16] For confidentiality's sake, the authors have refrain from revealing company names.

[17] Equipment observed include Chick Master, Buckeye, Asefac, Petersime, Westing and Beckier.

5.1.2 Supply of day-old Chicks

Formal domestic production of day-old chicks accounts for between 35 and 39 per cent of demand. Domestic formal hatcheries supply DOCs to production farms, based on a two-month pre-ordering system. Unlike commercial hatcheries, vertically integrated hatcheries replenish commercial-hen population of their own farms before supplying external primary producers.

In the informal sector, artisanal DOC producers, after restocking their commercial-bird population proceed to supplying small-holders and back-yard farmers. Information retrieved from Service and Commercial Hatcheries indicate that, over 60 per cent of DOCs produced by Artisanal Breeders are destined for export markets, mainly to Cote d'Ivoire and Burkina Faso[18]. Given the informal nature of production and low hatching rates, the authors were unable to ascertain the size of artisanal DOC production.

To bridge gaps in supply, sale-agents/resellers and primary producers import DOCs from Europe. Large and (some) medium-scale farms import directly from producers in Europe (mainly Belgium, France, Germany, and Netherlands). Whereas small-scale farmers obtain imported DOCs exclusively through resellers. Fifty per cent of DOC demand is satisfied through imports.

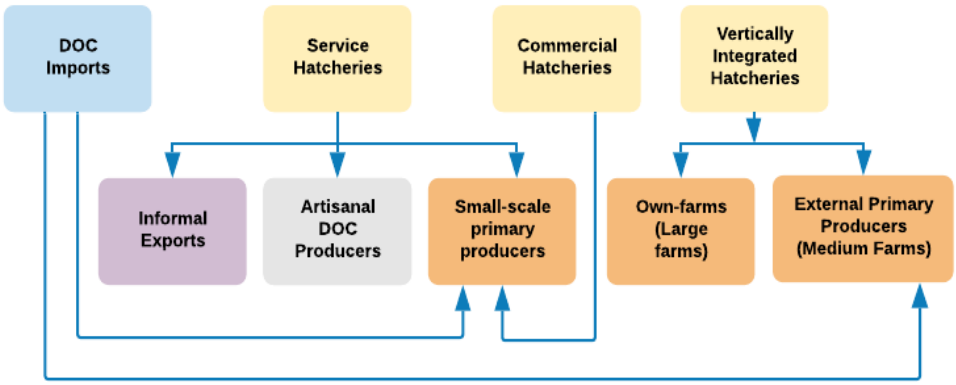


Figure 7: Structure of DOC Supply Market

Source: Schematic from authors' analysis, 2020

Table 11: Day-old Chicks Industry Figures[19]

Item	Volumes per annum	
	2017	2019
DOC demand (National)	34,200,000	36,252,000
DOC imports (National)	17,325,000	18,191,250
Formal Domestic DOC production (Focus regions)	11,255,580	11,593,247.4
Artisanal Domestic DOC production (Focus regions)	Unknown	Unknown[20]

Source: GPP 2017; Authors' computation derived from primary data 2020

[18] Artisanal breeders have succeeded in cultivating the DOC market in Cote d'Ivoire to an extent that a large vertically integrated Ghanaian hatchery is establishing a hatchery in Cote d'Ivoire.

[19] Figures presented is limited to the four focus regions. Data on DOC production is derived from 15 hatcheries in the formal and informal sectors, when operating at full capacity; total import figures were derived from the monthly import figures from the 8 major importers in Ghana. It must be noted total demand is derived from 400 farmers[19] the focus regions (representing 60 per cent of the total poultry production in Ghana). In the absence of high-quality data, the authors' resolved to blend national and regional data to gain to provide an estimate of DOC production and consumption.

[19] In the Ashanti Region, three Service Hatcheries were identified with an average capacity of 75, 000 per incubation cycle. These hatcheries indicated that were operating at full capacity and have to, on weekly basis, decline about 10,000 fertile eggs delivered by breeders for hatching. This is an indication of the size of informal DOC production in one region.

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5.1.2 Patterns and challenges of the day-old chick industry

From the analysis of field data, two critical challenging patterns emerge, these are:

I. Rising Demand, Stagnant Production Capacity

Between 2017 and 2019, demand for DOCs grew by 5.6 per cent. On the other hand, growth in domestic production[21] has been low as evidenced by 11 per cent supply deficit. Analysis of field data suggests this trend is driven by the following critical factors:

Table 12: Critical Challenges: Driving Rising Demand, Stagnate Production Capacity

Supply-side factors		Demand-side factors	
I.	Undeveloped technical capacity for large-scale parent stock breeding	I.	Poor perception of quality of domestic DOCs[22].
II.	High cost of quality primary feed ingredients for breeder farms	II.	Lack of confidence in the production capacity of domestic hatcheries.
III.	High cost and inadequate supply of electricity		
IV.	Situationally inappropriate incubation and hatching technology in use		
V.	Weak product marketing and consumer sensitisation capacity		
VI.	Lack of universal standard operating procedures or certification processes that guide production of quality day-old chicks		
VII.	Outdated hatchery equipment		

II. Supply deficit: Ineffective supply chain for imported DOCs

Although the gap in supply of DOCs is narrowed by imports, on the national level, there remains approximately 11 per cent of unmet demand. Since weak capacity of domestic production is well established, to understand the root cause of this trend, we examine the critical challenges[23] inhabiting access to imported day-old chick.

Primary producers obtain foreign day-old chicks in two ways. The first option is for producers to order day-old chicks directly from overseas hatcheries. The minimum volume for direct purchase is 20,000 birds per order. Second, producers purchasing below 20,000 birds place orders through a local sales-agent or reseller. Such intermediaries, aggregate domestic demand, import day-old chicks, and deliver them to producers, charging 10 to 15 per cent per DOC for coordination services.

The minimum volume requirement represents a barrier for medium-scale primary producers to import directly. On the other hand, intermediary service cost impairs the ability of medium and small-scale producers to obtain imported chicks through intermediaries. It is this structure of direct and intermediary importation that leaves a segment of effective demand unmet.

[21] Formal sector only

[22] The authors observed a sentiment among most primary producers regarding their doubt on the extent to which hatcheries vaccinated DOCs prior to delivering them.

[23] It must be noted that issues such as persisting currency fluctuation—where the Ghanaian Cedi tends to depreciate against the Euro—and import duties were offered by numerous producers and resellers as challenges. Although the authors recognise the importance of these two issues, they are not deemed critical challenges. In that, such issues are applicable to feed, vaccines, equipment etc., yet producers are able to internalise price fluctuations to these issues, into their operational cost. Rather, the issue at hand is that primary producers demand for imported DOCs is acutely price sensitive.

5.2 Primary Production Industry

5.2.1 Characteristics of primary production

Scale and System of Production

Commercial poultry production is dominated by small-scale producers(<10,000 birds) in terms of number of farms, representing 56 per cent of farms, and account for 25 per cent per of gross poultry output. Medium-scale producers (≥10,000-≤50,000 birds) account for 32 per cent of farms in the country with only 12 per cent of producer classed as large-scale farms (≥50,000 birds). The system of production is clearly determined by scale of production. For instance, it was observed that, all sector one companies consist of large producers, with sector two comprised of medium scale companies, whereas sector three companies are made of small-scale producers. In addition to informing system of production, scale of production, was noted to inform the level of integration.

Level of integration

Due to situational peculiarities, horizontal integration is seldom, whereas vertical integration is the norm of the industry. Of the 24 primary producers sampled, five producers are fully integrated, 14 bi-directional[24] integrated producers and 6 backward integrated producers. All full and di-directional integrated companies are either large or medium-scale producers; with the exception of one large-scale producer (100,000 birds), backward integration is pursued exclusively by small-scale producers.

Automated and mechanised production

The level of mechanisation in primary production is pervasive, whereas semi-automation and full automation is a rarity. Of the sampled companies, only one company is fully automated, over two-thirds of large and medium-scale companies have semi-automated systems, mainly drinker and feeder systems. Medium-scale farms prefer mechanisation as opposed to semi-automation due to costs; the extent of mechanisation among small-scale producers is low.

Feed production and utilisation

Feed production forms an integral part of the operations of primary producers. Indeed an estimated 40 per cent of feed is manufactured by primary producers for own use (Andam & Kufoalor, 2017)[25]. All primary producers sampled[26] manufacture their own feed. Concerns regarding reliable supply, quality, and price[27] stability of feed are the main reasons for producing own feed.

Installed production capacity of the sampled companies range between 2 and 10 tons per hour. Since production is for own use only, the fraction of the installed capacity utilised was noted to be commensurate with producers' current bird population. The average feed production per farm was noted to be approximately between 12 and 35 tons per day. Producers were noted to formulate their own feed.

[24] Forward and backward integrated but not fully integrated.
[25] Commercial Feed millers account for approximately 55 per cent with Service Feed-millers accounting for about 5 per cent (ibid)
[26] As well as specialised processors
[27] For the average Ghanaian producer, feed accounts for between 70-75 per cent of production cost. As such, most primary producers enter into feed production for own consumption.

5.2.2 Primary production

Poultry production is heavily clustered in Ghana's middle-and-southern belt mainly: Ashanti, Brong Ahafo[28], Eastern and the Greater Accra regions —accounting for 78 per cent of flock population. The agroclimatic conditions[29] of the middle-and-southern belt render it congenial for breeding chicken; moreover, the prevalence of maize and soya cultivation (in the middle belt) implies proximity to primary feed ingredients.

Between 2014 and 2019, our estimates reveal that the flock population in these regions increased by 57 per cent. The rapid increase is due, in part to, the expansion and establishment of two large scale farms (Akro Farms and Appah Farms respectively) in the Eastern region.

Table 13: Primary Production in Geographic Focus

Region	Bird population on commercial farms (Sectors 1-3)		Bird population on back-yard farms (Sector 4)	
	2014	2019	2014	2019
Ashanti	3,514,000	4,216,800	5,912,618	Unknown
Brong Ahafo	2,554,000[30]	3,320,200	7,478,871	Unknown
Eastern	770,000	1,047,200	2,421,801	Unknown
Greater Accra	2,190,000	2,737,500	324,363	Unknown

Source: IFPRI, 2017; Authors 'own calculations based on data from VSD and primary data.

Layer production

The layer sub-sector is the most well-performing segment of the poultry sector, in terms of domestic production.

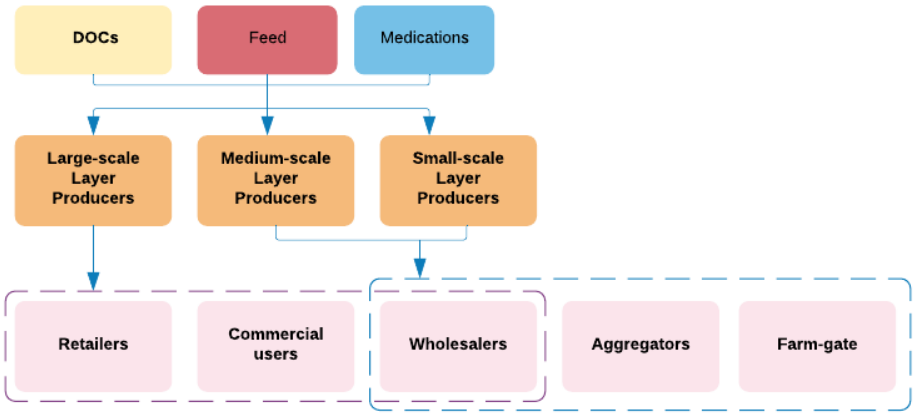


Figure 8: Structure of Layer Production & Supply Market
Source: Authors' own

Production comprises mainly of table eggs. Indeed, the National Poultry Census of 2009 indicate that layers represented 59 per cent of bird population in that year. According to industry experts, by 2019, layers accounted for two-thirds of flock population of commercial producers. The sector's success is largely an effect of the high productivity attained through adoption of improved farm management practices and increased capital investments in the sub-sector. Although small-scale production is widespread, production is dominated by large and medium-scale producers, jointly accounting for 64 per cent considering they represent 18 per cent of producers in the focus geographic region.

[28] Bono, Bono East and Ahafo regions until 2019 constituted the Brong Ahafo region.
[29] The regions are found in the Forest-Savannah and Semi-deciduous rainforest agro climatic zones with moderate temperatures compared to other parts of the country.
[30] The figure represents flock population in the Brong Ahafo, Ahafo, Bono regions.

Broiler production

Compared to the layer sub-sector, developments in the broiler sub-sector are less promising. The prevalent sentiment among producers is that broiler production is less commercially attractive. In that, production is severely encumbered by high cost of feed (making up 70 per cent of production cost), cost of electricity and inadequate processing and storage capacity. As such, domestic broiler production is vastly uncompetitive compared to imports.

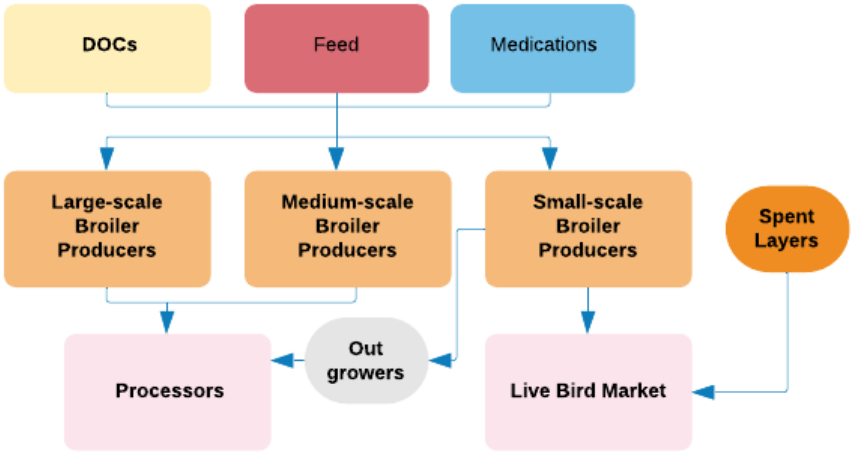


Figure 9: Structure of Broiler Production & Supply Market
Source: Schematic derived from NABC data analysis, 2020

Amidst this despondency, there exists a slither of commercial viability for the broiler sub-sector. Broiler production in Ghana is seasonal, with accelerated production occurring during festive seasons. Undeniably, broiler production is often timed to coincide with domestic festive seasons, during this period, majority of layer producers shift to broiler production. The reason for this is that effective demand for live birds is at its peak during festive seasons. From a seasonal production perspective, one begins to note an upbeat productivity growth in the broiler sub-sector. Anecdotal evidence, from the field, suggests that year-on-year demand for fresh poultry meat and live-bird have risen during festive seasons in the past years, yet year-on-year supply has been slightly above demand. From this, it can be reasonably inferred that there exists latent effective demand for domestic poultry meat, however the sub-sector is held back by high production costs.

Table 14: Flock Population in Geographic Focus Areas (2019)

Focus Region	Broiler flock population	Layers flock population
Ashanti	1,391,544	2,825,256
Brong Ahafo	1,095,666	2,224,534
Eastern	345,576	701,624
Greater Accra	903,375	1,834,125

Source: Authors' own computation derived from GNAPF, VSD and field data

Economics of Production

For layer and broiler production, and across all classes of producers, feed represents the largest share of production cost. Producers interviewed in the focus regions intimated that, on average, cost of feed accounts for 70 per cent of layer and broiler production. Cost of electricity was observed as the second highest component of production cost, particularly for large and medium scale producers.

Table 15: Layer & Broiler Farm Operation Cost Composition

Item	Large scale	Medium scale	Small scale
Feed	65%	70%	75%
Day-old chicks	15%	13%	10%
Drugs	3%	3%	5%
Workforce	3%	3%	3%
Electricity and water	13%	10%	2%
Marketing expenses	0%	0%	0%
Other	1%	1%	5%

Source: Author's field data 2020

Table 16: Broiler Production Cost

Item	Average price (GHS[31])
Cost/kg feed	2.53
Cost of feed/kg weight gain	6.83
Cost/kg bird	9.5
Price/kg live weight	15
Price/kg carcass weight	13

Source: Agbehadzi, 2019; Author's computation based on primary data

5.2.3 Supply of primary produce

Boiler meat: processors and live bird market

Broiler producers supply live birds to processors or to the live bird market. Large and medium scale producers—are predominately forward integrated and therefore—tend to produce exclusively for their own processing operations. Small-scale farmers produce mainly for wholesalers in live bird market. However, with the emergence of specialised processors, small-scale farmers are increasingly producing for specialised processors under out-growers production scheme.

The entire output of medium and large producers, as well as one-third of that of small-producers are delivered to processors. The remainder are sold on the live bird market. Furthermore, streams of spent layers enter the live market through aggregators.

Table 17: Broiler and Layer Output

Focus region	No table eggs	Live bird weight (Mt)[32]
Ashanti	565051200	3061
Brong Ahafo	444906800	2410
Eastern	140324800	760
Greater Accra	366825000	1987

Source: Authors' computation based on primary data[33]

[31] Ghanaian Cedi

[32] With an average bird weight of 2.2kg

[33] Assumptions made include live bird weight: 2.2kg; Eggs producer per layer: 200.

5.2.4 Patterns and critical constraints of primary production

Improved farm-management, high production cost

It was noted that majority of large-and-medium producers had in place improved farm management practices corresponding with the sector's level of development and sophistication. These improvements notwithstanding, cost of production, on average, accounts for 80 to 85 per cent of farm-gate price for eggs and live birds. All interviewees expressed high cost of production as critical challenge—key drivers propelling this challenge are:

Table 18: Drivers of High Cost of Production

Supply-side[34]	Demand-side
a. High cost of feed	High sensitivity to price
b. High feed conversion ratio due to low of quality ingredients	
c. Poor road network and transport infrastructure	
d. High cost and inadequate supply of electricity	

Working Capital Deficiency

Majority of producers indicated persistent working capital deficiency as a critical challenge. For primary producers, the amount of time needed for capital outlays to be converted into cash (cash conversion cycle) is on average 10 weeks. Producers' working capital capability is tightly stretched by the long cash conversion cycle—thus straining producers' ability restock flock at the right time or maintain adequate stock of feed ingredients. The main causes of working capital stress are:

Table 19: Drivers of Working Capital Deficiency

Causes	
a. Unconducive credit policy	Suppliers (DOCs, feed, medications) demand advance payment or prompt payment upon delivery. On the other hand, Institutional off takers (of poultry produce) take between 30-45 days to settle invoice upon receiving produce.
b. Inadequate supply of appropriate credit facilities	Credit facilities available in the market are not attuned to the dynamics of poultry industry. Interviewees indicated that interest rates on short-term credits are significantly high to relative return on poultry produce. Moreover, the design of debt servicing schedule is not aligned with sector's cash conversion cycle nor to the peculiarities of primary production.
c. Inaccessible supply-chain finance solutions	In addition, short-term credit inaccessibility, producers working capital stress is compounded by inadequate (agricultural) supply-chain of finance solutions in Ghana. Although a number of Ghanaian banks indicated they offer supply-chain financing facilities, producers submitted that they are unable to access such facilities.

[34] Although "inefficient farm management" or "outmoded operations/practices" are routinely referred to as the critical drivers of the high cost of production, the authors through their experience draw a direction conclusion. These two challenges indeed affect the cost of production, however, in the Ghanaian context, they can be eliminated without having substantial effect on the cost of production, hence their exclusion from *critical challenges.*

Weak Market Coordination

The rise in demand for eggs is mirrored by increase in production, yet the market persistently oscillates between periods of oversupply and undersupply. Although the rate of increase in production is not on par with demand, the gap does not warrant the breadth of market swings observed. Rather, such swings are driven mainly by the following two challenges:

I. Weak coordination between demand and supply

Table 20: Drivers of Weak Market Coordination

Drivers of weak coordination		
a.	Geographic coordination challenge: Poor infrastructure hindering access to market	Production is concentrated in the rural areas in the middle belt, whereas demand is spread across urban areas in Southern and Eastern parts of the country. Due to poor transport infrastructure and cost implications, off-takers tend to source eggs within proximity of their offloading market. Hence, the scope of undersupply, is due not to level of production but to the degree to which producers have access to market
b.	Market information challenge: Supply-driven production	The structure of layer industry is supply driven. Producers determine volumes and timing of harvest without aggregating *advance market demand* information. Hence quantities and timing of supply tend to lag behind that of demand. The broiler sub-sector, due to prevalence of out-growers model of production is less susceptible to asymmetric market information. Rather, it is the layer sub-sector, due to weak levels of exchange of information between off-takers and producers, the level of output tends to be synchronised to a lesser degree with volumes demanded.

II. Differentiated markets, undifferentiated produce

As Figure 8 illustrates, 'Farm-gate' aside, the layer industry has four market channels, each is attuned to a particular segment of consumers with varying product specifications. However, producers do not engage in product differentiation. As such, commercial bakers, quick-service restaurants, supermarkets, and traditional market traders all have to compete to source the same product. This challenge of undifferentiated produce does not extend to broiler producers.

6. VALUE CHAIN ANALYSIS: BROILER PROCESSING

The industry comprises of two categories of processors: 'formal' and 'informal'. Formal processors denote a group of processors producing in purposefully constructed spaces with requisite certifications from FDA and GSA; whereas "informal processors" slaughter and dress birds in makeshift spaces without FDA and GSA certifications. The analysis below focuses exclusively on formal processors.

6.1 Characteristics of the Broiler Processing Value Chain

The total number of poultry processors in Ghana is unknown. According to information gleaned from industry practitioners, it is estimated that, between 18 and 25 poultry processors operate within the study's geographic focus.

6.1.1 Scale of production and mode of processing

Scale of production is a salient marker in the sub-sector. Size of production capacity determines the set-up of production plant (levels of automation, mechanisation etc.) which in turn influences viable market segments accessible to a processor, and therefore the kinds of boiler meat to produce. For instance, processors with installed capacity of 1000 birds per day, 'large-scale processors', operate highly or fully automated processing systems on continuous production schedule; the costs of operating[35] at such scale implies large processors are, in principle, constrained to high-volume markets only. From the analysis of scale-of-production data retrieved from sample companies, four groupings of processors are identified, these are presented in Table 21 below.

Table 21: Boiler Processors Classification

Scale	Installed capacity (per day)	Plant set-up	Frequency of operation	Live bird acquisition
Large-scale processors	≥1000 birds	Moderate to full automation Full mechanisation	Continuous	Hybrid (own-farm & out-growers)
Medium scale	≥300 to <1000 birds	Advance mechanisation	Continuous	Hybrid (own-farm & out-growers)
Small-scale processors	≥100 to <300 birds	Moderate to high level mechanisation	Continuous	Hybrid; Out-growers
Micro-producers	<100 birds	Low to moderate level mechanisation	Intermittent; Seasonal processing	Own farm

Source: Authors' own

6.1.2 Cyclical demand

Processed broiler meat production is not steady, it fluctuates with the supply of live birds and demand for domestic meat. Demand for domestic broiler meat is cyclical: April-May, and November-December represent high-demand (bumper) seasons; the remainder of the year represent low-demand periods. Processing is attuned to the cyclical nature of demand. During bumper seasons, processors operate two or more eight-hour shifts per day, whereas, in lean seasons, single shift is the norm, some even limit processing to six hours per shift.

[35] For a highly automated processing system

6.2 Value-Addition Stages of the Broiler Processing Value-Chain

The broiler processing sub-sector takes delivery of live birds from producers and supply dressed birds to diverse off-takers. Consequently, processors' operations start at farm-gate of broiler producers and ends at designated delivery location. The process from live bird at farm-gate to dressed-bird in the hands of consumers comprises of four value-addition stages. In analysing the broiler value-chain, the authors examine the chain's activities across the four value-addition stages presented below.

6.2.1 Stage I: Broiler meat production

Slaughtering and dressing

The means by which 'slaughtering and dressing' operations are carried out is determined by the scale of a processor. From the sample, large-scale processors were noted to have synchronised system of operations: Processors take delivery of birds from farms at set dates in line with their processing schedule, live birds are hauled from farm to factory in processor-owned trucks retrofitted purposely for broiler haulage. Loading and unloading aside, all operations associated with processing of birds are either automated or mechanised. Two-thirds of operations performed by small processors are manual, the remainder is mechanised. Table 22 below presents the mode of operations (level of human labour or equipment usage) per each activity, as witnessed in the field.

Table 22: Mode of Dressing Operations Across Varying Processors

Activity	Large scale	Small-scale	Micro-scale
Live hauling	Processor-owned retrofitted trucks	Processor-owned retrofitted trucks	N/A
Loading	Manual	Manual	Manual
Unloading	Manual	Manual	Manual
Stunning	Automated process	N/A	Manual
Beheading & bleeding	Automated process	Manual	Manual
Scalding	Automated process	Mechanised	Manual
Feather plucking	Automated process	Mechanised	Manual
Evisceration and cleaning	Mechanised and manual	Manual	Manual

Cutting, portioning, and further value-addition

After carcases are deemed safe for human consumption, processors—based on final produce—perform single or combination of the following activities: prepping whole chicken, cutting-and-apportioning, or further value-addition. For all processors sampled, close to two-thirds of output are delivered in the form of whole chicken. Although representing less than one-third of output, the market for domestic poultry meat cuts is vastly uncompetitive relative to imports. Nevertheless, large, and small-scale processors engage in cutting and apportioning meat. The operations of large processors are less labour-intensive and precise due to high adoption of heavy equipment, whereas that of small-scale processors is labour-intensive.

While considered a niche market, further value-addition[36] has for a long time been part of the operations of all small and micro-processors interviewed. According to small processors, further-value addition accounted for less than 5 per cent of output, and accounts for 40 per cent of micro-processors output. In recent years, large and medium-scale processors have ventured into further

[36] Includes seasoning and ready-to-eat processing.

value addition, mainly grilled chicken. Investments in further value-addition equipment was noted to be low, significant share of equipment employed is sourced from local fabricators.

Table 23: Composition of Product Portfolio Across Varying Processors

Product category	Scale of processing		
	Large	Medium	Small
Whole chicken	83%	75%	60%
Chicken cuts	15%	20%	0%
Seasoned and ready-to-eat chicken	2%	5%	40%

Source: Authors 'own analysis

6.2.2 Stage 2: Processed meat packaging

Product packaging occurs across all categories of processors. For all processors, packaging activities are mainly manual labour with limited mechanised intervention. Plastic foils and trays are either imported or procured domestically, labelling is done at factory premises. Here too, the level of sophistication is informed by the processor's scale of operations.

Image 9: Whole-chicken package of large processor

Image 10: Whole-chicken package of medium-scale processor

6.2.3 Stage 3: Refrigeration

All processors were observed to preserve their produce by means of cool refrigeration and blast freezing. Large-scale producers have sophisticated refrigeration and freezing units on site, whereas small-scale processors were noted to have made modest investments in industrial refrigeration units. Micro-processors rely on household refrigeration and freezing units.

Among all processors, refrigeration was noted to be a sensitive matter. Given vast fluctuations in supply of live birds and demand for broiler meat, processors desire of refrigeration units with large storage capacity. However, the issue of inconsistent supply of electricity and high tariffs renders

refrigeration a major challenge. In response to this, the use of slabs of ice to chill fresh meat ahead of delivery is pervasive.

6.2.4 Stage 4: Distribution

Product distribution is the final operation. As illustrated in Figure 9, the market for broiler meat comprises of three off-taker segments. In serving these markets, processors prefer direct distribution channels. Indeed, with the exception of retail supermarkets and cold stores, all processors deliver directly to consumers. As a result of this, industrial and small processors maintain a fleet of refrigerated motor vehicles to make deliveries. Since industrial processors' deliveries cover larger swaths of geographic area, their fleets have superior refrigeration capabilities compared to that of small processors. Micro-processors make deliveries by means of non-refrigerated vehicles.

Image 11: Refrigerated truck of a large processor
Source: Darko Farms

Image 13: Refrigerated truck of a small-scale processor
Source: Joress,2020

Image 13: Refrigerated truck of a medium-scale processor
Source: Joress,2020

6.3 Supply of Broiler meat

6.3.1 Production capacity: Installed and actual

Demand variability and fluctuating supply of live birds[37] make it difficult to ascertain the exact size of domestic broiler meat production. In light of this challenge, the authors, have chosen to refrain from offering a nation-wide analysis regarding production of chicken meat on basis on inaccurate data. Rather, analysis of meat production is limited to the focus geographic areas and disaggregated into seasons using information gleaned from sampled processors.

Table 24 below presents production figures of the processors interviewed in the Greater Accra, and the Ashanti Regions[38]. During peak production seasons, large processors utilise, on average, up to 70 per cent of their installed capacity with small processors using, on average, up to 95 per cent of installed capacity, whereas micro-processors utilise, on average, 100 per cent of the available capacity. In lean seasons, large and small processors utilise, on average, 10 and 60 per cent of their installed capacity respectively, that of microprocessors could not be determined with adequate confidence.

Table 24: Output of Processors Sampled

Average output metric	Large-scale processors (MT)		Medium-small processors (MT)		Small-processors (Mt)	
	Per day	Annum	Per day	Annum	Per day	Annum
Installed capacity	27.2	8160	1.36	408	0.272	81.6
Actual output per single shift (8 hrs) in bumper seasons	9.52	2856	1.292	387.6	0.272	81.6
Actual output per single shift (8 hrs) in lean seasons	2.72	816	0.952	285.6	unknown	Unknown

Source: Authors' own

Table 25: Broiler Meat Production Cost and Pricing

Item	Average price (GHS[39])
Cost/kg whole chicken	2.53
Cost/kg Chicken meat	9.5
Price/kg live weight	15
Price/kg carcass weight	13
Price/local DOC	5.50
Price/imported DOC	7.40

Source: Author's computation based on primary data

[37] Processors expressed that they routinely have to shut-down processing due to undersupply of live birds.
[38] At the time of writing, Appah Farms' facility in the Eastern Region is yet to be operational. Since Appah Farms is the only processor sampled from the Eastern Region, the authors do not have processing data from the region.

[39] Ghanaian Cedi

6.3.2 Broiler meat market segmentation

The market for broiler meat in Ghana comprises of three segments, namely industrial, commercial, and domestic.

Industrial Market Segment

The industrial market segment comprises of industrial catering companies—including caterers in aviation, oil and gas industries, and quick-service restaurant chains. The segment absorbs only frozen chicken cuts in large volumes at scheduled times[40]. Owing to procurement modalities employed by industrial off-takers, the segment is supplied exclusively by large-scale processors. However, at the time of data collection, processors indicated that industrial off-takers absorbed a mere 10 per cent of their output. Although, industrial off-takers have large demand, they rely on inexpensive imported meat to satisfy significant portions of such demand.

Commercial Market Segment

The commercial market segment comprises of institutional off-takers in the non-industrial catering sectors, hotels, government agencies, commercial supermarkets chains, cold-stores etc. The segment takes delivery of whole chicken and chicken-cuts (chilled and frozen); it absorbs close to 60 per cent of processors 'output. Owing to the terms of trade extended by commercial off-takers, the segment is supplied mainly by large-processors and specialist processors[41]. Processors indicated that, institutional off-takers settle their invoices between 30 to 45 days upon receiving delivery. Such long invoice payment period is unfavourable for medium[42]and small processors, whereas industrial and specialist-small processors are able to accept such terms.

Direct-to-household Market Segment

The direct-to-household segment constitutes household and private consumers. This segment absorbs all product categories in the chilled form, as well as fully cooked (grilled meat); it absorbs a one-third of output. The direct-to-household segment is the most competitive segment in the market as it is readily accessible to all types of processors.

[40] At the time of data collection, three large processors were in the final stage securing a supply contract from KFC Ghana. Each estimate the contacted quantities will absorb approximately 60 per cent of their installed capacity. Production for KFC is expected to commence in during second quarter of 2020.

[41] A class of medium processors without backward integration in broiler production.

[42] Expect specialist processors.

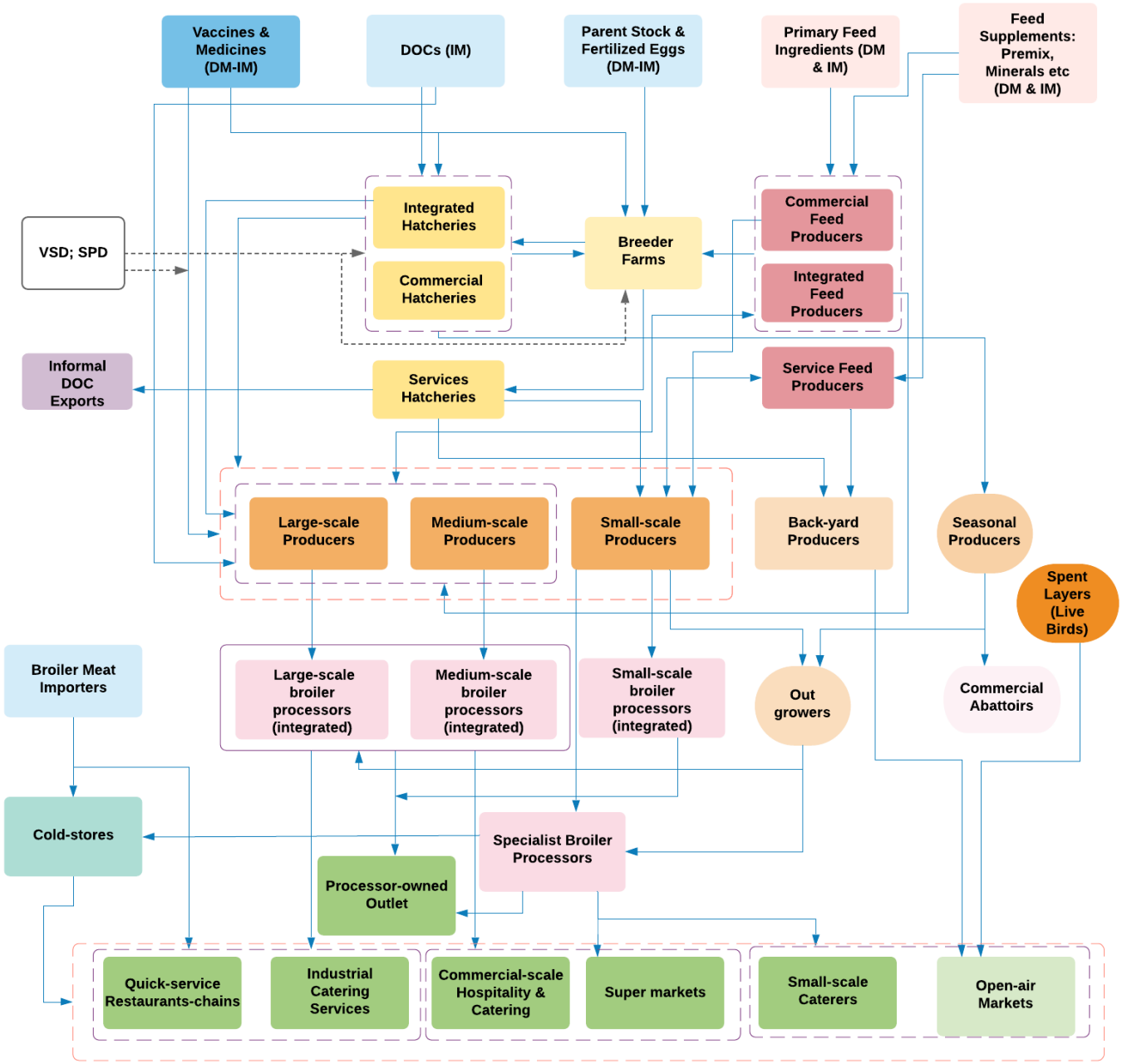


Figure 10: Ghana Broiler Processing Value Chain
Source: Authors' own

6.4 Constraints and Opportunities Broiler Processing Value Chain

Not all demand is created equal: Effective and non-effective demand of chicken meat

There is a general consensus that the interaction of certain macro trends[43] has and continues to stimulate increased consumption of processed poultry meat in Ghana. Emerging from this view is the dominant narrative that increased demand is poised to stimulate domestic processing industry, as processors strive to capture shares of new demand, and eventually vanquish chicken importation. The reality on the ground does not conform with this narrative. Although demand is growing, the *quality of growth* and the *dynamics of marketing and distribution* is not as of yet conducive for domestic processing to replace importation.

I. Poor quality of increased demand

The increased growth in demand is concentrated, in terms of volumes, at the 'industrial' and 'commercial' market segments. Yet, buyers in both segments consistently exhibit weak willingness to buy domestic chicken. The industrial segment absorbs less than 10 per cent of domestic output and recognises importation to be their primary source. The preference for imported over locally processed chicken meat arises from the former's cost competitiveness. Industrial buyers offer between GHS 10 and 12 per kilogram for domestic processed meat (imported chicken price parity), against average production cost of GHS 15. Indeed, majority of industrial-scale processors admitted that, although the industrial market segment abounds with high demand, the demand is not favourable to the cost structure of their operations.

II. Dynamics of marketing and distribution

Marketing of domestic processed chicken is less effective and thus results in the "premium-price justification gap". Presently, the processing industry has not succeeded in educating the general public as to the superior sensory and health benefits of consuming domestic chicken. As such, although Ghanaians profess a taste for domestic chicken, they are liable to consume imported chicken instead of paying a moderately higher price (premium price) for local chicken. This is because, the "value" for which consumers are asked to pay a premium price is not clearly articulated and conveyed—in other words, the value-for-money of domestic chicken is not conscious in the minds of consumers.

Moreover, even when consumers are willing to pay premium price for local chicken, they are more likely to consumer imported chicken as the latter is readily available due to wide distribution. As Figure 10 illustrates, for the most part, poultry meat reaches end-consumers through institutional actors (intermediaries). In the commercial segment, cold-stores, supermarkets, commercial hospitality, and catering companies are the major intermediaries. Since the profit margin on domestic chicken meat is low, it is not in the interest of such intermediaries to stock large volumes or actively promote domestic products in their establishments. Rather, there is a widely held view among practitioners that certain retailers and catering establishments mislead consumers to patronise imported chicken meat. A number of processors admitted that some supermarkets offer defrosted imported chicken meat as fresh produce, catering establishments engage in similar practices.

[43] Expansion of middle-class population, transformation in dietary preferences, growth of urban population etc.

Therefore, although general demand for processed chicken meat has expanded, the overall quality of growth and accessibility to those market segments recording the highest increase is poor in relation to its relevance for domestic processors. Hence, the narrative of import-substitution processing ought not be accepted, nor should the growth potential of domestic processing industry be viewed in terms of competing with imported produce. Rather, the nascent resurgence of the broiler processing industry should be viewed and understood in terms of serving the premium-product market, a latent but promising segment that cannot be served by importation.

6.4.2 Critical constraints to market growth

I. Weak Synchronisation of Upstream and Downstream Activities

Sub-standard operational efficiency in the processing sector was noted to be the bane of the industry. Operational efficiency in broiler processing requires continuous band operation from entry of live birds to exit of chilled or frozen produce. Maintaining uninterrupted operation requires effective synchronisation of upstream and downstream activities: from provision of DOCs, production on farms, as well as marketing and distribution. This absence of effective coordination of upstream and downstream activities represents a critical challenge to the processing sector's operational efficiency.

Notwithstanding that majority of processors secure live birds through outgrowing model, they are not impervious to supply variability. Indeed, previously mentioned upstream challenges (see section on DOCs and Feed) hinder reliable supply of inputs, which in turn weakens the alignment between volumes-and-timing of production with that of processing. At the downstream, limited exchange of market information between processors and off-takers impairs efficient coordination. The quality of relationship between processors and institutional off-takers allows for narrow exchange of market information. As such, processors do not have access to reliable information on purchasing trends with which to anticipate demand levels and align processing. Instead, processors engage in supply-led production, the least form of coordinated production.

II. Powering Cost Upward: High Cost of Electricity

Although Ghana currently has a 4,000 MW installed, actual electric power generation rarely exceeds 2,400 MW, hence persistent insufficient supply of energy prevails. As such, power outage is a common occurrence. As a mitigating measure, all processors, except micro-processors, have invested in independent electric power generation units, to supplement on-grid supply. Furthermore, the cost of electricity is high. Ghana's industrial rate for electricity is Euros 0.119 kWh as compared with a Euros 0.98 kWh rate in Nigeria. Most processors intimated that the high-cost electricity is a major reason for limiting their actual processing capacity. The rational is that, since preserving surplus produce in refrigeration units will incur high operational costs which they cannot recoup by internalising it into the price of chicken, which is already high, it is best to limit production.

III. Working capital deficiency

Similar to primary producers, working capital deficiency is a key challenge among processors. Of the entire poultry sector, processors have the longest cash conversion cycle of 14 to 16 weeks.[44] Such long cash conversion cycle weakens the working capital position of processors. More importantly, the limited supply of working capital facilities on the domestic financial markets, places further stress on processors working capital position with adverse effects on ability to secure new birds for future

[44] This is an effect of extended operating cycle involving backward integration activities (feed production), pre-financing of out-growers (DOC acquisition), and long sales revenue collection period.

operations, invest in marketing and direct distribution infrastructure etc. Factors underpinning persistent working capital deficiency include:

a. Unconducive credit policy — Input suppliers demand advance payment or prompt payment upon delivery or short invoice payment terms, whereas institutional buyers settle invoice 4-5 weeks upon receiving produce.

b. Inadequate supply of appropriate credit facilities — Credit facilities available in the market are not attuned to the dynamics of poultry industry. Interviewees indicated that interest rates on short-term credits are significantly high relative to return on poultry produce. Moreover, the design of debt servicing schedule is not aligned with sector's cash conversion cycle nor to the peculiarities of market.

c. Inaccessible supply-chain finance solutions — Although a number of Ghanaian banks indicated they offer supply-chain financing facilities, producers submitted that they are unable to access such facilities.

IV. Low Accumulation of Productivity Enhancing Capital Goods

Processing capability and general operational efficiency were noted to be acutely hampered by the weak capital goods position observed throughout the industry. Two processors aside, all sampled processors were observed to use outmoded industrial equipment or new equipment with narrow performance capabilities. Moreover, refrigeration and packaging units utilised were noted to be less energy efficient and therefore not conducive to the existing high energy tariff regime.

Scarcity of appropriate capital goods finance is the main cause of this challenge. Moreover, in the past 10 years, Turkish and Chinese capital goods manufacturers, under the aegis of the Türk Eximbank and Exim Bank China, have made strident headway into the Ghanaian market supplying low and mid-tier equipment with low energy efficiency and responsiveness to the domestic environment.

6.4.3 Critical opportunities for market growth

Of the current growth in consumption of processed chicken meat, approximately one-third represent effective demand for domestic processors. Yet, due to the dynamics of the poultry meat industry, processors are unable to capture the entirety of the share of effective demand. This section presents opportunities that will enhance the growth of domestic meat market. It must be noted that, a plethora of market growth opportunities were identified, however these were filtered to two. The selection criteria were based on: (a) degree to which processors have direct control over grasping the opportunity[45]; (b) the degree to which the opportunity is addressable considering all that is known about the value-chain; and (c) extent to which identified opportunities could increase market share.

I. Expanding Last Mile Distribution Outlets

In the current environment, access to consumer markets is effectively controlled by commercial distributors (supermarkets and cold stores) whose commercial interests and business model favours imported chicken meat. Consequently, to capture existing effective demand, domestic processors have to circumvent the gate-keeping function of commercial distributors. This involves establishing

[45] For example,

wide network of processor-owned distribution outlets (cold-stores) close to consumers. Indeed, four processors (Accra Abattoir, Amass, Darko Farms and Joeress Farms) have already established their own centralised distribution outlets.

To effectively reach wider consumers across major urban areas, a wide network of decentralised processor-owned/controlled distribution outlets will be necessary. The goal is for processors to improve product availability and accessibility throughout high income communities across the country. Given the high capital outlay of such an endeavour, outlets could be established by a consortium of processors. However, the current low level of cooperation between processors renders this approach thorny, instead, it is anticipated that individual processors will establish their own distribution chains.

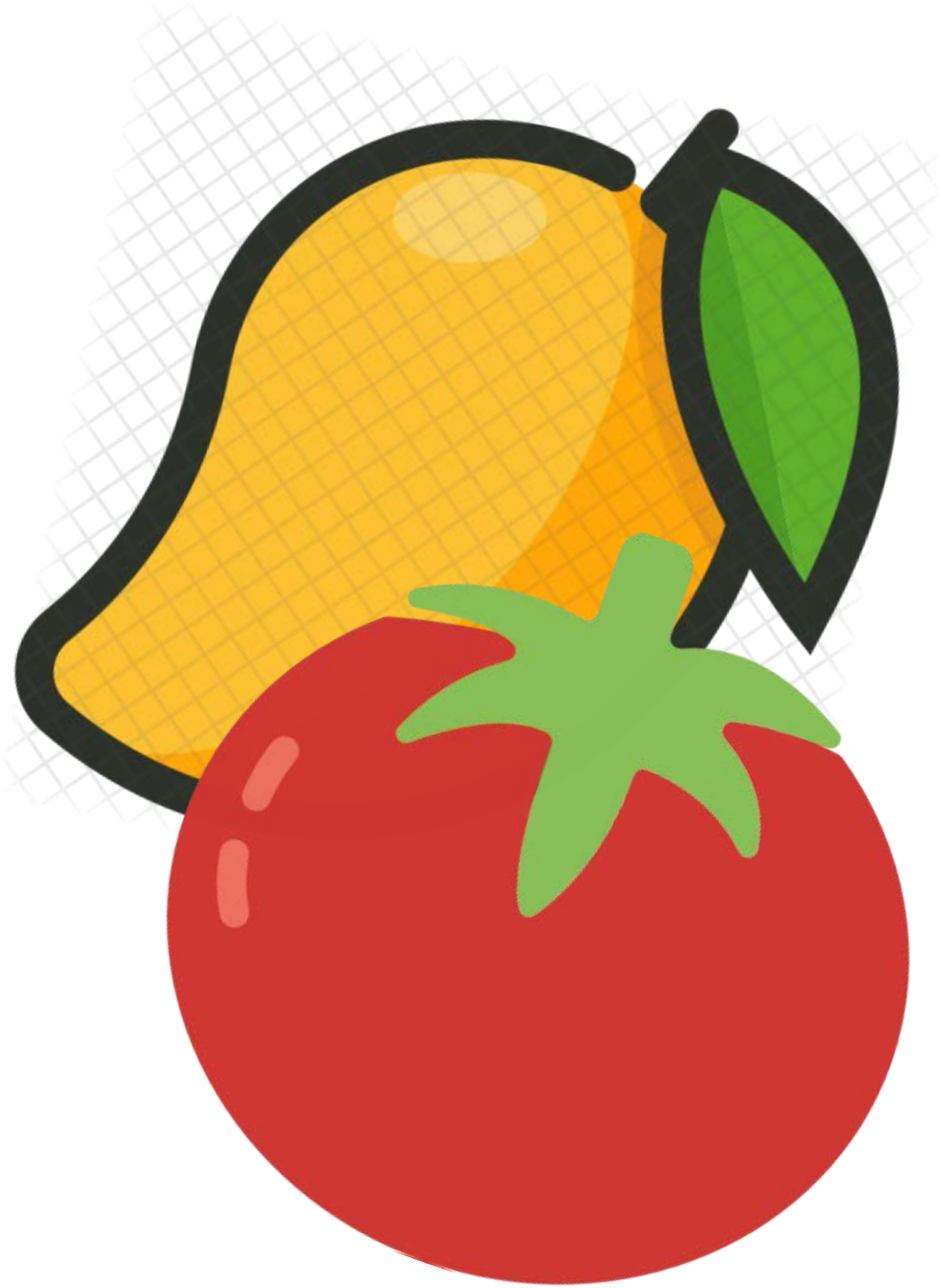
II. Bullish on High Value-added Produce

The convenience food segment is the most rapid growing component of the processed food market. Indeed, supermarkets stock quantities of high-value added convenience chicken produce (seasoned semi-cooked and seasoned fully cooked), the further value addition is performed in-house by supermarkets. Compared to demand, mainstream processors' output of high value-added produce is small. As such, the share of domestic chicken represented in the high-value added food segment is minuscule—this represents a market growth opportunity for processors. Processors, in order to grasp opportunities presented by high-value added segment will have to invest in acquisition of industrial or commercial-grade equipment.

6.4.4 Market opportunities for the Dutch private sector

Table 26: Market opportunities for the Dutch Sector

Segment	Need	Request frequency
Hatchery	Incubation and setting equipment (100,000 per cycle capacity)	2
Hatchery	Imported fertile eggs	1
Hatchery	Imported vaccination & medications	1
Hatchery	Hatchery management training	
Primary producer	Layer DOCs importation	3
Primary producer	Broiler DOCs importation	2
Primary producer	Housing and feeding systems	1
Processing	Defeathering machine	3
Processing	Cutting equipment	3
Processing	On-site refrigeration units	4
Processing	Blast freezers	2
Distribution	Refrigerated trucks	2
Packaging	Packaging equipment	4
Multiple	Biogas electricity solution Solar energy solution	4
Multiple	Working capital facilities	20



SECTION 3: FRUITS & VEGETABLE

Executive Summary Fruits & Vegetable Sector

Contrary to popular view that Ghana's fruits and vegetable processing sector low processing capacity is key challenge to its underperformance, the present study observed that the total installed processing capacity is sufficient. Rather the challenge with the fruits and vegetable processing sector lies with inadequate supply of quality raw material. In Ghana, primary production for the industrial market and for the non-industrial market is not differentiated; therefore, industrial processors compete with non-industrial users for access to raw material. Given the cost structure of industrial processing, processors are unable to match the relative higher priced offered by non-industrial consumers. Hence, processors are forced to rely on raw material rejected by non-industrial buyers or procure raw material during seasons of oversupply—an erratic model for souring raw material. Unreliable and costly supply of electric power is the second major constraint to the processing sector. Although Ghana currently has a 4,000 MW installed, actual electric power generation rarely exceeds 2,400 MW, hence persistent insufficient supply of energy prevails. Furthermore, the cost of electricity is high, with rates at € 0.119 kWh. Most processors intimated that the high-cost of electricity is a major reason for limiting their actual processing capacities.

Some recommended measures to mitigate the above constraints outlined include: First, decoupling the market for industrial use from that of non-industrial use. This can be achieved through the introduction and cultivation of varieties specific for industrial uses. In so doing, industrial and non-industrial consumers will have separate market for sourcing their raw material, and thus reduce the stress of their combined demand, and the resulting price inflation thereof. Secondly, diversifying source of electric power will reduce' processors' reliance on on-grid supply. Here, the development of renewable sources of energy at site will be a step in that direction.

Two main data collection approaches were adopted for this study. The first approach consisted of a literature review which entailed review of Ghanaian government policy and project documents, reports, and news articles. The second approach entailed a series of semi-structured interviews with key actors. A total of 18 interviews were conducted with representatives of the processing companies, farmer-based organisations, traders association, retailers, packaging suppliers and retailers. Companies interviewed are located in the, Ahafo, Bono, Greater Accra and Central regions. Further details on the VCAs interviewed may be found in Appendix 6.

7. OVERVIEW OF VEGETABLE PROCESSING SUB-SECTOR IN GHANA

Overall vegetable consumption in Ghana remains small relative to regional neighbours, although consumption is rapidly expanding. The overall production of crop and livestock products, vegetables represent a value of around US $675 million out of a total US $6.4 billion. Tomatoes, peppers (both sweet and hot chillies), onions and okra are the four top vegetables commonly produced in Ghana (WUR, 2016). As Table 31 illustrates, vegetable production has recorded year-on-year growth. Of the favourite vegetables produced, tomato production in particular has expanded significantly, recording a 23.3 growth from 317,000 tonnes (t) in 2012 to 395, 755 t in 2019. In addition, local production, substantial portions of fresh and dry onion found on the local markets are imported from Burkina Faso, Cameroon, and Togo, with anecdotal evidence suggesting import value of more than US $120 million for the Accra and Kumasi markets alone.

Between 2012-2013 Ghana Living Standards Survey (GLSS) report that household spending on vegetables was 12.8 per cent of total food expenditure. Household expenditure on tomatoes made up the highest share of total vegetable expenditure (35.2 per cent), followed by onions (19 per cent), chilies (9.7 per cent) and carrots (1.3 per cent). The increase in health-conscious middleclass consumers has seen growth in consumption of fresh vegetables in the form of salads. Production of fresh vegetables takes place all around the country and is strongly related to the specific weather conditions and market windows. In addition, irrigated agriculture is on the increase leading to new production areas around the Volta Lake as well as specific irrigation areas in and around Accra.

In Ghana, the most dominant form of vegetables processing is drying and further conversion into powder. This is evident in the value chains of chili and ginger as the volume of production is more than the demand on the market hence the value addition to enable product to be stored for longer periods. Vegetables in the value chain of tomatoes produced in Ghana are destined for fresh consumption with little available for processing. In all the vegetable value chains, with the exception of chillies, lettuce, cabbage and carrot, the rest are seasonal vegetables with production in certain geographical areas.

Ghana's vegetables exports show increased potential. Indeed, exports of peppers are believed to have a comparative advantage over competitors like Kenya, given Ghana's agroclimatic conditions and relatively short distance to the EU market. Comparative advantages notwithstanding, horticultural exports have declined due to failure to adhere to EU phytosanitary requirements.

Table 27: Top Vegetable Production in Ghana

Production MT	2012	2013	2014	2015	2016	2017	2018	2019
Chillies and peppers, dry	100,000	102,803	107,430	110,454	114,412	118,372	122,332	126,291
Eggplants (aubergines)	46,000	48,980	51,273	51,273	51,273	51,392	54,145	55,092
Okra	60,000	638,60	63,860	66,360	66,360	66,360	66,458	68,954
Onions, dry	130,000	138,188	143,982	143,982	143,982	144,900	157,181	155,402
Tomatoes	321,000	340,218	366,772	366,772	366,772	369,917	391,633	395,755

FAOStat, 2020

8. SUB-SECTOR ANALYSIS: PRIMARY PRODUCTION

8.1 Primary Production

The level of domestic tomato production continues to expand, albeit at a much slower pace. As Figure 11 illustrates domestic production from 310,000 tonnes in 2012 to 395,755 tonnes in 2019, representing a 23.3 per cent growth in the period. Gains in production are largely attributable to yield improvements, which expanded at a modest 2.7 per cent, as opposed to area expansion (MoFA & IFPRI, 2020).

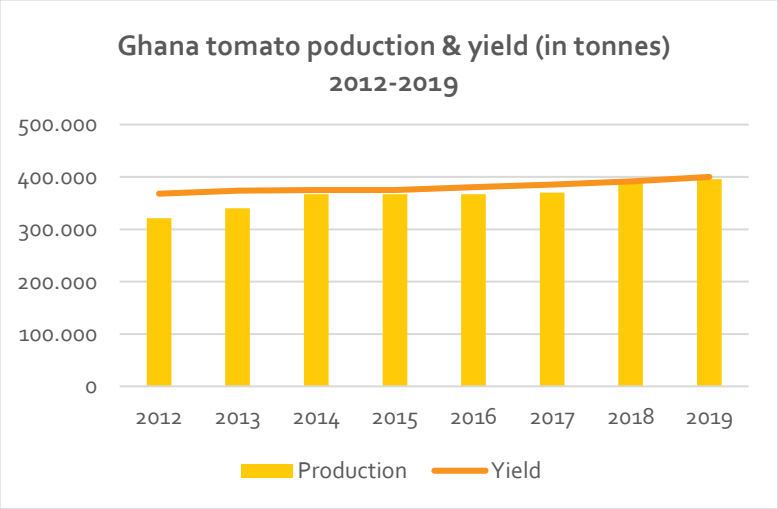


Figure 11: Ghana Tomato Production & Yield

Source: FAO 2020

Tomato is mostly produced in 10 out of the 16 regions in Ghana. These production regions include Upper East, Savanah, Northern, North East, Bono East, Brong Ahafo, Ashanti, Eastern, Greater Accra and Volta regions. The demand for both fresh tomato and tomato products is year-round , yet tomato production in Ghana is seasonal due to the differences in the rainfall patterns as well as water availability. Tomato produced during the rainy season reaches the market from June to October, but the varieties produced during this period are poor in colour, high water content, acidic and have a shorter shelf life, making them unsuitable for processing. With the exception of Upper East region where tomato is produced during the dry season under furrow irrigation system and some parts of the Greater Accra region, tomato production is generally rain-fed. During the rainy season, harvest is abundant, leading to glut and wastage even though there is scarcity during the dry season.

Tomato cultivation in Ghana is dominated by smallholders with average landholdings of less than two hectares. In the Northern parts, production occurs under irrigation, whereas southern production is mainly rain-fed, except in the Volta region, where most farms are irrigated. The agroclimatic conditions of Ghana is suitable for realising average yields of 17.5 tonnes per hectare. However, majority of tomato farmers (66 per cent) obtain yield ratio of less than 10 tonnes per hectare, as compared with 20 per cent with yield ratio of 20 tonnes per hectare and above, with the remainder securing between 10-20 tonnes per hectare (IFPRI, 2010). It appears that the agroclimatic conditions influence yield. Indeed, producers located in the Guinea Savannah, Transitional Forest, and Deciduous Forest Zones[46] record average yield ratio of between 15-17 tonnes per hectare. Whereas producers located along the Coastal Savannah record lower yields hovering between 7-5 tonnes per hectare.

Geographic location aside, the choice of variety and planting material used influences yield. The major varieties grown in Ghana include Roma VF, Laurano, Raki, Chocó TP, Power Reno, Rasta, Italy Heinz and Petomech, which are mostly suitable for processing. Of these, two varieties are

[46] Upper East, Ahafo, Ashanti, Bono, and Brong regions

most preferred: Power Rano is widely cultivated in Brong Ahafo and Bono East regions under rainfed conditions, and Pectomech, a variety suitable for processing that is grown widely in the Upper East and in Burkina Faso as well, outperform other varieties under most conditions. The norm of recycling seeds is gradually giving way to purchasing seeds. It is estimated that close to one-fifth of tomato farmers recycle their seeds, as compared to a quarter two decades earlier.

8.2 Trade and Marketing

The seasonality of tomato production affects that of marketing dynamics. Indeed, between late December through May, most of Ghana's domestic tomato supply stem from the Upper East region of Ghana. Whereas, from June onwards, tomato harvesting moves into Ghana's middle-belt (Ashanti, Brong Ahafo Bono, and Bono) and southern belt (Greater Accra and eastern parts). Regional trade is growing in stature, with market traders from Ghana's neighbouring countries crossing the border to purchase tomato, and Ghana's traders increasingly relying on tomatoes from Burkina Faso between January and May when the only region in Ghana producing significant volumes of tomato is the Upper East.

8.2.1 Trade of fresh tomatoes

Nearly all tomato products (fresh or processed) manufactured in Ghana are consumed domestically. Fresh tomatoes harvested in Ghana annually are absorbed by one of the two market streams:

I. Non-industrial market

The non-industrial market pertains to the sale of tomatoes to non-industrial processors. This market is the largest of the two, and the most complex. Although official statistics for internal trade in tomatoes is unavailable, anecdotal evidence suggests close a two-thirds of fresh tomatoes flows through this market.

Credit: SOL, 2020

The structure of trade in this market involves 'itinerant traders' purchasing tomatoes from 'producers' at farm-gates across the country. Itinerant traders transport tomatoes from farms to open-air markets, which function as wholesale markets. At these markets, itinerant traders sell their produce to traditional retailers and institutional buyers. The largest wholesale markets for tomato are in Kumasi (Kumasi Central Market) and Accra (Makola and Agbogbloshie). Other important markets are situated in Techiman, Tamale , and Navrongo, are located in key growing areas. These wholesale markets are the main conduits through which tomatoes reach retailers.

Tomato Traders Associations (TTA) retain strong control over these larger markets located in highly populated areas (in Kumasi and Accra), restricting who can bring tomatoes to the market, and the volumes permitted per day. In large markets only itinerant traders that are TTA members of are licensed to the bring tomatoes onto the market, with each itinerant trader allocated volumes and days they can bring produce to the market. Market associations by restricting direct access to whole market by competitors—be it farmers or other middlemen—are able to regulate the supply of tomatoes in the market as well as volumes of tomatoes that leave farm-gates, thereby effectively controlling price of fresh tomatoes. Tomato Traders' Associations affiliated with markets located in Techiman, Tamale, Navrongo and elsewhere have less control over such markets, allowing farmers access to such market. Since the demand in lesser markets are far below that of large markets, farmers still depend on itinerant traders to access large markets. This gate-keeper position makes the itinerant traders and chairperson (Market Queens as they are called) of tomato traders associations the most powerful constituents in the entire tomato value-chain.

II. Industrial market

The industrial market—in principle—serves as an alternative market for farmers aside from itinerant traders and wholesale markets. Yet the potential of the non-industrial markets remains dormant. In that, domestic processors source less than 23 per cent of fresh tomatoes from domestic producers. A blend of reasons accounts for this. First, excessive importation of processed tomato products limits processors' ability to compete on the market. Secondly, in other to compete, some large processors import bulk concentrate only to repackage it locally. All these notwithstanding, the issue of purchasing price is most critical: the clearing price of tomatoes at farm-gate is persistently higher than that which processors can afford. Hence, although pockets of fresh processing occur in Ghana, the industrial market remains a fringe market for tomato producers.

8.2.2Trade of processed tomatoes

Ghana is heavily reliant on imports to meet demand for processed tomatoes. In 2019, Ghanaians, it is estimated consumed 127,836[47] tonnes of processed tomatoes. In the same year, 77,769 tonnes of processed tomato products and 11,932 of peeled canned tomatoes were imported into the country (UN Comtrade Database, 2020). Whereas domestic processors manufactured less than 17, 000 tonnes of tomato paste, of which 11,388 tonnes were exported to regional markets. From this, it can be deduced that of the total tomato paste consumed in 2019, a mere 33.1 per cent (5612 tonnes) was manufactured locally.

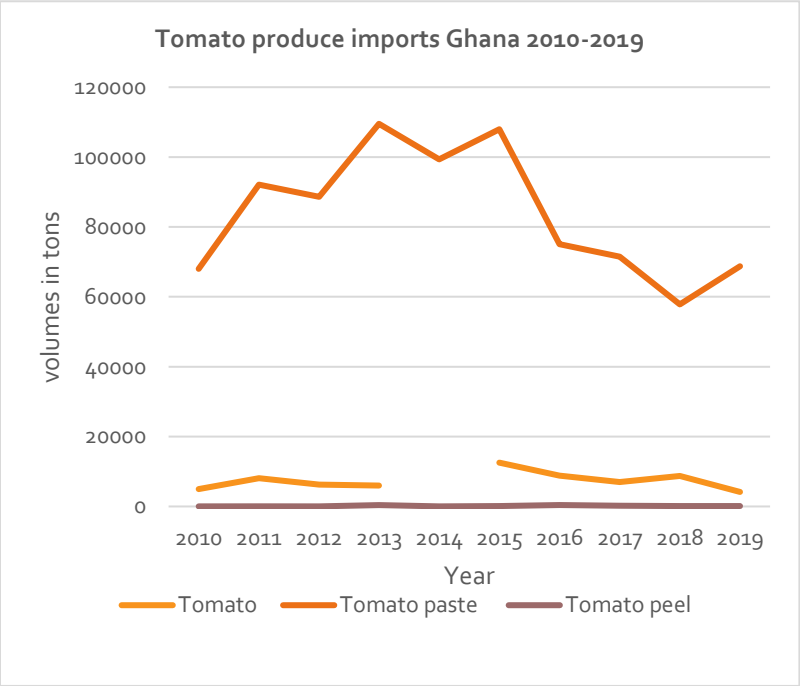
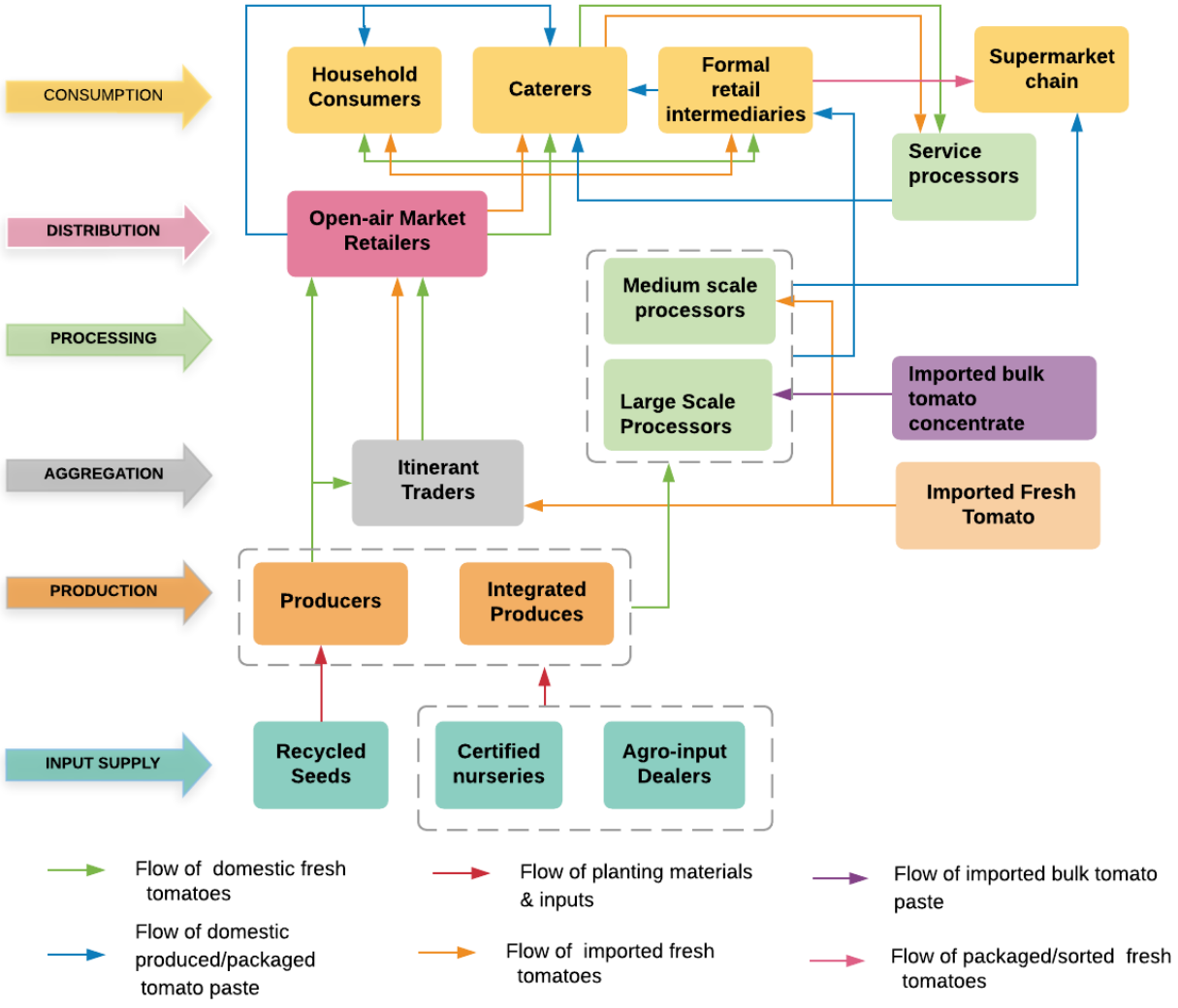


Figure 12: Processed Tomato Products Import

Source: UN, Comtrade Database

[47] This figure includes consumption of processed products manufactured in the informal sector.

Figure 13: Tomato (processing) Value Chain



Source: Authors' own

8. VALUE CHAIN ANALYSIS: TOMATO PROCESSING

8.1 Characteristics of Tomato Processing Industry

8.1.1 Discrepancy among tomato processors

Ghana's tomato processing sector comprises of two segments, namely industrial and non-industrial. The non-industrial processing segment entails elementary processing by small-and-microprocessors for non-industrial uses or clients. Such processing occurs in wholesale market places and occurs predominately in the informal economy. Industrial processing on the other hand entails processing of tomatoes in an industrial setting. In this segment, the medium and large processors apply advanced machinery and know-how to manufacture and market processed tomato products.

Segment aside, processors can be differentiated on basis of scale, of which there are three: small/microprocessors, medium processors, and large processors. Section 8.2.2 expounds upon these three distinctions.

8.1.2 Production of value-added tomato produce

I. Elementary processing

Elementary processing is the simplest and most dominant form of processing in Ghana. It involves milling and dicing of tomatoes; after milling/dicing no further processing (straining seeds or water reduction etc) ensues. This form of processed is engaged in predominantly by service processors and to a limited extent by medium-scale processors. Elementary processed products include tomato pulp and diced tomatoes.

II. Further value addition

Further value addition pertains to sophisticated forms of processing. This form of processing includes, cooking to reduce water content, straining of seeds and skin, introducing additives and preservatives. Further value addition is predominately engaged in exclusively by large and medium scale processors. Further value-added tomato produced manufactured in Ghana include tomato concentrate (36-38 per cent brix), tomato paste (28-30 per cent brix), tomato puree (20-24 per cent brix), and tomato pulp (10-12 per cent brix); and whole in juice/pulp. Tomato ketchup and sauces are also manufactured locally at a modest scale.

8.2 Structure and Operation of Tomato Processing

Based on field observations and interviews with processors, process of transforming fresh tomatoes into either elementary or advance value-added produce is categorised into four main categories, these are presented below:

8.2.1 Sourcing

Spot purchase

Sport purchase is the least preferred model of sourcing tomatoes for processors. Here, processors visit farm-gates during harvest time to procure fresh tomatoes at market rates determined by itinerant traders. In most cases, processors are only able to acquire tomatoes rejected by itinerant traders or absorb excess output in times of glut. Indeed, medium processors rely heavily on absorbing surplus output. Although this strategy allows for low prices during the periods of overabundance, during periods of scarcity processors are unable to source through spot purchasing due to the prohibitive market prices. Moreover, varieties available at farm gates are less conducive to industrial processing due to low solid matter etc.

Contract farming

Acquisition of fresh tomatoes is fundamental to processing. Three forms of sourcing models are employed in Ghana. The first involves contract farming whereby processors engage farmers to produce fresh tomatoes for their use under certain terms. Under this arrangement, contracts are introduced between farmers and processors at the start of the season that fixes the price at which farmers will commit to selling their tomatoes to the processor. Ordinarily, both farmers and processors benefit from this arrangement. The processor gets a guaranteed supply of fresh tomato at a pre-determined price that makes processing competitive with imported processed products. Farmers, on the other hand, are offered a fixed price which reduces uncertainty, which enables them to make production decisions based on the price. The farmer also is assured of a buyer, thereby granting farmers direct access to market instead of selling to itinerant traders. Moreover, processors engage in pre-financing in the form of provision of inputs on credit.

Techiman, Wenchi, and Trusty Foods all engage in contract farming, yet were unable to secure consistent and adequate supply at economical prices. Processors were noted to offer between Ghanaian Cedi (GHS) 4-6 for a 40kg of fresh tomatoes corresponding to GHS 100-150 per ton of fresh tomatoes. Alternatively, the farmgate of a ton of fresh of tomatoes ranges between GHS 15-300; whereas the market price range between GHS 200-500. Given this price discrepancy, processors indicate that, farmers are in the habit of selling their produce to itinerant traders, instead of honouring their contracts with processors. Thus, contract farming notwithstanding, processors still find it difficult to source adequate volumes of fresh tomatoes at affordable prices.

Integrated farming

Integrated farming is practiced by medium and large scale-farmers as a hedge against inefficiencies of contract and farm-gate sourcing. Under this model, processors cultivate their own tomatoes for their processing needs. Integrated farming offers processors complete control over sourcing process: cultivating varieties that are conducive in processing; synchronising cultivating and processing times; and guaranteed price for fresh tomatoes. All these benefits notwithstanding, fresh tomatoes from integrated farms accounts for a quarter processors' raw material. Operating large swaths of own farms increases the working capital burden of processors, hence their inability to cultivate sufficient tomatoes for own use.

Importation

To evade the challenges of the above forms of sourcing, large processors engage in bulk imports of tomato concentrate. Here, processors dilute concentrates, and repackage them into tomato paste for the local and regional markets. Bulk importation of tomato concentrate is the largest source of input large processors, accounting for 93% of their inputs.

8.2.2 Processing

Tomato processing in Ghana occurs in the form of industrial or non-industrial processing. The operations of service processors occur under the non-industrial processors, whereas medium and large processors are under industrial processing.

Service processors

Tomato processing in Ghana is dominated by small-and-microprocessors accounting for 70 per cent of tomato processing in the country (WUR, 2018). Processing at this tier consist wholly of small processors who provide rudimentary processing services to clients at a charge. Service processors, located near major tomato markets, engage in milling fresh tomatoes for institutional buyers. In addition to tomato milling services, small processors manufacture tomato-based products for clients. Analogous to the Service-Feed Producers in the poultry sector, service tomato processors mill tomatoes and mix it with other ingredients in accordance with their client's formulation. In this sense small processors merely enable the conversion of fresh ingredients into fresh tomato-based products (condiments, tomato sauce etc.).

Image 14: Small processor Tip Top Foods in the Volta Region
Source: C. Randall, 2012

After the milling and mixing stage, service processors do not engage in any form of preservation, be it chemical by means of adding preservatives or physically by means of pasteurisation. Moreover, processors at this level do not operate according to standard processing techniques or protocol, causing low level of product homogeneity. Small-and-microprocessors for the most part operate in the informal economy. Given their modest financial capabilities, the calibre of machinery used by small-and-microprocessors is rudimentary. Machinery is sourced from local fabricators.

Notwithstanding, the makeshift nature of their operations, service processors are the most resilient of the three processors, in that their service is demand rather than supply led. Secondly, given their service provision function, small-and-microprocessors do not engage in sourcing fresh tomatoes, hence are not affected by tomato price fluctuations. Equally, their offering, mainly fresh tomato pulp, is not in competition with imported tomato products as Ghana import paltry volumes of canned peeled tomatoes.

Medium-scale processors

Unlike their small-scale counterparts, medium-scale processors are the least resilient and dominant in the sector. Indeed, the operations of medium-scale processors account for less than 7 per cent of fresh tomato processed in Ghana. Medium processors for the most part manufacture natural tomato pulp and diced tomatoes thus serving niche markets rather than compete with large-scale processors and importers; some do engage in producing puree as well.

Image 15: Medium processor Techiman Tomato Processing Complex in Bono East Region

Source: Authors'own

Traditionally, processing at this scale occurs for no more than three months in the year. In that, the operating model of medium processors is to absorb excess supply of fresh tomatoes during periods of glut. Since the abundance of tomatoes is a seasonal phenomenon caused by harvesting of rain-feed local varieties, medium processors are limited to processing during period of glut. Hence, medium processors operate on average two-three months per year. Outside these periods, medium processors compete with itinerant traders for fresh tomatoes, with the latter offering higher buying price. However, two medium processors, Wenchi Tomato Factory, and Techiman Food Processing Complex, have shifted to relying on sourcing fresh tomatoes from their own farms, the effect on this sourcing model on the operations is unclear at the moment.

Medium-tier processors were observed to have instituted and adhere to operational and processing standards. With regards to machinery, medium tier processors tend to have state of the art machinery—as in the case of Techiman Processing Complex—or old but refurbished industrial machinery.

Large-scale processing

Large-scale processors account for 13 per cent of locally tomato paste. Large-scale processors manufacture tomato concentrate, puree, and paste for the domestic and regional markets. Although, large-scale processors are plagued with competing with itinerant traders for fresh tomatoes during off-peak season, unlike medium-tier processors, large-scale processors engage in all-year round processing. This is because, in addition to processing fresh tomatoes, large processors import bulk tomato concentrate and paste, which are locally diluted and repackaged for domestic and regional markets. It estimated that fresh tomatoes constitute less than 10 per cent of Trusty Foods and Olam's input, with imported tomato paste comprising of the rest.

Image 16: Large processor Conserveria Africana Limited in Greater Accra Region

Source: GBC Ghana

Processors at this tier possess state-of-the art industrial equipment and produce in accordance with well safety and food hygiene protocols.

Table 28: Classes of Tomato Processing in Ghana

Type of Processor	Products portfolio	Processing machinery	Sourcing Fresh tomatoes	Imports concentrate
Small/micro	- Tomato pulp	- Rudimentary	N/A	N/A
Medium	- Tomato puree - Tomato pulp	- Refurbished machinery - State-of-the-art	- Spot market - Contract sourcing	No
Large	- Tomato puree - Tomato paste	- State-of-the-arty	- Contract sourcing	Yes

8.2.3 Packaging

In the industrial processing sector, metal cans and plastic sachets are the major forms of packaging. Of this metal cans are used mainly for preserving pulp, whole in juice or pulp, puree, and mix. Cans are used primarily for preserving products of 400 grams and above. Processors indicated they preference canning over glass bottle due to the durability and affordability of metal cans. The use of plastic sachets is for preserving products with net content of below 100 grams.

Source: Olam

Both metal cans and plastic sachets are sourced locally, from producers such as Crown Packaging. However, processors also routinely source plastic sachets also from China and India. Concentrates—as an industrial commodity—on the other hand are stored in large metal drum (220 litres).

8.2.4 Distributions and Marketing

Unlike broiler processors in the poultry sector, tomato processors do not sell directly to end-consumers. Rather tomato both meidum and large processors reach end-consumers through three distinct market channels. First, the the wholesale market. Here bulk buyers offtake products from processors to further distribute to small and micro retailers across the country. Super-market chians is the seocnd market channel. Major super markets such as Shoprite, Koala, Meclom, Palace supermarkets are the main retail off-takers. Finally, processors operate their own distribution channels to supply small and micro retailers.

8.3 Critical Constraints Within the Value Chain

I. High cost of sourcing fresh tomatoes

As previously mentioned, tomato farmers have at their disposal the industrial and non-industrial markets. Given the local dynamics of the sector, the two markets compete against each other to source fresh tomatoes. Indeed, the advent of industrial processing has caused an increase in demand of tomatoes—and amidst low yields—has driven up the price for fresh tomatoes. Considering local processors are in competition with imported processed products, sourcing tomatoes at high prices renders the finished products less competitive as against cheap imported processed products. Consequently, processors lose out to traders who have price setting power, and thus unable to obtain raw material.

Indeed, one may point to processors 'buy-up surplus tomatoes' operational model to evade the high cost. Although buying up surplus is cheaper it is not a durable pathway. First, the phenomenon of fresh tomatoes oversupply occurs for about 16-18 weeks each year. Secondly, in Ghana farmers cultivated either 'improved' or 'local non-improved' varieties. Improved varieties are suitable both for industrial and non-industrial markets; whereas the non-improved varieties are suitable only for non-industrial market. However, the non-improved varieties are cultivated solely for the oversupply season. Thus, although processors obtain cheap raw material during the oversupply season, the varieties processors have access to have high moisture content and weak textual structure, characteristics not suitable for industrial processing .

II. Unstable and undersupply of preferred varieties

Processors intimidated that farmers were unable to supply them with a continuous flow of fresh tomatoes. Regardless of raw material sourcing strategy employed, Ghanaian processors are unable to secure stable supply of high-quality raw material. A confluence of upstream challenges accounts for this: For instance, farmers unwillingness or inability to cultivate varieties that are fit for industrial use or that are high yielding. Moreover, lack of readily appropriate working capital facilities renders the additional cost of operating integrated farms prohibitive; equally, the provision of monetary incentives to dissuade farmers from not honouring their contracts remains an impediment

III. Transaction costs, transport and infrastructure

Transport costs are a major issue affecting profitability for processors, according to small-scale food processors. Processors obtain their raw material from smallholders who are scattered in rural areas connected by poor feeder roads and who produce small surpluses of many crops. Meanwhile, most of Ghana's large-scale processing capacity is located near the ports in Accra or Tema, making it easy for larger-scale processing firms to rely on imported raw materials rather than those produced by small farmers up-country. This decreases the competitiveness of small-scale processors of domestically produced crops.

IV.	**High cost of processing**	Unreliable and costly supply of electric power is a major constraint to the processing sector. Although Ghana currently has a 4,000 MW installed, actual electric power generation rarely exceeds 2,400 MW, hence persistent insufficient supply of energy prevails. As such, power outage is a common occurrence. As a mitigating measure, all processors have invested in independent electric power generation units to supplement on-grid supply. Independent power generation is mostly reliant on diesel, a costly fuel. Furthermore, the cost of electricity is high. Ghana's industrial rate for electricity is Euros 0.119 kWh as compared with a Euros 0.98 kWh rate in Nigeria. Most processors intimated that the high cost of electricity is a major reason for their weak competitive position relative to imported products: in that, any savings realised through efficient raw material acquisition is lost to high cost of electricity.
V.	**Suboptimal packaging for local context**	It was observed that, in Ghana's high ambient temperature and high average humidity environment, the quality of products preserved in metal cans unless stored in cool areas tend to be compromised. However, as shown in Section 8.2.3 processors rely mainly on metal cans which is not conducive to conditions under which their produce is stored by wholesalers, small and micro retailers, and even at their own pack houses.
VI.	**Market viability dampened by high levels of importation**	The flux of retail-ready imported processed tomato products available on the Ghanaian market is a barrier to the marketability of locally processed tomato products. As an emerging sector, most processors, and the entire value-chain do not yet possess the expertise and know-how to compete on cost basis with imported produce.

8.4 Market Growth Opportunities Within the Value Chain

I. Supply of varieties fit for industrial processing

At present, the selection of tomato varieties planted in Ghana are heavily based on their agronomic characteristics. Tomato diseases in Ghana are mainly due to nematodes, fungal and bacterial infections are rightly addressed in selecting suitable varieties. However, the functionality of the tomato fit for purpose should not be overlooked. Therefore, in selection of varieties for industrial use, desired processing tomato characteristics (brix, liquid-solid matter ratio, texture etc.) and current post-harvest handling practices should also go hand in hand when selecting tomato varieties. This can be achieved through sufficient supply of suitable varieties and sensitisation of farmers and processors to these varieties.

II. Supply of efficient post-harvest solutions

The quality of road network leading to farms leaves much to be desired. However, improving roads is beyond the capability of any non-state actor. However, the improvements in post-harvest handling and transport of fresh tomatoes from farm to factory is an opportunity that that can be pursued by non-state actors. First, the traditional mode of sorting tomatoes is highly labour and time intensive and causes the texture of tomatoes to deteriorate.

At present, ill designed wooden crates are used to haul fresh tomatoes. Due to poor design and properties of the material used, the quality of fresh tomatoes suffers fair amount of deterioration during the haulage.

Image 17: Metal Can and Plastic Sachet Packaging in Ghana
Credit: GBN

III. Supply of standardization and training

Although quality systems and quality protocols are existent in the processing industry in Ghana. increased investment in standardization of operation and monitoring by relevant institutions to ensure compliance to protocols. Indeed, recently Ghana Standard Authority ordered a number of tomatoes paste brand to be redrawn from the market for lack of conformance with health standards.

Intensive training will also be required for these processors to maintain high quality standards. Process control for processed tomato products is also important to maintain high quality standards. While instrumentation of equipment is critical, implementation of quality control systems and quality assurance systems along all unit operations remains essential. To achieve this, increase in supply of quality management training will be required.

8.5 Market opportunities for the Dutch Private Sector

In vegetable cultivation, Dutch companies have by far the biggest experience, as The Netherlands is the biggest exporter of fresh vegetables in the world. The areas where Dutch expertise could be utilized are:

1. Improved Varieties of seeds/ Seed banks/ Tissue culture seedling production
2. Supply of horticulture-specific agrochemicals
3. Tailor-made equipment solutions for small and medium scale enterprises
4. Sustainable packaging solutions, particularly restorable pouches for retail markets and large storage solutions conducive to high average temperature and humidity environments.

9. FRUIT PROCESSING SUB-SECTOR IN GHANA

9.1 Overview of Fruit Processing Sub-Sector

Ghana's fruit processing sector is teeming with considerable growth potential due to the abundance of opportunities for exporting primary and value-added produce, and for import substitution. The sector ranks fourth, in terms of export earnings and employment generation after cocoa, gold, and petroleum (van den Broek et al. 2016). Fruit juice is widely consumed locally. A report by Millennium Cities Initiative estimates that over 10.4 million litres of fruit juice is consumed yearly in Ghana. Unfortunately, a significant share of demand for juice is met by imports. Indeed, in 2017, 62 per cent of juice consumed in Ghana were imported at estimated value of US$150 million; whereas domestically manufactured fruit consumed was valued at US$40 million, representing 28 per cent of total consumption (IFPRI, 2020).

Export-market and domestic-market oriented processing

Growing domestic processing of pineapples, citrus, and mangoes serve both domestic and export markets. At present, fruit processing is dominated by elementary processing, i.e., juicing, drying, and fresh cuts. Further value-addition (production of marmalades, jams, jellies etc.) is modest. The size of various fruit processing sub-sector varies. The per annum processing capacity for pineapple is estimated at 40,000 tons and approximately 30,000 tons; that of mango is estimated at 60,000 tons per annum. Between 2012 and 2010, processing capacity is likely to have expanded given the growth in fruit salad exports to Belgium, the United Kingdom, and the Netherlands.

Before the turn of the current millennium, export-market oriented fruit processing segment comprised of four companies. The capital-intensive nature of production and high cost of international cargo transport rendered the export-oriented processing unattractive. However, in the past two decades, improved airfreight connectivity, increased domestic capital accumulation, coupled with growth in the financial markets, and a surge in European demand for semi-processed tropical fruits have resulted in increased interest in fruit processing. At present, numerous private firms have made substantial investments in fruit processing, namely Bomarts, Blue Skies, HPW, Peelco, Pinora, to name a few.

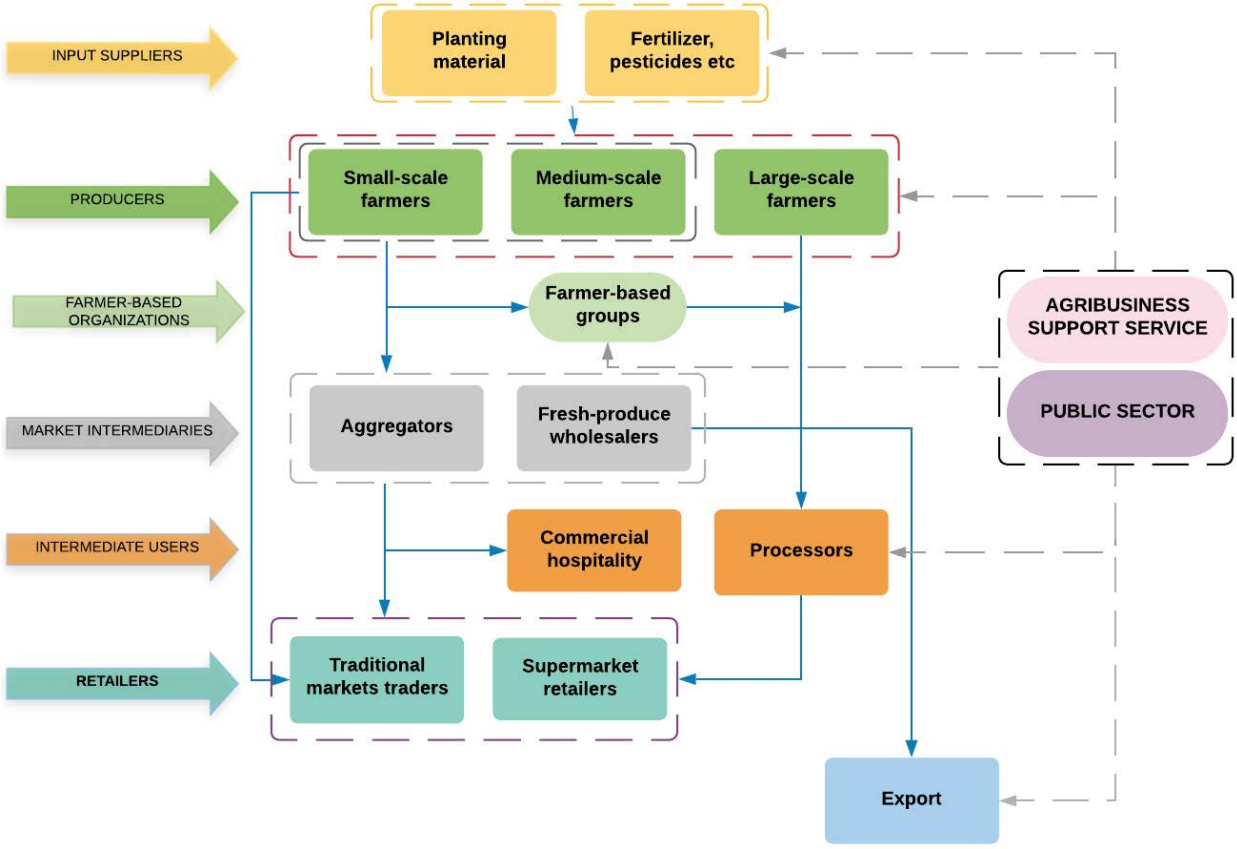
In addition to targeting markets overseas, processors are gradually developing the local market for processed fruits. Indeed, the explosion of syrup-based flavoured fruits drinks in Ghana, at the turn of the current millennium aided the growth of domestic market for processed fruits. Unlike export-oriented processing, fruit juice production requires considerably less start-up capital, hence a surge in domestic firms entering en masse into fruit juice manufacturing. At the onset, entrepreneurs engaged local engineers to manufacture simple machines and equipment for small scale extraction and bottling. The washing and cutting up of fruits, however, remained a manual process. Recently, local technologies have been further advanced with the introduction of hydraulic presses for juice extraction, a semi-automated process that further increases efficiency. A main factor that increased the adoption of these technologies was its affordability. The domestic market-oriented fruit processing industry has expanded from drinks to dried products, among others. At present the domestic-oriented processing segment comprises of over 50 companies and accounts for 28 per cent of fruit juice market as of 2017.

10. MANGO SUBSECTOR

10.1 Structure of Ghana's Mango Value Chain

The functioning of Ghana's mango value chain (from farm-gate to domestic commercial consumer[48]) hinges upon the interaction of seven stakeholders. "Input suppliers" furnish farmers with supply seedlings, fertiliser, pesticide, among others. Although, input suppliers deal primarily with farmers, suppliers were noted to work closely with processors and agribusiness support service organisations as well as Ghanaian government. "Primary Producers" encompass small (<4Ha), medium (>5 <20Ha) and large-scale farmers (<20Ha). Given resource deficiency, small and medium-scale farmers were noted to organise themselves into farmer associations and cooperatives ("farmer-based organisations") to facilitate access to input, technical assistance, and markets. Moreover, small and medium-scale farmers were, in some cases, noted to form alliances with large-scale farmers under contract-farming arrangements, whereby the latter provides technical and financial assistance to the former. Farmer's output are either absorbed by intermediate users for further value-addition, and retailers for further distribution in the domestic market. Most small and medium farmers access the retail and intermediate user market through "market intermediaries", these are aggregators and wholesalers that purchase mangoes from farmers for onward selling. At the periphery of the chain operations is "Agribusiness support service" actors representing a class of organisations providing structured support (technical, financial or logistical) to primary producers, processors and retailers. The final stakeholder is the "public sector institutions".

Figure 14: Ghana Mango Industry Chain



Source: Authors' own, 2020

[48] As differentiated from final consumer i.e., households or overseas importers.

10.2 Primary Production

Compared to cocoa or oil palm, mango cultivation in Ghana is a recent phenomenon, nevertheless, it has become the fastest growing horticulture crop under large-scale production. Ghana produced an estimated 90,300 Metric tonnes (MT) of mangoes on 12,200 hectares (Ha) in 2016, an increase from 40,000 MT on 6,900 Ha of land in 2009. Productivity grew from 6.0 MT/Ha in 2009 to about 7.4 MT/Ha in 2016. Nevertheless, such yields are lower than in neighbouring mango-growing countries. Burkina Faso, for example, produced an estimated 120,000 MT on 12,250 Ha with a productivity of 9.8 MT/Ha in 2008 (FAOSTAT, 2017).

Notwithstanding low productivity levels, Ghana's production of certified mangoes is rapidly growing. It is estimated that 21 per cent of mangoes produced in Ghana are certified. This is due to the interventions of private enterprises, such as Blue Skies, Bomarts, and HPW, and those of several projects supported by bilateral and multilateral agencies. Large scale producers, nucleus farmers, and smallholders now produce mango that are GlobalGAP or organic certified. Commercial-scale mango production is clustered in Ghana's Southern and Northern zones. The Southern zone consists of the Central, Eastern, Volta and Oti regions; whereas, the Northern zone comprises of Ashanti, Brong, Ahafo & Bono regions. There are two cultivation seasons: major season occurring between mid-April to mid-August; and the minor season between mid-December to mid-March. The Southern zone, due to its bimodal rainfall pattern, is characterised by two cultivation seasons, whereas the Northern zone has a single season (mid-April to mid-August). Owing to the superior agro-climatic conditions, the Southern zone accounts for a substantial share of cultivated mango land area, an estimated 81.3 per cent of mango cultivation occurs in the Southern zone (Abu, 2011) and 60 per cent of yield.

In terms of production under cultivation, small-scale farmers constitute 10 per cent with large-scale farmers representing 35 per cent and medium-scale producers accounting for 55 per cent of land area under cultivation. Presently, there are 15 varieties of mangoes under cultivation in Ghana. Of the 15 varieties, *Haden*, *Kent*, *Palmer*, *Keitt* and *Tommy Atkins* are cultivated in accordance with EU's benchmark, hence, these are the widely grown varieties for export market.

10.3 The Mango Trade

Approximately 70 per cent annual output is traded on the domestic market mainly in the form of fresh fruits (whole and cuts) and juice. According to FAO, Exports of mango from Ghana grew from 226 MT in 2011 to 3,611 MT in 2016. The share of production exported also has nearly doubled, although

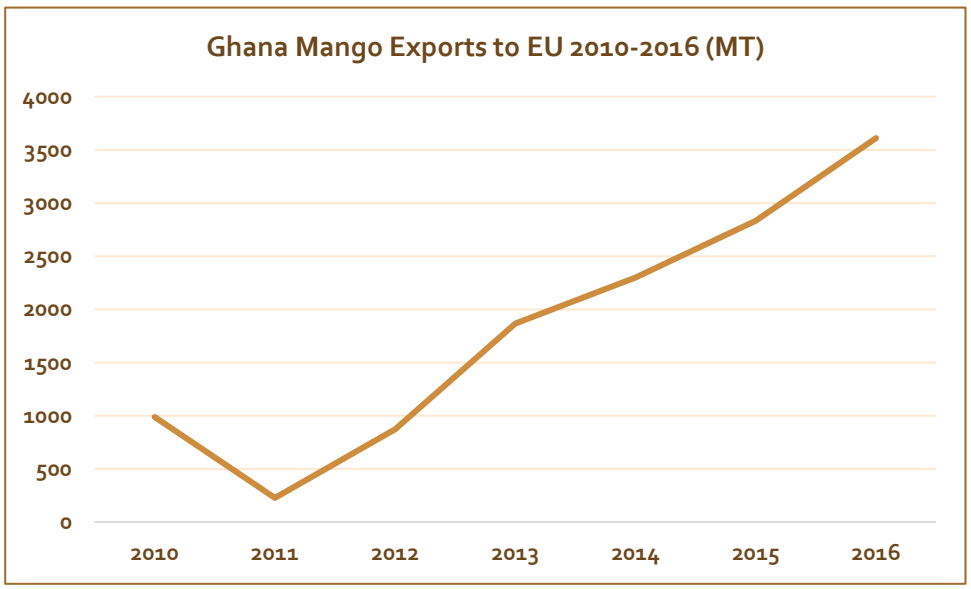


Figure 15: Ghana Mango Exports
Source : Eurostat, 2017

from a small base, from 2.2 percent in 2009 to 4 percent in 2016 (FAOStat, 2017). Haden, Keitt, Kent, Tommy Atkins, Valencia Pride, Amelie, Osteen and Maya are the most exported varieties, mainly to Europe.

On the other hand, in 2015, the country imported about 432 MT of fresh mangoes to feed local processing industries mainly in the off-season period and about 479 MT of juices. Given that Ghana is a net importer of fresh mangoes to feed its industries, it is curious to note that 37 per cent of annual domestic primary output is not absorbed into the market, due to post-harvest losses and limited processing capacities of the big four processors.

Table 29: Mango Trade Figures

Item (2016)	Size
Plantation area	20,000 Ha
Total production	110,000 MT
Fresh exports	845 MT
Dry mango exports	900 MT
Fresh cut exports	1,700 MT
Industrial utilisation (processing)	30,000 MT
Share of domestically cultivated produce exported	31.3%

Source: Grumiller, Jan et al. (2018)

10.3.1 Marketing mangoes: Ascent of export markets

Of the 110,000 tons produced in 2016, 40,000 MT were consumed locally as fresh products with 30,000 MT absorbed by industrial processors. Of the remainder, 33,000 MT were lost after harvest (MOAP, 2016) with 7,700 MT unconsumed due to lack of effective market. Primary producers have three markets to off-load their produce, namely domestic fresh produce market, domestic processing market, and export market.

I. Domestic fresh produce market

Local consumption of fresh mango is the largest market for primary producers, absorbing approximately 70 per cent of output. Conceptually, the market denotes the domestic of consumption of mangoes in its primary form by end-consumers, as such excludes domestic consumption by "intermediate users". The market for domestic fresh produce segment comprises of three distribution channels: namely, supermarket retailers, traditional (open-air) market traders, and commercial hospitality industry. The trade is dominated by aggregators that serve as intermediaries between farmers and diverse off-takers; close to a third of farm-to-market transactions are coordinated by market intermediaries. Aggregators purchase mangoes at farm. Farmers and Farmer group associations harvest their mangoes meant for industry in crates. A full crate typically weighs between 45 to 50 kg, although producers are paid only for 40 kg (IFPRI, 2020).

Image 18: Mango Production in Somanya
Credit: Authors' own

During peak season, the average price of a 45 kg crate hover around GHS 30 and GHS 50. There is a price distinction between mangoes destined for local consumption and for export market. As of 2020, mangoes destined for domestic market were selling at farm gate for GHS 1.40 per kg, whereas those intended for export markets were sold for GHS 2.3 per kg. The price discrepancy stems from the quality of the produce: first-grade mangoes are channelled to export markets with the lesser quality grade diverted to local markets.

II. Export market

Of the three market segments, export market is the fastest growing. Export market comprises of whole fresh and value-added products. According to the Ghana Export Promotion Agency (GEPA), in 2018, mango exports (fresh whole mangoes, fresh cut and dried) amounted to US$ 12,946,162 a 50 per cent growth from 2008. Western Europe is the main export market, with Belgium, France, Netherlands, United Kingdom and Germany as top destinations. Aside Western Europe, Eastern Europe and the Levant, and South Africa are other top export destinations. According to GEPA's data there are over 33 mango exporters, of these, Ghana Volta River Estates, Eve-lyn Farms, Cotton Weblink farms, Dhillon Farms, John Lawrence, Tack Farms are major exporters of primary produce. With regards to export of processed produce, Blue Skies, Bomarts, Peelco and HPW are among the largest exporters.

III. Domestic processing market

*Small and Medium Scale p*rocessors

The domestic processing industry for mango is largely characterized by a number of small to medium sized businesses processing fruit drinks, fresh-cuts, and dried mango slices with cottage to medium level processing equipment. Most of these processors employ second and third grade mangoes that have attained a specified degree of ripening, free from insect pests, some evidence of Anthracnose and bruising. The small and medium enterprises accounts for approximately 4.4% of the total processing capacity in the country. The authors' estimate that, the value generated by small to medium processors amounts to between USD 1.9-2.5million. Equipment used in processing are either designed and sold by local fabricators and manufacturers or imported by Cottage Italia Industries. Due to limited finances, most of the small-scale firms do not invest in the right food grade processing equipment compromising the safety and health of consumers.

An emerging trend in the capital and in traffic prone areas is the provision of fresh cut mango in plastic containers sold by street hawkers as well as retailing of whole fruits which is peeled and sliced on demand. This is especially when mangoes are in season. This cottage operation is done in the comfort of one's kitchen and packed in trays or crates for sale in traffic. The products are handled mostly by women with neither proper facility nor hygiene protocol.

Large Scale Processors

The four largest processors of mango in Ghana buys almost 96% of the total mangoes meant for industry. They utilize mangoes for minimally processed fresh cuts, fresh fruit juice and dried fruits mainly for exports with some local sales. The large-scale processors in a season could purchase over USD 12 million for onward value addition annually. Peelco, HPW, Blue Skies and Bomarts are four of the most successful mango processing companies in Ghana. The price per kilogram for each buying season is negotiated by the large processors and the farmers or farmer groups. Before the buying season, large processors would send agronomists to farms that have been approved to supply to the processors. The pre-harvest inspection is done to ensure only quality mangoes are harvested for these processors. After mangoes are received at the farm gate, they are checked and sorted to meet the company's internal quality requirements.

The value created at the large-scale processing level from dried mangoes, fresh cut and juices is estimated between USD 60 million – USD 90 million.

10.4 Critical Constraints in the Mango Industry

In the course of primary data collection, the authors' observed primary production is the most critical segment of the entire industry. In that four of seven stakeholders in the industry—mainly, input suppliers, market intermediaries, intermediate processors and retailers—out are directly dependent on primary producers (see Figure 2-1).

Image 19: Bacterial Black Spot Disease Spotted
Source: Authors 'own

As such, in addition to presenting industry-wide key challenges hindering the growth of mango sector, we pay particular attention to key challenges faced by primary producers.

Challenges found within the primary production segment include:

Input Provision

- **Seedling Variety**
  Apart from the popular varieties of Keitt and kent, research has not focused enough on other late bearing varieties to prolong the mango season in order to reduce the burden of processors from importing when mangoes are out of season.

Primary Production

- **Ineffective farm management practices**
  Many small and medium holder farms are not well maintained with poor farm hygiene and high disease incidence. Majority of these farmers do not belong to any grower associations and do not benefit from the training and capacity development initiatives offered by the associations and projects. Since these farms occur in the same production areas as the farms that are well maintained, they serve as reservoirs of pathogens making disease management difficult. Poorly maintained farms along with low or non-usage of agrochemicals is responsible for the intractable control of the Bacteria Black spot disease and attendant high fruit drop.
- **Undersupply of appropriate financial solutions**
  Limited and or expensive credit facility is a setback to farmers' investment in better production practices like adhering to the frequency of chemical application and paying for labour to manage and maintain farms. Furthermore, the absence of crop insurance for the mango producers increases the risk profile of mango production, thus unattractive for financial institutions to provide lending at affordable rates to producers.

Aggregation

- Underutilization of packing facilities for export/local markets.
- Weak capacity for effective post- harvest crop handling increases losses.

Trading	• Poor market infrastructure and storage facilities. • Non-compliance to contractual agreement with suppliers. • Trade & logistics are still largely inefficient but developing steadily. • Underdeveloped state of logistics and inefficiencies undermine product integrity.
Infrastructure and regulations at macro level	• **Poor road connectivity** Road networks leading to smallholder farms are mostly inaccessible, even worst in the rainy seasons. • **Undersupply of appropriate storage and packing facilities** There are limited pack houses at major production areas. Public pack houses constructed by MiDA and EMQAP are under-utilized; major issues being lack of fruits, ownership, and management structure. • Limited government policy direction for the industry though it is an important NTE foreign exchange earner for the country.

11. VALUE CHAIN ANALYSIS: MANGO PROCESSING

11.1 Characteristics of Mango Processing Industry

The domestic processing industry is a salient market for fresh mango. The sub-sector absorbs over a third of farmers' output and accounts for more than half of value of amount exports. From a regional perspective, Ghana's mango processing industry is significant compared to its neighbouring countries. Whereas neighbouring Burkina Faso, Ivory Coast and Senegal are successful at fresh exports to the EU, Ghana is competitive with exports of value-added produce i.e., fresh cuts, juice, and dried mangoes. Although seasonal availability[49] plays out to the disadvantage of the processors in Ghana, the large-scale mango processors in Ghana import mangoes from regions that have an early or late season to complement the season in Ghana.

11.1.1 Types of processed produce

I. Elementary processed produce: Fresh cut fruits and fruit juice

Elementary processing entails rudimentary form of value-addition that requires no added ingredients and short conversion timeframe. Fresh-cuts and juice manufacturing are by far the leading forms of mango processing. Most fruit juice processors in Ghana are small scale processors with production capacity of less than 2 tons per day. This operation, along with minimally processed fresh cut fruits for the domestic market are left in the hands of the informal sector. Minimally processed mangoes market accounts for about 3* per cent of mango processing in Ghana.

Juice processors depend on local equipment fabricators for their equipment capacity needs. Their packaging materials are usually plastic PET bottles for fresh juice with limited shelf life which is sourced from plastic manufacturing companies in the industrial area of Ghana. The pasteurized juice processors employ the use of reusable glass bottles for the packaging of their juices.

II. Advanced processed produce: Dried Fruits, Fruits Leathers & Concentrate Production

A more sophisticated operation in the processing of fresh fruits are dried fruits, fruit leather and concentrates. Advanced processing accounts for about 57% of mango processing in terms of volume processed.

11.1.2 Scale and mode of processing

Scale of production is the salient marker in the sub-sector. Size of production capacity determines the set-up of production plant (levels of automation, mechanisation, or human labour), which in turn influences the type of produce manufactured as well as viable market segments accessible to a processor. During the field work, four classes of processors were identified, of this three are commercial categories, these are presented below.

Small-scale processors

Small-scale processors represent a class of processors with daily processing capacity ranging between 1 ton and under 5 tons per month. These processors produce exclusively for the domestic market. Small processors, as a result of their modest capitalisation are for the most are only able to source second and third grade mangoes, Equally, small-scale processors are reliant on domestic-fabricated equipment, a tiny class of such processors procure equipment from the Chinese market. This class of processors tend to produce fresh cut fruits and mango pineapple juice blends with

[49] Ghana's fresh mangoes are available for maximum 28 weeks out of 52 weeks in a year.

shorter shelf-life for the local markets. Small-scale processors account for about 80 per cent of commercial mango processing in the country in terms of the number of players.

Medium-scale processors

With a daily processing capacity ranging from 5 tons to under 10 tons, medium-scale processors dominate the fruit juice market segment in terms of their numbers. Similar to small-scale processors, medium-scale processors process lesser quality mangoes, mainly second-grade mangoes. Operational set-up then to be highly mechanised. This class of processors tend to produce pasteurized fruit juice blends for the local markets (supermarkets, convenient shops) (targeted off-taker markets).

Image 20: Medium-scale processing planet, KPC
Source: Authors' own

According to authors' estimates, collectively, small, and medium processors contribute to about 4.4% to the total processing capacity in the country, with an estimated processing value of US$1.9m - US$2.5million.

Large-scale processors

Lastly, large-scale processors represent a group of commercial intensive manufacturers, with daily production capacity of above 10 tons. Large-scale processors engage in both elementary and advance processing, producing fresh cuts, fresh fruit juice and dried fruits mainly for exports with some local sales. Large-scale processors absorb all of the over 30,000 tons of first grade mangoes produced in Ghana. Given their dominant purchasing position, large-scale processors—unlike small and medium processors—

Image 21: Large-scale processing plant, Ekumfi
Source: Authors' own

invest in out-grower schemes, providing technical assistance services to growers and negotiating purchasing price prior to harvest, a strategy that ensures stable supply and mitigates against price volatility. The four largest processors of mango in Ghana buys almost 96 per cent of the total mangoes available for industry. They utilize mangoes for processed fresh-cuts, fresh fruit juice and dried fruits mainly for exports with some local sales. The large-scale processors in a season could purchase over 30,000 of fresh fruits valued at USD 12 million for onward value addition annually (author's estimate, 2020).

Table 30: Mango Processors Classification

Scale	Installed capacity (daily in MT)	Plant set-up	Types of processed produce
Large-scale	>10	Advanced mechanisation; low labour intensive	Elementary & advanced
Medium scale	>2 to <5	Moderate mechanisation; moderate labour intensive	Elementary
Small-scale	1 to <2	Low mechanisation; high labour-intensive	Elementary
Micro scale/cottage enterprises	<1	Highly labour intensive	Elementary

11.2 Production of Value-added Mango Produce

11.2.1 Elementary processing

Juice processing

Fresh-cuts fruits and fruit juice processing is by far the most dominant form of fruit processing in Ghana. Most processors of fruit juice are engaged in either fresh unpasteurized processing with a shelf life of one week or pasteurized juices with six months' shelf life. Most fruit juice processors in Ghana are small scale processors with production capacity of less than 1 ton per day, small-scale processors account for 60 per cent of juice production; 3 per cent by one large processor and the remainder is produced by micro-scale processors clustered in the informal market. Processors of juice depend on local equipment fabricators for their equipment capacity needs. Their packaging materials are usually plastic PET bottles for fresh juice with limited shelf life which is sourced from plastic manufacturing companies in the industrial area of Ghana. The pasteurized juice processors employ the use of reusable glass bottles for the packaging of their juices.

Fresh cuts

Micro-scale processors dominant the fresh cut segment for domestic market—most of these enterprises are informal. Such processors tend to focus on producing fruit salads utilising fruits that are in in season and packaged in plastic containers or polystyrene containers. Processors in this space strive to sell all off the limited quantities produced in a day to prevent incurring costs of storage and refrigeration.

Image 22: Fresh Cut Mango in Plastic Pot
Credit: Authors' own

More recently, there has been the entrance of some medium scale companies in the space to organize production for supplies to the formal supermarkets. A typical example is Eden Tree Ltd. Fresh cut mangoes for the export market in Europe and North America is huge and have two major players in the industry. Blue Skies and Peelco are the biggest fresh cut mango exporters in Ghana. Products are standalone mango cuts or mango with other fruits served as fruit salad.

11.2.2 Further value-addition: Dried Fruits, Fruits Leathers & Concentrate Production

With the introduction of fruit drying in the early 2000's as a shelf stable product with opportunities for consumers to continue to enjoy mangoes in a dry form, the industry has seen growth in investment over the past years. Commercial dried fruit businesses are usually handled by large scale processors who have advance marketing and distribution channels in their targeted export markets. The large processors also sell about 30 per cent of their production output in the local supermarkets in Ghana. There is a wave of medium scale processors entering the dried mango segment who process for the supermarkets, largely within Accra and Tema. These processors also depend on other smaller market channels (e.g., ethnic shops/specialty/health shops) to export their products to Europe, Canada, and the United States of America.

Image 23: Dried mango in crates at HPW factory
Credit: Authors' own

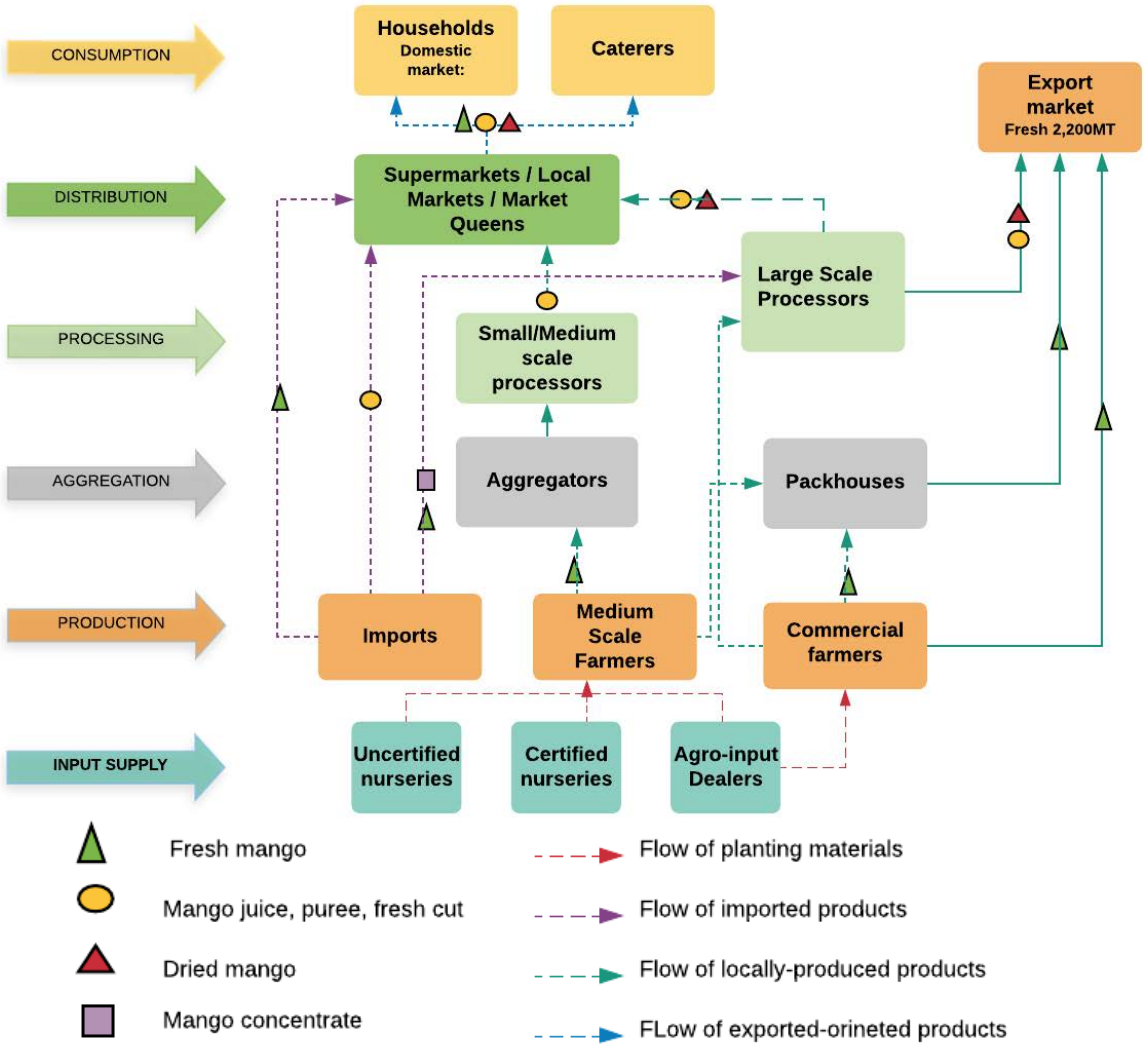
Table 31: Mango Processing Figures

Processor Type	Juice (annual in MT)		Fresh cuts (annual in MT)		Dried fruits (in MT)		Leathers & Concentrates	
	Output	*Raw materials use*	*Output*	*Raw materials use*	*Output*	*Raw materials*	*Output*	*Raw materials*
Large	120	240	5,700	11,400	1,400	14,000	0	0
Medium	12	19	4.6	10	40	280	0	0
Small	200	360	N/A	N/A	N/A	N/A	0	0
Micro	N/A	N/A	N/A	N/A	N/A	N/A	0	0

Source: Author's construct from processor's production estimates

11.3 Structure and Operation of Mango Processing

Figure 16: Mango Processing Value Chain



Based on field observations and interviews with processors, the process of transforming fresh mangoes into either elementary or advance value-added produce is categorised into four main categories, these are presented below:

I. Aggregation

Aggregators serve as courier service to the markets, whether large wholesale market or specific supermarket. Distributors do not add any (material) value to processed mangoes before transporting to intended markets. They arrange logistics for produce to reach intended markets. Some aggregators pre-finance some farm management operations like weed control, pruning, and spraying against diseases with the mutual understanding that the farmer gives them priority during harvest time and the cost of inputs supplied is deducted from the total value supplied. Aggregators supply mainly to open regional markets and some supermarkets within the capital, Accra.

Table 32: Classification of Aggregators

Type of actor	Description	Number of Firms/Groups	Production Delivered and Values
Market queens	Market queens are the main conduits between mango farmers and the domestic fresh markets. They are not vertically integrated in the chain. They ply their business with availability of a commodity at a particular time. They may specialize in either fruits only, or vegetables only. They may provide inputs for farmers in order to gain selling priority at harvest. No formalize contracts exist between market women and farmers.	They could number about 130	47,000TONS = $34,169,000 (1ton =$727)
Aggregation Centres		Two centres: - Akorley. Eastern region - Vakpo, Volta region.	400 tons (1 ton = $1,500 - $2,000)

II. Processing

Processors are involved in the transformation and value addition of fresh mango produce. Their scale ranges from small scale to large scale, depending on the volumes of production and the sophistication of their production operation and value addition.

Large processors are vertically integrated along the chain. They control production by offering trainings and input support to farmers in order to purchase from them. Large producers are largely export-market oriented. Some large-scale processors have subsidiary local companies via which they reach the local market with their products. This is true for companies that are in the free zone agreement and can only sell 30 per cent of their output on the local market. Trade relationship between large processors and farmers involve some contractual agreements. Small and medium scale processors on the other hand largely depend on market queens as it is efficient for their low volume operation. There are no aggregators involved in the value-chain of processed juices, dried fruits and concentrates. There are however distributors to pick the products from factory and supply to underserved identified markets.

The supermarkets or intended retail outlets will usually fix a 25-40% commission on any article supplied for retail.

Table 33: Classification of Processors

Type of Processor	Number of Firms	Production Delivered and Values	Profits
Small scale	More than 50 small scale processors	About 900 tons of juice/fresh cut/dried fruits at $1,900,000	$600 - $680 per ton
Medium Scale	About 6 medium scale companies	Output: 8,540TONS at $7,000-$10,000 per	$2,810 -$4,215 per ton
Large Scale	4 large scale processors	Output: 8,540 at $7,000-$10,000 per	$2,810 -$4,215 per ton

Source: Authors' computation based on field interviews and estimates

Table 34: Processing Capacity Across Processing Classes

Scale	Organization	Capacity (tons p.a.)	Share of mango processing capacity (%)
Large	Blue Skies	8,400	24.6%
	HPW	15,000	43.9%
	Bomarts	6,250	18.3%
	Peelco	3,000	8.8%
Small/Medium	Others	1,500	4.4%

Source: Authors' computation based on field interviews and estimates

III. Packaging

Packaging plays a crucial role in food processing, as it stores, preserves the product, and informs the consumer of its nutritional value. Ghana's growing food processing industry is heavily dependent on imported packaging materials and prints for primary packaging. Forms of packaging include:

Bottling

Large scale processors in the fresh fruit juice business in Ghana have their own blowing machines for converting plastic preforms into bottles. Large juice processors either employ tetrapak packaging or plastic bottles for their freshly squeezed juices. There are three companies in Ghana that produce generic plastic bottles for the food processing industry in Ghana. They are Kane-Em, Qualiplast and Duraplast. Small and medium processors usually purchase already blown bottles directly from manufacturers or resellers.

Image 24: Sterilized Bottles, Ndaana Eco Juice
Credit: Gregory Lankano

Glass bottles are used in packaging long shelf-life pasteurized juices. All glass bottles are imported into the country. The small and medium scale companies in Ghana rely heavily on glass bottles for their packaging needs. Most glass bottles are recycled. They are originally imported soymilk products that are collected by lead boys and sold to the processors. The processors in turn wash them and use them for their juice packaging. The Italian company, Cottage Italia, imports different equipment for the food processing industry and recently have added recycling of glass bottles to their business portfolio.

TetraPak Packaging

The use of tetrapak packaging in Ghana continues to grow. This is evident in their usage in the newly created processing companies in the government's one-district-one-factory (1D1F) policy. Tetrapak ensures longer shelf life compared to other primary packaging materials. Products in tetrapak packaging are less bulky and enhances light transportation. Ekumfi fruits and juices and Fruittiland employ the use of tetra Pak packaging.

Crown Corks

Ghana's metal can industry is still at an infant stage although there is a vibrant aluminium industry to supply this part of the food manufacturing value chain. As of 2018, only one aluminium can company was producing metal cans and closures. Crown corks constitute the preferred closure used by breweries, fizzy drink bottling companies and small-scale fruit juice processing companies.

Secondary Packaging

Ghana's paper/pulp and corrugated carton box industry is well developed compared to its West African neighbours to provide bulk packaging solutions for the food industry and beyond. Some major manufacturers of corrugated packaging materials are Sonapak, Crown Packaging etc. In the area of corrugated carton boxes and printing, Ghana has sufficient capacity to provide for the industry. Corrugated carton boxes serve as the secondary packaging for bulk transportation and haulage.

Image 25: Telescopic Carton Boxes & Tetrapak In Use Ekumfi Fruits & Juices
Credit: Authors' own

IV. Distribution & Marketing

Processors in Ghana have their own distribution vans they use to reach their markets; depending on the nature and shelf life of the product. For large processors who process freshly squeezed juice, the use of refrigerated van and cooler boxes are widely employed. For small and medium enterprises who process pasteurized juices, own vans, tricycles and sometimes the renting of taxis is used to reach their destination markets.

Large processors in the areas of dried fruits liaise with freight forwarding companies who handle all shipment from the points of processing to destination export market. The same arrangement exists for exporters who are exporting fresh mangoes by sea or air.

11.4 Critical constraints within the value chain

I.	**Underdeveloped infrastructure**	Logistics both within the network of production to factory and factory to export due to inefficient transport system and exhausted air shipment (for some large processors). For example, large processors could potentially process more fruits from the North and Middle belt if there is a rail network linking the South to North via the middle belt.
II.	**Poor Quality of raw materials**	Mango has a 20-week availability in the year. Large processors have to import to ensure continue use of capacity. Poor quality raw materials reduce processing efficiency. Over 80 per cent of respondents agree that raw material seasonality, shortage, and quality impact severely on their operations.
III.	**Market Demand for Products**	Local processors are faced with onslaught of fruit juice imports, hence cannot compete with imported fruit juices. In this survey, 21 per cent of respondents say they face "extreme severity with access to market". These are usually processors who have the local market as their sole market. The 25 per cent of participants who responded to "less severe with access to market", are those that have export market links.
IV.	**Limited Access to Finance/High interest on loans**	Access to finance and cost of capital continues to hinder a lot of more local processors from reaching their potential. About 46 per cent of respondents mentioned that access to finance and high interest on loans is extremely severe for the success of their business. Currently, interest rates range from 17.5 - 45 per cent for agriculture and manufacturing sectors. There is currently support from the German Bank – KFW via OVCF to provide 12 per cent interest on loans for manufacturing companies that work without-grower schemes in various agricultural value chains.
V.	**Unreliable access to and high cost of electricity**	Unreliable and costly supply of electric power is a major constraint to the processing sector. Although Ghana currently has a 4,000 MW installed, actual electric power generation rarely exceeds 2,400 MW, hence persistent insufficient supply of energy prevails. Furthermore, the cost of electricity is high, with rates at € 0.119 kWh. Most processors intimated that the high-cost electricity is a major reason for limiting their actual processing capacities.
VI.	**Inappropriate processing equipment**	Most companies procure equipment that are oversized for their operations or and therefore are not fit for purpose. Whereas domestic equipment manufacturers lack the needed training in material selection to ensure equipment manufactured for small scale processors are of food grade and meets hygienic quality requirements. Small and medium scale processors depend largely on local equipment fabricators for their equipment needs. Most of the construction do not meet hygienic equipment design standards and the material of construction is usually coated cast steel instead of the industry required stainless steel. This impacts greatly the quality of the final product.

11.5 Market growth opportunities within the value chain

The market for mango products continues to increase substantially. In the past two decades, dried mangoes as a value-added snack were non-existent in Ghana. The introduction and setting up of mango drying facilities coupled with substantial investments in new and existing orchards have opened up the industry to growth in demand and supply. There still exists a very grey area in the area of concentrate production to service the local and export markets to absorb up 30 per cent of postharvest losses and third grade mangoes. The opportunities to increase growth within the value chain could be summarised below as follows:

1. Encouraging large processors to take up specialized processing in IQF and concentrate production.
2. Coordinating growing and farm maintenance activities to reduce the prevalence of pests and diseases.
3. In the past years, there have been various research and demonstrations on early/late fruiting varieties to extend the harvest period to increase the seasonal availability of fresh produce. This presents a good opportunity to reduce seasonal imports.
4. Packaging materials and packaging equipment component of the processing sector is underdeveloped. This is evident in the volumes of imports of tetra Pak packaged fruit juices and fruit juice drinks imported into the country. There exist significant opportunities for filling this gap.

11.5.1 Export market potential for processed mangoes

I.	**Fresh cut fruits & salads**	Ghana's mango varieties (keitt, kent, palmer, tommy atkins, haden) under cultivation are preferred varieties for their sweet tasting and appealing colour. This positions Ghana ahead of its mango producing neighbours in the sub-region. Europe, Middle East, and North Africa are interesting target markets for Ghana's processed and fresh mangoes due to daily/weekly logistics availability and short transit times. Though the
II.	**Concentrates & Leather**	Ghana's mango comes in grades. The domestic manufacture of concentrate depends on the last grade of raw materials to feed operations. As 30 per cent of fresh mangoes are lost at the postharvest stage, a concentrate processing plant could transform these losses into gains for export.
III.	**Dried mangoes**	The market for mango products especially dried mango exports continue to increase in Europe for the healthy snack market. According to one of the largest dried mango processors in Ghana, in 2019, there was unmet export market demand of over 300 tons of dried mango (3,000 tons of fresh produce).
IV.	**IQF Mango dices**	European companies in the dairy industry are looking for innovative ways to incorporate fruits in their dairy mixes as awareness for healthy eating increases. The markets for frozen diced mangoes continue to increase. Current demands are met by European companies who import and transform fresh mangoes into IQF.

Opportunity to create value at source of production would be preferred by European buyers.

11.5.2 Domestic market potential for processed mangoes

V. **Fresh cuts & Fresh fruit salads**

With increasing affluence, Ghanaian consumers have become more health conscious. As such, the population is consuming more fresh fruits and fruit salads. Moreover, urban consumers desire for time-saving food options bodes well processed mango products, as evidenced in the domestic mass markets and supermarkets.

VI. **Concentrates & Leather**

Ghana's fruit juice import bill is estimated at over $150 million per annum. The imported juices on the local markets are largely concentrates that have been mixed with other ingredients. There are companies like HealthiLife and other juice blending companies that import concentrates from Italy and Brazil. The high import bill presents a perfect opportunity for import substitution through concentrate production in the country. The production of concentrates in Ghana could lead to exports to other West African and East African countries that have alternate mango seasons to Ghana.

VII. **Dried mangoes**

Dried mango products are gradually finding their ways into mainstream supermarkets for in-season and out-of-season sales. Not only do dried mangoes serve consumers in times of unavailability of fresh mango; but as healthy snacking options for the health-conscious consumer. According to ShopRite, a retail chain in Ghana, the chain imports over 2 Tons of dried fruits per month for retail in their shops across the capital, Accra. The chain has started stocking locally processed dried fruits in order to reduce their imports. This presents opportunity for local processors to gain access to formal supermarkets. The market continues to grow as disposal incomes increase for the growing middle-income earners.

11.5.3 Market opportunities for the Dutch private sector

I. **Supply of superior and context appropriate input**

a. *Improved planting material*

Production and supply of disease-free improved planting materials. There is still more room for other players in the input supply business in Ghana. Out of the over 20,000 ha of mango plantation in Ghana, there are only eight certified seedling providers to supply the industry should a farmer want to replant new orchards. The seedling growers are producing seedlings at a medium scale and do not have the capacity to produce on large scale.

Companies such as D. Invitro Labs B.V. (Iribov) are best positioned to leverage their proved capability in the Netherlands to serve in the market for seedlings.

b. *High quality fertilizers and agrochemicals for organic and conventional production.*

Fertilizers and agrochemicals with tested efficacies have the potential to breakthrough in the agrochemicals market as farmers are overburdened with fake agrochemicals in the market. Organic farmers experience difficulties in accessing organic fertilizers for their crops. Companies such as

		Wienco and the likes are best positioned to leverage their proved capability in the Netherlands
II.	**Refrigeration solutions**	*Construction of processing facilities and cold rooms.* Much of the postharvest losses incurred in the industry is as a result of low/inadequate sizeable cold storage facilities at the aggregator and market levels. Celtic cooling is in the cold room and factory construction business in Ghana. A model where Celtic cooling or other providers can provide affordable construction of cold rooms for aggregators or marketers at the market centres will reduce greatly the losses in these areas.
III.	**Temperature-controlled warehousing solutions**	Provision of warehousing and cold room facilities Linked to the solution on refrigeration above, warehousing solutions in Ghana tend to focus more on dry storage spaces awaiting shipment or goods in transit. Affordable temperature and humidity-controlled warehousing solutions for short storage of goods in transit will help exporters in their export business.
IV.	**Logistics**	There's room for investors in transport and cold chain provision from pack houses / factories to ports of exit.

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13. APPENDIX

Appendix 1: Institutional Setting of Ghana's Aquaculture Sector

Policies and Regulations

In 2012, government launched the Ghana National Aquaculture Development Plan (GNADP). This plan sought to increase annual aquaculture production from the 2010 baseline level of 10,200 MT to 100,000 MT by the end of 2016, increasing both the market share and value of Ghanaian farmed fish (Ministry of Food and Agriculture Fisheries Commission 2012). The plan outlined an extensive list of constraints in the aquaculture sector that it aimed to address, including issues with fish feed, financing for local production, institutional and regulatory arrangements, and research. Several activities have been implemented under the GNADP, including training sessions for improved fingerling production, zoning of Lake Volta to facilitate site selection for new farmers, setting up of fish disease laboratory, and renovation of the Aquaculture Research and Development Centre (ARDEC).

Under MOFAD's policy for sustainable development of aquaculture, fish production from aquaculture has grown over the past decade; from a paltry 6,514 MT in 2008 to 76,620 MT in 2018 (Fisheries Commission data). The GNADP (2012–2016), was developed by the Government of Ghana through the Ministry of Food and Agriculture (MoFA) and the Fisheries Commission as a strategy adopted to increase aquaculture production by encouraging the private sector to participate in the production of fingerlings instead of sending brooding stock to neighbouring countries to fingerling production.

Import tariffs instituted by the Government of Ghana (GoG) on aquaculture inputs are closely implemented. There is a general consensus among actors in the sector is that tariffs on imported inputs are high. Indeed, import duties for imported feeds are 5 percent, but with other taxes and fees, between 20 and 30 percent of feed costs is reported to be the difference in the price of fish feed between its arrival in port and after it leaves the port (IFPRI, 2018). Conversely, although GoG has banned the importation of non-native tilapia strains (including eggs and fingerlings) into Ghana in response to fears over Tilapia Lake Virus (TLV), due to lax enforcement, there continues to be an influx of the Genetically Improved Farmed Tilapia (GIFT) strain illegally imported in the country from China. Similarly, the ban on importation of mature tilapia is enforce without adequate vigour, as evidenced in the presence of imported tilapia from China through Togo.

The high tariff on imported feed is undermines GoG's efforts to strengthen the domestic aquaculture sector. More importantly, the varying levels to which import regulations are enforced (in the case of feed) or not (in the case of tilapia strains) does not reflect positively on GoG's commitment to the Sector.

Regulatory, Capacity Building and Service Provision Institutions

Table 35: Regulatory, Capacity Building and Service Provision Institution

Organization	Mandate
Ministry of Fisheries and Aquaculture Development	In charge of the development and implementation of fisheries and aquaculture policies that govern the sector
Fisheries Commission	Regulates and manages the utilization of the fishery resources of Ghana and co-ordinates the policies in relation to them
Water Resources Commission	Responsible for the regulation and management of the utilisation of water resources, and for the co-ordination of any fisheries policy in relation to them

Ghana Standards Authority	Mandated to set standards and ensure that goods and services conform to the standards and are of acceptable quality both for local consumption and export, the GSA ensures that quality of raw fish as processed to be sold on the local market meets standard specifications. The role of GSA also involves registration of exporters , landing sites, cold stores, processors of canned fish, smoked fish, frozen fish, salted and dried fish, and fish oil, as well as issuing of Export Certificates to assure importers that the Ghanaian products meet the required health, safety and sanitary standards. It is recognized by the EU as a Competent Authority,
Food and Drugs Authority	Mandated to implement food and drugs law. It ensures the safety and wholesomeness of foods. FDA also facilitates training programmes for personnel in the processing, handling, and storage of products. Provides quality standards for sale of fish for consumption and fish traceability.
Environmental Protection Agency	Ensures environmental requirements for fish farming are adhered to by undertaking an environmental impact assessment of all fish farming projects. Co-ordinates the activities of bodies concerned with the technical or practical aspects of the environment and serves as a channel of communication between such bodies and the Ministry; co-ordinates the activities of such bodies as it considers appropriate for the purposes of controlling the generation, treatment, storage, transportation and disposal of industrial waste; works to secure, in collaboration with such persons as it may determine, the control and prevention of discharge of waste into the environment and the protection and improvement of the quality of the environment.
Ghana Ports and Harbours Authority (GPHA)	Responsible for seeing to construction and operation of ports and harbours in relation to fish export and import. These include fish landing sites and bays utilized by fish farms.

Financial Institutions

Table 36: Financial Institutions and Interventions

Organization	Mandate
Agricultural Development Bank	Providing profitable and diversified financial services for a sustained contribution to Agricultural development and wealth creation. Its focus is universal banking with a developmental focus on Agriculture and more.
GEXIM bank:	Export Development and Agricultural Investment Fund (EDAIF) now GEXIM Bank was established with the mandate to provide funds to support agricultural investments that are export-oriented by financing export costs. It operates through two main facilities: a) The Export Development and Promotion Account (EDPA) which only provides loans to institutions, organizations and trade associations both in the public and private sectors, and b) The Credit Facility (CF) for the provision of loans at 15 per cent interest rate through Designated Finance Institutions (DFI) to producers and exporters
Stanbic Bank	Provides agricultural production loans for farmers who need short-term credit to pay input costs once you meet relevant conditions or provide more documents subject to specific borrower conditions.

Appendix 2: Institutional Setting of the Poultry Sector

Production volatility, non-linear growth patterns and sustained dominance of imported poultry meat observed in Ghana are all effects of the environment (ecosystem) within which poultry actors operate and the institutional arrangements regulating their operations. The current segment examines actors in this ecosystem, exploring how their activities has shaped and continues to shape Ghana's poultry sector

Institutions Promoting Poultry Sector Development

Regulatory, Capacity Building and Service Provision Institutions

There are several regulatory bodies that have the responsibility for ensuring feed quality control and certification, the key ones are:

Table 37: Regulatory, Capacity Building and Service Provision Institutions

Organisation	Mandate
Animal Production Directorate (APD)	Mandated to ensure all facets of animal breeding and rearing follows sound principles and that supply of animal produce is safe for human consumption. The Directorate undertakes : (i) the production and supply of genetically improved breeding stock for breeders, (ii) regulate domestic and imported animal feed. (iii) promote adoption of appropriate technologies and farm management practices, among others.
Veterinary Services Directorate (VSD) MOFA	Undertakes the following services: (i) diagnosing, control and eradication of diseases through vaccination and quarantine, (ii) provision of laboratory services, (ii) , (iii) control of imported livestock, imported meat and meat products and hatching, (iv) meat inspection, (vii) training selected farmers (Community Animal Health Workers) to offer primary health care.
Ghana Standards Authority (GSA	Mandated to set standards and ensure that goods and services conform to the standards and are of acceptable quality both for local consumption and export, the GSA ensures that quality of animal feed, feed ingredients, eggs, broiler meat etc to be sold on the local market meets standard specifications.
Food and Drugs Authority (FDA)	Mandated to implement food and drugs law. It ensures the safety and wholesomeness of foods (including meat and milk and their products) and the safety and efficacy of veterinary drugs. The Animal Products Unit of FDA is responsible for regulation of (i) processing; (ii) transport and storage of animal products (including poultry eggs and meat); (iii) inspection and audit of meat processing and cold storage facilities. Additionally, facilitates training programmes for personnel in the processing, handling, and storage of animal products. The unit is also responsible for consumer education on food safety in relation to animal products
Environmental Protection Authority (EPA)	Inspects and assesses the appropriateness of the feed mills and feed additive facilities and provides certification to commence production
Agricultural Extension Services Directorate	Responsible for overseeing agricultural technology diffusion through the management of an extension delivery service and ensures that appropriate technology is transferred to actors in the livestock/meat and milk value chains in the country

Institutions Advancing Primary Production and Processing

Table 38: Institutions Advancing Primary Production and Processing

Organisation	Mandate
Ghana Veterinary Medical Association	Mandated to support the development of a viable and vigorous poultry and livestock industry, to protect public health by the control of zoonotic diseases and to alleviate pain and suffering in animals.
Council for Scientific and Industrial Research (CSIR) - Animal Research Institute (ARI)	mandated to conduct research and develop improved solutions for the livestock sector. At present is conducting a broiler feeding trial using the black soldier fly larvae (insert larvae) as part of efforts to find cheaper sources of protein.

Non-State Institutional Actors

Table 39: Non-State Institutional Actors

Organisation	Mandate
Ghana National Association of Poultry Farmers (GNAPF)	A sector-wide membership organisation representing the interests of actors in the poultry sector. Regional chapters represent the interests of actors on the regional level, of which the Greater Accra and Ashanti region chapters are the most influential on the national scene.
Ghana Livestock Development Network (GLIDEN)	Represents the interest of stakeholders in the livestock sector and allied industries. Its mandate is to the advocate and lobby GoG in developing cogent policies conducive to commercial livestock industry. The Network together with Veterinary and Animal Services departments of MoFA has drafted the Ghana Veterinary and Animal Production Bill which seeks to regulate the livestock industry in order to reduce imports eventually increasing local production.
Ghana Poultry Project (GPP	A USAID-funded initiative that aims to increase the competitiveness of domestic production and processing of poultry meat and eggs in Ghana.
AMPLIFIES[50] Ghana Project	A USAID-funded initiative that aims to bolster market linkages for locally produced maize and soybean commodities utilized in feed and poultry production

[50] Abbreviation expanded: Assist in the Management of Poultry and Layer Industries with Feed Improvement and Efficiency Strategies

Financial Institutions and interventions

Table 40: Financial Institutions and interventions

Organisation	Mandate
Agricultural Development Bank (ADB)	Providing profitable and diversified financial services for a sustained contribution to Agricultural development and wealth creation. Its focus is universal banking with a developmental focus on Agriculture and more.
GEXIM bank:	Export Development and Agricultural Investment Fund (EDAIF) now GEXIM Bank was established with the mandate to provide funds to support agricultural investments that are export-oriented by financing export costs. It operates through two main facilities: a) The Export Development and Promotion Account (EDPA) which only provides loans to institutions, organizations and trade associations both in the public and private sectors, and b) The Credit Facility (CF) for the provision of loans at 15 per cent interest rate through Designated Finance Institutions (DFI) to producers and exporters
Stanbic Bank	Provides agricultural production loans for farmers who need short-term credit to pay input costs once you meet relevant conditions or provide more documents subject to specific borrower conditions.
Ghana Incentive-based Risk Sharing System for Agriculture Lending	An AfDB project enhancing agriculture financing and sector transformation through increased capital inflows into critical value chains by supply de-risking financial services.

Appendix 3: Institutional setting of the Fruits and Vegetable Sector

Institutions Promoting Fruits Sector Development

Ghana has various institutions and agencies that are responsible for setting the agenda on international quality standard, regulation and control, market and export promotion, financial linkages and SME development for the manufacturing industry and the food processing industry in particular.

Regulatory, Capacity Building and Service Provision Institutions

Table 41: Regulatory, Capacity Building and Service Provision Institutions

Organisation	Mandate
Ghana Standards Authority	Mandated to set standards and ensure that goods and services conform to the standards and are of acceptable quality both for local consumption and export, the GSA ensures that quality of fresh and processed fruits products sold on the local market meets standard specifications.
Food and Drugs Authority	Mandated to implement food and drugs law. It ensures the safety and wholesomeness of foods. FDA also facilitates training programmes for personnel in the processing, handling, and storage of products.
Agricultural Extension Services Directorate	A division of MoFA responsible for overseeing agricultural technology diffusion through the management of an extension delivery service and ensures that appropriate technology is transferred to actors in the livestock/meat and milk value chains in the country
Environmental Protection Agency	Ensures environmental requirements for horticulture are adhered to by undertaking an environmental impact assessment of all horticulture projects. Co-ordinates the activities of bodies concerned with the technical or practical aspects of the environment and serves as a channel of communication between such bodies and the Ministry

Institutions Advancing Primary Production and Processing

Table 42: Institutions Advancing Primary Production and Processing

Organisation	Mandate
Food Research Institute (FRI)	Research, Testing, Product and Process development for the food industry.
Ghana Investment Promotion Centre (GIPC)	Promote foreign direct investments.
Ghana Export Promotion Authority (GEPA)	Established by Act 396 in 1969. National Export Trade Support Institution of the Ministry of Trade and Industry (MOTI) responsible for the facilitation, development and promotion of Ghanaian exports.
National Entrepreneurship and Innovations Plan (NEIP)	Provision of business development services and start-up funding for SMES.
Medium and Small Loans Centre (MASLOC)	Provision of loans for small and medium processing enterprises.
National Board for Small Scale Industries (NBSSI)	Facilitation of access to information for MSMEs

Non-State Institutional Actors

Table 43: Non-State Institutional Actors

Organisation	Mandate
Papaya and Mango Producers & Exporters Association of Ghana (PAMPEAG)	An association of papaya and mango companies with the aim of developing and promoting premium fresh mango and papaya produce for exports.
National Mango Growers Association of Ghana	The umbrella body for Mango growers in Ghana.
Ghana Institute of Horticulturists (GIH)	Promote and maintain professional standards and the advancement of horticulture in Ghana.
Famer-based Organisations	Prominent ones include: Yilo Krobo Mango Farmers Association, Volta Mango Growers Association, Ghana Commercial Mango Growers.
Hortifresh	A commercial and fruit and vegetable sector development initiative-funded by the Dutch Embassy in Accra.

Financial Institution and Intervention

Table 44: Financial Institution and Intervention

Organisation	Mandate
GEXIM Bank	Mandated to provide funds to support agricultural investments that are export-oriented by financing export costs.
African Development Bank (AfDB)	Provides diverse financial services to agribusiness
Stanbic Bank	Provides agricultural production loans for farmers who need short-term credit to pay input costs once you meet relevant conditions or provide more documents subject to specific borrower conditions.

Interventions driving sub-sector development

Successive governments have initiative programs to stimulate primary production, processing and marketing of agricultural produce. Stated below are a list of such interventions.

Table 45: Interventions Driving Sub-Sector Development

Organisation	Mandate
One district One Factory (1D1F) (Decentralization industrial development)	Promotes agro-industrial enterprises and is geared towards decentralizing industrial development. The government facilitates and assists medium large-scale business to set up. The state will only have an equity interest. It also promotes a demand driven approach to agricultural development, focusing on quantity, quality and timely delivery of products, while safeguarding food adequacy in short term, and food security in the medium and long term.
National Industrial Revitalization Program	An initiative oriented toward reviving private sector growth and stimulate broad industrialization. The program aims to: revamp distressed but viable companies; provide technical assistance to distressed but viable companies; provide business development services; and facilitate access to markets.
National Export Development Programme (NEDP)	It is the implementation roadmap accompanying the National Export Strategy (NES). This programme has 23 projects across 5 thematic areas: (i)Expansion of production and supply base, (ii) Export market development, (iii) Manpower development and institutional capacity building for exports, (iv) Incentives and regulatory framework,

	and (v) Cross cutting issues. MoTI will encourage and facility business to take advantage of AGOA and EPA
Planting for Food and Jobs (PFJ) Programme	Provision of improved seeds, supply of fertilizers, provision of dedicated extension services, a marketing strategy and the use of e-agriculture.
Industrial Parks and Special Economic Zones	An intervention that seeks to establish fully-service industrial manufacturing catchment areas across the country. It seeks to do so by: - Developing industrial land acquisition and security systems at national, regional and district levels to facilitate easy zones/enclave planning for industrial development - Establishing an institutional framework, modern services and physical infrastructure that may not be available in the rest of the country to foster development and economic activities

Appendix 4: Aquaculture VCAs Interviewed

Table 46: List of Aquaculture Actors Interviewed

Company	Principal Actor Category
1. UG Cage Fish	Grower-Processor
2. , S-Hoint	Hatchery
3. Gadason	Grower-Processor
4. WRI	Grower-Processor
5. Grace Farms	Grower-Processor
6. Volta Rapids	Grower-Processor
7. Jassa Farms	Hatchery
8. Vision 2000	Grower-Processor
9. AMTRA	Processor
10. Lee's Farm	Grower-Processor
11. Ainoo Ansah	Hatchery
12. Philipo	Processor
13. Terra Veg	Processor
14. Raana Feeds	Feed Production
15. Jaydel's Kitchen	Processor
16. Nafissah	Processor
17. Monney	Processor
18. Bosco	Grower-Processor

Appendix 5: Poultry Sector VCAs Interviewed

Table 47: List of Poultry Sector Actors Interviewed

Company	Principal Actor Category
1. Akropong Hatchery	Specialist hatchery
2. Darko Farms	Hatchery; Feed processing; Layer & Broiler production; Boiler processing; Retail outlet
3. Asamoah Yamoah	Hatchery; Feed processing; Layer & Broiler production; Boiler processing;
4. Mfum Farms	Hatchery; Feed processing; Layer production
5. Chicks and chicken	Hatchery; Feed processing; Layer production
6. Topman Farms	Hatchery; Feed processing; Layer & Broiler production; Boiler processing
7. Akate Farms	Hatchery; Feed processing; Layer & Broiler production; Boiler processing; Retail outlet
8. St Charles Hatchery	Specialist hatchery
9. Akro Farms	Feed processing; Hatchery; Layer production
10. Nana Abeyie	Feed processing; Layer & Broiler production; Boiler processing
11. Oserby Ventures	Feed processing; Layer & Broiler production; Boiler processing
12. Rockland Farms	Feed processing; Layer & Broiler production; Boiler processing
13. Appah Farms	Feed processing; Layer & Broiler production; Boiler processing
14. Aglow Farms	Feed processing; Layer & Broiler production; Boiler processing
15. Afrifa Farms	Feed processing; Layer & Broiler production; Boiler processing
16. Joeress Farms	Feed processing; Broiler processing;
17. Amankwah Farms	Feed processing; Broiler processing;
18. Accra Abattoir	Broiler processing
19. Jfamco	Broiler processing
20. Reform Egg Processing	Egg processing
21. Charity	Egg processing
22. Agricare	Feed manufacturer
23. Koudijs Ghana	Feed manufacturer
24. GNAPF	Poultry Association

Appendix 6: Fruits & Vegetable VCAs Interviewed

Table 48: List of Fruits & Vegetable Actors Interviewed

Company	Principal Actor Category
1. Bomarts Farms	Mango and pineapple farming and processing
2. Yvaya Farms / Pure and Just Company Ltd	Mango/Pineapple/Papaya
3. Eden Tree Ltd	Fruits & Vegetables processing
4. Keltrice Juice	Fruits juice processing
5. Srighan Farms	Gherkins processing
6. St. Michael's Fruit Juice	Fruit juice processing
7. Agri Commercial Company Ltd	Tomato /mango processing
8. KNUST Fruit Processing Company	Pineapple, mango, ginger and tiger nut processing
9. Techiman Processing Complex	Fruits & Vegetables
10. Integrated Tamale Fruit Company Ltd	Fruit processing
11. Volta Integrated Agriculture Development Group (VIAD)	Fruit processing
12. Vakpo Fruit Packhouse	Fruit processing
13. Selasi Farms	Fruit Juice Processing
14. Bothapraku Citrus Company	Citrus peels processing
15. KNUST Fruit Processing Company	Pineapple, mango, ginger and tiger nut processing
16. Techiman Processing Complex	Fruits & Vegetables
17. KNUST Fruit Processing Company	Pineapple, mango, ginger and tiger nut processing
18. Crown Packaging	Corrugated carton Boxes, Metal Cans and Corks
19. Olam	
20. Nurevas Food Ghana Limited	Tomato processing
21. Weddi Africa Tomato Processing Factory	
22. Tip Top Tomatoes	Tomato processing
23. Tuabodom Tomato Framers Association	Farmer-based organisation

Appendix 7: Broiler Domestic DOC Production Business Case

1. Context: Sources of DOC supply

Broiler day-old-chicks in Ghana are either locally produced or imported. The source of DOC has an impact on the production cost and eventual profit margin for mature broiler birds. Table 1 presents two scenarios whereby broiler day old chicks are obtained from a local hatchery for GHS 5.5, and one imported from the Netherlands at cost of GHS 7.2. It was observed that besides cost of DOCs, feed, medications and vaccination, and production experience of staff are the major drivers of production cost. With a reliable supply of quality day old chicks from a local hatchery, it was realized that the cost of DOCs was lower. Also, farm-formulated feed reduced the cost of feed. Whereas medication cost for imported DOCs was lower, due possibly to their higher quality and reduced health challenges. The brooding charges of local chicks were higher because of the higher number of small sized birds, an average of 33 grams on arrival. As a result, they require extensive care and heating which makes brooding charges go up, thus affecting the profit margin of mature birds.

Notwithstanding the GHS 0.7 profit margin difference between local and imported birds, the authors posit that locally produced DOCs represent a resilient source of DOCs for Ghanaian farmers. In that, the degree to which locally produced DOCs are exposed to the adverse effectives of foreign currency exchange risk is much lower than that of imported DOCs, hence rendering the medium-term price variability of the former stabler than the latter. Moreover, external shocks—i.e., ban on importation, disruptions to international freight tend to have severe impact on the supply of imported DOCs. It is with these economic and sector development rationales that we propose a business case for investment in domestic DOC production.

Table 49: Profitability comparison between locally produced DOC and imported DOC

	Imported[51]	Locally produced
Item (Day-old chick)	**Expense (GHC) over 8 weeks**	**Expense (GHC) Over 7 weeks**
Day old chicks	7.2	5.5
Feed	13.7	8.1
Medication and vaccine	1.9	5.2
Brooding charges	0.5	0.7
Rental charges	0.1	0.1
Labour charges	0.5	0.5
Cost of rearing chicks	**23.9**	**20.1**
Item (Mature bird)	**Unit Imported**	**Unit Locally produced**
Live bird (kg)	3.1	2.6
Selling price per kg live bird (GHC)	10	9
Selling price whole live bird (GHC)	31	26
Profit whole live bird (GHC)	7,1	5,9
Profit margin (%)	**23.8**	**22,6**

[51] Figures Ries and Co. (imported from Belgium).

2. Market Need

Annually, the broiler sub-sector records a deficit of 15 million DOCs. To narrow the supply deficiency, local production of DOCs appears superior to DOC importation. However, the low levels of broiler grand-parent population in Ghana remains a critical challenge. This represents ripe opportunity for increasing supply of grandparent DOCs from the Netherlands.

3. Cost-benefit Analysis

To resolve the deficit of 15 million DOCs, a total of 99,000 breeder broiler chicks are required. For practical reasons, we assume increasing breeder stock by 99,000 birds at once is not feasible. Instead, a business case for supply of 40, 000 breeder chicks to produce 6,054,400 DOCs per annum is presented below.

The business case involves an investment of € 1,524,762 (GHS 10,392,400) into three breeder farms to supply 6,054,400 DOCs per annum. As Table 2 illustrates, 41.7 per cent of the investment sum will be deployed to rearing of breeder chicks, with the remainder earmarked for covering hatching costs.

As per our projections, an investment of € 1,524,762 is set to generate pre-tax earnings of €2,872,300 at a pre-tax ROI of 88 per cent. Using the statutory Ghanaian corporate income tax rate of 25 per cent, net profit is expected to decline to € 2,154,225 (14,682,660 GHS) at 41.3 per cent ROI after tax. Hence, should the source of investment be in the form of equity the net profit is significant enough to—after deducting Year 2 working capital of € 1,137,424—warrant payment of dividends.

Assuming the source of investment is debt with a three-year amortisation schedule at 10 per cent interest rate per annum, projections in Table 2 points to a sound revenue flow. In that, at the end of year one, of the €2,154,225 earnings after tax, € 1,137,424 constitutes working capital for Year 2, thereby leaving € 1,01,6801 for debt servicing and interest coverage for Year 1. Of this amount, € 508,254 is allocated to retire 33.33 per cent of the initial debt, and € 152,476 for interest coverage in Year 1. All things being equal, similar trends can be expected for year 2 and 3, hence the debt and interest servicing is projected to be in good stead.

Table 50: Projection DOC production

Item	Unit(s)	Year 1 Cost (GHS)	Year 2*[52] Cost (GHS)	Year 3[53] Cost (GHS)
Breeder rearing				
No. of breeder DOCs (birds)	40,000	2,640,000	0	0
Feed (kg)	220,000	1,110,000	1,110,000	1,110,000
Medications & vaccinations	Entire breeder stock	110,000	110,000	110,000
Brooding charges	Entire breeder stock	64,000	64,000	64,000
Housing charges	Entire breeder stock	72,000	72,000	72,000
Vitamins	Entire breeder stock	30,000	30,000	30,000
Manager and labour charges		220,000	220,000	220,000
Equipment depreciation		92,000	92,000	92,000
Sub-total: Breeder rearing cost (GHS)		**4,338,000**	7,040,000	7,040,000
Hatching commercial DOCs				
Fertile eggs per breeder	176			
Total fertile eggs produced	7,040,000			
Hatchability rate	86%			
Total chicks at hatch (No of birds)	6,054,400			
Hatchery charge per bird (GHC)	1			
Sub-total: Hatching commercial DOC cost (GHS)		**6,054,400**	**6,054,400**	**6,054,400**
Total cost commercial DOC production (GHS)		**10,392,400**	7,040,000	7,040,000
Sales & revenue				
Saleable chicks	90%	5,448,960	5,448,960	5,448,960
Sales (GHC)	5,5 (per DOC)	29,969,280	29,969,280	29,969,280
Earnings before tax		**19,576,880**	22,216,880	22,216,880
Profit margin (%)		**65%**	**186%**	**186%**
**Cooperate Income Tax	25%	4894220	5,554,220	5,554,220
**Net profit (GHC)		14682660	16,662,660	16,662,660

[52] Assuming same prices as Year 1
[53] Assuming same prices as Year 1

4. SWOT Analysis

Analysis of the internal and external environment of the domestic DOC production points to a predominately favourable investment environment. As shown in Table 3, the current supply shortfall amidst growing demand, coupled with abundance of hatching capacity and breeder facilities bode well for the DOC production sub-sector. However, outmoded equipment and challenges with access to affordable and reliable supply of electricity , as well as poor access to skilled workforce represent effective impediments to securing sustainable returns on investment.

Table 51: DOC production

Strength	Weakness
1. Adequate domestic hatching capacity 2. Sufficient breeder housing facilities 3. Adequate infrastructure, research facilities and technical know-how at KNUST Animal Science Department for technical back-stopping	1. Low supply of highly skilled workforce at farm level
Opportunities	**Threats**
1. Significant supply deficit 2. Emerging broiler processors in need of reliable source quality of DOCs 3. Poultry sector identified as a strategic focus by the Ghanaian government	1. Outmoded hatchery equipment 2. Unreliable supply and high cost of electricity 3. Poor road and transport infrastructure hampers sector development

Appendix 8: Business Case: Recirculating Aquaculture System Tilapia

1. Context: Introducing Recirculating Aquaculture Systems as a means of Reducing Fish Mortality Rates

Traditional tilapia farms usually operate one or several 3 to 5 meters (m) deep fishpond(s) with a sluice gate, and a feed storage. Stocking densities vary depending on the size and availability of fingerlings and the financial capacity of farmers to purchase feedstock. The application of Recirculating Aquaculture Systems (RAS) in tilapia farms requires additional investment in a moving bed bio-filter, filter media, septic tank, and pumps and pipes for water movement and aeration. Recirculating aquaculture systems (RAS) are used in home aquaria and for fish production where water exchange is limited, and the use of bio-filtration is required to reduce ammonia toxicity. Other types of filtration and environmental control are often also necessary to maintain clean water and provide a suitable habitat for fish. The main benefit of RAS is the ability to reduce the need for fresh, clean water while still maintaining a healthy environment for fish. To be operated economically commercial RAS must have high fish stocking densities.

The data in Table 1 showcases a two-case scenario of cultured tilapia being produced using a RAS with an assumed potential mortality rate of 10 per cent on one hand; and in the lake environment with a potential mortality rate of 75 per cent on the other hand. The cost of all inputs—i.e., cost of fingerlings, feed, urea, CaCo3, harvesting, employment, contingency and the sales and marketing expenses—were held constant in order to see how the environment for the production of fingerlings as well as cultured tilapia affects the output and quality of fish produced. As a result of the reduced levels of pollution and consequently a lower mortality rate in the RAS, the cost of fingerlings per piece of cultured tilapia produced (GHCo.2713) was much lower than that of tilapia produced from the pond which cost stood at GHCo.9768. All the other inputs showed similar lower costs for the RAS than for the Ponds resulting in an overall profit margin of 218.63 per cent for the RAS and 163.06 per cent for the Pond production system. Even though the RAS comes with additional costs, a business model for both fingerling and cultured tilapia production based on a 5-year cash flow projection, and a financing structure of 30 per cent equity and 70 per cent loan, returned a ROI of 73.78 per cent and 44.39 per cent respectively; and a payback period of 1.37 and 2.35 years respectively for fingerlings and cultured tilapia production. A comparison of the business models for the various open and closed systems of production show that at the current rate of mortality, the RAS is the most promising option for saving the loss-making lake production system. A SWOT analysis has shown that the potentials and opportunities of a RAS system far outweigh the challenges and constraints. Pitching this business case to strategic investors as well as identifying and facilitating engagement between willing partners, are two of five key strategic actions that would need to be undertaken in pursuit of making the investment in RAS a reality.

Table 52: Profitability Comparison between RAS and Open Lake Production Systems

Item	Closed (RAS) Production System	Contaminated Open (Lake) Production System
	Expense Over 1 Year (GHC/ 270,000 pcs Tilapia output [300,000 pcs Fingerling Input	Expense Over 1 Year (GHC/ 75,000 pcs Tilapia output [300,000 pcs Fingerling Input
Fingerlings	0.2713	0.9768
Feed	0.3690	1.3285
Fertilizer (Urea)	0.0025	0.0090
Calcium Carbonate	0.0054	0.0193
Harvesting Costs	0.0019	0.0070
Employment Cost (17.5%)	0.1041	0.3749
Contingency (4%)	0.0259	0.0933
Sales and Marketing Expenses	0.0390	0.1404
Cost of Tilapia Production (GHC/piece)	**0.8193**	**2.9493**
Item	**Price Per Unit Produced**	**Price Per Unit Produced**
Cost price per kg Cultured Tilapia (GHS/kg)	1.8	6.5
Selling price per kg cultured Tilapia (GHC/Kg)	20.26	20.26
Selling price per pc cultured tilapia (GHC/pcs)	9.20	9.20
Profit per pc cultured tilapia (GHC/pcs)	8.38	6.25
Profit margin (%)	218.63%	163.06%

2. Market Need

The open systems being used for tilapia production in Ghana have been identified among the causes of high mortality rates among fingerlings and juvenile fish, the high cost of production and nutrients polluting the lake environment where production is undertaken. Under normal circumstances mortality rates in cultured fish production are pegged at 10 per cent. However, as a result of contamination in the lake environment, this has increased sharply to 75 per cent leading to significant loses for farmers in the industry. This development opens up an opportunity for the introduction of closed hatcheries and flow-through systems with filtration, closed production systems as well as recirculation systems. Closed production systems provide optimum conditions for fish to grow, thereby leading to reduced mortality and growth time and consequently reducing cost price. Closed hatcheries and flow-through systems with filtration have the potential of reducing the risk for juvenile fish coming into contact with diseases during the early life phase where they are more vulnerable to diseases. On the other, recirculation systems hold the key to preventing nutrients from polluting the lake and consequently reducing fish mortalities by ensuring that water can be used for a longer period of time and therefore a reduced volume of polluted water.

3. Cost-benefit Analysis

The RAS-Based Fingerling Production model shown in Table 2 is based on a 5-year cash flow projection at 10 per cent annual increments in operating costs and revenue, making use of a GHS2,647,378.54 (€ 385,188) investment capital comprising a 70 per cent loan component. It is envisaged that two 400,000L capacity RAS systems would be acquired to facilitate the production process. Other assumptions include a 25 per cent corporate tax, a 22 per cent interest rate, 10 per cent mortality rate and a targeted production capacity of 24million fingerlings per annum. With a net profit margin of 50.83 per cent, a ROI of 73.78 per cent and a payback period of 1.28 years, the investment can be said to be very profitable.

Table 53: Business Model for a RAS-based Fingerling Production System

Item	Unit(s)	Cost (GHS)
Cost of Production		
Fingerlings (pcs)	24,000,000	-
Feed (kg)	100,800	2,133,365.73
Employment Cost (17.5%)		337,903.34
Contingency (4%)		85,334.63
Sales and Marketing Expenses		127,830.19
Equipment Depreciation		235,332.75
Total cost commercial Cultured Tilapia production (GHS)		**2,919,766.64**
Sales & revenue		
Saleable Fingerlings (No. of Pcs)	90%	21,600,000
Sales (GHC)	0.24	5,184,000
Gross revenue (GHC)		5,184,000
Gross profit		**2,264,233**
Profit margin (%)		**78%**
ROI before tax (%)		**94.04%**
Payback Period Before Tax (Years)		**1.32**
**Cooperate Income Tax	25%	(566,058.34)
** Interest Payment		(214,040.56)
**Net profit (GHC)		1,484,134.47
**ROI after taxes (%)		73.78%
**Payback Period after tax (Years)		1.28

Again, the RAS Tilapia Production model shown in Table 3 is based on a 5-year cash flow projection at 10 per cent annual increments in operating costs and revenue, making use of a GHS3,917,559.02 (€ 569,950) investment capital comprising a 70 per cent loan component. It is envisaged that ten 400,000 litre (L) capacity RAS systems would be acquired to facilitate the production process. Other assumptions include a 25 per cent corporate tax, a 22 per cent interest rate, 10 per cent mortality rate and a targeted production capacity of 270,000 pieces of cultured tilapia annually. With a net profit margin of 169.81 per cent, a ROI of 44.39 per cent and a payback period of 2.35 years, the investment can be said to be a very worthwhile venture

Table 54: Business Model for a RAS-Based Production of Cultured Tilapia

Item	Unit(s)	Cost (GHS)
Cost of Production		
Fingerlings (pcs)	300,000.00	73,261.20
Feed (kg)	24,000.00	99,635.23
Fertilizer (Urea) kg	1,350.00	677.04
Calcium Carbonate (kg)	1,350.00	1,450.57
Harvesting Costs (GHS)		526.17
Employment Cost (17.5%)		28,115.86
Contingency (4%)		7,000.96
Sales and Marketing Expenses		10,533.35
Equipment Depreciation		578,323.64
Total cost commercial Cultured Tilapia production (GHS)		**799,524.03**
Sales & revenue		
Saleable Cultured Tilapia (No. of Pcs)	90%	270,000
Sales (GHC)	11.23	3,032,100
Gross revenue (GHC)		3,032,100
Gross profit		**2,232,576**
Profit margin (%)		**279%**
ROI before tax (%)		**56.89%**
Payback Period Before Tax (Years)		**2.19**
**Cooperate Income Tax	25%	(558,143.99)
** Interest Payment		(316,734.65)
**Net profit (GHC)		1,357,697.33
**ROI after taxes (%)		44.39%
**Payback Period after tax (Years)		2.35

The current system for producing Cultured Tilapia in cages on the lake or in ponds with its attendant 75 per cent mortality rate is depicted in the model in Table 7. As with the other two models it is based on a 5-year cash flow projection at 10 per cent annual increments in operating costs and revenue, making use of a GHS3,323,713.46 (€483,847) investment capital also comprising a 70 per cent loan component. It is envisaged that seventy-five 125m^3 capacity fish cages would be acquired to facilitate the production process. Other assumptions remain same, and with a targeted production capacity of 270,000 pieces of cultured tilapia annually. However, because of the high mortality rates only 75,000 pieces could be produced at the same operating costs as the RAS system. .With a net profit margin of -22.92 per cent, a ROI of -0.4 per cent and a payback period of more than 5 years, this investment is nowhere comparable to the profitability of the RAS system; and this is what underscores the crux of this business case for investing in a RAS to boost the aquaculture industry in Ghana. And with the huge demand for tilapia this is a venture no investor would regret putting his/her money into.

Table 55: Business Model for an Open (Lake) System Tilapia Production

Item	Unit(s)	Cost (GHS)
Cost of Production		
Fingerlings (pcs)	300,000.00	73,261.20
Feed (kg)	24,000.00	99,635.23
Fertilizer (Urea) kg	1,350.00	677.04
Calcium Carbonate (kg)	1,350.00	1,450.57
Harvesting Costs (GHS)		526.17
Employment Cost (17.5%)		28,115.86
Contingency (4%)		7,000.96
Sales and Marketing Expenses		10,533.35
Equipment Depreciation		475,701.68
Total cost commercial Cultured Tilapia production (GHS)		**696,902.07**
Sales & revenue		
Saleable Fingerlings (No. of Pcs)	25%	75,000
Sales (GHC)	11.23	842,250
Gross revenue (GHC)		842,250
Gross profit		**145,348**
Profit margin (%)		**21%**
ROI before tax (%)		**-4.00%**
Payback Period Before Tax (Years)		**Beyond 5 Years**
**Cooperate Income Tax	25%	(36,336.98)
** Interest Payment		(268,722.23)
**Net profit (GHC)		(159,711.29)
**ROI after taxes (%)		-4.00%
**Payback Period after tax (Years)		Beyond 5 years

4. SWOT Analysis of RAS-Based Production

The strengths of the RAS and the opportunities available to be taken advantage of far outweigh the weaknesses and the threats. With regards to the threat of price dips from overproduction, a sensitivity analysis on the RAS-Based Tilapia Production model showed that even if revenue should dip by 10 per cent the venture would still be profitable at 48 per cent. The funding issue relating to the second threat is what this business case seeks to mitigate. The high investment, high operating and high staff costs identified as weaknesses in the system have already been taken care of in the model to arrive at the financial indicators that clearly demonstrate high profitability,

Table 56: RAS-Based production investment SWOT analysis

Strengths	Weaknesses
1. Reduced water requirements as compared to pond aquaculture systems. 2. Reduced land needs due to the high stocking density 3. Site selection flexibility and independence from a large, clean water source 4. Reduction in wastewater effluent volume. 5. Increased biosecurity and ease in treating disease outbreaks. **6.** Ability to closely monitor and control environmental conditions to maximize production efficiency. **7.** Independence from weather and variable environmental conditions. **8.** Willingness of Actors in the industry to partner potential investors.	1. High upfront investment in materials and infrastructure. 2. High operating costs mostly due to electricity, and system maintenance. 3. A need for highly trained staff to monitor and operate the system. 4. Higher greenhouse gas emissions than non-recirculating aquaculture.
Opportunities	**Threats**
1. Better market opportunities in terms of pricing, higher value products and niche opportunities. 2. Climate change adaptability 3. High Domestic demands for cultured fish 4. Decreased environmental costs 5. A relatively stable political environment	1. Price dips resulting from overproduction. 2. Limited availability of funds for financing RAS Equipment.

Appendix 9: Business Case: Aquaculture Feed Manufacturing Plant

1. Context: Fish Feed Supply and Demand

It is projected that Tilapia cage farming output in Ghana will increase with several thousand tons per year. National aquaculture production for 2018 was estimated at 76,620 tons. With an estimated FCR of approximately 1.4 for cage culture a total of about 107,000 tons of feed is required to produce 76,620 tons of Tilapia. Raanan Feed Mill—an Israeli Company—is the only specialised local fish feed producer in Ghana. Raanan produces 25,000 tons annually for the Ghanaian market, and 5000 tons for the sub-regional market. This implies an 82,000 tons of feed deficit that is partially covered from imports by major importers like Aller aqua, Multifeed, Coppens, Skretting and Cargill. Imported feed is however approximately 30 per cent more expensive than locally produced Raanan feed so importation does not offer a cost-effective solution. There is therefore the need to increase the local feed production capacity. Considering that feeds constitute up to 70 per cent of the total production costs and are responsible for the high production costs in Ghanaian fish farms, in order to pursue and achieve the objective of a feed cost reduction strategy, there would be the need to invest in a feed mill that would make use of alternative local raw materials through the deployment of the country's local crops and by-product resources, which are presently being underutilized or wasted.

2. Market Need

The high susceptibility of fish to diseases coupled with lake pollution by feed nutrients and the high cost of feed have been linked to the quality of fish feed used in the production of cultured fish. Good quality starter feeds have the potential of boosting the immune system of fish whilst the low FCR feed reduces the feed costs and mortality during the production cycle and the amount of nutrients excreted from the fish. Considering that a FCR of 1.2 for tilapia is achievable, optimising feed management methods would therefore allow tilapia farmers to significantly reduce production FCR and consequently feeding costs. Assuming that 50 per cent of the feed deficit is covered by imports, it still leaves whooping gap of over 40,000 tons of fish feed that can be produced by any strategic investor. The establishment of a 20,000 ton/annum aquaculture specific feed mill to produce good quality starter feed as well as low FCR feed would serve as a strategic approach to resolving the challenges observed.

3. Cost-Benefit Analysis

3.1 Business model for the establishment of a fish feed production plant

The model for the fish feed Production Plant shown in Table 6 is based on a 5-year cash flow projection at 10 per cent annual increments in operating costs and revenue, making use of a GHS 19,887,446.15 (€ 2,895,581) investment capital comprising a 70 per cent loan component. It is envisaged that two 3MT/hr capacity Feed Production Lines would be acquired to facilitate a two 10-hour shift production process. Other assumptions include a 25 per cent corporate tax, a 22 per cent interest rate, a targeted production capacity of 20,000 MT of feed per annum and a 1.5 per cent estimated production losses. With a net profit margin of 45 per cent, a ROI of 124 per cent and a payback period of 0.95 years, the investment is a very profitable one.

Table 57: Business Model Fish Feed Production

Item	Units (Tons)	Cost (GHS)
Cost of production		
Corn	750.72	2,909,040.00
Rice Bran & Wheat Bran	5936.64	8,014,464.00
Soybean Meal	5658.24	44,275,728.00
Animal Wastes	1660.80	7,992,600.00
Tapioca/wheat Flour	1536.96	2,958,648.00
Limestone	115.20	31,392.00
Dicalcium phosphate	148.80	502,200.00
Vitamin-mineral mix	32.64	471,648.00
Vegetable oil	480.00	4,158,000.00
Operating Supplies (10%)		7,131,372.00
Employment Cost (17.5%)		8,275,119.72
Factory Overheads (10%)		4,514,294.89
Sales and Marketing Expenses (5%)		4,514,294.89
General Services (5%)		4,514,294.89
Equipment Depreciation		571,180.00
Total cost commercial Fish Feed production (GHS)		**100,834,276.37**
Sales & revenue		
Saleable Feed (tons)	98.5%	20,094
Sales (GHS)	7,150.00	145,860,000
Gross revenue (GHC)		145,860,000
Gross profit		**45,025,724**
Profit margin (%)		**45%**
ROI before tax (%)		**161.00%**
Payback Period Before Tax (Years)		**0.95**
**Cooperate Income Tax	25%	11,256,430.91
** Interest Payment		(1,607,900.02)
**Net profit (GHC)		32,161,392.70
**ROI after taxes (%)		124.00%
**Payback Period after tax (Years)		0.95

3.2 Business model for the production of cultured tilapia from a feed-efficient production system

The Cultured Tilapia Production model shown in Table 7 is based on a 5-year cash flow projection at 10 per cent annual increments in operating costs and revenue, making use of a GHS 2,324,916.53 (€ 338 481) investment capital comprising a 70 per cent loan component. It is envisaged that ten 400,000L capacity RAS systems would be acquired to facilitate the production process. Other assumptions include a 25 per cent corporate tax, a 22 per cent interest rate, 37.5 per cent mortality rate[54] and a targeted production capacity of 270,000 pieces of cultured tilapia annually. With the establishment of a Fish Feed manufacturing Plant that utilises alternative cheaper sources of feed ingredients, a 10 per cent reduction in cost price of the feed is also assumed in the model. With a net profit margin of 169.81 per cent, a ROI of 31 per cent and a payback period of 3.17 years, the investment can be said to be a very worthwhile venture.

Table 58: Profitability of a Feed-Efficient Tilapia Production System

Item	Unit(s)	Cost (GHS)
Cost of Production		
Fingerlings (pcs)	300,000.00	73,261.20
Feed (kg)	24,000.00	89,671.71
Fertilizer (Urea) kg	1,350.00	677.04
Calcium Carbonate (kg)	1,350.00	1,450.57
Harvesting Costs (GHS)		496.55
Employment Cost (17.5%)		26,533.05
Contingency (4%)		7,000.96
Sales and Marketing Expenses		9,934.63
Equipment Depreciation		475,701.68
Total cost commercial Cultured Tilapia production (GHS)		**684,727.40**
Sales & revenue		
Saleable Tilapia (No. of Pcs)	90%	270,000
Sales (GHC)	11.23	3,032,100
Gross revenue (GHC)		3,032,100
Gross profit		**2,347,373**
Profit margin (%)		**343%**
ROI before tax (%)		**40.00%**
Payback Period Before Tax (Years)		**2.88**
**Cooperate Income Tax	25%	(586,843.15)
** Interest Payment		(316,734.65)
**Net profit (GHC)		1,443,794.80
**ROI after taxes (%)		31.00%
**Payback Period after tax (Years)		3.17

[54] Premised on the assumed that 50 per cent of the observed 75 per cent mortality rate is accounted for by feed inefficiencies.

3.3 Business model for the production of cultured tilapia from a feed-inefficient production system

The current system for producing Cultured Tilapia in floating cages on the lake or in ponds with its attendant 75 per cent mortality rate is depicted in the model in Table 8. As with the other two models it is based on a 5-year cash flow projection 10 per cent annual increments in operating costs and revenue, making use of a GHS3,323,713.46 (€483,847) investment capital also comprising a 70 per cent loan component. It is envisaged that seventy-five 125m^3 capacity fish cages would be acquired to facilitate the production process. Other assumptions remain same, and with a targeted production capacity of 270,000 pieces of cultured tilapia annually. However, because of the high mortality rates only 75,000 pieces could be produced at the same operating costs as the RAS system. With a net profit margin of -22.92 per cent, a ROI of -0.4 per cent and a payback period of more than 5 years, this investment is nowhere comparable to the profitability of the Feed Efficient production system described above—thus, underscores the crux of this business case for investing in a Feed Manufacturing Plant to boost the aquaculture industry in Ghana. And with the huge demand for tilapia this is a venture no investor would regret putting his/her money into.

Table 59: Profitability of a Feed-Inefficient Production System

Item	Unit(s)	Cost (GHS)
Cost of Production		
Fingerlings (pcs)	300,000.00	73,261.20
Feed (kg)	24,000.00	99,635.23
Fertilizer (Urea) kg	1,350.00	677.04
Calcium Carbonate (kg)	1,350.00	1,450.57
Harvesting Costs (GHS)		526.17
Employment Cost (17.5%)		28,115.86
Contingency (4%)		7,000.96
Sales and Marketing Expenses		10,533.35
Equipment Depreciation		475,701.68
Total cost commercial Cultured Tilapia production (GHS)		**696,902.07**
Sales & revenue		
Saleable Fingerlings (No. of Pcs)	25%	75,000
Sales (GHC)	11.23	842,250
Gross revenue (GHC)		842,250
Gross profit		**145,348**
Profit margin (%)		**21%**
ROI before tax (%)		**-4.00%**
Payback Period Before Tax (Years)		**Beyond 5 Years**
**Cooperate Income Tax	25%	(36,336.98)
** Interest Payment		(268,722.23)
**Net profit (GHC)		(159,711.29)
**ROI after taxes (%)		-4.00%
**Payback Period after tax (Years)		Beyond 5 years

4. SWOT Analysis of Fish Feed Production and Supply System

The strengths in favour of the establishment of a fish feed plant in Ghana and the opportunities available to be taken advantage of far outweigh the weaknesses and the threats. The identified weaknesses will be resolved with the establishment of the feed production plant. The unfriendly financial environment issue identified under the threats is also what this business case seeks to mitigate by involving Dutch investors. The high investment cost identified as weaknesses in the system is taken care of in the model by the high return on the investment which makes the investment worthwhile in spite of the high cost of investment.

Table 6o: Fish feed production investment SWOT analysis

Strengths	**Weaknesses**
1. High ROI and short payback period 2. Available Dutch technical expertise and feed production technology 3. Available local technical expertise and labour. 4. Available cheaper alternative sources of feed ingredients. 5. Available information from FAO on fish feed formulations using local alternative cheaper sources of feed ingredients.	1. High dependence of feed industry on expensive imported feed ingredients. 2. High dependence of aquaculture industry on expensive imported feed 3. Only one local fish feed mill is operational in the country 4. High cost of investment
Opportunities	**Threats**
1. High demand for Tilapia 2. Unmet local demand for fish feed 3. Expensive imported feed 4. Stable democratic governance and conducive investment environment. 5. 5-year tax holiday and other incentives for agro-business start ups	1. Unfriendly financial environment - Fluctuations in local currency, high interest etc. 2. 12 decision making and investments. 3. Competition from existing fish feed manufacturers.

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