

## Assessing and Mapping the Supply Chain of Pineapple Production in Ghana

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### Authors' contributions

This work was carried out in collaboration between all authors. Author EKA designed the study and wrote the first draft of the manuscript. Author OFA managed the literature searches, all drawings, analysis and correspondents while author KOS was responsible for editing and led the interview sessions. All authors handled the discussion and conclusion, read and approved the final manuscript.

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### ABSTRACT

The aim of the study was to evaluate fresh pineapple production processes and activities in Ghana and to graphically map the various stages of the value stream involved. The study targeted pineapple producing organisations in Ghana. Three organisations were selected based on their experience in the field and their readiness to provide data and other relevant information for the study. Names of the selected organisations are withheld for ethical reasons. The study adopted qualitative approach using primary data. Departmental heads and supervisors from the selected organisations constituted the target population of the study. The primary data was collected using semi-structured interview and observation instruments. The data obtained was analysed through deductions and inferences. The study established that pineapple Supply Chain (SC) processes and activities starts from the supply of pineapple production inputs from various suppliers to production of pineapples, export, through to retailing at the destination countries. The value chain of pineapple production and export was mapped graphically. The SC mapping developed from the study could

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serve as management tool that can be applied in the production of fresh pineapple fruits to improve efficiency and productivity. It is recommended that parties in the pineapple SC should collaborate and coordinate their activities through effective communication and information sharing in order to maximize consumer satisfaction and SC profits.

*Keywords: Pineapple production; pineapple supply chain; mapping; value chain; Ghana.*

## 1. INTRODUCTION

Beyond their nutritional value which is essential for human development, fruits have become important commodities for income generation. Fruits and vegetables play important role in the global economy. Developing countries, including Ghana, are increasingly becoming important part of the global food chain as demand for exotic product across the globe increases (Trienekens & Willed, [1]).

Ghana is located in the center of the Gulf of Guinea coast, 2,420 km of land borders with three countries in West Africa: Burkina Faso, Ivory Coast and Togo. To the south are the Gulf of Guinea and the Atlantic Ocean. Agriculture is a key stay of the Ghanaian economy. The contribution of agriculture to the country's Gross Domestic Product (GDP) was 31.8% in 2009 (Natural Resources Institute, [2]). The production of fresh fruits and vegetables for export has increased among several countries in the sub-Saharan African.

In Ghana production has increased in volume as a result of rise in global demand. Pineapples rank first as the most important non-traditional horticultural export commodity within the fruits and vegetables sub-sector in Ghana. Indeed, pineapples contribute about 24% of total horticultural exports and there is an indication of more prospects in the sector on the evidence of rapid growth in demand for fresh pineapples on the world market (Ghana Export Promotion Council (GEPC), [3]). According to Fold and Gough [4] the export sector of the pineapple industry has provided significant benefit to Ghana since 1983. This gives indications of positive economic potential for Ghana, one of the largest producers of pineapple in West Africa (Natural Resources Institute, [2]).

The global market environment, including the pineapple industry is becoming increasingly competitive. This has great influence on business activities, especially in the era of trade liberalization. In fact, Supply Chain (SC) has become a key business process model for

organizations to be able to compete favorably in the market place, both locally and internationally (Otchere, Anan and Anin [5]; Ou, Liu, Hung and Yen [6]; Baharanchi, [7]). In the pineapple sector of the fruit and vegetable industry, the role SC plays include coordination in the supply network, alignment with customer satisfaction and sustainability of the overall competency throughout the supply chain (Faisal and Banwat, [8], Chopra and Sodhi [9]). Due to the immense contributions from the pineapple production sub-sector to Ghana's economic growth in terms of foreign earnings, there is the need for systematic study into the pineapple operations to develop a structured supply chain configuration for fresh pineapple production in Ghana. Such configured network of value stream for the pineapple production sector will not only inform theory and contribute to knowledge but also serve as spring board to developing pineapple SC in Ghana in order to compete favorably on the global market. It is on this basis that this study is set out.

The general objective of the study was to assess the value stream of pineapple SC and to offer suggestions that will inform policy decisions to improving pineapple production in Ghana. Accordingly, the study is guided by the following specific objectives: to establish and map the SC network for pineapple production in Ghana and to determine specific activities within each stage of the value chain of pineapple production in Ghana.

## 2. RELATED STUDIES

### 2.1 Supply Chain Management (SCM)

Dealing with today's ever changing and turbulent business environment have put a substantial pressure on most businesses to adopt effective supply chain. The reality of the current business environment involves a complex network of suppliers, partners and customers (Christopher, Peck, and Towill [10], Otchere, Anan and Anin [5], Faisal and Banwat [8]; Chopra and Sodhi, [9]; Ou, Liu, Hung and Yen [6]; [6]; Baharanchi [7]). The term supply chain is defined in many ways, but it is defined in this research as the

network of organisations, which are involved through upstream, operations, and downstream linkages, in different processes and activities that create value in the form of products and services to customers (Christopher, 1998 cited in Peck [11]). Again, Supply chain management seeks to enhance competitive performance by closely integrating the internal cross-functions within a company and effectively linking them with the external operations of suppliers, customers, and other channel members to be successful (Monzcka and Morgan [12]; Otchere, Anan and Anin [5], Lambert, James and Elram [13]; Kim [14]; Tan, Kannan, and Hadfield [15]). The intensification of global competition and the demand for better customer service have considerably increased the need for SCM. The basis of SCM is characterised by cooperation, collaboration, information sharing, trust, partnerships, shared technology, and a fundamental shift away from managing individual functional processes, to managing integrated chains of processes (Otchere, Anan and Anin [5], Vickery, Jayaram, Droge and Calantone [16]; Kahn [17]; Pagell [18]).

A supply chain consists of all stages involved, either directly or indirectly, in fulfilling a customer request. The objective of supply chain management is to maximize the overall value generated rather than profit generation. Although the importance of supply chain relations is widely acknowledged, seamless coordination is rarely achieved in practice (Hussain and Nassar [19]; Otchere, Anan and Anin [5]) Indeed supply chain has essential roles in the development of the pineapple industry. These roles take the form of coordination in the supply network, alignment with customer satisfaction, and the sustainability of overall competency throughout the supply chain (Faisal and Banwat [8]; Chopra and Sodhi [9]).

The global market environment, including the pineapple industry is becoming increasingly competitive. This has great influence on business activities, especially in the era of trade liberalization. Accordingly, the adoption of SC as a key business process model for organizations to be able to compete favorably in the market place, both locally and international is imperative. The competitive nature of the international business environment as well as trade restrictions and barriers imposed on organizations in various countries such as strict regulations on export makes SC one of the effective drivers for firms to compete and

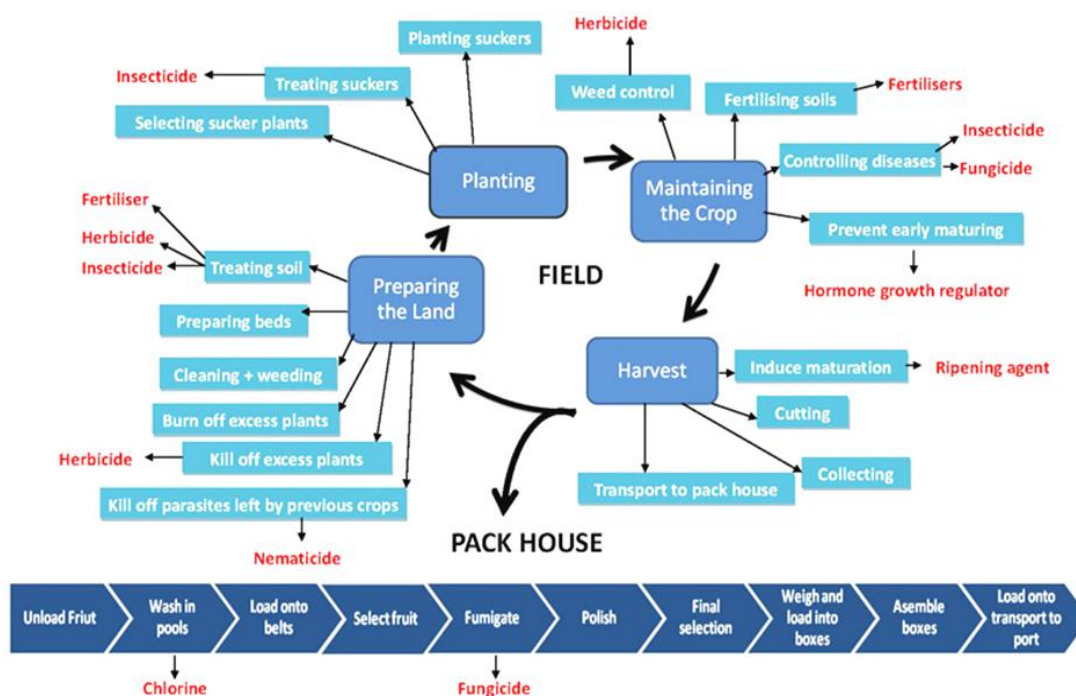
improve performance (Ou, Liu, Hung and Yen [6]; Baharanchi [7]). This means that close and seamless coordination among all the members of the supply chain, i.e. growers, shippers, wholesalers and retailers is required (Habib and Jungthirapanich [20]).

## 2.2 Pineapple Production

Fruits and vegetables are critical source of nutrients and other substances that help protect against chronic diseases, including heart diseases and cancer, stroke and other chronic diseases, (Prior & Cao [21]; Produce for Better Health Foundation [22]; Quebedeaux and Elisa, [23]; Southon [24]; Tomas-Barberan and Robins [25]). Fruits, and vegetables play a significant role in human nutrition, especially as sources of vitamins (C, A, B6, thiamine, niacin, E), minerals, and dietary fiber (Quebedeaux and Bliss [26]). The production of vegetables and tropical fruit for export in Ghana is expanding. Pineapple is now a crop of great importance to Ghana as traditional crops such as cocoa, yam and maize are facing increasing pressure due to low world market prices. Producers are becoming aware that production of pineapples for the export market is a very profitable business and generate fast returns (12 to 15 month's production cycle) and remain on the plant for a longer time without spoiling.

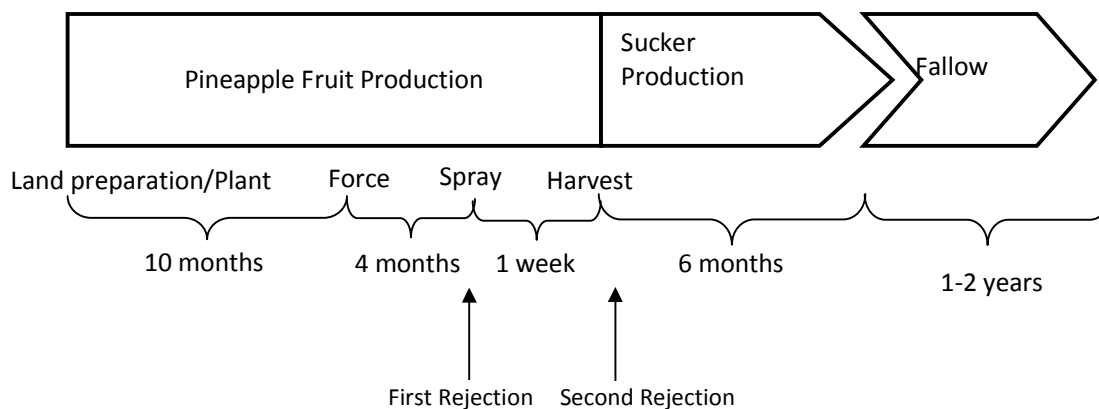
Pineapples are sprayed at two stages: First to force maturation (forcing) and second to change fruit colour from green to yellow (de-green). The yellow colour adds value to pineapples sold in EU markets, but not in the domestic market. Exporters spray to de-green only fruits that are of export quality, and harvest occurs one week after (Suzuki, Jarvis & Sexton [27]; Ghana Export Promotion Council (GEPC) [3]; Trienekens and Willems [1]). Besides that, pineapple is a relatively easy product to cultivate. It is considered one of the Ghana's most important non-traditional horticultural export products, contributing around 24% of total horticultural exports (GEPC [3]; Trienekens and Willems, [1]) Figs. 2.1 and 2.2.

Pineapple share of the world's production of tropical fruits is 20%, and about 70% is consumed fresh. The world production has risen up by 400% over the last five decades with Brazil being the world leading producer but Costa Rica is the world largest pineapple exporter, followed by Philippians, Cote d'Ivoire, Ecuador, Honduras before Ghana (French Ministry and Agricultural



**Fig. 2.1. Production processes of pineapples**

Source: Adopted from Banana Link (Photo of Pineapple plantation, Buenos Aires) [28]



**Fig. 2.2 Production processes of pineapples**

Source: Adopted from Suzuki, Jarvis and Sexton, [27]

and Statistical Division (FAUSTAT) of Food and Agricultural Organizations of United Nations (FAUN) [29]; Kleemann [30]). Currently Ghana's market share in Europe has improved (Suzuki, Jarvis and Sexton [27]). The production level of pineapple in Ghana was 63,798 metric tons in 2001, and has been fluctuating since 2002. It went up to 71,637 metric tons, dropped to 60,000 metric tons in 2005, from there it increased to all time high of 74,715 metric tons in 2009, and eventually dropped to 73,700

metric tons in 2010 (Natural Resources Institute [2]).

The production of pineapple for export is geographically concentrated in the peri-urban zones along the coastal savanna near the capital, Accra. This is due to the proximity of the international airport in Accra and of a major port in Tema. The perishable nature of the produce and underdeveloped transport networks in rural areas are the main reasons for this

concentration. In addition, processing companies producing pineapple juice are concentrated in the cities of Accra, Nsawam, and Tema (Trienekens and Willems [1]). Furthermore, these cities offer a major domestic market for fresh pineapples. These factors constitute an advantage for the peri-urban regions; as compared to the rural population in remote areas who have less chance of participating in export pineapple production (Takane [31]). The world market for fresh pineapple has been growing rapidly during the past years. Like other tropical fruits, pineapple is grown predominantly in developing countries, where two thirds of rural people live on small-scale farms of less than two hectares (IFPRI [32]). According to the Ghana Living Standards Survey [33] 170 627 households (2 percent of all households in Ghana) grow pineapples although not all of them are on commercial basis.

### **2.2.1 Cold chain management**

Because fruits and vegetables are perishable, the retail value of the product lies in the ability to transport the product to the market in a timely fashion. Despite their strategic importance and profitability, perishables subject grocery retailers to losses of up to 15 percent due to damage and spoilage. Cold chain management is paramount to ensure the freshness of fresh produces. Temperature management of perishables begins with proper handling at harvest. Produce should usually be picked in the cool hours of the day and shaded to protect it from the sun. Ideally, produce is cooled to its long-term storage temperature in special facilities designed for rapid refrigeration. There are six common cooling and temperature control methods of which Forced-air 12 cooling is the most widely used cooling method (Thompson, Mitchell, Rumsey, Kasmire and Crisosto [34]).

### **2.2.2 Packing**

Good packaging is critical to extend the shelf life of produce and vegetables. Optimal temperature and packaging slows down the aging of fruit and vegetables by more than 800% (Steeman [35]). The important parameters for this shelf life extension are temperature, moisture and a modified atmosphere (oxygen, carbon dioxide and ethylene). When the product consumes oxygen and expels carbon dioxide, water and heat, carbohydrates and other substances important to the product's freshness, taste and health quality are broken down. Fruit and

vegetables expel ethylene. Ethylene is a gas which accelerates the ripening process in fruit and vegetables. Thus, an important design goal is to reduce the accumulation of product decomposition liquids in the packaging and slow the product's respiration [1]. In Ghana basic packing and storing facilities have been constructed in the harbor by various exporters. There seem to be no supply chain system innovation. Transportation infrastructure is still weak with old transportation facilities (except for a few modern trucks owned by large producers such as Golden Exotics) [1,36].

### **2.2.3 Trading and export**

Fruits and vegetables processing, trading and marketing require some vital support of integrated supply chain management system. Due to its perishable nature and more consistent application of quality standards, the organizations involved in business of these horticultural commodities have to face colossal quality problems (Trienekens and Willems [1]; Pegge [36]). According to Trienekens and Willems [1], there are no longer many traders in Ghana who only trade in the pineapple fruits. Most traders acquired pineapple farms during the past few years to ensure regular and sufficient supply. The number of exporters has fluctuated between 50 and 70 during the last decade, although just 10 companies accounted for over 80% of all exports. The other exporters can be classified as medium-scale (diversified) export farms. 16 large producers are members of Seafreight Pineapple Exporters Association Ghana (SPEG) (Trienekens & Willems [1]).

### **2.2.4 Transportation**

In transportation logistics management, better information is required throughout the supply chain from crop-picking, demand forecast, continuous monitoring and adjusting to truck timing. It also calls for clear and efficient procedures at receiving docks and responsiveness in changes in delivery schedule. For instance, warehouse and retailer should have flexible unloading procedures allowing the drivers to do less than-truck-load (LTL) unloading and reducing truckers' waiting time at receiver docks. In Ghana, we can distinguish two means of transport from farm to port; privately owned trucks and contracted trucks. The contracted trucks are mainly operated by one-man businesses that accept almost any type of load. The trucks are often in poor condition and they

don't have a cooling facility. Privately owned trucks are mainly used by large scale export firms and by organized smallholders. Most of these trucks are in good condition and some have a cooling facility (Pegge [36]). Around 95% of the total pineapple export is transported by boat. Due to the relatively small scale of the Ghanaian exporters, they are often forced to accept the residual space available on ships and airplanes, resulting in delays and extra costs (Pegge [35]; Trienekens and Willems [1]).

### 2.3 Pineapple Export in Ghana

Export of fresh pineapples in Ghana began in 1940s and initiated air export of fresh pineapples to the EU market in the 1970s (Danielou & Ravary [37]). Export has increased constantly since the mid- 1980s. The export volume of fresh pineapple in 1983 was only 57 tons, and significantly moved to 15,319 tons in 1994, while in 1999 it exceeded 33 thousand tons despite the temporary decrease in 1998-1999, due to drought. It further went up to 46,391 tons in 2002 (Takane [31]; Trienekens and Willems [1]). According to Fold and Gough [4] the export sector of the pineapple industry has provided significant benefit to Ghana especially between 1983 and 2005. This gives indications of positive economic potential for Ghana, one of the largest producers of pineapple in Africa (Natural Resources Institute [2]). Again Ghana's volume of export declined from all time highest of 56,094 metric tons in 2004 to 17,780 metric tons in 2010, representing over 68% (FAUSTAT of FAUN [29]).

Fresh pineapples constitute 15% of the total value of Ghana's nontraditional agricultural exports in 1999. Most pineapple is exported to the EU, with Germany as the most important importing country (30% of total exports) followed by countries such as Belgium, Switzerland, France, Italy, Luxembourg, the Netherlands, and the UK ( GEPC [3]). The rapid increase in pineapple export has been associated with series of liberalization policies adopted under the Structural Adjustment Programme (SAP), began in 1986, of foreign exchange controls. By the end of 1992, Ghanaian exporters were free to repatriate all foreign exchange earnings, which they can use for any purpose (Obeng [38]). In addition, all nontraditional exporters became exempt from export duty and eligible to claim a corporate tax rebate. Such increased incentives among exporters contributed to the increased

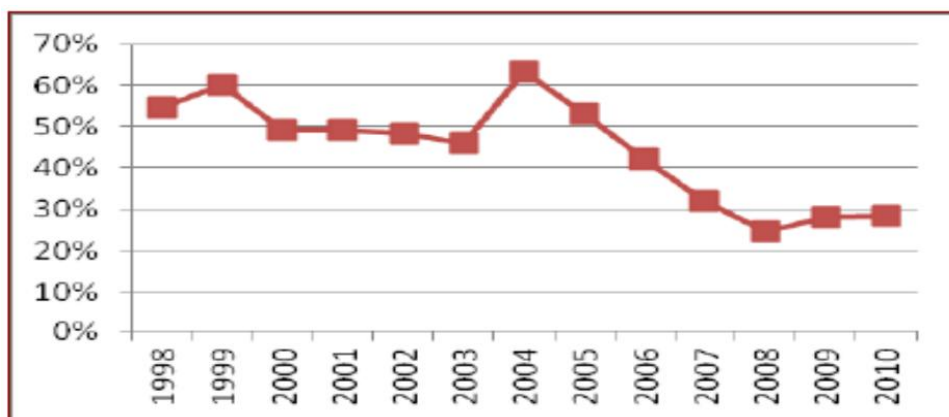
volume of pineapple export. As of 2000, 57 companies were registered as pineapple exporters, although not all were actually exporting Takane [31].

In terms of value, Ghanaian pineapple exports were US\$13,316,459 in 2001 and US\$15,519,989 in 2002. Almost 50% of the total export volume was exported by four large companies: Jei River Farm (8403 tons), Farmapine (6255 tons), Koranco Farms (4147 tons) and Prudent Farms (3420 tons) (GEPC [3] Trienekens and Willems [1]). However, recent statistics indicates that Golden Exotic limited has taken over the export market with 41.0% in 2007 (Suzuki, Jarvis and Sexton [27]). Notwithstanding, Current statistics from SPEG according to Suzuki, Jarvis and Sexton [27], indicates that as at 2011, Ghana was the third-largest supplier of fresh pineapples to the European Union after Costa Rica and Cote d'Ivoire with an 8% market share. This feat has been achieved because of huge investment in the sector by the new addition companies such as Golden Exotics which is run by Compagnie Fruitiere (CF) owned primarily by Dole, who invested US\$35 million; and benefiting from tariff free access to the EU market within the agreed 775,000 tons tariff free quota. In 2007 the top three exporters increased their market shares in 2006-07 to 61.6% with Golden Exotics who is the largest exporter, controlled 41.0% of pineapple export volume.

### 2.4 The Supply Chain Network

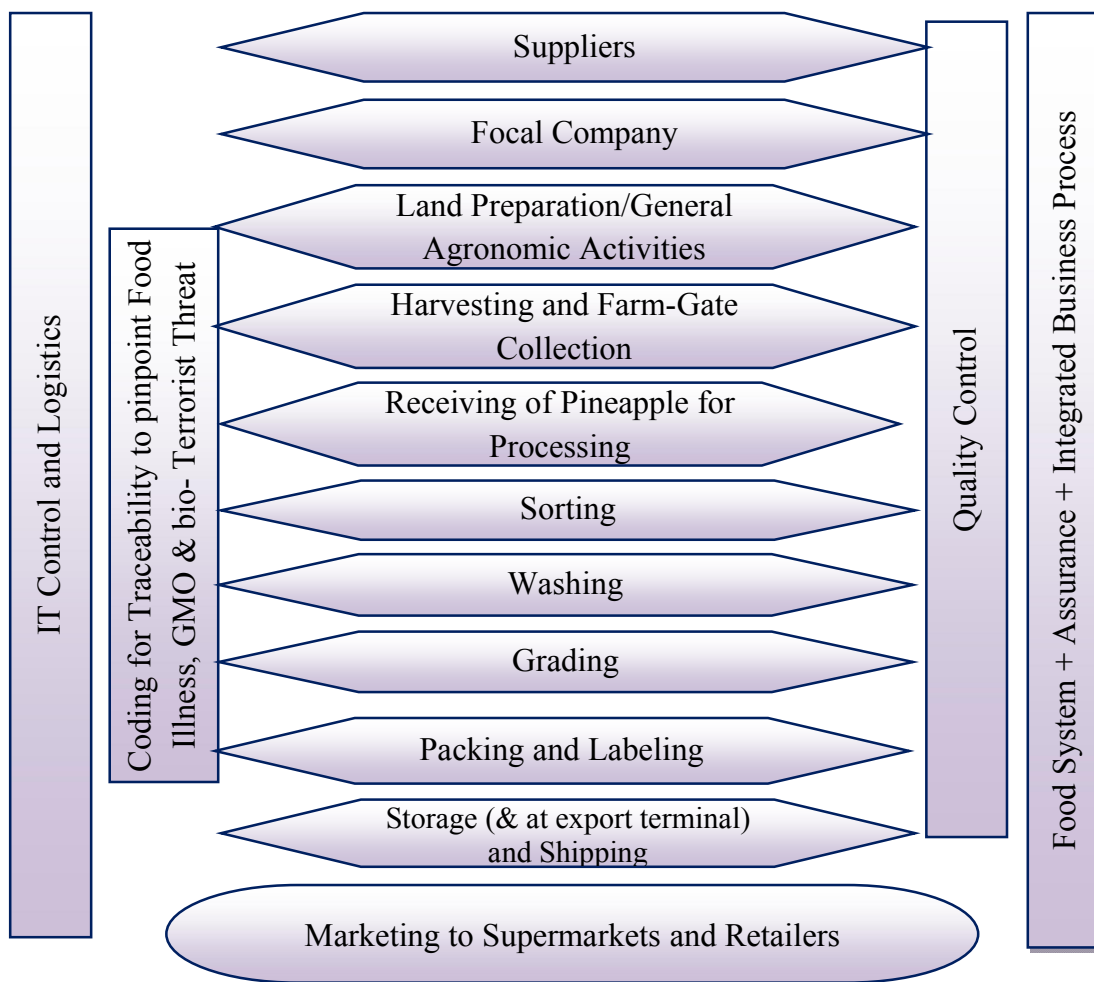
The supply chain network explains the supply chain process of pineapple production that has been discussed in the literature for this study. The stages of pineapple production starting from the agronomic practices such as nurseries activities and growers activities, followed by harvesting activities, packaging and/ processing activities, storage activities, bulk transportation activities, distribution activities, wholesaler/retailer/customer activities, consumer activities and waste management activities. All the nine stages are moderated through the marketer (market knowledge, communication and coordination).

Fig. 2.4 also explains the flow chart or business processes of SCM in the Pineapple industry. Suppliers, focal company, land preparation and general agronomic activities, harvesting and farm-gate collection, receiving of pineapple for



**Fig. 2.3. Contribution of exported pineapple volumes to total horticultural volumes in Ghana 1998-2010**

Source: Ghana Export Promotion Authority (GEPA) Cited in Food and Agricultural Organisation of the United Nations (FAO-UN) Working Report [39]



**Fig. 2.4. Flow chart – Business processes of SCM of pineapple industry**

Source: Adapted from Ahmad & Fehér [40]

processing, sorting, washing, grading, packing and labeling, followed by storage and shipping and finally, marketing to supermarkets and retailers. All these processes are affected by IT control, logistics and food system, integrated business process among others. The focal company also ensures quality control from their suppliers to the storage and shipping processes. Finally, from the agronomic stage to the packing and labeling stage the certification organisations and the focal firm ensures that there is compliance of coding for traceability to pinpoint food illness, bio- Terrorist Threat, etc. This is because the new age consumers are becoming more health conscious in terms of hygiene, source of the food, ingredients of processed food and caloric content (Loader and Hobbs [41]). Therefore enforcement of standards and also to carry out certification by organisations such as: Fair Trade, GLOBALGAP, TESCO and HACCP right from planting to-produce, best pre-harvest practices is mandatory for each grower, for ultimate produce traceability. Otherwise, fresh produce pack will be rejected by the buyers.

### 3. METHODOLOGY

The study targeted pineapple producing organisations in Ghana. Three organisations were selected based on their experience in the field and their readiness to provide data and other relevant information for the study. Names of the elected organisations are withheld for ethical reasons. The study adopted qualitative approach using primary data. Departmental heads and supervisors from the selected organisations constituted the target population of the study. Eight (8) people from each organisation, (comprising two (2) each from administration, procurement, production, and marketing departments and units) totaling twenty-four (24) were purposively selected based on their ability to provide relevant information to the study. The primary data was collected using semi-structured interview and observation instruments. The data obtained was analysed through deductions and inferences.

Based on the data collected from the interview and the observations made, the supply chain network for pineapple production and export was mapped using Microsoft Word 2007 Software. This was presented to the representatives of the organisations involved in the study for revision

and confirmation as the true reflection of the activities on the ground. The necessary corrections and revisions were made based on the collective advice and consensus of the respondents. The value chain of pineapple production and export was finally re-mapped graphically.

## 4. RESULTS AND ANALYSIS

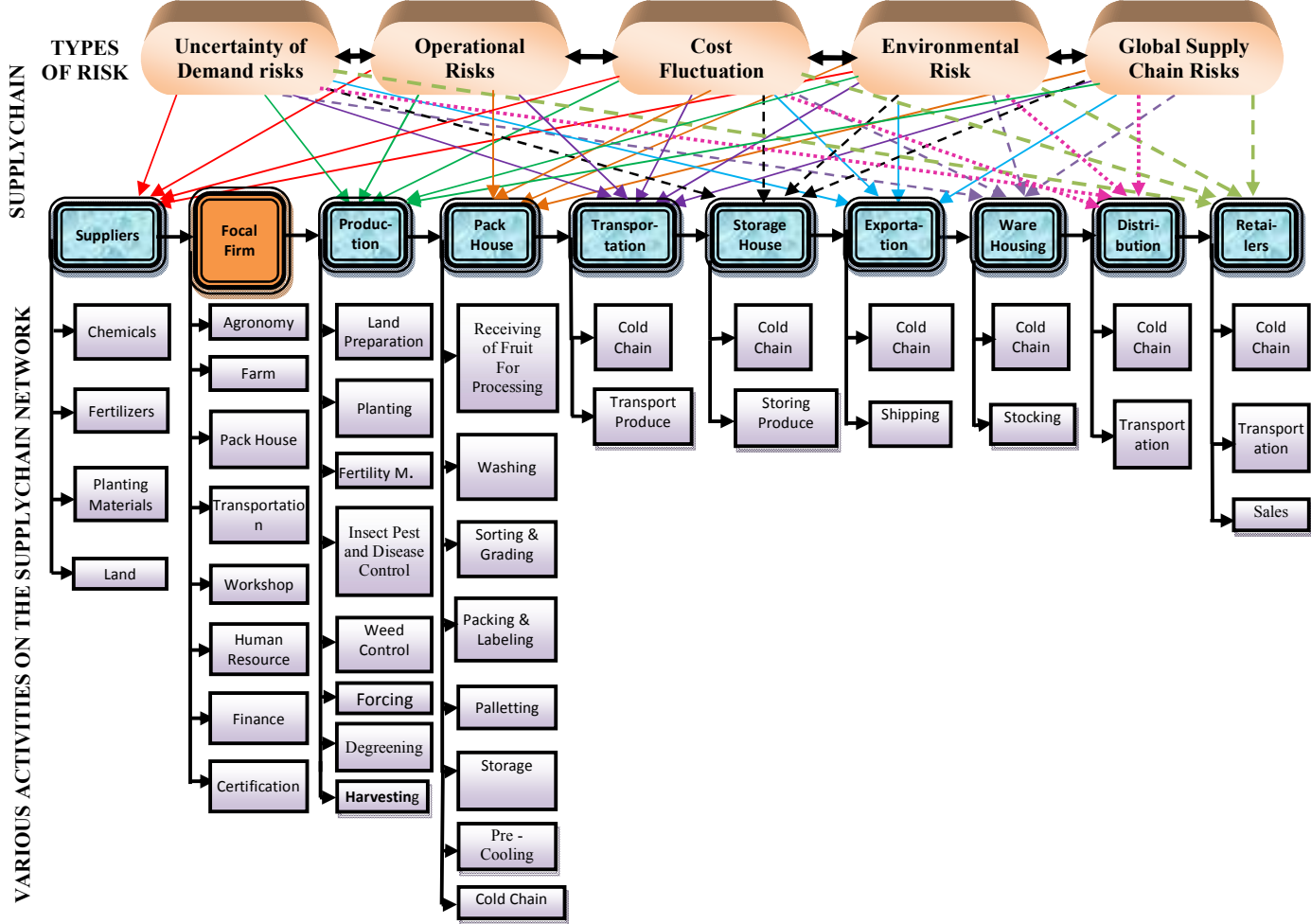
### 4.1 The Nature of Pineapple Supply Chain in the Selected Organizations

The pineapple supply chain network in Ghana and activities involved is graphically illustrated in Fig. 4.1. This is based on the interview session held with the three selected organisations involved in the study and the observations made during the studies. The various stages and the associated activities at each stage on the network, start from the suppliers who supply various inputs and logistics for production through to the retailers where consumers pick up the produce for consumption. Suppliers represent Tier one indicates the suppliers who directly supply the pineapple SC, followed by the focal firm (pineapple producing companies). This is followed by the production stage, pack house activities, transportation, storage, exportation, warehousing, distribution and retailers. The various activities are indicated under each tier on the network shown in Fig. 4.1.

## 5. DISCUSSION

Three pineapple production organisations involved in the study were interviewed on the business process and activities involved in the production of fresh pineapple fruits. It emerged from the interview sessions that the value stream of pineapple production in Ghana does not depart from the other SC configuration developed by previous authors such as Ahmed and Fisher [39], Suzuki, Jarvis and Sexton [27] and Banana link. It came out from the interviews that the Ghanaian pineapple production process starts from supplies of production inputs through to Sale of fresh pineapple fruits to final consumers (retailing). Various stages of value addition and their associated activities of pineapple supply chain in Ghana as established from the interview session and observations are detailed in Table 5.1.





**Fig. 4.1. The supply chain of pineapple production in Ghana with its associated risk**  
 Source: Author's own mapping based on the field survey (2014)

**Table 5.1. SC processes and activities**

<b>SC stages of value addition</b>	<b>Business processes and activities</b>
Suppliers activities	Supplies of production input: land, chemicals, fertilizers, planting materials.
Focal firms	Production and Export of pineapples
Pineapple production	Land preparation, Planting, Agronomics activities (Fertility Management, Insect Pest and disease control, Weed control, Forcing, Degreening) and Harvesting.
Pack house activities	Receiving of fruits, washing, Sorting and Grading, Packaging and Labeling, Palletting, Pre-cooling and cold chaining.
Transporting	Transporting produce and Cold Chaining.
Storage house (Export terminal)	Storing produce and Cold Chaining.
Exportation	Shipping and Cold Chaining.
Warehouse	Stocking and Cold Chaining.
Distribution	Transporting produce and Cold Chaining.
Retailing	Sale of fresh pineapple fruits to final consumers.

*Source: Author's field survey (2014)*

The first stage in the pineapple production process is the Suppliers activities which involve supply of production inputs: land, chemicals, fertilizers, planting materials to the production organisations (the focal firms). This is a critical stage of the value stream. Availability of the planting materials, chemicals and fertilizers is crucial. Farm managers and supervisors need to give critical attention to this stage in order to manage the inherent risks. The supplying stage is the input or upstream phase of the supply chain. The operational efficiency and effectiveness of the stage affects the subsequent stages. This stage is followed by the activities of the focal firms, i.e., mobilising and allocating resources for the production and distribution of fresh pineapple fruits. Production stage has to do with preparing the land, planting activities, agronomics activities (Fertility Management, insect pest and disease control, weed control, forcing, Degreening) and harvesting of pineapple. The freshly produced pineapples are then sent to the Pack House. Pack House activities, which follows harvesting involves receiving the fresh fruits, washing, sorting and grading the fruits. It also involves packaging and labeling, palletting, pre-cooling the fruits to the desired temperature that will keep the freshness of the fruits. This condition is maintained and preserved through consistent refrigeration, a situation referred to as cold chaining. From production to Pack Houses stage constitute the throughput or transformational phase of the SC.

Transportation is a crucial value adding stage in the pineapple SC since it constitutes the logistical driver of SC and creates place utility. It involves in the distribution and transporting (physical movement) of the fresh fruits to various points of needs, i.e. the ports and various retail points to reach the final consumers. At the export

terminal, pineapple products are stored in the temporary Storage House prior to export to maintain the freshness through cold chaining. Exportation stage is where physical movement of the pineapple produces from the producing country to the destination countries takes place through Shipping. At this stage the required temperature is again maintained through refrigeration and cold chaining. The fresh pineapples are then warehoused at the destination countries prior to distribution. The warehouse should be equipped with refrigeration facilities to maintain the freshness of the fruits. Distribution involves inland movement of fresh pineapples to the various wholesale and retail outlets in their fresh state. Finally the fresh pineapples are sold to the individual final consumers for consumption. From transportation to the retailing stage constitutes the output or downstream phase of the SC. The process involved in fresh pineapple fruits supply chain is mapped in Fig. 4.1

## 6. CONCLUSION

The study was set out to evaluate fresh pineapple production processes and activities in Ghana and to graphically map the various stages of the value stream involved. The study established that, pineapple SC processes and activities starts from the supply of pineapple production inputs from various suppliers to production of pineapples, export, through to retailing at the destination countries (Fig. 4.1 and Table 5.1). The SC mapping developed from the study could serve as management tool that could be applied in the production of fresh pineapple fruits to improve efficiency and productivity. Each stage of the pineapple SC has its inherent risks and requires close attention from farm managers. The timing of fertilizers and chemicals application

also requires close attention from farm managers. We recommend that parties in the pineapple SC should collaborate and coordinate their activities through effective communication and information sharing in order to maximize consumer satisfaction and SC profits.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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