

Horticulture Business Opportunities in Ghana: 2019

Sector Report 1



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Foreword

This HortiFresh Business Opportunities report presents the state of the art of the horticulture sector in Ghana and Ivory Coast. Over the past years major progress has been made in professionalizing the fruit and vegetable sector of the two countries. Especially in Ghana, the private sector has stepped up its involvement and both exports and domestic market activities have thrived.

The Netherlands Government considers the HortiFresh program as one of its flagship programs in the agricultural sector. Being part of our 'Ghana and Holland Growing Together' Agenda, it contributes strongly to growing more top-quality and healthy fruits and vegetables. More recently, the need to improve access to finance for small- and medium-sized companies has been incorporated into the program. Access to credit and equity have for long been one of the main bottlenecks for agricultural growth in Ghana. Through the HortiFresh program, we now have robust instruments in place that can assist professionally run companies to have indeed better access to finance and hence make it to the next level. Specific access to finance opportunities as presented in this report exist for greenhouse farming, exporter-outgrower models and solar irrigation.

Horticulture in Ghana and Ivory Coast are currently at a crossroads. On the one hand, increased competition and strict EU regulations are setting the bar high for the private sector and government institutions. On the other hand, entrepreneurs and government have shown that they are committed to rise to these challenges by having undertaken important steps. Initiatives like the Ghana Green Label scheme, the Ghana Incentive-based Risk-Sharing system for Agricultural Lending (GIRSAL) and the envisaged Horticultural Development Agency are major moves forward.

The Hortifresh Business Opportunities Report will help companies in Ghana to make decisions on their future investment strategy. I would strongly recommend you to make use of the great opportunities the HortiFresh has on offer.

Let us grow great fruits and vegetables together!

Ron Strikker
Netherlands Ambassador to Ghana



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Abbreviations & Acronyms

BBC	Bacteria Black Spot Disease	IRAC	Insecticide Resistance Action Committee
BRC	British Retail Consortium	ISO	International Organization for Standardization
CABI	Centre for Agricultural and Bioscience International	KIA	Kotoka International Airport
CAGR	Compound Annual Growth Rate	MoFA	Ministry of Food and Agriculture
EC	European Commission	NABC	Netherlands African Business Council
EPA	Environmental Protection Agency	PERD	Planting for Export and Rural Development
EU	European Union	PPRSD	Plant Protection and Regulatory Services Directorate
FAO	Food and Agriculture Organisation of the United Nations	SMEs	Small and Medium Scale Enterprises
FDA	Food and Drugs Authority	SPS	Sanitary and Phytosanitary
FRAC	Fungicide Resistance Action Committee	TA	Terpinyl Acetate
FSC	Forest Stewardship Council	TML	The lures Trimedlure
FVO	Food and Veterinary Office	US FDA	United States Food and Drug Administration
GDP	Gross Domestic Product	USA	United States of America
GFFB	Great Fruit Fly Bait	USAID	United States Agency for International Development
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit	WHO	World Health Organisation
GMP	Good Manufacturing Practices (GMP)	ZECC	Zero Energy Cooling Chamber
GSA	Ghana Standards Authority		
HACCP	Hazard Analysis and Critical control Point		
IFPRI	International Food Policy Research Institute		

1. Introduction

A growing population and urbanization, as well as better education in health and nutrition, is leading to an increased consumer preference for healthy fresh, processed and ready-to-eat products in Ghana. In addition, market liberalization and a trend towards export diversification have played an important role in stimulating the exports of high-value horticulture crops.

The recent ban on export of fresh vegetables from Ghana to the EU show the vulnerability of export dependence and the need to respond quickly to changes in the market. Although perceived as more lucrative, the EU export market is characterised by high costs and stringent requirements. It is therefore often more profitable to invest in products for the domestic and regional markets. Regional trade of horticulture commodities is increasing; such as tomatoes and onions from Burkina Faso to the coastal urban centres in Ghana and Côte d'Ivoire. In the period 2014–2016, the combined imports of vegetables of Benin, Côte d'Ivoire, Ghana, Nigeria and Togo doubled, with the share of imports from the region increasing from 21% in 2014 to 46% in 2016. (Source: Tradeline)

Most of donor attention has gone to smallholder fruits and vegetable producers. It is obvious that the inclusion of existing smallholders can enable them to capture higher returns and income, but only when this is done in a sustainable way looking at the available resources and the equitable distribution of benefits between the farmer and the buyer. Experience shows that the inclusion of smallholder farmers in highly competitive value-chains such as fruits and vegetables is a complex process which requires time and the building of strong partnerships. At the same time the horticulture sector by its nature of being intensive and high-value, is an excellent sector to enhance youth employment, increase rural incomes and reduce poverty. When crops are produced in the right way, applying good agronomic practices and using quality

inputs, the produce can fetch high prices from relatively small pieces of land, and as a result significantly boost local economic growth.

Realizing the potential of horticulture value chains and taking full advantage of emerging market opportunities, requires substantial efforts from both public and private actors in and around the horticulture sector. Key policy factors essential for a successful horticulture sector development in West Africa include:

- Political and economic stability
- Sound implementation of Sanitary and Phytosanitary (SPS) measures
- Investments in applied horticultural research and training; especially on irrigation and pest and disease management
- Linking smallholders to high-value national and export markets
- Development of the logistics sector, including seaports and air transport

West Africa needs more agribusiness; and horticulture should be seen as a business opportunity rather than a development challenge. HortiFresh therefore particularly invests in the growth of agribusiness like those active in: input supply, food processing; professional wholesale and retail markets; and food service; as well as financial service providers.

This report, a sequel to the business report series of GhanaVeg, outlines a number of innovative business opportunities and business cases, which are based on opportunities that have been identified in the sector. HortiFresh is ready to support potential investors that are interested in the business cases outlined, and can facilitate market and finance linkages where needed. In the end, the West African horticulture sector can only grow on the back of strong growth of individual private sector companies and farmers.

2. Opportunities in the Fruit Sector

2.1 Overview of the Fruit Industry in Ghana

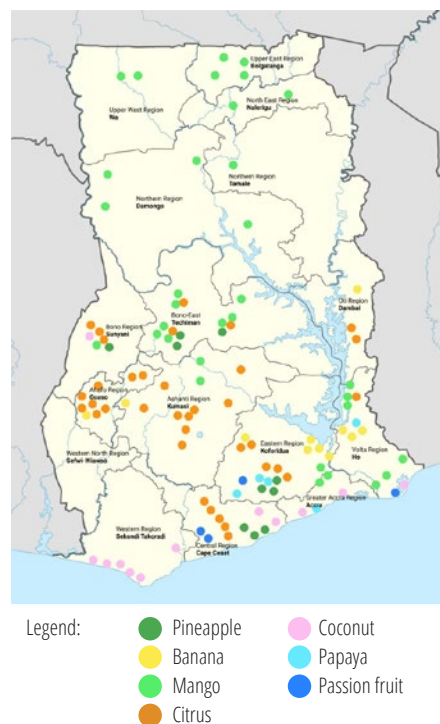
Fruit production plays a crucial role in Ghana's economy and it is one of the major sources of export earnings contributing 15.74% to the Ghanaian economy in 2015 (source: Agriculture in Ghana – Facts and Figures 2015, MoFA). The country is endowed with a variety of fruits such as pineapple, mango, banana, citrus, papaya, passion fruit, coconut, among others. The opportunity exists to transform these fruits into value added products such as juice, dried fruit and concentrates to increase trade for the domestic, regional and export markets. However, few local companies have taken advantage of this opportunity for fruit processing, currently these are mainly exported as fresh whole fruit.

Considering the economic importance of these fruits, the Government of Ghana has over time implemented programs and policies together with donors to promote the fruit industry. Currently, under its program Planting for Export and Rural Development (PERD), the government seeks to promote the production, export and value-addition of crops such as mango, coconut, citrus, cashew, shea, and other tree crops to increase exports earnings and provide sources of income for farmers in the rural areas and generate employment for youth and rural people.

2.2 Production Areas

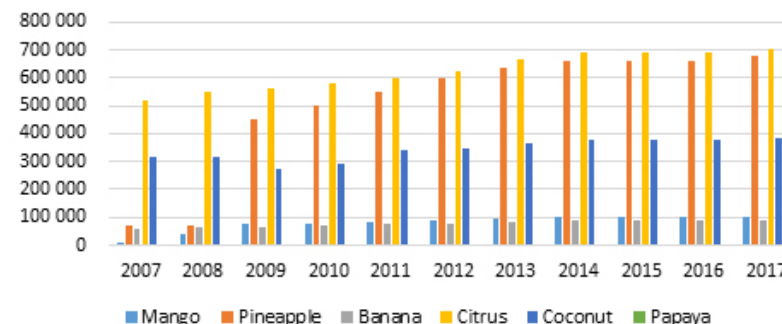
Ghana's agro-ecology offers favourable conditions for the cultivation of tropical fruits and its proximity to EU market gives it a comparative advantage in terms of marketing. Although tropical fruits can be found all over Ghana, commercial production of fruit is mainly found in eleven regions stretching from the middle belt to the south. It is worth mentioning that mango is also cultivated in five regions in the Northern part of Ghana (Figure 1).

Figure 1. Map of Production Areas in Ghana



There are seasonal variations in the supply of fruit, there are for instance two seasons for crops such as mango and citrus, a short season in December to February – complement the traditional May to July for the production of mango. In the case of citrus the harvest season ranges from October to March and from April to July for the lean season depending on the varieties. Pineapple is however grown all year round as is banana production under drip irrigation, both are commercially available all year round.

Figure 2. Production of the major fruit in Ghana (MT), 2007–2017. Source: FAO Stats



According to data compiled by FAO Stats in 2017, banana, citrus and coconut production have been growing steadily (Figure 2). After a dip in 2007 and 2008 due to delays in shifting production from the Smooth Cayenne variety to MD2, production of pineapple and mangoes have also increased over the years.

According to Mordor Intelligence, the economic drivers for the Ghanaian fruit and vegetable market is the growing middle class with a heightened health-awareness, coupled with the rise of supermarkets. The proximity to the European markets and increasing irrigation facilities are also stimulating the increased production. The potential for growth in the fruit industry is still high as fruits consumption is increasing with the growing urban population in Ghana and the increasing awareness of a healthy lifestyle.

In Ghana, domestic consumption represents 70% of the fruit and vegetable market. Vegetable consumption in Ghana is still relatively small but is expanding rapidly. Apart from local vegetables, the most important vegetables are tomato, pepper (both sweet and hot chillies), onion, and okra. Especially, the market for tomato and pepper has boomed recently. This can be easily gauged by the fact that tomato production witnessed a CAGR of 4.6% and chili production recorded a CAGR of 8.81% over the 2011–2014 period. A total of 78,000 ha of land acreage is dominated by vegetable production in Ghana. In the fruit segment, orange dominates the fruit segment, followed by pineapple. Orange production witnessed a CAGR of 4.78% over the 2011–2014 period. The trends are a clear indication that the

Ghanaian fruit & vegetable market is going to witness a healthy growth in the 2017–2022 forecast period.

2.3 Value Chain of the Fruit Sector

An analysis of the value chain of the fruits sector could be looked at in three main areas. These include the fresh exports, fruit processing and the local market.

Fresh exports

Exports of fresh tropical fruits commenced in Ghana in the 1980s with smooth cayenne pineapples, relying on smallholders who contributed about 50% of export volumes. This was followed with commercial production of banana, mango and passion fruit for the fresh export market. Exports of pineapple, banana, mango, citrus and papaya is about \$59.9M and constitutes about 73% of horticultural products (Source: GEPA Export Data 2016).

The export sub-sector has experienced declining volume of exports due to a number of reasons. For pineapple the reason was a shift in variety based on market demand from smooth cayenne to the MD2 variety of pineapple. Coupled with this is the tough competition from Latin American companies such as Dole and Del Monte producing at a much cheaper cost than their Ghanaian counterparts who were transitioning to growing MD2. Ghana has 20% gross margin of turnover compared to Costa Rica which has 49% gross margin and six times more revenue per hectare

than Ghana (FAO report 2013). In addition to this, the fresh export market faces challenges in production, low productivity and response to market shifts and transitioning to new varieties of the product. It is therefore crucial to address these challenges to increase fresh exports and most importantly, strengthen the supply chain for the existing processing firms established in the country.

Fruit Processing

Fruit processing companies can be categorized into companies producing for the export as well as the local market and those producing solely for the local market. The six major fruit processing companies are Blue Skies, HPW Fresh & Dry Ltd, Bomarts Farms Ltd, Pinora, Peelco and Fruittiland Processing Company. These companies are mainly operating in the free zone enclaves and export the following products mainly to the EU market:

- Fresh pre-cut fruit such as mango, pineapple, papaya, passion fruit, etc for exports;
- Dried mango, pineapple, coconut, papaya and banana;
- Mango fruit bars and rolls as snack packs;
- Orange and pineapple juice, concentrate and ready-to-drink juice (both conventional and organic), mango juice and fruits blend juices are sold mainly on the local market;
- Essential oils.

Total exports volumes of the various processed products is about 20,500 MT per annum. Fresh pre-cuts constitute a larger share of exports, representing 64%, followed by concentrates 27% and then dried fruits 9%. In terms of processing, mango constitutes about 60% of the companies' production of both fresh pre-cuts and dried fruits products, followed by pineapple 25% for dried fruits and the rest for coconut, papaya and banana. Additionally, orange concentrate is about 21% and single-strength pineapple juice is about 6%. Together, these companies have a theoretical processing capacity of 1,600 MT per day, but currently they are producing at a total capacity of 1,100 MT/day.

There is a current deficit of 550 MT/day and the potential therefore exists to increase production.

On the domestic market, fruit processing is undertaken by Vintage Farms, Crescent Juice, Kalyppo, St Michael, Healthy Life, Papsop to mention a few. However, the companies face competition from imported fruit juices such as Don Simon, Ceres, Frutelli, Sammi, Stute, etc.

Regional Market

Currently, the regional market for tropical fruits is dominated by itinerant traders from Cote d'Ivoire and Burkina. Oranges are purchased and transported by these buyers to Cote d'Ivoire and Burkina Faso during the harvesting seasons. Copra is also traded by Nigerian buyers and the demand for copra is growing on the regional market.

Local Market

The local market for tropical fruits is dominated by local market women, supermarkets, hotels, schools, etc. Apart from pineapple, banana and passion fruits where greater volumes are exported, about 35% of mango, citrus and coconut are sold at the farm gate to these buyers. Prices for the fruit usually fluctuate depending on the seasons.

2.4 General Challenges in the Fruit Sector

The fruit industry covers key export commodities and offers great potential for contributing to Ghana's effort at enhancing the non-traditional export economy and for accelerating the domestic fruit processing sub-sector. However, some production difficulties are hindering its export and processing activities as indicated below:

- Various diseases (anthracnose, powdery mildew, alternaria, stem-end rot, pseudocercospora leaf and fruit leaf disease of citrus, Cape St Paul wilt for coconuts, bacteria black spots (BBS) on mango) and pests (fruit fly, mealybug, termites, mango bugs, etc.) are major concerns and have a direct economic impact on the various operators, despite some success in controlling diseases.

- Lack of irrigation facilities to address drought and prolong the seasonality of fruits such as citrus, mango, papaya.
- Value chain actors in the fruit industry have partial knowledge of production potential, available varieties, post-harvest practices, market access requirements, demand trends and international competition.
- Poor post-harvest practices in the area of fruit handling, transportation, among others, lower the quality of fruits produced as well as contributing to post harvest losses.
- Difficulty of producers and exporters in maintaining international quality standards (GlobalGAP, Fairtrade, Organic) certification due to the associated costs, hence low volumes of fresh exports and challenges in supplying excess production to fruit processing companies. In addition, some processing companies are confronted with traceability issues and meeting local and international Good Manufacturing Practices (GMP) certifications such as HACCP, ISO, BRC, US FDA, SGF (customer certificate) etc. On the local food some of the processing companies lack or have failed to renew food safety standards certifications such as EPA, FSC, FDA, GSA etc. to enable them operate effectively.
- At the processors end we see difficulties in meeting consistency and quality of product supply, frequent equipment breakdowns (fruit in silos may spoil if it takes a longer time to be repaired), which affects production volumes, risk of contamination, increased production cost and other constraints.
- Competition from imported fruits juices which invariably are cheaper on the local market.

The results of these problems are low yields, poor quality fruits and high post-harvest losses per acre, which leads to low competitiveness on the international market, where potentially a lot of revenue can be obtained.

2.5 Business Opportunities in the Fruit Industry

Production Opportunities

1. Healthy Orchards and Planting Materials

Healthy seedlings affect the development of various orchards in terms of production cost, yields and quality of produce. The current fruit sector is challenged with pest and diseases which increases the cost of production and reduces yields drastically. Introduction of improved technologies into the production of seedlings in a protected environment (greenhouse) will contribute to healthy seedlings and orchards. This is an excellent opportunity for investors to help introduce disease resistant varieties by using tissue culture technology. Tissue culture is a new technology which helps in producing true to type planting materials which are also disease free. There is also business opportunity in exploring the development early maturing varieties for farmers.

Mango

The current plantations face with many pest and diseases challenges. Currently, Bacteria Black Spot Disease (BBS) is major issue in the mango sector leading to significant crop losses and its impact on the income of farmers. This disease affects the crop at all stages. This offers opportunities for business entities (especially agro-input supply companies) to explore effective management practices to ensure disease free orchards.

Coconut

Coconut farms along the coastal belt are being attacked by the Cape St Paul Wilt disease which is reducing acreage under cultivation and yield. The sector requires new and resistant varieties to combat this disease which is wiping away the coconut plantations along the coast. Resistant varieties have recently been developed, these are early bearing and high yielding. However, the planting material of these varieties need to be multiplied in mass quantities for supply to farmers especially along the coastal areas. This offers

an excellent opportunity for investors to nurseries for rapid multiplication of cocoa seedlings for farmers.

Passion Fruit

The production of passion fruit planting material is fairly new. The production of the purple colour passion (small size) by tissue culture is an opportunity for investors. This tissue-cultured plants offer growers the opportunity to get true to type varieties, uniformity of growth and also avoid the stress of going through the nursery activities.

Citrus

In the citrus sub-sector, about 85–90% is orchards are planted with the Late Valencia variety, this offers an opportunity for early varieties to be introduced into the sector.

2. Professional Services in Production

The provision of professional services has become a necessity in orchard management because of the current challenges farmers face in their activities. The control and management of fruit fly, BBS and others in orchard have become critical hence the need to have a professional service provider to handle it, this creates the opportunity for skilled service providers who have technical know-how. Provision of farm services in orchard management which involves pruning, spraying, harvesting and other activities offers opportunity for investors. Demand of service from skilled harvesting team have become necessary because farmers do not have permanent staff for this activity, in addition market requirements for quality fruits keeps on increasing hence the need for trained harvesters who will offer this service.

The demand for small chain saw machines, spray machines, and other logistics for the pruning of mango and citrus orchards have become an opportunity for investors to explore. In addition, logistics for pruning and supporting passion orchards offer another opportunity for investors.

3. Improved Fruit Handling, Transport and Storage

Post-harvest losses in the fruit sector is high and contributes to the percentage loss of the farmer. Building the

capacity of the farmers with post-harvest skills and the introduction of basic storage facilities along the value chain of these actors. In addition, the introduction of handling facilities, like crates for harvesting and transporting produce will help increase the shelf life of the fruits and reduce the post-harvest losses. Value chain actors who are into storage facilities operation and pack house activities can explore this opportunity to enhance the activities of the farmers, wholesalers and the retailers of the fresh produce.

4. Irrigation

Water is an important element in plant development right from the nursery stage to orchard establishment. Supply of water to orchards may be rainfed or through irrigation. Sufficient, regular and reliable supply of water to orchards helps in the early development of the orchards resulting in uniform growth and a continuous and consistent supply of fruit. Yields from such orchards are high and farmers are able to manage their fruit availability timings to their advantage. Supply of water to many orchards in Ghana is not consistent and this affects the yields and consistent supply of fruits.

This gap offers a good opportunity for investors to invest in the drilling of boreholes in fruit orchards. Further opportunities exist in the area of irrigation systems, whether drip, furrow, sprinklers and any form that farmers can use to supply water to their plants in their orchards. The adoption of any of these systems by farmers will increase their yields and the sectors contributions to GDP. Consistent and timely supply of fruits will enhance competitiveness of the sector.

Diesel and petrol pumps are the most common known system in Ghana but not used by many orchard operators, the system is suitable for small, medium and large scale orchards owners. This pumps can fit a variety of irrigation systems. Solar irrigation offers a big opportunity for operators of this service because most of the orchards do not have access to electricity to enable them use electric pumps for their irrigation system. This is a new system which turns to be an ideal option for farmers to adopt but it requires more awareness creation and marketing efforts.

Marketing Opportunities

The fruit sector offers a wide range of opportunities for investors to explore, specific opportunities for some commodities are:

Mango

Introduction of early maturing mango varieties will to help expand the harvesting period and make the sector more competitive. This will attract international fresh exporters to Ghana because exporters will have extended season.

A challenge is however the unavailability of a ready market for fresh mango export contributes to more than 16% of the various issues accounting for a total postharvest loss of 45.6% (IFPRI, 2018). A study in the North (Augustus, 2016) revealed that about 65% of farmers harvest their produce when fully ripe, with 32% of them harvesting at half ripe state with less than 3% of farmers harvesting their fruits at physiologically matured stage. In the middle belt, postharvest losses are about 35% due to lack of market opportunities, especially for fresh export and processing. The distance from the North and the middle belt to the port or the south where most processors are based is a contributing factor to the marketing problem. Investment in value added processing of fresh fruits to juices and concentrates will offer potential market avenues for mango farmers and also reduce postharvest losses.

Coconut

Coconut has seen a growth in the international, regional and local markets in its fresh, dried, processed forms and also its by-products. Over the years, the export of dried coconut was common, but currently the demand for fresh coconut for export has increased significantly. The consumption of fresh coconut domestically also increased drastically and the price per fruit ranges from GHS 1 at the production centre to GHS 2.5 and GHS 3 in Accra. The consumption of coconut virgin oil is increasing hence the demand of copra by coconut processors, this offers investment opportunity.

Passion Fruit

There is an increase in demand of this tropical crop on the international, regional and local markets both fresh and processed, a potential that should be further

exploited. The common varieties grown in Ghana include the Purple Passion (*passiflora edulis*), Orange/Yellow Passion (*passiflora flavicarpa*) and Giant Passion. The export fresh market demands the purple small fruit which is a special variety for that market. The small scale processors require juicy varieties for the blending. Those into the production of fresh juice and smoothies have seen the increase demand from the hospitality sector as driver of their business because of the taste and flavour the commodity adds to their products. The supply of passion fruit is currently not sufficient.

Citrus

The current lack of activities by the citrus value chain actors have rendered the sector inactive resulting in farmers having challenges in marketing of their fruits and most of the processing companies are not functioning well. However, there are opportunities for investors in the area of processing fruits into single strength for the domestic and regional markets and concentrate for both international and domestic market. Ghana currently imports tons of concentrates. Production of essential oil from the peels is an additional commodity for processors with a fair demand for export as is dried peel.

Papaya

The crop thrives well in different areas in Ghana and its commercial production sees a vibrant export of papaya. There is high demand for the commodity in the local market but production is inadequate to serve this market as well as the export market. Papaya from Ghana to the international community have a unique characteristic of taste and freshness through same day exports to the EU market gives the country an edge over other competitors. There is the need to build production volumes for the Ghana to be competitive. The demand for papaya by processors for drying is also increasing gradually. The number of farmers producing papaya is limited and they do not have access to the right varieties demanded by the export market. There is a business opportunity for agro-input companies to invest in supply of different varieties of papaya. This also offer a good opportunity for any exporter who is willing to allocate resource to develop the sector and buy the fruit for export.

3. Opportunities in the Vegetable Sector

3.1 Introduction

Vegetable consumption in Ghana is still relatively low in comparison to other African countries like Kenya, but is increasing rapidly. Apart from the consumption of local vegetables, the most important vegetables are tomato, pepper, both sweet and hot chillies, onion and okra. Tomato production in particular has increased significantly in the last ten years, more than doubling from 180,000 tons (t) in 2007 to more than 370,000 t in 2017.

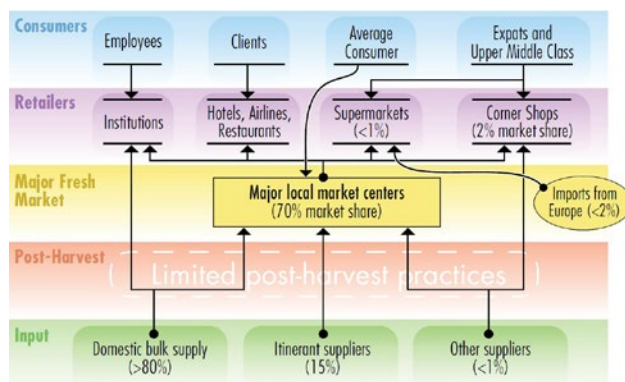
Traditionally, vegetables in Ghana are mostly eaten processed or cooked as both a spicy tomato paste (shito) as well as 'soups' with banku or fufu. More recently, the urban population is turning to fresh salads. This is mainly a result of Ghana's sustained economic growth that has led to the emergence of a middle class of consumers demanding higher quality fresh products. This middle-class is demanding better quality products, including a greater emphasis on food safety. In turn, this is leading to a greater market segmentation between specialized food service and retail markets on the one hand, and wholesale bulk ('wet') markets on the other, catering for different production-consumption systems.

3.2 Opportunities for the Domestic Vegetable Sector

One in two Ghanaians buys fresh vegetables from a limited number of local markets dotted around the country (AgrImpact, 2013). These markets are mostly operated by so-called "market queens" who serve as a point of sale for most buyers who run corner shops, hotels and restaurants. There are market queens for vegetables like tomato, onion, hot pepper and okra. The vegetable traders in Ghana are organized by the market queens, who in turn settle disputes between traders, and represent them in negotiations. Each crop has a specific market queen selected by all traders, and is later introduced to the local traditional community leaders and the district assembly. Market queens are never removed but rather retire or get replaced when they pass away (Peppelenbos et al., 2008).

The traditional open market comprises approximately 80 percent of the fresh fruit and vegetable market in Ghana. The main ones are Makola, Techiman, Agbobloshie and Abinkyi markets and are mostly operated by market queens. Figure 3 depicts the general value chain for vegetables serving the domestic market. It starts with production at the bottom, and

Figure 3. Simplified value chain map for the vegetable sector in Ghana. Source: Adapted from Agri-Impact, 2013



follows the produce all the way to consumers on the domestic market on top.

The domestic vegetable sector is plagued with a number of challenges at various stages of the value chain. These challenges can be grouped into three categories: farmer practices, post-harvest management and market dynamics. Related to these challenges a number of value chain innovations have been designed. These value-chain innovations relate to: i) improved inputs and farmer practices in order to increase the productivity and safety of the product; ii) post-harvest innovations to prevent losses and preserve quality; and iii) marketing innovations. Irrigated agriculture is on the increase, leading to new production areas around the Volta and Volta Lake as well as specific irrigated areas around Accra.

Improved inputs and farmers practices

In a recent IFPRI study (Lolavalli et al., 2017) on the competitiveness of vegetable production in Ghana the overall conclusion was that productivity lacks behind neighbouring countries and that the lack of well-adapted inputs are an important cause for low productivity. The study further recommends the increased availability of seeds (and new varieties), irrigation technology and crop protection products. It is in this line that a host of initiatives have started up, introducing:

- New hybrid varieties of the main vegetable crops (e.g. with companies like East West, RijkZwaan and Syngenta expanding their activities).
- New types of irrigation (including solar irrigation), with new systems being introduced to the country like SunCulture and FuturePump.

In the same vein, good agricultural practices are being promoted through the Ghana Green Label initiative. Ghana Green Label is a local certification scheme that promotes sustainable agricultural practices and safe fruit and vegetables. The initiative is now championed by a number of supermarkets in Accra. This creates the necessary pull for the hundreds of farmers that have been certified in the last years. It is expected that the combination of better inputs and better practices

will lead to greater availability of quality products in the market in the coming years.

Private Extension Services

Under GhanaVeg, a quick scan was implemented to explore private sector driven technical support services in Ghana's vegetable sector. Below the main technical support needs are listed for differentiated per supply chain actor:

- Commercial growers:
 - Production and investment planning (assessing qualitative and quantitative demands; financial planning and funding; dealing with uncertainties)
 - Cultivation (irrigation, pest and disease management, soil fertility)
 - Product handling (preservation, sorting, grading, handling, packing)
 - Quality assurance and traceability
 - Emerging commercial grower
 - Cultivation (choosing the right cultivars, soil fertility management, irrigation, crop protection and safe use of chemicals, harvesting)
 - Product handling (preservation, grading)
 - Input suppliers (wholesale/large scale)
 - Trends and opportunities in the sector
 - Input suppliers (rural shops)
 - Cultivation (choosing cultivar, soil fertility management, crop protection, etc.)
 - Handling agents and logistical service providers
 - Quality management systems and traceability
 - Handling of vegetables (sorting, grading, processing and packing fresh vegetables)
- Based on the assessment of technical support needs, the available know-how and expertise and the operational and financial possibilities, three types of private extension services are recommended:
- Local GAP advisors for smallholder vegetable growers who (wish to) supply high-end markets

- Vegetable study groups for (emerging) commercial growers producing the same type of vegetable crops
- Vegetable business development coaches for large-scale commercial growers and wholesale traders/exporters.

Postharvest innovations

Various low cost initiatives have been tested in developing countries, mainly in Sub-Saharan Africa and Asia. An important source for post-harvest innovations in Sub-Saharan Africa is the Horticulture Innovation Lab which is a collaborative research project implemented by UC Davis and funded by the Feed the Future program of the U.S. Agency for International Development (USAID) (WFLO, 2010). The Horticulture Innovation Lab promotes smallholder participation in markets and post-harvest innovation in 35 projects.

In order to reduce postharvest losses farmers can introduce innovations in cooling and packaging of a vegetables. The loss of quality of the product at harvest often relates to high temperatures. High temperatures are known to result in increased rates of respiration, deterioration and water loss in fresh produce. Therefore, there is a business opportunity to decrease the temperature after harvesting and during the entire process of handling, storing and transporting of fresh vegetables.

Packaging

Packaging that adequately protects (fresh) food products can significantly extend shelf-life. Shelf-life duration is influenced by environmental factors such as temperature and light, as well as oxygen and carbon dioxide levels. Good packaging is essential to maintain quality throughout the chain. Currently the volumes packed in one crate or sack are too large and the materials used for packaging have a high contamination risk.

In Ghana most vegetables are packed in traditional sacks or wooden crates. For tomato, the common way of packaging for transport is a large wooden crate of about 20 kg. Cabbages are packed in sacks that contain

more than 65 cabbages each. A study in Tanzania (Barrett et al., 2014) shows that also there wooden crates are generally rough and large (up to 50 kg). The researchers there developed a number of improved locally made crates, including half sized crates, smooth wooden crates (sanded inside) and liners for crates. The study showed that simply by decreasing the size of large packaging material (crates, sacks or baskets) the damage to the produce can be reduced by 50 percent or more.

Marketing

Besides improved agronomic practices and technical innovations, there are also ways to bridge the gap between farmers and consumers in such a way that post-harvest losses can be reduced and value can be added.

Some examples:

- Home or office delivery: Energy Africa Ltd, a local company operating in Kenya, expanded its services by introducing home delivery of organic fresh fruits and vegetables. They operate from a nucleus farm and work with outgrowers, supplying more than 15 different fruits and vegetables.
- Prepackaged selections: In South Africa, a local company 'Wild Organic Foods' offers a choice of three bags directly to consumers: the standard bag, the mini-bag and the made-to-order bag. Both the standard and mini-bag include a seasonal selection of products. In the made-to-order bag the consumer chooses the products from the catalogue. Importantly, bags are delivered to a collection point from which consumers can collect at any preferred time.
- Farm to consumer: In South Africa, a nonprofit development organization developed a marketing project through which micro-farmers would sell their excess of organically-grown vegetables, packed in boxes, to consumers. The project, called Harvest of Hope, ensures that farmers are paid at the moment of delivery. Members of Harvest of Hope sign up for a box and pay for their weekly delivery of vegetables in advance.

Processing

In Sub-Saharan Africa there are many examples of local companies that invest in processing fresh vegetables in order to store them for longer periods. Tomatoes are a favourite produce used for processing purposes, about 1 litre of concentrate requires 7 kg of fresh tomatoes (Gathani & Stoelinga, 2013). In addition, large volumes of water and sugar are needed for processing tomatoes, adding serious costs. To establish tomatoes processing facilities, the expected total investments costs are high and since (over-) supply is seasonal in most African countries the facilities are only running during a small period of the year, making it an inefficient business. In addition, most African countries face large imports of cheap tomato paste and ketchup from other countries (i.e. Italy, China, USA). The imported products use specific types of open field tomatoes with high yields (up to 100 t/ha) that are machine-harvested, leading to a competitive cost advantage.

3.3 Opportunities for Export Sector: A Business Case

A detailed financial analysis showed, that a medium sized export company of around 20 ha, that is professionally run, can expect a profit before tax of more than GHS 500,000 annually. Table 1 shows the profit calculation for the farm as a whole. The farm gate price for each product has been derived from interviews with various stakeholders in Ghana and the UK.

Table 1. Economic indicators for a 20 ha mixed cropping farm (in GHS)

Ref	Indicator	Total	Ref	Indicator	Total
A	Total Volume produced	240 t	C	Total Revenue per year (A x B)	GHS 1,394,700
	- Hot pepper	93 t	D	Total Variable costs per year (seeds, fertilizer, labour, packaging, certification, transport)	GHS 699,573
	- Okra	60 t	E	Total Fixed costs per year	GHS 195,250
	- Bitter Gourd	87 t	F	Total Costs per year (D + E)	GHS 515,350
B	Final Farm Gate price per ton		G	Profit before tax per year (F - C)	GHS 500,000
	- Hot pepper	4,100 GHS/t			
	- Okra	5,000 GHS/t			
	- Bitter Gourd	8,200 GHS/t			

A business case was made for an export farm which cultivated three vegetables, bitter gourd, okra and hot pepper on a 20 ha equally demarcated plots producing 240 t of various Asian vegetables. The unit produced 93 t of hot peppers, 60 t of okra and 87 t of bitter gourd per season. All vegetables were sold in 4.5 to 5.5 kg carton boxes. The business case assumed a finance model whereby 30 percent investment comes from own capital and 70 percent comes through a loan at 25 percent interest with a grace period of 2 years after loan disbursement in 2015. An investment plan envisioned the farm was prepared using the estimates of equipment of lasting and enduring quality. Investments were made for soil testing and soil adjustment and planting materials, construction works, plant production products, packhouse, office equipment, refrigerated trucks and cooling rooms and GlobalG.A.P certification.

In brief, revenues generated from the export of Asian vegetables in the international market would be GHS 1,394,700 annually. On the other hand, variable costs (seeds, fertilisers, etc.) on 20 ha would amount to GHS 699,700 and fixed costs would set at GHS 195,250 per year. Fixed costs included the loan disbursement, depreciation on total assets, fixed labour and land rental. The payback period for the model export farm was 2 years given the amount of investment. This means that it will take 2 years for the investor to break even on the initial capital investment.

4. Competitiveness of Ghana's Vegetable Sector

A study was commissioned on the Competitiveness of the Ghana Vegetable Sector (IFPRI, 2017). The study examined the competitiveness of tomato, onion, carrot, and Scotch Bonnet peppers in relation to imports. These are four vegetables that are essential for Ghanaian diets and for which a significant portion of consumption is met by imports. For the study, competitiveness was defined as the ability to deliver goods and services in the time, place, and form desired by consumers at prices as good as or better than those of other potential suppliers while earning at least opportunity costs of resources employed (Sharples and Milham, 1990; Abbot and Bredahl 1992). Three indicators were used: 1) per unit cost of production; 2) per unit cost of vegetable delivered to markets in which they need to compete with imports; and 3) gross margins per hectare (ha). The selected indicators measured competitiveness in production, efficiency of the marketing system, and whether farmers had incentives to produce the selected vegetables instead of other crops that they could cultivate.

4.1 Overview of the Vegetable Sector (Consumption, Trade, Production)

Vegetables especially tomato, Scotch Bonnet and onion forms an important part of the Ghanaian diet. In 2010, vegetable consumption per capita in Ghana was estimated at GHS159 (World Bank, 2010). This represents approximately 10 percent of total food consumption. These vegetables and their processed products (tomato paste, shito) are used in traditional foods such as jollof rice and soups.

Vegetables are widely consumed in Ghana with household estimated spending on vegetables being 12.8 percent of total food expenditures in 2012–2013. Tomato made up the highest share of vegetable

expenditure (35.2 percent), followed by onion expenditure (19.0 percent) and chili expenditure (9.7 percent). The IFPRI report found out that, while vegetable spending patterns were similar across rural and urban areas there were spatial differences in spending. The six southern regions devoted a much higher budget share (36.8 percent) to tomatoes than the northern regions (28.7 percent), while the four northern regions devoted a much higher budget share (21.9 percent) to onions than the southern regions (12.3 percent).

In terms of trade, despite government's push to increase horticulture exports, vegetables exports remain low. Vegetable exports are not well monitored, thus export data for vegetables is hard to validate creating a gap, but the IFPRI report made estimates based on available information. Taking a looking at the export of the common vegetables produced in Ghana; tomatoes, onions, carrots and chili, Ghanaian exports of tomatoes, onions and carrots are relatively small. On the other hand, Chili exports are quite significant; exports averaged \$5.7 million annually between 2013 and 2015. The United Kingdom was the largest trade partner and accounted for 95 percent of chili exports from Ghana. However, all exports of capsicum (chili) to the EU were banned in October 2015 due to failure to comply with sanitary and phytosanitary (SPS) measures.

Vegetable imports are key to meeting Ghanaian consumption demand. While official estimates suggest that over the period 2009 to 2013, tomato imports made up only 2 percent of consumption, chili imports made up less than 1 percent of consumption and onion imports accounted for 34 percent of consumption, evidence from traders suggest that imports are much more essential than these official data suggest. Official estimates of Ghanaian imports of tomatoes, onions and carrots are relatively small. Tomato imports were \$1.2 million annually over the period 2013 to 2015. Onion imports were substantially larger, averaging

\$9.3 million annually over the period. Regardless of the source, these import figures appear to be gross underestimates. Porous borders, poor enforcement and rent seeking results in large trade volumes going unreported. Although, official figures for carrot and chili imports appear to be more reliable as these vegetables enter the country through major ports, the IFPRI report states that there is also significant unreported regional trade. Ghana imports vegetables from its neighbors and countries in the region. Burkina Faso accounted for 96 percent of all official tomato imports while Niger and Burkina Faso accounted for 92 percent of all official onion imports from 2013–2015. Netherlands however, was the largest source of carrots and chili, with 82% of carrot imports and 79% of chili imports.

Production of the selected vegetables has been increasing annually but has not been enough to keep pace with growing demand. It was noted that commercial vegetables production in Ghana is concentrated on a line running southeast from Sunyani to Ho, with additional planting running south from Bolgatanga to Tamale. While commercial production is concentrated in the Northern, Upper East, Ashanti and Brong Ahafo regions, household vegetable production is more widespread. Although Ghanaian vegetable production does not currently meet local demand, vegetable production is spread across the country and Ghana benefits from having several climatic zones, giving it the potential to supply vegetables year-round.

4.2 Yield and Practices in Ghana

While yield estimates for vegetables in Ghana vary between sources, all estimates of vegetable yields in Ghana are significantly lower than those in neighboring countries. MoFA estimated that in 2013 the average tomato yield was 7.5 mt/ha. This is only 50 percent of what they deemed an "achievable yield" of 15 mt/ha. Robinson and Kolavalli (2010) found that in 2009, rainfed tomato yields in Brong Ahafo were 14 mt/ha and irrigated yields in the Upper East were 15 mt/ha. They found much lower yields (5 mt/ha) in the Greater Accra Region, both in irrigated and rainfed conditions. Ayerh (2015), in a recent survey of mainly rainfed tomato farmers in the Ashanti Region, found that yields averaged 7.0 mt/ha, with maximum yields

of 11.8 mt/ha. Ashanti tomatoes averaged a yield of 6.2 mt/ha. Yields were lower in the Upper East in irrigated conditions – 4.6 mt/ha – and much lower than estimates from Robinson and Kolavalli (2013). We found that tomato yields in Keta, Volta Region, were slightly higher, at 6.64 mt/ha. The International Water Management Institute (IWMI) estimates show yields ranging from 5.2 mt/ha in Bawku West to 6.2 mt/ha in in Talensi, and 7.9 mt/ha in in West Mamprusi, all under irrigation. However, all of these figures are lower than those from neighboring countries.

The type of seeds and varieties used by Ghanaian producers is one of the reasons for the low yields obtained. We found that most seeds were either recycled or obtained from the local market. Tomato and Scotch Bonnet seeds were largely recycled, while onion seeds were most likely to be from the local market. Carrots were the exception, as 82 percent of the seeds used were from private input dealers. Most tomato, onion, and Scotch Bonnet pepper farmers could not name the variety they planted, unlike the carrot farmers who knew. Vegetables are usually cultivated in plots of less than one ha. Vegetables production is generally irrigated in the Upper East, Northern, and Volta regions. The use of irrigation did not increase yields. Nearly all vegetable farmers surveyed used fertilizer. Use of manure and mulch were much less common. Farmers used pesticides, insecticides, herbicides, and weedicides to protect their plants. Seventy-seven percent of farmers used either insecticide or pesticide. The application of herbicide or weedicide was less common.

4.3 Competitiveness (Production Cost, Marketing, Gross Margins)

Competitiveness in international markets is indicated by the cost of production relative to alternative supplies, either imports or exports. The IFPRI study used three indicators: per unit cost of production at the farm level; per unit cost of vegetables delivered to markets in which they compete with imports, and gross margins per hectare to assessed competitiveness of the Ghanaian vegetable sector.

Ghanaian vegetable farmers produce at relatively low costs, less than 1,000 GHC/mt. The study found per mt costs varied by production system. Further, some value chains faced higher costs than others, particularly those in Kassena and Keta. Two broad patterns emerge from the per mt cost of production data. First, in some cases, input use intensification did not increase yields, which resulted in high per mt costs. In Kassena, Scotch Bonnet farmers had high input costs 640 GHC/mt, because of very high pesticide use. Since this high pesticide use did not increase yields, per mt costs were high. Further, these farmers reported that pests consumed on average 18 percent of their Scotch Bonnet fields.

Except for irrigated carrots grown in Mampong, more than 50 percent of the vegetables are sold at the farmgate. Farmgate sales are higher than 80 percent for Scotch Bonnets produced in Kassena and tomatoes produced in Upper East. Producers sell to an average of little more than one buyer.

The buyers at the farmgate are of two kinds: local market buyers who may retail and sell to retailers in nearby markets; and traders or agents of traders who transport the produce to major markets. The type of buyer gives an indication of where the vegetables will be retailed. Ashanti rainfed farmers, for example, most often sell to traders, whereas Upper East irrigated tomato farmers mainly sell to local market buyers. Onion and carrot farmers usually sell to traders. Scotch

Bonnet farmers in Kassena mainly sold their crops to local buyers whereas Tolon pepper farmers sold their crops to traders.

Tomatoes, during peak harvest season in September, farmgate prices are at their lowest. Farmgate prices are highest during April, May, and June when there is limited local production. Wholesale and retail margins are also highest during this period. Wholesale margins are also high from November through January when production is concentrated in the Upper East. Onion farmgate prices are at their lowest in April and May, which is not during the peak harvest season in Ghana, but instead when prices are lowest in Niger. Finally, fresh chili farmgate prices fall dramatically from June to December. During this period, wholesale margins increased from only 12 percent of wholesale prices from January through May to 52 percent of wholesale prices.

Contrary to the expectation that sales at farmgate are likely to yield lower prices than at nearby markets, tomato prices were nearly GHC80 greater on average per crate if the sale was made at the farm as opposed to off the farm. Likewise, onion prices were GHC40 greater per maxi bag if the sale was made at the farm. Scotch Bonnet farmers in Kassena received GHC50 more per maxi bag for an on farm sale. In Tolon, however, there was no statically significant difference between prices for on farm and off farm sales, but this appears to be due to lack of buyers in Tolon.

Table 2. Source: SRID MSU, 2016

	Chili	Onion	Tomato
Farmgate price (GHC/kg)	7.2	3.0	4.0
Wholesale price (GHC/kg)	8.9	3.6	5.5
Wholesale margin (GHC/kg)	1.6	0.6	1.6
Percent of Wholesale price	18%	18%	29%
Retail (GHC/kg)	10.1	4.8	6.6
Retail margin (GHC/kg)	1.3	1.2	1.0
Proportion of retail price	12%	25%	16%

Table 3. *On-farm and Off-farm Sale Prices*

Source: Author's calculations based on the Producer Survey, 2017:
Note units are: crates for tomato, maxi-bags for onion and pepper

District/Production Systems	On-farm	Off-farm
Ashanti Rainfed	227	124
Keta Irrigated Tomato	226	142
Upper East Irrigated Tomato	139	115
Bawku Irrigated Onion	145	106
Kassena Irrigated Scotch Bonnet Pepper	207	166
Tolon Irrigated Scotch Bonnet Pepper	30	39

Most farmers who transported their crops to the buyer used buses. Traders who wish to transport products to major markets buy directly from producers rather than from local markets. Aggregation does not seem to take place in smaller markets for movement to larger markets. Many traders obtain their requirements from producers through contract farming with supply of credit to various degrees. Most vegetable farmers in Ghana only sell to one buyer, which decreases their marketing power. With access to few buyers, and no storage, vegetable farmers are forced to sell their crops at the price set by the wholesaler.

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

In the producer survey, farmers were asked to list any problems that they faced during vegetable production. The biggest issue identified by farmers was pests

and diseases – 68 percent. Farmers also had issues accessing credit, inputs and water for watering – 46 percent, 43 percent and 42 percent respectively.

4.4. Conclusion

Ghana depends on imports to meet total consumption requirements of essential horticultural foods such as onions, tomatoes, Scotch Bonnets and carrots because domestic production does not meet demand despite growth in recent years. Quantifying the trade in vegetables is difficult because the bulk of it takes place informally across borders. However, discussions with traders in major markets suggest that imports are significant. Seasonality is one reason that vegetable production cannot meet local demand. Although several production systems under the diverse agro-ecological conditions in Ghana can supply vegetables year-round, vegetables such as onions are produced in significant quantities in just one season. Low-yields are another important reason for limited supply response. One of the reasons for low-yields is the varieties used.

Despite low yields, average gross margins that do not take into consideration value of household labor for the selected vegetables are much higher than can be obtained from the cultivation of crops like maize and rice. Though the margins are good, the vegetable sector in Ghana is regarded not competitive in their production because they simply do not produce enough despite the importance of these vegetables in local Ghanaian diet, and the potential for crop diversification.

5. Access to Finance

There is a need for more sustainable financing structure for the fruit and vegetable sector shifting from less aid towards more of trade and an increased focus towards loans obtained from commercial or development banks. To support this shift in the financing structure, the Access to Finance component was designed to serve as a platform by which horticultural companies and commercial and development banks are linked. There are four types of finance that are being explored, greenhouse, exporter-outgrower, solar irrigation and input packages financial products. These products have been developed in close collaboration with companies that (largely) are the agent or distributor for the products.

Additionally, HortiFresh seeks to support individual horticultural companies in the entire value chain with the development of sound business plans and financial linkages to obtain loans and equity through a network of private equity funds and loan providers, individual company support.

5.1 Greenhouse Financing

Over the past years many investments have been done in greenhouse production in Ghana. Both the government and development projects promoted the introduction of small-sized (135–270 m²) tunnel structures with the objective of modernizing Ghana's agriculture, creating jobs for young people and producing quality and healthy vegetables. The most important two of these structures it is difficult to make them profitable (Herms et al., 2016), due to high upfront investments (e.g. in a borehole and generator). The report also undertook three scenario analyses; (1) increasing potential yields, (2) increasing the size of the greenhouse and (3) cutting on costs like borehole and office (assuming the investor already has these in place). The result of the analysis clearly showed that only by increasing the size of the greenhouse the

production can be made profitable. A minimum size of 1,000 m² as recommended.

In addition, earlier work (Elings et al., 2015) indicated that there are serious flaws with the design of the existing greenhouses. Given the high temperatures and humidity in the Southern production belt, the report strongly recommends natural ventilation through top vents so that hot air can leave the greenhouse. Secondly, the report recommends more attention for the professional skills of the greenhouse growers seriously looking at well-adapted varieties (heat and disease resistance) and judicious pest and disease management (i.a. through biological control).

In the new programme, HortiFresh has taken these three recommendations on board: (1) promote bigger-sized greenhouses; (2) encourage better designed greenhouses with top ventilation; and (3) invest in the capacity of greenhouse farmers. This was combined with the need for sustainable financing of the greenhouses; ensuring investor farmers or SMEs can afford the more professional structures. As such a financial product on greenhouse financing has commenced in HortiFresh.

The purpose of the greenhouse financing project is to: (a) establish a proof of concept that commercial greenhouse horticulture is feasible in terms of profitability and technical production, while ensuring the production of safe and quality vegetables; and (b) develop a strong and supportive knowledge infrastructure on greenhouse farming.

5.2 The Greenhouse

The Greenspan greenhouse design has been carefully selected from a wide range of options, looking at criteria like the design, value-for-money and durability. The selected Greenspan 960 modular multispan greenhouse offers top ventilation in two direction (through an umbrella vent) and has a high gutter



Greenspan greenhouse with umbrella vent (9,6 m bay width)

height of 5 meter, allowing for hot air to rise up and to leave the structure. The side netting has a relatively coarse mesh size allowing for sufficient ventilation into the greenhouse, and the structure can handle crop loads of 25 kg/m², which is sufficient for crops like tomato, bell pepper and cucumber. The greenhouse can be built in modules of 1,690 m² and comes with a separate nursery building for transplant raising. In the first prototype project with Fruitmaster three multispan structures and a nursery house are erected, totaling 5,070 m² of greenhouse area. Including the costs for construction, pumphouse, fertigation facilities, generator, propagation materials (tables and seed trays) and all production equipment (ground cover, medium, troughs) the greenhouse arrives at a price of less than US\$ 30 per m².

5.3 Financing

The greenhouse pilot project is financed by a loan of the Rabobank Foundation that covers 80% of the investment. It is estimated in the business plan that, while taking into account annual loan repayments in year 2, 3 and 4, a net profit of US\$ 40,000 can be achieved in year 2, growing to US\$ 130,000 in year 4. The business plan assumes commercial vegetable production of tomato, bell pepper and cucumber with two seasons per year and a conservative benchmark productivity of 15 kg/m² for tomato. The overall internal rate of return (IRR) for a 7-year project is 63% with a loan payback period of 2.4 year.

5.4 Technical support and Upscaling

The first demonstration project with Fruitmaster started late 2018. The project is being supported by HortiFresh through technical support, bringing in an international greenhouse expert (on consultancy basis) and financial support for the very experienced farm manager. To this end, a Technical Assistance Agreement was signed between Rabobank Foundation, HortiFresh and the Fruitmaster.

Dependent on the proof of concept, anticipated for the end of 2019, HortiFresh is looking for companies to upscale its greenhouse activities. Already a number of financial institutions have been identified that are interested to invest in sustainable greenhouse projects



Signing ceremony of TA Agreement between Rabobank, Fruitmaster and HortiFresh

(either through debt financing or equity). Interested companies can approach HortiFresh for more information.

5.5 Exporter-Outgrower Financial Product

Commercial farmers operating large scale farms currently exist with some focusing on the Asian export market producing and supplying Asian vegetables such as: chillies, turia, marrow, ravaya, tinda and okra. The fruits and vegetable export market has a positive outlook given low airfreight costs from Ghana, the good quality of produce and the large market in the UK and EU region. Interestingly, Ghanaian exporters are unable to meet the current demand due to investment and working capital constraints. The huge unmet demand in the UK and EU serves as a financing opportunity for financial institutions involved in agriculture lending in Ghana.

Operational Models – What Really Works?

In Ghana's horticultural export sector, two operational models are adopted by exporters. The first is an integrated system where exporters have their own nucleus farm and also work with a dedicated outgrower base (exporter-outgrower) while exporters adopting the second operational model only maintain a dedicated outgrower base and basically operate as traders. The latter model is usually adopted by relatively small exporting companies that dominate the sector in terms of numbers. In terms of volume however, the players that utilise the first model are the largest. Even for this category of exporters, the focus on nucleus farm cultivation has been limited, with most of them cultivating around 10 acres of land.

Analyses carried out by the HortiFresh Team showed that the exporter-outgrower model is more financially viable with shorter payback periods and higher IRRs. For example, for a financing need of about US\$74,000 for capital investments on an exporter's nucleus farm as well as an input support package system for the expansion of an outgrower base alongside training through a team of dedicated agronomists, the project had a payback period of 2.9 years and a 7-year IRR of 57%. For the project, 60 outgrowers cultivate 1.5 acres

on average in the rainy season while 25 outgrowers cultivate 1 acre in the dry season with irrigation. The exporter's nucleus farm cultivates another 20 acres in both the rainy and dry season as financing covers irrigation equipment. The focus crops for the exporter-outgrower model are Asian vegetables, specifically Legon 18 chilli, birds-eye chilli, okra, ravaya and turia.

Funding for the project came from a bank in the form of a loan. The bank especially financed the capital expenditures and the outgrower scheme expenses. The company itself contributed to the working capital expenditures. The outgrower scheme expenses covered the pre-financing of the quality seed as well as Ghana Green Label training for outgrowers. In a tripartite agreement between the bank, the company and HortiFresh the additional support has been laid out. As such, HortiFresh co-finances the agronomy support and outgrower training and certification. Table 4 on next page summarizes the loan details, the use of funds and the results of the analysis.

Based on the results and interactions with horticultural export companies, HortiFresh has designed the exporter-outgrower financial product, a tailored financial product that aims to improve access to finance for export companies and smallholder farmers in a sustainable manner. The approach is a combination of financing of investment capital for the exporter and value chain financing for the outgrower. The financing typically is brokered through a partner financial institution of HortiFresh with HortiFresh providing support for project implementation and technical assistance. This model aims to ensure that the exporter accessing the funding has sufficient capacity to manage the project; and whereas the outgrowers have access to the right quality and volume of inputs, including fertilizers, pesticides and seeds. The model puts the responsibility for the payment of the loan with the exporter, making the loan management easy to handle for the financier.

Conclusion

In 2019 and 2020, HortiFresh is looking to upscale its exporter-outgrower financial product to benefit a lot more companies in the horticultural space. To this end, it is partnering with financial institutions both in Ghana

Table 4. Project details and results of analysis

Project details		Exporter-Outgrower				
Loan details						
Amount	\$	74,000				
Interest rate	%	12				
Repayment period	years	4				
Moratorium on Principal Repayment	year	1				
Use of funds						
Capital expenditure	\$	55,000				
Outgrower-scheme	\$	19,000				
Results		Year 1	Year 2	Year 3	Year 4	Year 5
Production volume	tons	-	356	407	457	508
Turnover	\$	-	361,347	412,968	464,589	516,210
Profit after tax	\$	(67,033)	52,881	60,315	78,397	94,343
Payback period	years	2.9				
7-Year IRR	%	57				

and outside to provide various financing solutions. Interested companies seeking to move to their next level of growth can contact the HortiFresh team for further information.

5.6 Individual Company Support

Financing is one of the key constraints for the growth of the horticulture sector. From the side of the companies, interest rates are seen as too high, lending conditions are too complex and most financial institutions focus on short-term loans (for working capital). From the side of the banks, horticulture financing is seen as risky; companies have limited track-record and projects are often too small. In order to accommodate both parties' concerns, HortiFresh brokers financial agreements between professionally run horticulture companies and financial institutions (both debt financing and equity).

HortiFresh has developed a portfolio with business cases of well-respected horticulture companies with clear plans for expansion and/or innovation. Business cases range from fruit processing to farm expansions; and from irrigation projects to retail innovations. For these companies detailed business cases and financial

projections are made looking at the technical capacity of the company, its track record and financing needs.

From the financing side, HortiFresh has established a strong network of financial institutions that are interested in investing in sound horticultural projects. The financial institutions range from commercial banks, development banks to equity investors, with diverse terms and conditions. Typically they are looking for companies with at least two years track record and a minimum project size of US\$ 100,000. At the same time, HortiFresh is exploring a 'Horticulture Fund' for smaller sized projects, together with another development initiative, for which projects can apply with a financing need in the range of US\$ 20,000–100,000.

Interested companies can approach HortiFresh for more information. When applying, be prepared to provide the following information:

- Financial statements for the last three years
- Summary of project plans and envisaged budget needs
- Company registration certificate

Contact details: info@hortifresh.org (subject: Access to Finance)

6. Roadmap for Pest Reduction in Fruit and Vegetable Exports in Ghana

There is also a huge market for fruits and vegetables both locally and internationally and constitute a good source of foreign exchange for the nation if measures are put in place to produce quality and safe fruits and vegetables that will meet the expectations and demand of consumers. Despite their importance, fruits and vegetables production are faced with several challenges, most importantly the attack by insect pests in the field which have over the years resulted in reduced yields and quality, thus, the inability of farmers and exporters to meet the strict phytosanitary regulations in international trade and export (GhanaVeg Sector Reports 2017). For example, Ghana was placed under a ban by the Food and Veterinary Office (FVO) of the European Commission (EC) for some vegetables, mainly *Capsicum* sp. (pepper), *Solanum* spp. (eggplant and aubergine, other than tomato and potato) and the Gourds (*Luffa*, Bitter and Bottle gourds) until December 2016, which was further extended to December 2017. The ban was a result of several interceptions due to the presence of harmful organisms, mainly insects. Key among them were thrips, false codling moths, whiteflies and fruit flies in exported produce. The ban was lifted after its expiration on 31st December 2017 due to the handwork and coordinated efforts from Ghana's NPPO (i.e. PPRSD), other players of the Ministerial Taskforce for Export with the support of GhanaVeg (now HortiFresh), CABI, GIZ and USAID. A major contributor to the lifting of the ban was also the development of the roadmap for pest reduction which was sponsored by GhanaVeg and was adopted by PPRSD as the protocols for managing the key pests of quarantine importance in vegetables exported from Ghana to the EU.

The current article will offer updated information on how to sustainably manage these pests of quarantine importance in some commonly exported fruits and

vegetables, so as to boost their export to the EU and other international markets.

6.1 Crop/Pest-Specific Management Interventions

The target vegetables which are normally exported and intercepted for quarantine pests include gourds (ridged, bottle and bitter gourds), tinda, chillies (long chillies and bed eye chillies), eggplant (African eggplant and aubergines), Turkey berries and leafy vegetables. Similarly the fruits that are normally intercepted with pests at the exit point at KIA include; mangoes, pineapples, pawpaw, and white star apple (*Chrysophyllum albidum* or 'alasa').

The roadmap for pest reduction was developed from a participatory field research study with farmers and exporters, and the outcome was compiled into an Integrated Pest Management (IPM) strategy consisting of a three step approach, made up of pest prevention techniques (prevent), monitoring for timely decision-making (monitor) and what to do (act) to control the pest. In international trade, the acceptance levels for quarantine pests is zero i.e. zero tolerance. Therefore, these pest management measures must be strictly enforced to ensure the produce is completely free from pests.

Pests of cucurbits and their management

The cucurbits include the gourds, ridged gourd or turia (*Luffa acutangula*), bottle gourd or marrow (*Lagenaria siceraria*), Bitter gourd or Karela (*Momordica charantia*) and Tinda or Apple gourd (*Praecitrullus fistulosus*). The major pests that attack the cucurbits include fruit flies and thrips. The most important fruit fly species are the Melon fly, *Zeugodacus (Bactrocera)* cucurbitae and the *Bactrocera* spp. (*B. dorsalis*). The important species of



Turia (*Luffa acutangula*)



Bitter Gourd (*Momordica charantia*)



Tinda (*Praecitrullus fistulosus*)

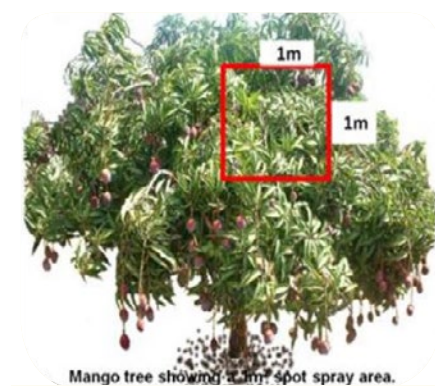
thrips commonly reported to be intercepted on the cucurbits, especially Turia in the UK, is *Thrips palmi*.

Management of fruit flies on vegetables

- Preventive measures:** Orchard or field sanitation: Keep farm free of weeds, collect all fallen fruits and tie them in thick black polythene bags and expose bags to the sun (10–14 days). Alternatively, bury fallen and infested fruits beyond a depth of 30 cm.
- Monitor:** Look for fruit fly damage symptoms on fruit, e.g. oviposition punctures, rot, exit holes. Cut fruits to observe the presence or absence of larvae (maggots). Trap target fruit fly species using the appropriate attractants or lures at the four corners of the field. Rotate different lures and trap positions weekly. Use Methyl eugenol (ME) for *Bactrocera* spp. (e.g. *B. dorsalis*) and CueLure for *Z. cucurbitae* and *Dacus bivittatus*. Use of protein food bait to attract fruit flies within the crop field also takes attention of flies from the fruits. A few traps will be enough for monitoring for timely decision-making to control the pests.
- Act:** Fruit flies can be successfully managed by using a combination of protein food bait, e.g. Great Fruit Fly Bait (GFFB) and SUCCESS® Appat (GF-120) and more of the lure-baited traps for mass trapping and population suppression. The food bait can be applied in traps (as trap lures) or as spot sprays on portions of the foliage, making sure fruits are avoided during spotting. The protein food bait when applied effectively will kill both sexes and all the stages of the different species of fruit flies, thereby serving as a key management intervention.

However, food baits must be placed within the crop field as short range attractants and must be replenished weekly, as they always need to stay fresh and attractive. The lures are long-range attractants and could have activity periods of 1–2 months, and must be placed along the borders of the field. Yellow sticky traps with lures can also be used to mass trap fruit flies in the vicinity of the crop as this was found to be very effective during our field trials with the farmers and exporters.

- Use of bio-rational insecticides:** Use neem seed extract @ 50 g/L of water, neem oil at 30–60 ml/15L of water. An alternative is Maltodextrin, which is applied at 150 ml/15 of water. These two products will interfere with egg laying by the fruit fly on the fruit surface as fruit becomes smooth and unattractive for egg laying.



Mango tree showing 1m² spot spray area.

Selective and restricted use of protein Food bait on a mango tree

Note that the conventional insecticides may not be effective in controlling fruit flies in the field. The above tactics of food baits and lures can be used to control fruit flies on different crops. On chillies, the target fruit fly species are *Ceratitis* spp. (*C. capitata* and *C. cosyra*). The lures Trimedlure (TML) and Terpinyl Acetate (TA) are needed to control them on chillies, respectively. On eggplant the most important species are *Zeugodacus cucurbitae* and *Bactrocera* spp. and thus, CueLure and Methyl Eugenol (ME) are needed, respectively.

Management of thrips on vegetables

The most commonly reported thrips species intercepted on cucurbits and eggplants at the EU is *Thrips palmi*. The preventive measures for thrips include keeping the crop field clean from weeds and destroying leftover crop residues after harvesting, which serve as harbouring places for the insects. Monitor for thrips in flower buds, flowers, young leaves and their damage scars on fruits (e.g. damage scars on eggplant fruit). Beware of high proportion of flower abortion, and open them to check for presence of thrips with the aid of a magnifying hand lens or head visor. Trap thrips with blue sticky traps (with or without lure) to monitor their population at the early stages of crop growth. Act by using EPA approved binary synthetic insecticides such as Acetamiprid + Indoxacarb; Lambda cyhalothrin + Acetamiprid; Dimethoate + Cypermethrin; Imidacproprid + Emamectin benzoate; Emamectin benzoate + Acetamiprid, etc. These synthetic insecticides could be used from the seedling stage up to flowering. During the flowering and fruiting stages, use Neem seed extract, Neem oil, Maltodextrin, *Beauveria bassiana* + *Metarhizium anisopliae* and pyrethrins to control thrips. Removal of dried/fresh floral parts from fruits such as *Turia* and Eggplant and washing them in mineral oil solution will ensure thrips are detached from fruits. Exporters need to monitor fruits sorted and processed at the packhouse are devoid of thrips by using head visors which will magnify the thrips to be seen easily, as most of them are very tiny when observed with the naked eyes.

Pests of eggplant

The quarantine pests normally intercepted on eggplant are the Eggplant fruit and shoot borer (EFSB), *Leucinodes orbonalis*, thrips, whiteflies, fruit flies and occasionally the False codling moth (FCM), *Thaumatotibia leucotreta*. The Fall Armyworm (FAW), *Spodoptera frugiperda*, is also one of the quarantine pests of concern recently added by EU, and which should also be monitored in the eggplant field. The lepidopteran borers (EFSB, FCM and FAW) could be managed as follows; Prevent by establishing your seed nursery and seedlings in a protective net or screen house, to prevent the EFSB from laying into the young shoots of the developing seedlings. Keep farm free from weeds and remove all crop residues which serve as hideouts for pests. Deep plough to bury or harrow or rake to expose larvae or pupae to harsh weather conditions (e.g. excessive sunlight) and natural enemies. Destroy infested and fallen fruits by tying them in thick black polythene bags and exposing them to the sun or by burying them about 30 cm deep. Monitor adult moth population by using species-specific pheromone traps with lure for EFSB, FCM and FAW (Fening and Billah, 2017; GhanaVeg Sector Reports 2017). One trap per hectare for monitoring each of the moths is recommended. Sample fruits, both healthy and fallen fruits and dissect for the presence of larvae or damage symptoms like emergent holes. Act by destroying egg masses. Mass trap the different moths using their species-specific lures as a population suppression tool. About 10–20 traps per hectare of field will be very useful. The pheromone traps reduce the male moth population, and thereby their inability to frequently mate with their female counterparts, leading to population suppression – the higher the number of traps, the better the outcome. The use of the following bio-rational insecticides during fruiting can also minimise infestation by these moths. For instance, Neem oil, Neem seed extract, Maltodextrin, *Bacillus thuringiensis* (Bt), *Beauveria bassiana* + *Metarhizium anisopliae*, Bt + *Peris rapae* Granulovirus (PrGV), Bt + *Monosultap*, *Creptophlebia granulovirus* (CrleGV) for FCM and Emamectin benzoate. Strictly follow the pre-harvest interval for



Well-managed Fresh chilli fruits



Green chilli fruits showing exit hole of FCM

both the synthetic and the biological pesticides to avoid the accumulation of residues in harvested produce.

Management of whiteflies and thrips

Thrips can be managed as described above under cucurbits. Prevent whitefly infestation by keeping the crop field clean from weeds as these serve as harbouring places for them. Protect seedlings with insect netting material at the nursery stage. Monitor whitefly population by regularly scouting for eggs, nymphs and adults on the young shoots and leaves, especially at the underside. Yellow sticky traps (with or without lure) could be used to monitor whitefly populations. Other control measures (use of synthetic and biological pesticides) described earlier on for thrips is also applicable to whiteflies. The immobile stages (eggs and nymphs) of whiteflies are the stages normally found on commodities (leafy vegetables) meant for export at KIA and also in the UK.

Pest of chillies

The key pests normally intercepted on chillies are the FCM, fruit flies, thrips and whiteflies. The methods described earlier on for these pests are applicable. It is recommended to set at least 15 pheromone traps per hectare for FCM in addition to other control methods, especially in areas with high pest pressure (hotspots). Look for small emergent holes of FCM larva on fruit with yellowish-brown edges. Control methods for fruit flies and whiteflies are as described earlier on. The *Ceratitis* spp. (*C. capitata* and *C. cosyra*) of fruit flies are the most important pests on chillies.

Turkey berries and leafy vegetables

The key pest of Turkey berries, *Solanum torvum*, is the EFSB. The management interventions described earlier are applicable. However, since most of the Turkey berries are harvested in the wild without any form of pest control, it is advisable that farmers begin to cultivate Turkey berries and have pest management plans. Also, proper sorting should be done in the packhouse to remove all rotten, punctured, black and soft fruits or berries that are likely to harbour the EFSB larvae. It appears the EFSB survives well and even prefers the Turkey berries to the eggplant fruit based on our observations at KIA during inspections.

The common pests normally intercepted on the leafy vegetables at KIA are the eggs and nymphs of whiteflies on the underside of leaves (e.g. Cocoyam leaves, Cassava leaves, Sweetpotato leaves, Corchorus, Amaranthus, etc.). Thus, the control methods suggested earlier for whiteflies are applicable. The main species of whitefly intercepted is the Sweetpotato whitefly, *Bemisia tabaci*. However, the spiralling whitefly,



Leucinodes obonalis larva



Fresh green Turkey berries, *Solanum torvum*

Aleurodicus dispersus, which is a non-quarantine pest, is also found sometimes especially on Cocoyam leaves for export. Other pests intercepted locally on the leafy vegetables include *Spodoptera* spp. and thrips.

Mango

Mango is normally exported to the UK in the green or unripe form and also to Lebanon. The key pests normally intercepted on mango include the Mango stone weevil, *Sternochetus mangiferae*, and fruit flies, of which the most common is *Bactrocera dorsalis*. Another pest that might reduce the productivity of mango is the mango mealybug. The mango mealybug lives in association with a mould or fungus resulting in the production of sooty mould or black soot which covers the leaves and fruits of mango leading to reduced photosynthetic ability of the plant, yield reduction and reduced marketability. Even though the mealybugs are not quarantine pests, they also form large colonies on the mango fruits making them unattractive and unmarketable.

Management of fruit flies attacking mango

The control methods described earlier for fruit flies are applicable. In addition, bagging of fruits prevents fruit flies from laying eggs on the fruits, and provides physical protection from mechanical injuries (scars and scratches). Although laborious, it is cheap, safe, and gives a more reliable estimate of the projected harvest. Bagging does not only protect fruit from fruit fly damage but protect the fruit from physical damage, thus improving the aesthetic appearance of fruits. However, it is only practicable on small trees, under scale production or where cost of labour is cheap.



Freshly harvested Aubergines, *S. melongena*

Management of the mango stone weevil

Prevent infestation by employing good orchard sanitation which is an effective way to reduce adult populations. This involves the destruction of all fallen fruits, stones and fruits with seed weevil damage during, and immediately after mango harvest, and proper management of waste. Waste management includes treatment of the waste (e.g. deep burial, composting, incineration, chipping, production of bio-energy, etc.) in authorised facilities and official restriction on the movement of waste. Roguing and pruning will complement these efforts. Also ensure only healthy mangoes are transported from one location to the other to prevent the spread of weevils. This is because, although the mango stone weevil can fly, it is considered a poor flyer. Individuals often remain within the vicinity of the original mango tree on which they developed. This can be inferred from the normally aggregated distribution patterns observed in infested areas (Billah et al., in press). Therefore, *S. mangiferae* spreads over long distances mostly by transportation of infested symptomless fruits, since this weevil develops within the mango seed and thus remains most often unnoticed until adult emergence. The use of resistant mango varieties (thick fresh and hard stone) is encouraged, if available.

It is important to monitor or scout for the early detection of the presence of the stone weevils. Monitor by cutting open of mango fruits and seeds with knife to observe damage symptoms (internally infested fruits rot from the outer surface of the stone, which show holes with the cotyledons turning black and becoming a rotten mass), and the presence of larvae, pupae or

adult weevils. Although, adult weevils have been collected in various traps, their use for monitoring has not been very effective as the weevils are poor flyers. The use of plastic materials with a thin film of insect glue on the surface can also be used around the stem as a band to monitor movement and also capture weevils. Act by using chemical control targeting adult populations. The main strategy for chemical control is to attack diapausing adults by trunk applications and foliar sprays at the time of oviposition. Examples of insecticides known to be effective include Imidacloprid, Deltamethrin, Chlorpyrifos, Neem seed extract or Neem oil (Azadirachtin) and Mineral oil. Spraying of insecticides about 2–3 times at 14-day-intervals on mango trees initiated at pea size fruiting stage was also effective. Promote conservation practices that enhance the action of bio-control agents. For example, the weaver ants, *Oecophylla smaragdina* and *O. longinoda* have been effective bio-control agents of *S. mangiferae* adults in Australia and Tanzania, respectively (Peng and Christian, 2007; Abdulla et al., 2016). Use of sticky bands: In areas with a history of high infestation, applying sticky bands (with a thin layer of Tanglefoot® glue or grease) or tangle trap at the upper end of tree trunks when the trees start flowering helps reduce migration of weevils to branches for egg laying.

Physical treatments on consignments or during processing

Irradiation is the most effective method of killing or sterilising weevils within fruit. An irradiation dose of 300 Gy is approved for control of mango seed weevil in mangoes exported from Hawaii to the continental USA (US Federal Register, 2002). In South Africa, irradiation of ripe, marketable fruit protected it from damage and prevented adult emergence (Kok, 1979). Phytosanitary measures are currently applied to mango seeds, whose introduction into EU protected zones is banned unless originating from a Pest Free Area (PFA). Phytosanitary measures also apply to mango fruits from third party countries, which are subject to a plant health inspection before being permitted to enter the community.



Adult Mango seed weevils, *Sternochetus mangiferae*

Management of mealybugs on mangoes, pineapples and pawpaw

The Mango mealybug, *Rastrococcus invadens*, the Pineapple mealybug, *Dysmicoccus brevipes* and the Pawpaw mealybug, *Paracoccus marginatus*, are the key species on the above crops. The most successful control for mealybugs is through control of the ant populations that tend to the pests. Without the care of ants, the mealybugs become much more susceptible to predators and parasitoids, and the effectiveness of biological control increases. Ant bait traps and other ground traps have also been effective. Biological control is also very effective for mealybug control. The parasitoid, *Gyranusoidea tebygi* has been used successfully to control mango mealybugs in commercial mango plantations in Ghana by PPRSD. The encyrtid endoparasitoids *Acerophagus papayae*, *Anagyrus loecki* and *Pseudleptomastix mexicana* were brought to Ghana and mass reared in PPRSD insectary for mass release to control the invasive papaya mealybug. The establishment of the parasitoids in the field have been confirmed in a recent study by Glikpo (2017).

We have detected high levels of mealybugs in pineapple consignment at the airport. It is recommended that exporters do proper sorting and grading at the packhouses. Washing of pineapple in water to clean them from debris and pests is highly recommended. Other recommendations include the use of head visors, especially by the Quality Control Officers for effective detection of mealybugs in pineapple fruits, and use of high pressure air compressor to blow off (detach) mealybugs from pineapple fruits is also effective.

Mealybugs are generally difficult to control by chemical insecticides due to their thick waxy cottony sacs, and are often concealed inside damaged leaves and buds. Adult mealybugs are also more difficult to control than younger instars. The application of effective treatments at the field level, such as the use of the physically-acting insecticide, Eradicoat T GH (Maltodextrin @150 g/15 L of water) and detergent (e.g. local soap *alata samina*, 8 g/L of water) to suffocate and dehydrate the mealybugs, respectively, thereby killing them is also recommended.

Pests of passion fruits

The pests of passion fruits are mites, fruit flies (e.g. *B. dorsalis*), thrips, aphids, beetles, barnacle scales and mealybugs. Fruit flies are usually injurious to young passion fruits in areas where wild guavas and other host fruits are present. The flies tend to move into passion fruit orchards after the fruiting season of the wild hosts. Control methods are applicable as discussed earlier.

Fruit flies attacking banana

Bactrocera dorsalis and *C. capitata* are the key species of fruit flies attacking banana. Fruit bagging: Bagging consists of placing a special 'breathable' paper bags or cover over the bunch to protect the fruits against damage caused by insects and other animals. It also protects fruits from rubbing against leaves and/or protecting against drift during application of chemical products. Control methods are applicable as discussed earlier for the fruit flies.

6.2 Discussion and Conclusion

Exporters and their out-growers have to strictly follow these pest reduction protocols in the field and packhouse to ensure commodities (fruits and vegetables) for export are free from pests, especially those of quarantine importance. Key among the management interventions are the preventive

measures for pests, involving cultural control practices such as farm sanitation, removal and destruction of crop residues. There is the need to monitor, detect and establish pest levels for timely control. Monitoring could also be done by scouting plant parts such as leaves and fruits for the presence of pests or their characteristic damage symptoms. Various traps (pheromone, blue and yellow sticky traps with or without lures) can be used to monitor pest populations. There is the need to act or initiate control measures on time. The control options may include mass trapping of pests as a population suppression strategy to avoid build-up of pest populations. The use of effective and less-persistent binary insecticides (Acetamiprid + Indoxcarb; Lambda cyhalothrin + Acetamiprid; Imidacropid + Emamectin benzoate; Emamectin + Acetamiprid), and single formulation insecticides (Deltamethrin, Imidacropid, Emamectin benzoate, etc.) are recommended to manage pests during the seedling and vegetative stages of the crop. At the onset of flowering and fruiting, bio-rational pesticides (Neem, Bt, *Beauveria bassiana*, *Metarhizium anisopliae*, Pyrethrins, Maltodextrin, local soap, etc.) would be the best option to control pests to ensure food and environmental safety, promote activities of natural enemies of pests and beneficial insects like pollinators (bees) to enhance the yield of crop. Care must be taken during harvesting and transportation to maintain the quality of commodities. At the packhouse, exporters need to do sorting and grading, and final post-harvest treatment, depending on commodity, to ensure they are pest free and packaged in durable user-friendly and aerated packing materials for export. This will result in a boost in the export of these commodities to the international market without any interception of pests. With the implementation of the new EU Plant Health Regulations, which comes into effect December 14th 2019, Ghana has to position itself well by ensuring that all the requirements are met to ensure we continue to export our high quality fruits and vegetables to the EU and all international markets.

Box 1 Safe pesticide application and handling

Fruits and vegetable growers must wear Personal Protective Equipment (PPE) before the application of pesticides (for both synthetic and botanicals). The applicator must carefully read the pesticide label and strictly follow the instructions, such as the recommended rate of application, bearing in mind the pre-entry period, pre-harvest interval and frequency of application. The right applicator i.e. 15 or 16 L capacity Knapsack sprayer fitted with the cone nozzle is preferred for insecticide application on vegetables, while the motorised knapsack or mistblower is suitable for tree crops like mango, banana and passion. Use the appropriate spray equipment and calibrate it before use for the first time. Only EPA approved insecticides must be used. Always consult the most recent list of registered pesticides of MoFA Ghana, which is approved by EPA. Insecticides should be

stored separately from food stores, such as vegetables and fruits packhouses, and in well-ventilated stores meant only for that purpose. Insecticide stores must be labelled to caution people about the risk involved. Do not use chemicals with the same mode of action year after year as this could lead to the development of resistance by pests. Farmers must select novel, less-persistent and narrow-spectrum (specific) insecticides, as opposed to persistent and broad-spectrum insecticides that could pollute the environment and also impact negatively on beneficial organisms (e.g. natural enemies of pests and pollinators) and other non-target insects. Persistent insecticides may also leave high levels of residues in produce, especially if they are not properly applied. Thus, their use must be discouraged. Pesticide containers must be properly disposed of after use.



Farmer showing the pesticide product he uses on his vegetable crop

7. Pesticide Choice and Use for Vegetable Production

Jemima Djah, Herman de Putter and Irene Koomen

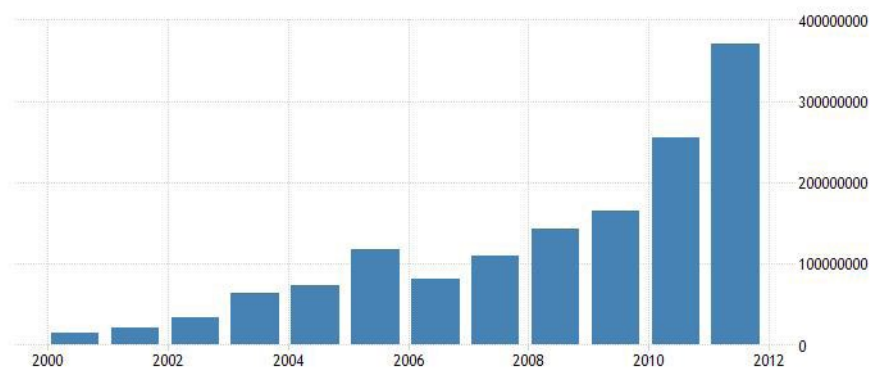
7.1 Availability of pesticides in Ghana

The Environmental Protection Agency (EPA) and the Pesticides and Fertilizer Regulatory Division of the Ministry of Food and Agriculture (MoFA) are responsible for the registration and issuance of pesticide use permits. As no pesticides are produced in Ghana itself all products and formulations are imported. FAO statistics show that the volume (in US\$) has been rapidly increasing (Figure 4), as was confirmed by Onwona et al., 2018. An average of 814 tons of pesticides was imported into the country every year between 1995 and 2000 (Fianko et al., 2011). This increased from 7763 metric tons in 2002 to 27,886 metric tons in 2006. This increase includes both the number of chemicals and quantities registered as well as recorded by the competent authorities and regulators such as the Food and Drugs Authority (FDA), EPA, Ghana Standards Authority (GSA) and the MoFA (Onwona et al., 2018). Other economic activities such as sheries and tourism [2,8,9]. In the cocoa belts of Ghana it is likely that pesticides approved for controlling.

Nonetheless, many farmers across the country do not have access to quality pesticides. Only the larger suppliers have a few branches in regions outside Accra and Kumasi. The majority of farmers obtain their pesticides from local agrochemical input dealers (Afari-Sefa et al., 2015) or extension staff (Ngowi et al., 2007). Many farmers are unable to distinguish between different pest and disease pathogens and control measures such as insecticides and fungicides and therefore rely on information and advice provided by local agro-input dealers for the decision making. Mattah et al. (2015) recommended that equipping pesticide sellers with relevant and adequate information and involving them in farmer education on pesticide use will greatly complement the work of the extension workers.

Ghana has implemented regulation on the registration, distribution and usage of pesticides in order to evaluate their environmental and human health effects (Onwona et al., 2018). However, environmental monitoring and certified laboratories for pesticide analysis are lacking. Pesticide misuse, misapplication, contamination of the environment and human exposure are problematic, and little is known to what extent

Figure 4. Ghana – Pesticides imports (current US\$). Source: FAO



pesticide registration, distribution and use is properly implemented in Ghana. A study by Ngowi et al. (2007) revealed that information from the registration authorities is not disseminated easily to the farmers and neither is information on the status of pesticides regularly published. It is expected that the registration authorities would seriously engage the services and expertise of the extension staff to disseminate information to the farmers.

Our own assessment of availability of pesticides for vegetable production revealed that for fungicides 29 different active ingredients (a.i.) with 64 products are registered by the EPA while for insecticides these numbers are respectively 49 and 205, the majority are generic pesticide that have their patent expired and as such there are multiple formulations and brands available of the same a.i. E.g. for insecticides most products are based on active ingredients from Mode of Action groups 1A, 1B, 3A and 4. When we assessed the stock available at agrodealers this consisted mainly of the insecticides belonging to the pyrethroids (group 3A), neonicotinoids (group 4A) and emamectin benzoate (group 6) and for fungicides mainly mancozeb+metalaxyl is available. For a rationale crop protection programme farmers should be aware of using more than 1 type pesticide to avoid resistance and agrodealers should be able to offer a range of products to give farmers a better choice. Although the more novel pesticides are more costly than the old generic ones as currently sold, they are more effective and are an essential part of the resistance strategy. In the long run farmers will save money.

7.2 Current Situation and Knowledge of Pesticide use by Vegetable Farmers in Ghana

A study by Dzobo (2016) noted that farmers, of whom most can read (Mattah et al., 2015), have good knowledge of the effect of pesticides on human health and the environment, but this does not translate into good work practices. In spite of this, many of them do not read the labels and instructions on pesticides before using them. They rather depend on the

recommendation from agrodealers, extension officers, colleagues, and sometimes their own intuition on how to apply the pesticides. This might be a major contributing factor to the excessive use and hence the abuse or misuse of pesticides (Afari-Sefa et al., 2015). Continuous use of the same pesticide against a particular pest can lead to the development of resistance by the pest against the pesticide, thereby rendering the pesticide ineffective. Usually, the different insecticides that are applied have the same active ingredient and similar concentrations, albeit with different trade names, a fact that is hardly understood by many farmers. In the cocoa belts of Ghana it is likely that pesticides approved for controlling pest and diseases on cocoa are used on vegetable crops, even though there is no registration for this, or vegetables are contaminated with these pesticides when intercropped with cocoa (Afari-Sefa et al., 2015).

This brings the justification of the need for a tool that assists extension staff, agrodealers and farmers to select the appropriate pesticides from a list of approved pesticides. For this purpose the Pesticide Selection Tool has been developed by the HortiFresh programme.

7.3 The Pesticide Selection Tool

The Pesticide Selection Tool (PST) is an interactive, digital tool which provides information regards the pesticides registered by EPA on their use on crop/pest combinations.

The starting points

For selecting a pesticide the following parameters are of importance:

Efficacy

The efficacy of the pesticides in the programme is based on information provided in The Pesticide Manual (18th edition) published by the British Crop Protection Council. Based on expert opinion a simple rating is applied in terms of adequate and good for the time being. Based on further developments of the programme and local information this rating could be fine-tuned.

Toxicity

Toxicity of pesticides is based on The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2009. In the tool toxicity is given for the active ingredient and not for the final product. In some cases toxicity of the final formulated product could be less than the toxicity given for the active ingredient in the tool. Toxicity of the active ingredients in the Pesticide Selection Tool is rated as can be seen in Table 5.

Table 5. Toxicity of pesticides as indicated by the WHO classification

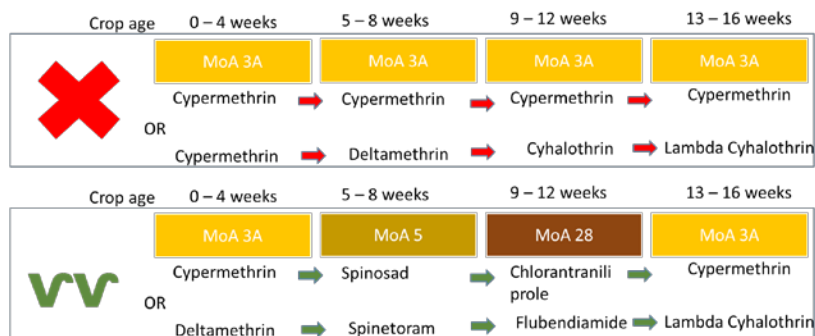
WHO Class	Description
Ia	Extremely hazardous
Ib	Highly hazardous
II	Moderately hazardous
III	Slightly hazardous
U	Unlikely to present acute hazard

Automatically the tool presents the list of active ingredients controlling a selected pest or disease in order from low to high toxicity.

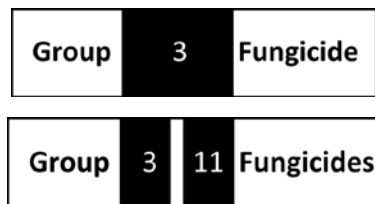
Mode of Action

Resistance of pests and diseases is a worldwide problem caused by indiscriminate use of pesticides

Figure 5. How to position pesticides based on mode of action



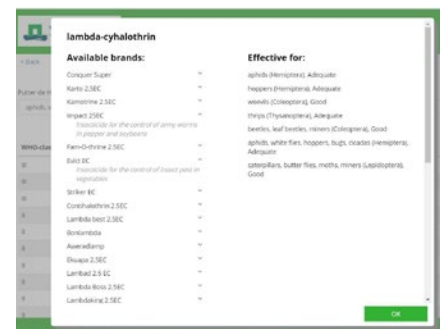
and continuous use of pesticides with the same mode of action. On pesticide packages one can easily detect the brand name and to some extent the active ingredient(s). Recently agrochemical companies start to print the mode of action group on the label like the examples below:



The mode of action codes are defined by the Fungicide Resistance Action Committee and the Insecticide Resistance Action Committee. These organisations are founded by Crop Life which is an association of the agrochemical producers. The committees provide information about the active ingredients grouped according to the mode of action.

Based on the information on Mode of Action and crop protection strategies a user has better information which pesticide based on mode of action should be used in order to prevent resistance of pests and disease. General advice is to use same type of pesticides in a period of 3 to maximal 4 weeks only and after that change to products from a completely different mode of action.

Figure 6. Pesticide Selection Tool screen on website



Each screen provides additional information and choices to be made. On screen 3 next for each active ingredient the following information is presented:

- 1st column: in order from lowest to highest WHO class toxicity classification
- 2nd column: efficacy rating of the active ingredient
- 3rd column: the active ingredient(s) of available formulated products
- 4th column: Mode of action(s) according to IRAC or FRAC

By clicking on the brand name additional information on pests and crops the products is registered for will show up.

Intended users

In the first place the tool is developed for extension officers, agrodealers and key farmers. Without proper knowledge about the toxicity and mode of action a user will not be able to select the proper pesticide. The user should also have good knowledge about strategies to prevent resistance.

Since the tool presents current available and registered products the tool will be maintained by the EPA who have access to the latest information of newly registered or banned products to keep the information to the users up to date. Proposed is to improve the tool in 2019, to start a pilot with intended users (extension) in 2020 and after making adjustments based on their feedbacks hand over the tool in 2021.

Conclusion

The Pesticide Selection Tool is only an aid to allow advisors, agrodealers and farmers to make an informed choice which pesticide to use and on which crop. However, unless the range of pesticides, and particularly those pesticides with low-toxicity and biologicals is increased and made available through agrodealers, farmers will continue to use the same range of pesticides as they do now. This will lead to resistance, issues with maximum residue levels (MRLs) and unnecessary exposure of both farmers and the environment while alternatives can be made available.

More information of pesticide resistance and how to prevent can be found on the websites of the Fungicide Resistance Action Committee (FRAC) and the Insecticide Resistance Action Committee (IRAC).

Registered product

After an active ingredient is selected a user needs to know which product he can buy. Based on the most recent list of registered pesticides by the EPA all registered brand names are listed in the Pesticide Selection Tool. Once the user has selected the active ingredient he wants to use a list of all brand names will pop up.

The tool

Currently the Pesticide Selection Tool is a web based version but can be used on a smart phone as well since it will resize automatically when opening it with a web browser on the smart phone.

The user will be asked to:

1. Make a choice between pest or disease (screen 1)
2. Select a specific pest or specific disease to be controlled (screen 2)
3. In the next screen a list of all Active ingredients effective to control the selected pest or disease will appear (screen 3). Here the desired active ingredient can be selected
4. After selecting the desired active ingredient a complete list of all registered Brand names containing this active ingredient will appear (screen 4)

8. Onion Variety Trial Results

8.1 Introduction

Onion (*Allium cepa* L.), is one of the major vegetables grown in West Africa (Norman 1992). In Ghana, it is grown on large scale in the Northern and Upper Region of Ghana especially in Bawku and Bolgatanga (Norman 1992). The common varieties grown are 'Bawku Red' (a local variety), 'Early Texas Grano' and 'Red Creole' (Abbey et al., 2000). Demand for onion in Ghana is higher than production to the extent that there is presently substantial importation of onion from neighbouring countries such as Mali and Niger. The low supply may be attributed to low yields, seasonal and small scale production. On average, 34,387 MT of onion is imported annually into the country (FAO, 2013). In order to reduce the high levels of importation, farmers have to increase the scale of onion production in the country. This may be achieved through the introduction of high yielding hybrid varieties and improved agronomic practices.

The objectives of this study were to:

- i) Evaluate the growth and yield of six hybrid onion varieties and two local controls in three zones of Ghana;
- ii) Evaluate the performance of the onion varieties in storage.

8.2 Methodology

Experimental Sites

The trials were conducted in three locations: Yemu in the Northern Savanna agro-ecological zone, Legon (Accra) in the middle zone and Tegbi (Keta) in the Coastal Savannah agroecological zone of Ghana. At Yemu two trials were conducted between September 2016 and March 2017 as well as December 2017 and March 2018. The trials at Tegbi and Legon were conducted from May to October 2017.

Varieties

Six hybrid varieties and two standard open pollinated varieties (OPV) were used at all the three locations. These were BGS 329F, Dayo, Neptune, Orient F1, Prema, Sivan, Bawku Red (OPV) and Red Creole (OPV).

At Yemu, seedlings were raised in wooden trays, filled with carbonated rice husk, whilst in Legon and Tegbi, seedlings were raised on nursery beds. Pesticides (Imidacloprid 200 g/L and Mancozeb 5 g/L) were sprayed to protect the seedlings. Fertilization was done with NPK 15-15-15 dissolved in water. Five week old seedlings were transplanted at Yemu while at Legon and Tegbi, the seedlings were six weeks old at transplant.

The experimental plot size was 10 meters long and one meter wide and seedlings were spaced at 10 cm × 10 cm. The design used at all the three sites were Randomized Complete Block Design with three replications.

At Yemu, the crop was grown under drip irrigation but at Legon the crop was rainfed but supplemented with hand watering when necessary. At Tegbi the crop was rainfed but supplemented with sprinkler irrigation. At Legon, 10 kg of chicken manure was applied to each plot and worked into the soil two weeks before transplanting the seedlings. Two weeks after transplanting 471/kg NPK (15:15-15) fertilizer was applied to each bed and stirred into the soil. Fifty-six (56) days after transplanting, 200 g of potassium nitrate (KNO₃) was dissolved in water and applied to each bed. Fertilization at Yemu was a basal application of 7.5 kg Triple superphosphate followed by Yara winner (15:9:20), Yara Nitabor (15:4:0) and 25.6% calcium, at the rate of 120:70:100 per hectare.

Weeds were controlled manually at all three locations but at Yemu there was an initial application of pre-emergence herbicide, Topstar at the rate of 40 ml/16L of water. Stirring of the soil was also done in addition

to the manual weed control to improve aeration of the soil and aid percolation of water.

Storage Equipment

Wooden structures of length 90 cm, width 40 cm and height 180 cm was used at Legon. The individual compartments measured 40 × 28 cm. Five kilograms of cured and field air dried onion of each variety was weighed and number of bulbs counted and then randomly allocated to the compartments. Minimum and maximum temperature and humidity was taken for six months using a thermos-hygrometer. Results on performance of the varieties in storage are shown in Figure 7, 8 and 9 on pages 39–40. Experimental design used was Completely Randomized with three replications.

8.3 Data collection

The following data were collected during the trials and results are shown in tables and figures below.

Harvesting

At maturity, plants were harvested from an area of 2.4 m² for yield determination. Data was taken on number of plants harvested, bulb length, bulb diameter and weight of bulbs.

Farmer's Evaluation

Before harvest, farmers' evaluation of onion varieties was conducted at all three locations and graded.

Data collected was analysed using the analysis of variance (ANOVA) for randomized complete block design (RCBD) with the aid of Genstat 12th Edition software. Means which differed significantly were compared using the Fisher's Protected Least Difference (LSD) at 5% level of significance ($p=0.05$).

8.4 Results

Performance

The performance of the eight onion varieties in the nursery and the field are shown in Table 6 below.

Table 6. Percent seedling establishment of eight varieties of onion at 7 and 14 days after transplanting (DAT), number of leaves, bulb length and diameter of eight onion varieties grown at Legon

Variety	Plants at 7 days (DAT) %	Plant at 14 days (DAT)	Plant at harvest (%)	Number of leaves per plant	Bulb length (mm)	
					Legon	Tegbi
Bawku Red	95.7	93.4	63	9	38.4	48.7
Red Creole	89.6	82.6	47	9	40	43.8
BGS 729 F1	98.6	97.9	95	9	40.9	45.6
Orient	99.2	99.0	96	10	47.4	47.3
Dayo F1	99.0	97.5	89	9	44.8	49.9
Prema F1	99.5	98.3	95	10	48.2	45.1
Sivan F1	99.5	93.3	87	7	51.4	42.3
Netpune F1	96.3	95.4	95	9	58.6	55.7
LSD ($P \leq 0.05$)	3.6	5.7	17.9	1.4	5.7	6.9

Figure 8. Storage effect on percentage sprouting of eight (8) onion varieties for six months under room temperature and humidity

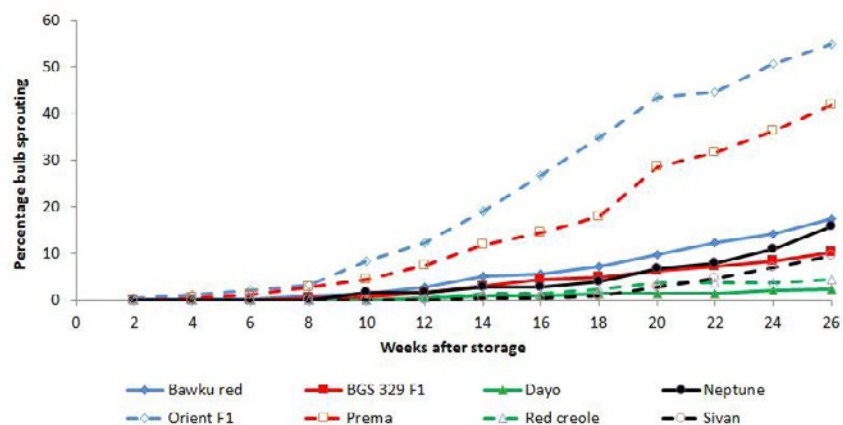
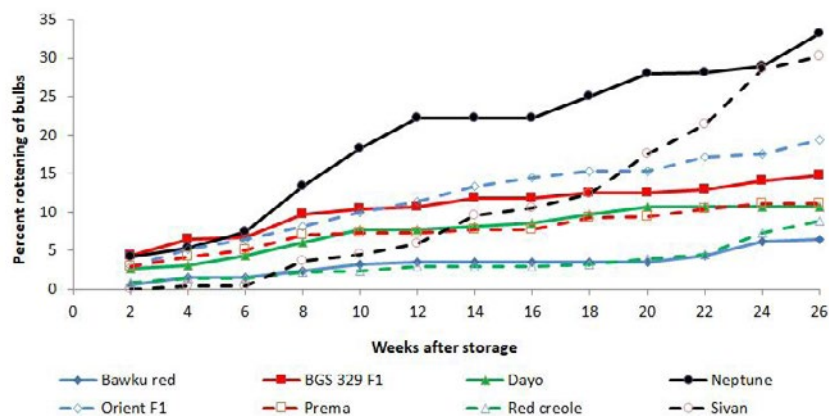


Figure 9. Storage effect on percentage rotten bulb of eight (8) onion varieties for six months under room temperature and humidity



8.5 Cost-Benefit Analysis

The cost-benefit analysis for the cultivation of eight cultivars of onion indicated a net revenue of GH¢ 5,268.50 based on 240 m² area as shown in Table 10 on the right.

8.6 Recommendations

Onion production depends largely on the raising of healthy seedlings and good establishment after the seedlings have been transplanted in the field. Viable seeds are necessary for the production of healthy seedlings. As a recommendation, seeds should be stored in a cool place preferably in a refrigerator (5–10%) to ensure that they remain viable over a reasonable period of time.

8.7 Conclusions

The potential for onion production in Ghana is quite high provided supplementary irrigation can be provided when necessary and adequate pest and disease control put in place. The six hybrid varieties produced higher yields than the local checks Bawku Red and Red Creole. However storage may be better in the local checks than most of the hybrids. This implies that some varieties cannot be stored for long period of time and should therefore be marketed immediately after curing.

Table 10. Cost-benefit analysis of eight cultivars of onion produced at Legon

Items	Cost (GH¢)
Land preparation (ploughing and harrowing)	30
Making of 24 beds	165
Cost of manure	24
Cost of seeds (eight varieties)	500
Labour for transplanting seedlings	240
Labour for stirring and picking of weeds for the period	520
Cost of insecticides and fungicides	75
Cost of harvesting bags	120
Labour for harvesting of onions.	320
Total expenditure for cultivation	1994.00
Total cost of onion at harvest	7262.50
Cost benefit (revenue from onion harvested-total expenditure for cultivation)	5268.50

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- <http://storeitcold.com/>
- http://horticulture.ucdavis.edu/main/36_postharvest_Zambia.html
- <http://www.feedthefuture.gov/>

Annex 1. HortiFresh

The mission of the HortiFresh – Commercial Fruit and Vegetable Sector Development in West Africa – programme is to establish “a sustainable and internationally competitive fruit and vegetable sector that contributes to inclusive economic growth, food and nutrition security” in Ghana and Ivory Coast.

The HortiFresh programme consists of two components: fruits and vegetables. In Ghana activities focus on both the fruit and vegetable sectors while in Ivory Coast the focus is on the fruit sector. HortiFresh support transformation of the sectors through improving productivity; facilitating more efficient markets, including linking producers and other value chain operators with the Dutch private sector; improving the business climate and further professionalizing the value chain for fruit and vegetable production and consumption in Ghana. The programme aims to reach 15,000 farmers and increase their productivity by 20% by 2021.

What does HortiFresh want to achieve?

A competitive and innovative high-value fruit and vegetable sector

HortiFresh West Africa supports the sector through activities and funds that contribute to: increasing the value of exports, both to the EU and to regional markets; improving quality and value-added in the domestic market, aiming at reducing imports. This will be achieved through business partnerships and cluster development activities focusing on innovation and scaling. Importantly, it will stimulate the banking sector to develop tailored financial products for the horticulture sector.

A conducive business climate

HortiFresh aims at improving the business climate for SMEs and international companies active in the F&V sector of West Africa. The programme particularly

focuses on the existing platforms of the Export Taskforce in Ghana and the activities of Ghana Green Label. The programme will address other regulatory issues in the area of: imports, registration of crop protection products and food safety.

Inclusive and sustainable growth of the fruit and vegetable sector

HortiFresh will create opportunities for women and youth to engage in the horticulture sector. In addition, it will contribute to food and nutrition security. The aspect of sustainability will focus mostly on increasing the long-term economic viability and the environmental impact of the activities and enhancing the resilience of the sector to various kind of shocks be it financial or climate related.

What does HortiFresh do?

Enabling Environment

HortiFresh continues its work with the Ministry of Food and Agriculture (MoFA) and other institutions and donor agencies in building the capacity and strengthening consumer confidence in the consumption of fruits and vegetables. HortiFresh aims at a close collaboration with Ghana’s lead financial institutions, including GIRSAL and EXIM Bank.

Financial support services

The programme’s backbone consists of four financing modalities. One of these modalities focus on increasing the access to (semi-)commercial financing for the horticulture sector. These are:

- *Sustainable financing for the horticulture sector*; including exporter-outgrower financing and greenhouse financing as well as assisting horticulture SMEs to access loans and equity, and provide technical and management support for project implementation.

The other four modalities have a grant component and are aimed at stimulating innovative business ideas from the sector, targeting smallholder farmers:

- *Horticulture cluster development funds*; focusing on geographical hotspots of mango, tomato and onion production, addressing joint problems of productivity and environmental sustainability.
- *Innovation funds*; focussing on specific technical and organizational innovations in the horticulture value-chains. These can range from increasing availability of (new) inputs, to establishing new market outlets and (value-added) horticulture products to agronomic support services.
- *Youth employment fund*; aiming at increasing opportunities for youth to engage in the horticulture sector, and setting up their own business.

Technical Assistance: Business Management and Agronomy

The programme provides technical assistance to fruit and vegetable companies to support the implementation of the access to finance modality and co-financing grants. With respect to business management; companies receive support in business planning and project management. For up to date knowledge on agronomy, a training programme is being organized, and individual company visits and coaching is in place.

Employment, Social Inclusion and Nutrition

An important element of the programme is to enhance employment and social inclusion in the horticulture sector. In order to facilitate this, the programme’s partners engage in increasing young men and women’s opportunities in finding jobs. The programme further aims at improving the nutritional status of workers in horticulture companies, through trainings and coaching. In addition, the programme will work on increasing the awareness of the general public about the nutritional benefits of fruits and vegetables.



HortiFresh training program

Business Platforms and Events

HortiFresh continues the biannual Business Platform meetings with active matchmaking sessions for service providers, retailers/wholesalers, producers, processors and traders in the fruit and vegetable sector. In addition, a number of Round Table meetings will be organized, focusing on emerging topics in the sector, like food safety and peri-urban horticulture. The programme will take the lead in organizing a dedicated Horticulture Trade Fair, to facilitate companies to exhibit their products and increase business-to-business trade deals.

Trade Promotion

HortiFresh will expand its network with the Dutch private sector, both for fruit and vegetables. Companies from the Netherlands include leading input supply companies (e.g. seeds and greenhouse technology), importers of fruit and vegetables, as well as service providers. The programme further invites relevant financial parties from the Netherlands that want to invest in Ghana and Ivory Coast. HortiFresh does this through the organization of Trade Missions and individual matchmaking.

Annex 2. Directory of Horti-culture Sector Actors in Ghana

Organization	Phone	Email	Location	Website	Address
AB Farms Ventures	0244798691	Abfarm2013@gmail.com	Nsawam	www.abfarmventures.com	P.O.Box.1857 Achimota-Accra
Agri-Impact Consult		dencherama@gmail.com	Accra	www.agri-impact.com	PMB 18, KANDA-ACCRA
Agritop Limited	0555603481	info@agritopgh.com	Accra	www.agritopgh.com	P.O. Box KIA 30408, Accra-Ghana
Agrodeal Ghana Limited	0557662172	agrodealgh@gmail.com	Accra	www.agrodealgh.com	
AICL Specialty Fertilizers	+31-418-655778 / 6-53339916	philippe.daubresse@everris.com	Geldermaisen Koeweistraat	www.ic-group.com www.everris.com	P.O.BOX 40-4190 CA Geldermalsen Koeweistraat 4-4181 Waardenburg. The Netherlands
Amatis Terminal	+233 (0) 201489031 / 501422220/1	ropoku@amaristerminal.com	Tema - Accra	www.amaristerminal.com	Former Publishing Building Heavy Industrial Area, Tema P.O.BOX CO 4388, Comm 1 Tema - Ghana
ARB Apex Bank	+233 (0) 302772129		ACCRA	www.arbapexbank.com	No.5 9th Road Gamel Avenue south Ridge, Accra- Ghana
Ardhi Investment Group	0559484779	Akofa.ata@ardhiinvestm.com	Accra	www.ardhiinvestm.com	11 Salamander Close, Community 18, Lashibi
Ascend Quality Services	+233 (0) 553030053 / 207386033	Sam.lefoneh@aqsgghana.com	Accra	www.aqsgghana.com	P.O.BOX LG 1108 UNIVERSITY POST OFFICE LEGON - ACCRA
ATC Farms	+233 (0) 244971439	cametefe@yahoo.com	Sogakope	-	P.O. Box 167, Sogakope, Ghana
Beausants Farms	+233 (0) 208111814	beausants5@yahoo.co.uk	Accra	-	P.O.Box AN6769, Accra- Ghana
BOMARTS	+233 (0) 244467928 / 208122924	aboutthway@bomarts.com	Dobro – off Nsumia Road	www.bomarts.com	P.O.BOX 124, Nsawam ER,
Bio Tropical products Company Limited	0244 514 824	marian@biotropicalghana.com	Accra	www.biotropicalghana.com	P.O. Box KIA 9732, Kotoka International Airport
Chilli Central	+233 (0) 246996905	tdannyame@gmail.com	Kwabinya	-	P.O.Box WV 2442, Kwabinya, Accra
Chriss Organic Farms	0244762300 / 0272698096	chrissplandge@yahoo.com	Accra		P.O. BOX ST 461
Commonwealth Agricultural Bureau International (CABI)	+233 (0) 302797202	westafrica@cabi.org	No. 6 Agostino Neto Road Airport Residential Accra	www.cabi.org	P.O. Box CT 8630 Cantonment- Accra Ghana
Crescent Farms	0244228074	Crescentfarms2013@gmail.com	Kasoa		H/No OB 136/16, Kasoa Bawjiase Rd, C/R
Crop Research Institute	+233 (0) 322060396 / 322062522	Csir.cridirector@gmail.com	Fumesua -Kumasi	www.croprosearch.org	P.O. Box 3785, Fumesua – Kumasi, Ghana
CSIR-OPRI	+233 (0) 3420610258 / 244707370	wildans@yahoo.com	Kade		P.O.BOX 74 Kade E/R
Dawa Foods ltd	0208217731	Folasade.rufai@vodafone.com			P.O. BOX CN10761, CANTONMENTS
Directorate of Crop Services	+233 (0) 302665066		Accra	www.mofa.gov.gh	P.O. Box MBA 37, Accra
Ministry of Food and Agriculture (MoFA)					
Dizengoff Ghana Ltd	+233 (0)302221831 / 302227601	enquiries@dwag.com/info@dwag.com	Circle	www.dizengoffgh.com	P.O.Box 3403, Accra
E-Darkey and Associate	+ 233 (0) 302780924	edarkey@yahoo.com	Accra	-	P.O. Box 7155, Accra, Ghana
Ebenliz Farms	+233 (0) 244806263 / 302660842	-	Tema	-	P.O. Box 11595 CE II, Tema

Organization	Phone	Email	Location	Website	Address
ECLIPSE MICROFINANCE LTD	+233 (0) 261278292 / 501394401 / 303930150	Info.eclipsemfi.com / k.amegah@eclipsemfi.com	Adenta - Newsite	www.eclipsemfi.com	P.O.BOX An 11175 Accra – North H/No. Block G/335 – Okatabanman
Eden Tree	+233 (0)302812266 / 302815625	edentreegh@gmail.com	Accra	www.edentreetld.com	P.O. Box 165, Legon-Accra
EKKLESIA FARMS LTD	+233 (0) 246688486 / 203797498	Samuelanabai4@yahoo.com / ekklesiafarms@gmail.com	Tabora - Accra	-	P.O.BOX 233, Abeka Lapaz office location. Nii Okaiman Main Road H/No 221 Taborah
Eltrut Enterprise	233 (0) 542692079	info@eltrut.com	Aburi	-	P.O.Box CT 5084, Cantonments, Accra-Ghana
ENZIMITIANU VIRGIN COCONUT OIL	+233 (0) 243058283 / 202660433	-	Enzimitianu	-	PRODUCERS ASSOCIATION ENZIMITIANU WESTERN REGION
Esoko	+233 (0) 302211611 / 2464658527	castro@esoko.com	Accra	www.esoko.com	42 Ring Road Central, Accra - Ghana
Farmklass Company Limited	0241528764	farmklass19@gmail.com	Accra	-	P.O Box KN 2358 Kaneshie
F. Odoro Koranteng Limited	+233 (0) 244639215	Francis_koranteng@yahoo.com	Accra	-	P.O.Box 10878, Accra-North, Ghana.
Food and Drugs Authority	+233 (0) 302233200 / 235100	fdia@fdaghana.gov.gh	Accra	www.fdaghana.gov.gh	P. O. Box CT 2783 Cantonments – Accra Ghana
Foodserve Consulting	0244926735, 0266497408	harry@foodservegh.org	Accra	www.foodservegh.org	P. O. BOX GP 3856, ACCRA

Organization	Phone	Email	Location	Website	Address
FTF COMPANY LTD	+233 (0) 244205071 / 208000008	Kwa_adjie@yahoo.com, ffrighana@gmail.com	Accra	-	H No. 6 central Link Road, Okpoi Gonno Near Spintex Road, Ghana
Ghana Institute of Entrepreneurship Development (GIED)	0206621106	kwawstephen@gmail.com	Adenta- Accra	-	P.O. Box 10849 Accra North
Ghana Angel Investment Network (GAIN)	+233 (0) 303935097	info@gain.com.gh	Ministries Accra	www.gain.com.gh	12th Floor Premier Towers, Ministries Accra
Ghana Association of Vegetable Exporters	+233 (0)303 965689 / (0) 248 121512	gavexghana@gmail.com	2nd Floor, Old Revenue House, Mile 7 Achimota	-	2nd Floor, Old Revenue House, Mile 7 Achimota
Ghana Export Promotion Authority (GEPA)	+233 (0) 302673153, +233 (0) 302675234	gepa@gepaghana.org	Opposite cedi house Ambassadorial Enclave	www.gepaghana.org	P.O. Box M146 Accra
Greencesta Ventures and Consultancy Limited	0546202405	onofori@greencesta.com / oforiobengniketiah@gmail.com	Accra	www.greencesta.com	
Green gold Organic Farm	+233 (0) 242684426	sirhatsun@yahoo.com	Koforidua	-	P.O.Box KF 2439, Koforidua Ghana
GreenEf eco-business village	+233 249667347 / 207581311	greenefebv@gmail.com	Tamale	www.greenef.com	PMB 16, Tamale, N/R, Ghana
Green Label Ghana Foundation	055 843 9499	www.ghanagreenlabel.org	Trade Fair, Accra	-	
GKV Investments Ltd	-	fknustuego@gmail.com / nunoo.kojo@avacoconutoil.com	Takoradi	www.avacoconutoil.com	71 NTWAABAN ROAD SECONDII -TAKORADI
Hendy Farms	+233 (0) 500554130	hendyfarmsgh@gmail.com	Accra	-	No. 24 Duchesville development. 2nd Circular Road Cantonments

Organization	Phone	Email	Location	Website	Address
HENSON GEODATA TECHNOLOGIES	+233 (0) 501295252/ 555191950/ 302511115	info@hensongeodata.com / bdk.henaku@hensongeodata.com	Accra	www.hensongeodata.com	P.O.BOX CT 9183, CANTONMENTS 1 Adjetej Din Avenue, Ashaley Botwe, Adenta Municipality
HMR Collections	+233 (0) 262967014 / 265258858 / 200832677	hettie@hmrcollections.com / hettiem@gmail.com	Accra	www.hmrcollections.com	East Legon
HONEY COMB	+233 (0) 268989898 / 244658871	samuel@honeycombfoods.com	Accra		Accra Ghana
HPW Fresh & Dry Ltd	+233 (0) 271934060	maik.blaser@hpwag.com	Adeiso, Bawjase Road	www.hpwfnd.com	P.O.BOX NW 740, Nsawam, E/R, Ghana
Iribov West Africa		d.invitrolabs@gmail.com	Sokakope	www.iribov.com	PO BOX 61
Irrigate	0244880902	sara.hatoum@htcghana.com	Accra	www.htcghana.com	34 Spintex Road
IWAD	+233 (0) 544313146 / 302797316	busia@iwadghana.com	Accra	www.iwadghana.com	8 Yapel link, Airport Residential Area, PMB CT 35 Cantonments
JAPSON COMPANY LTD	+233 (0) 244983038	samueladjapii@gmail.com	Takoradi	-	P.O.BOX 2104 Takoradi C.34 Sapara Grant Street, Effiakuma Newsite
JEGS Company Limited	+233(0)-243543535	info@jegscompanylimited.com	Accra	www.jegscompanylimited@gmail.com	House No. 9 Taifa Community School Street
Jodek Farms	+233 (0) 244316355	joekpeng@gmail.com	Accra	-	P.O. Box AN19083, Accra
Joe-kopan Enterprise	+233 (0) 302407407	info@joekopangh.com	Accra	www.joekopangh.com	P.O.Box 01063 Osu-Accra

Organization	Phone	Email	Location	Website	Address
Joro Farms Agriculture Processing Ltd	+233 (0) 302221947 / 244382227	josephito@yahoo.com	Accra		P.O.Box NK 306, North-Keneshie Accra-Ghana
KNOWLEDGE AND SKILL	+233 (0) 244221666	m.dohmen@knowledgeandskills.org	Accra		P.O.BOX CT 3434 Cantonments Accra Ghana
Kukobila NAsia Farms Ltd	+233 (0) 264988197 / 208114488	seidulhisham@gmail.com	Tamale		P.O.Box CT 4031 Cantonments, Accra
Lakeysde Farms	0243968479	lakeysde@farms@yahoo.com	Teshie Nungua Estate	www.lakeysde@farms.com	Box TN906
LovingHut Natural Food	0243347098	scheikes@yahoo.com	Accra		Asafoatse Doodoo street
MacroFertil Ghana Limited	0544310634	Stephen.tour@lbc.com	Accra		PMB 283, COMMUNITY 1
Meridian Seeds and Nurseries Gh Ltd	0249618162	aaron.ampofo1@gmail.com	Accra	www.meridianseedsgh.com	P.O. Box LG1094
NKASST ENTERPRISE	0244561416	nkaastcompany18@gmail.com	Somanya		P.O.BOX 293, Somanya ER, Ghana
NOVELTY COCONUT LTD	+233 (0) 268640889 / 244250653	novelycoconut@gmail.com	Accra		Lakeside Estate, behind Madina, University of science and technology, Ashaley Botwe
Param Farms	+233 (0) 244513076	paramproduce@yahoo.com	Accra		P.O.Box KIA 18118, Accra
PETERFIELDS & REY GROUP LTD	+233 (0) 244659109 / 208254030	jonathandennisabraham@yahoo.com	Ataabadze, Elmina	www.petersfield-rey.com	P.O.BOX 660, Cape Coast
PEG Ghana Solar	0244907209 / 0203005311	Julian.ayim@pegafrika.com	Accra	www.pegafrika.com	Mile 13, Adenta – Off Aburi Road
PINORA	+233 30 2680994 / 0501566196	marcio.simon@sonointernational.com	Asamankese	-	P.O.BOX 331 Asamankese

Organization	Phone	Email	Location	Website	Address
Plant Pests & Disease Control Company LTD	+233 (0) 242984157 / 205545715	asensomensahyaw@yahoo.com	Kintampo – Near New Market	-	Office location Near Adom guest house
Quin Organics	+233 (0) 302500999/ 287010438	info@quinorganics.com	Accra	www.quinorganic.com	P. O.Box TF313, Trade Fair, Accra
Quist Farms	+233 (0) 244379173	marjorieaboin@gmail.com	Accra	-	P. O.Box CT 8566 Cantonments, Accra
Rejuvenate Gaia Global Limited	0240118387 / 0262227638	beatrixakogyeram@gmail.com / r.obengfrimpong@gmail.com	Accra	https://www.facebook.com/rejuvenategaiaglobaltd/	71 Bamako Road – East Legon
Rainbow	+233 3 03317028 / 501479715	george.ocloo@rainbowchem.com	Tema	www.rainbowchem.com	Rainbow House, Hospital Road by Pass, Sixth Avenue, behind NHIS Office, Community 8, Tema, Ghana
Ribeth Hygenyk Foods	-	Alex.kodwii@ribeth.com	Accra	www.ribeth.com	
RMG Ghana ltd	0544312841	ken.addy@rmgconcept.com	Accra	www.rmgghana.com	No. 14 Narku Ipan Rd., near Nyaho Clinic, Airport Residential Area.
Ropryn Company Limited	0244041224	ropryn@gmail.com	Takoradi		P. O. Box 7593, Accra - North
Senam Foods ltd.	0244011020	senamfoods@gmail.com	Takoradi	www.senamfoods.com	P. O. Box GP 3049, Accra
SGA FARMS LTD	+233 (0) 507579504	bobby@sgafarms.com	Dansoman	www.sgafarms.com	P. O. BOX TD175, TAKORADI
Socialfarm Company Ltd	0244046334	info@socialfarmghana.com	Accra	https://www.socialfarmghana.com/	P. O. Box Tn1170, Teshie Nungua Estates, Accra
SowGreen Farms	+233 (0) 241234234	kobinahudson@gmail.com, kobis@sowgreenfarms.com	Ayim		P. O.Box AH 217, Ayim Ghana

Organization	Phone	Email	Location	Website	Address
Srighan Farms (GH) Ltd	+233 (0) 302412685	ponsaatheesh@hotmail.com	Adoagyir Nsawam	-	P. O.Box GY 117 Adoagyir Nsawam-Ghana
Sokocentre.com	0553151971	leodekukojo@yahoo.fr	Accra	www.sokocentre.com	
Start Right Nutrition Limited	0550352976	veeose@gmail.com	Accra	www.startrightfoods.net	
SyeComp Ghana Ltd	0201442191	team@syecomp.com	Accra	www.syecomp.com	3 Ankua Mansah Link, Dzorwulu, Accra
Symbol Ghana Limited	+233244362473	symbolghana@yahoo.com	Western Region	https://www.facebook.com/symbolghanaid/	P. O. Box PT32, Takoradi, Western Region, Ghana
TEPCO LTD	+233 (0) 542576540 / 200721963	wilofori@gmail.com / wilofori@tepcogh.com	Techiman	www.tepcogh.com	P. O. BOX TH 436, TECHIMAN, B/A REGION
Terra Agric Group Ltd	+233507635758	info@terraagric.com	Tema	-	Terra Agric Group Ltd
Tikola Ghana Ltd		info@tikolaltd.com	Accra		P. O.Box Ax222 Takoradi-Ghana
The Farmer's Market	0501481140	frederick.asare@thefarmersmarketgh.com	Accra	http://www.thefarmersmarketgh.com	P. O. BOX 1371
The Fruit Master	0243150250 / 0560893614	Mgariba2002@yahoo.com	Tema		Office.No.1, Lumumba Loop, Comm 3, Tema, Ghana
Tuorosong M.S Farms Company Limited	0245284091	mahamasufuyani@gmail.com	Upper East Region		Post Office Box 1, Wa East, Funsi, Upper West Region.
USAID Farmer-to-Farmer (F2F) Winrock International	+233-541656680	Mina.Lassey@winrock.org	Accra	www.winrock.org	P. O. Box YK632, East Legon, Accra- Ghana 5B Libreville Street, East Legon, Accra- Ghana

Organization	Phone	Email	Location	Website	Address
Vegpro Ghana Ltd	+233 (0) 269547415	jagdish@vegpro-group.com	Accra	www.vegpro-group.com	P.O.Box PMB MD 210 Madina, Accra, Ghana
VEPEAG	+233(0) 244382227	josephinton@yahoo.com	Accra, Ghana		P.O.Box SD 239 Accra- Ghana
Vegetarian Association of Ghana	0553556279	kbrahmah@gmail.com	Accra	www.veggghana.org	
Viamo Technologies Limited	0264370536	office.gh@viamo.io	Accra	www.viamo.io	4TH FLOOR, OKSART PLACE, RING ROAD, ACCRA
VICDAV	+233 (0) 242911605 / 240099998	vicdavmangoproducts@gmail.com	Agomeda		Agomeda Somanya road
Volta Presentation Company Limited	+233544799109	hannah.dorkenu@ashesi.edu.gh	Sogakope	www.voltapresentation.com	P.O. Box KA 9116, Accra Ghana
Welgrace Research Farm	+233 (0) 303306697	jake_fenning@welgrace.com	Tema		P.O.Box DT 604, Tema
WestPark	+233 (0) 505282170 / +351 918628825	pcruz@westparkghana.com	Accra	www.westparkghana.com	West Park Enterprise Limited The Grand Oyeeman – Mezzanine #9 Airport commercial centre 37 raiton road, Accra Ghana
Whytebage Int. Ltd	+233 (0) 248121512 / 268121512	whytebage@yahoo.com	Achimota		P.O.Box AH 1374, Achimota, Accra Ghana
Wienco Ghana Ltd	+233 (0) 30277251 / 30773458/9	Roland.quaye@wienco.com Ken.addy@wienco.com	Accra	www.wienco.com	P.O.Box AN7593, Airport-Accra
Yara Ghana limited	030279854	kwame.okyere@yara.com	Accra	www.yara.com.gh	P.O. Box CT 5258, Accra, Ghana

Annex 3. Dutch Horticulture Sector Linkages

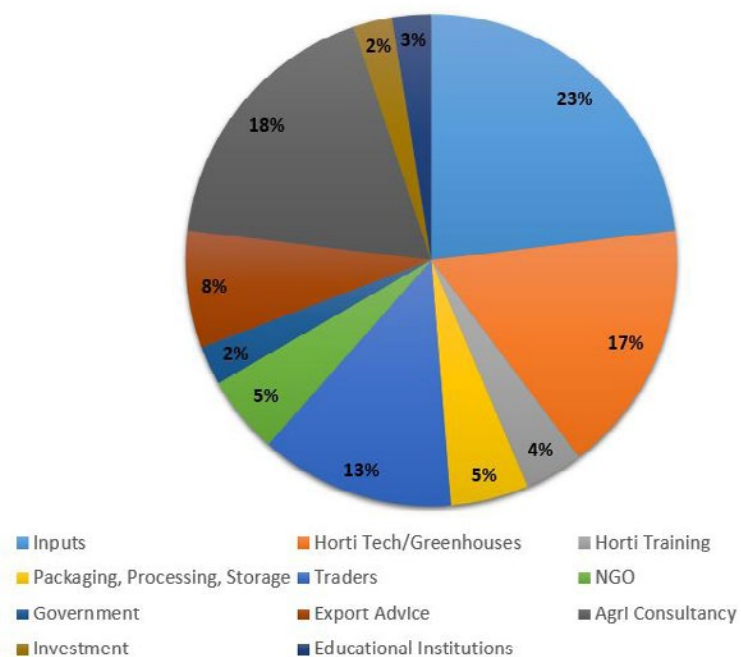
	Company	Product / Services	Contact
1	DuijdamGreenconsult	Agro Consultancy	martienduijdam@gmail.com
2	Wegdam Meat Link	Meat Distributor	logistics@wegdamml.com
3	WUR International Office	Higher Education	Jennie.vandermheen@wur.nl; Matthijs.montsma@wur.nl
4	Enza Zaden	Seeds	m.devoogd@enzazaden.nl
5	Daapah Performance Improvement	Processing	Dapaah.dpi@gmail.com
6	Eosta	Import Fresh Produce (Organic)	Henk.Zoutewelle@eosta.com
7	Ferm-o-Feed	Fertilizers	sales@fermofeed.com
8	Syngenta	Agrochemicals & Seeds	anoma.lokossou@syngenta.com
9	KBAgro	Export Support and Advice	kbagro@gmail.com
10	Bon Berger International	NGO	info@csbonberger.org
11	AgriProFocus	Agribusiness Development Cooperation	nmetz@agri-profocus.nl
13	SIMONIS B.V.	Fertilizers	fertilizer@simonisbv.nl
14	Bejo Zaden	Seeds	a.dekker@bejo.nl
15	PowerNed	Energy	donald.keus@gmail.com
16	Rijk Zwaan Export B.V.	Vegetable Distributor	c.mannee@rijkszwaan.nl
17	Tikola Ghana Ltd	Seeds and AgriDev	korritsema@hotmail.com
18	Celtic Cooling	Cooling	dz@celtic.nl
19	BoP Innovation Center	Development Cooperation	vandijk@bopinc.org
20	Emprise Projects	Consultancy	wouter@empriseprojects.com
21	Nanafico Marketing Company Ltd	Marketing	nanafico@hotmail.com
22	NNZ	Agri Packaging	jcoetzee@nnz.nl
23	WorldwideFood Export	Food Export	marcel@worldwidefoodexport.com
24	Bakker Brothers	Seeds	jacob@bakkerbrothers.nl
25	Hoogendoorn Growth Management	Horticulture Innovation	ks@hoogendoorn.nl
26	Agriement International BV	Consultancy	r.oosteweichel@agriement.com
27	Netherlands Export Combination	Export Support and Advice	dam@nec.nl
28	East West International B.V.	Seeds	eastwestafrica@gmail.com
29	Jofox B.V.	Fruit & Vegetable Trader	Sales@jofoxbv.nl
30	Berg Hortimotive	Agri Logistics	sjefflooms@berghortimotive.nl
31	Remco Afrique	Services	mititelu@hafkon.com
32	Hortimat	Horti Equipment	marco@hortimat.com
33	Farming Africa	Consultancy	marc@farmingafrica.net

Company	Product / Services	Contact
34 Berenschot	Consultancy	lvj@berenschot.nl
35 Sweere Agricultural Equipment	Agri Equipment	info@sweere.net
36 Eel Consult	Agro Consultancy	elijah.bediako@yahoo.com
37 Dapaah Performance Improvement	Processing	Dapaah.DP1@gmail.com
38 Viscon Group	Design & Engineering & Greenhouses	rj.intveld@viscon.eu
39 AfricanWise	Legal Consultancy	frans@africanwise.com
40 Bakker Brothers	Seeds	ed@bakkerbrothers.nl
41 Bejo Zaden	Seeds	a.dekker@bejo.nl
42 GroetenFruit Huis	Fruit and Veg	verbaas@FrugiVenta.nl
43 Amatrex	Agro Equipment & Consultancy	info@amatrex.nl
44 Amatrex	Agro Equipment & Consultancy	info@amatrex.nl
45 Friss B.V.	Greenhouse grower/Investment Project	jjmcof2000@yahoo.com
46 Takii Seeds Europe	Seeds	sni@takii.eu
47 Agri BSA	Organic fertilizer	Chris.strijbosch@agribsa.com
48 Looye Kwekers	Tomato Grower	michiel.bontebal@looye.com
49 Roveg	Fruit importer/trader	ben_burgers@roveg.nl
50 BIO Invest	Investment (Belgian FMO)	Dimitry.vanraemdonck@bio-invest.be
51 Eoasta Organic F&V	Distributor Fresh Fruit & Vegetables	sander@eoasta.com
52 NL MoFA West Africa	Policy officer trade relations Africa	larens.den.hartog@minbuza.nl
53 RVO	Partners in Business, PSD Coach	rosalind.boschloo@rvo.nl
54 Biotropic	Import Bio Foods	rnv@biotropic.nl
55 East West International	Seeds	maaike.groot@eastwestseed.com
56 CBI	Promotion of Imports	pjonkers@cbi.eu
57 Ferander (Bamboobikes)	Import Bamboo, Bikes	ferdinand@ferander.nl
58 Delphy	Greenhouse Expertise and Training	l.bakker@delphy.nl
59 Suba Seeds	Seeds	Bernhard.krikke@subaseeds.com
60 OTC Holland	Organic fruit & veg distributor	nuriavlouk@otcorganics.com
61 Topsector T&U	-	info@topsectortu.nl
62 Celtic Cooling	Cold Storage	dz@celtic.nl
63 Agri BSA	Organic Fertilizers	Chris.strijbosch@agribsa.com
64 Takii Europe B.V.	Seeds	sni@takii.eu
65 Suba Seeds	Seeds	Bernhard.krikke@subaseeds.com
66 Green Farming	Greenhouse Suppliers	Nspdegroot1953@gmail.com
67 Your Business Expansion	Export Support and Advice	peterobeng@yourbusinessexpansion.com
68 Delphy	Greenhouse Expertise	l.bakker@delphy.nl
69 BIO Invest	Development financing	Dimitry.vanraemdonck@bio-invest.be
70 Omnivent	Storage (potato/onion)	Paul.kok@omnivent.nl

Company	Product / Services	Contact
71 Enza Zaden	Seeds	mdevoogd@enzazaden.nl
72 Golf du Benin	Import and Export Support	laliki@gmail.com
73 BDO Accountants & Belastingadviseurs B.V.	Accountancy	adan.ashkir@bdo.
74 Q-Point B.V.	Consultancy	m.bos@q-point-bv.nl
75 Pionira	Logistics	info@pionira.nl
76 Quatin B.V.	Services	marjon.castelijns@yahoo.es
77 AgDevCo	Agribusiness Development Cooperation	jhidanovic@agdevco.com
78 EMSA	Advice & Private Sector Consultancy	hillen@emsa-africa.com/nl
79 East West Trade & Consulting	Consultancy	l.kuijs@eastwest-trade.com/nl
80 Slavenburg en Huyser B.V.	Logistics	g.ponstein@slavenburg-en-huyser.com
81 Tikola Ghana Ltd	Seeds and Agri Development	Korritsema@hotmail.com
82 East West International	Seeds	maaike.groot@eastwestseed.com
83 Friss B.V.	Greenhouse grower/ Investment Project	jjmcof2000@yahoo.com
84 Horticon B.V.	Horti Equipment Retailer	fer.weerheijm@dutchplantin.com
85 Rijk Zwaan Export B.V.	Vegetable Distributor	h.gyasi@rijkszwaan.nl
86 Inclusive B.V.	Development Cooperation	roland.waardenburg@inclusive.com
87 Tradin Organic Culture B.V.	Organic Products Sourcer & Distributor	maren.peters@tradinorganic.com
88 Celtic Cooling	Cooling	albert.obadia@celtic.nl
89 Stichting Koppert Foundation	Sustainable Agro Solutions	emoerman@koppert.nl
90 SI Technologies International	Soil Technology	bart@sitecin.com
91 Soil Cares Holding B.V.	Agro and Soil Technology	pieter.smits@agrocared.com/nl
92 Aminocore	Organic Fertilizers & Biostimulants	Stephan.hoving@aminocore.nl
93 Simonis Fertilizers	Fertilizers	fertilizer@simofert.nl
94 Mantis/Mankar	Spraying Systems	F.Verder@mantis-ulv.com
95 Bakker Brothers	Seeds	coen@bakkerbrothers.nl
96 Jiffy Products International	Propagation & Hydroponic Systems, Containers and Substrates	Ganga.wijawardaane@jiffygroup.com
97 Agrocared	AgriTech	pascal.murasira@agrocared.com
98 HAS Hogeschool	Higher Education	M.Baeten@has.nl
99 Olmix Group	Bio-Nutrition for Plants and Animals	MAinguy@olmix.com
100 Delphy	Greenhouse Expertise and Training	e.vanzandwijk@delphy.nl
101 Dapaah Performance Improvement	Processing	Dapaah.dpl@gmail.com
102 Enza Zaden	Seeds	m.devoogd@enzazaden.nl
103 Ferm-O-Feed	Fertilizers	sales@fermofeed.com
104 Eosta	Import Fresh Organic Produce	Henk.Zoutewelle@eoasta.com

Company	Product / Services	Contact
105 Greenfresh	Trader in Fresh Herbs	Willemkea@greenfresh.nl
106 Total Produce	Import of Fruits	sales@totalproduce.nl
107 SI Technologies	Soil Technology	bart@sitecin.com
108 JoFox	Fruit & Vegetable Trader	sales@jofoxbv.nl
109 Looye Kwekers	Tomato Producer	Michiel.botental@looye.com
110 Friss B.V.	Greenhouse grower/ Investment Project	Jjmcof2000@yahoo.com
111 Growpact/Viscon Group	Agri Equipment	sales@viscon.eu

Figure 10. Company sectors 2014–2019



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