

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF ARCHITECTURE

FRUIT PROCESSING PLANT, AKORLEY-SOMANYA

EASTERN REGION

**A DESIGN THESIS REPORT SUBMITTED TO THE DEPARTMENT OF
ARCHITECTURE, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR
THE AWARD OF THE POST GRADUATE DIPLOMA IN ARCHITECTURE.**

BY

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(BSc. Architecture)**

MAY, 2009

DEDICATION

DECLARATION

I hereby declare that this Design Thesis Report, except in portions where references were made, has been entirely undertaken by me, duly supervised and submitted herein.

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Date.....

DEDICATION

ACKNOWLEDGEMENT

I am very grateful to the Almighty God for His love, grace wisdom and protection throughout my six-year study in Architecture and for the knowledge and strength He

Unto God be the Glory

I dedicate this work to my Mum Miss. Veronica Gorleku, to my late uncle Mr. J.O.

Gorleku and His Wife Mrs. Margaret Gorleku. You place me in the orbit of love for

education and your love, support and prayers have been the spine in my pursuit to be an

Architect.



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Finally, to all my friends who helped in one way or the other to make this project a

success. I am very grateful to all who have supported me in my journey.

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ACKNOWLEDGEMENT

I am very grateful to the Almighty God for His love, grace wisdom and protection throughout my six-year study in Architecture and for the knowledge and strength He gave me to finish this project successfully.

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ABSTRACT

To facilitate coordinated development of the fruit production industry and participation of all stake holders in both the public and private sector including the farmers, Emphasis must be laid on the development of fruit processing factories all around the country.

Although various initiatives have been taken in the recent past for promoting industrial growth in the country: Bold and forward looking measures would be required if Ghana is to capitalise on its unique strengths which the fruit production industry possesses to the socio-economic development of the country.

The growth potential for this Fruit Processing Industry is enormous as the demand for processed fruit products is increasing in the domestic as well as in the overseas markets.

In view of this, the State has to promote this sector through public investment and also by facilitating private investment in the development of more processing industry and supportive infrastructure in this sector.

The methods of extending the storage life of fruits include refrigeration, regulation and modification of the storage atmosphere, hypobaric storage, packaging in plastic films, chemical treatments etc. The practicability and economic justification for the use of some of these methods in Ghana could be doubtful, since the investment, maintenance and operating costs are not compatible with the market values of fruits especially mango, orange and pineapple. Also these methods can only extend the shelf life of the fruits for only some few days or weeks. (2-10 days)

The most feasible approach would be to process them to juice and other more stable products by the establishment of more processing plants to add value to these products. This thesis therefore seeks to come out with a design of modern fruit processing plant which will be in a position of processing these fruits for both local and international consumption.

Acknowledgements

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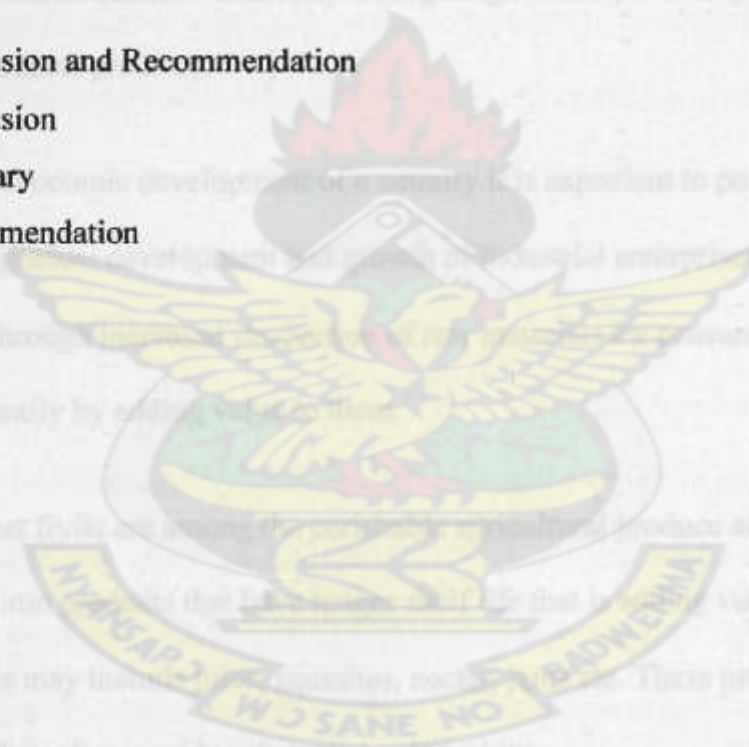
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2.1 PROBLEM STATEMENT

Mus tropical fruits are seasonal and highly perishable. They include oranges, pineapples, mango, pawpaw (papaya), and others. Just to mention a few. Once harvested, they continue to ripen daily and lose moisture through transpiration because of the tropical atmospheric conditions (High temperature and low relative humidity). This accelerates

CHAPTER ONE

1.0 INTRODUCTION

1.1 PREAMBLE

In the backdrop of the nation's resolve to strive for high economic growth rate and to spread its benefits across all sections of society through Agriculture, it is very important to add value to Agricultural products.

To assure the overall economic development of a country it is expedient to put in place arrangements for the gradual development and growth of industrial enterprises in a competitive manner through increased production of raw materials for consumption both locally and internationally by adding value to them.

It is worthy to note that fruits are among the perishable agricultural produce and this, need to be processed into products that have longer shelf life that is adding value to the produce. The products may include juice, squashes, nectar, jams etc. These products have longer shelf life and they also provide substantial value addition.

1.2 PROBLEM STATEMENT

Most tropical fruits are seasonal and highly perishable. They include oranges, pineapple, mango, pawpaw (papaya), cashew fruit to mention a few. Once harvested, they continue to respire rapidly and lose moisture through transpiration because of the tropical atmospheric conditions (High temperature and low relative humidity). This accelerates

biochemical reactions that speed up the deterioration of the fruits. The ability to naturally keep the fruits wholesome is limited to few days (i.e. 2-10 days) unless deliberate attempts are made to store them at controlled atmosphere or process them into more stable products such as juices, drinks, jellies, jam etc. Methods available for extending the storage life of fruits include refrigeration, regulation and modification of the storage atmosphere (Controlled Atmosphere Storage-CAS); hypobaric storage, packaging in plastic films, use of food surface coatings, chemical treatments (Ethylene absorber, Gibberellin infusion etc.) and irradiation. The practicability and economic justification for the use of some of these methods particularly hypobaric controlled atmosphere storage, irradiation and refrigeration in Ghana as well as other developing countries could be doubtful, since the investment, maintenance and operating costs are perhaps not compatible with the market values of the fruits.

A physiological disorder known as "Chilling Injury" is a major problem in postharvest storage of most tropical fruits, which are susceptible to it. This is because it precludes their storage at low temperatures (Below 15°C) that otherwise would prolong their storage life considerably. It is therefore obvious from the reasons mentioned above that, besides packaging the fruits into plastic films and application of food surface coatings with some chemical impregnation, which can only extend storage for few weeks, the most feasible approach would be to process them to juices and other more stable products i.e. jam, jellies etc. However the processing plants available currently are not enough to process these fruits, hence the need to establish more processing plants in these fruits growing areas.

This fact was buttressed when the Orange farmers in the Kwaebibirem District of Ghana on 26th May 2008 appealed to Pinora, a fruit processing company near Asamankese to purchase their produce to prevent them from rotting. Speaking to the Ghana News Agency at Kade, a spokesman for the farmers, Mr. Alex Owusu Gyapong, said the farmers were increasingly becoming disappointed as a result of the company's reluctance or inability to purchase large quantities of their produce as expected. He said early this year, he harvested four and a half truck-loads of oranges but the factory was able to buy only three trucks. Without ready market the rest of the one and a half truck-load was left to rot.

1.3 JUSTIFICATION

The world-wide market for commercial fruit juices is growing very fast. Almost ten billion gallons were consumed in 1995, resulting in a market of more than US\$ 35 billion in sales. By the year 2000 an increase of 25% in these numbers was anticipated (Tillotson, 1997). These expectations are motivated by changes in geographic variables, mainly the urbanisation of the population, demographic variables, and behavioural variables, mainly natural, healthy lifestyle, benefits, convenience and others, which fit very well in the juice consumption.

In developed countries, fruit juices are widely consumed in very large quantities. The contrast is however the case in Ghana where despite the enormous nutritional benefits of fruits and their juices, they have not been given a pride of place in the diets of the

Ghanaian people. The main reason for the neglect being ignorance of the nutritive values of most of the fruits, which abound in our environment. Other reasons include the rising cost of perishable commodities and that of distribution. The fruit juice industry is therefore still in its infancy stage in Ghana, resulting in importation of different brands of fruit juices.

As the country is yearning to get to a middle income status and in the wake of a huge cry for the country's over dependency on imports, it is very important to look inwardly to our enormous Agricultural potentials and to see how best it can be developed so as to add value to it. This when done can go a long way in making the country self sufficient and also earn her foreign exchange since some of these produce can be exported.

Finally, the construction of a fruit processing plant would not only be beneficial to the people in Ghana but also earn a lot of foreign exchange for the country. The potentially large market this facility holds would bring a positive change to the industry and also fulfill the sector ministries vision of developing the Agriculture sector as the engine of growth on a sustainable basis.

1.4 OBJECTIVES

1. To facilitate processing of fruits such as oranges, mango and pineapple to improve the shelf life of these fruits and to encourage consumption of fruits.
2. To facilitate an increased growth in the fruit industry.
3. To prevent postharvest losses of farm products.
4. To facilitate the use of fruit juice in Ghanaian diets.

1.5 STUDY

The primary focus of this thesis is to provide a modern facility for the processing of fruits thus facilitating socio-economic growth and the health of Ghanaians.

1.6 TARGET GROUP

- . Residents of Ghana and the country's trading partners in Africa and Europe.

1.7 CLIENTS

- . Ministry of Food and Agriculture.
- . Yilo Krobo District Assembly/Mango Farmers Association.

1.8 CLIENTS' BRIEF

1. Administrative Unit

- Car park (customers and staff)
- Reception lounge
- Common room
- Offices
- Conference room
- Exhibition hall
- Sanitary facilities

2. Production Unit

- Maintenance area
- Production floor

- Sanitary facilities

3. Storage Unit

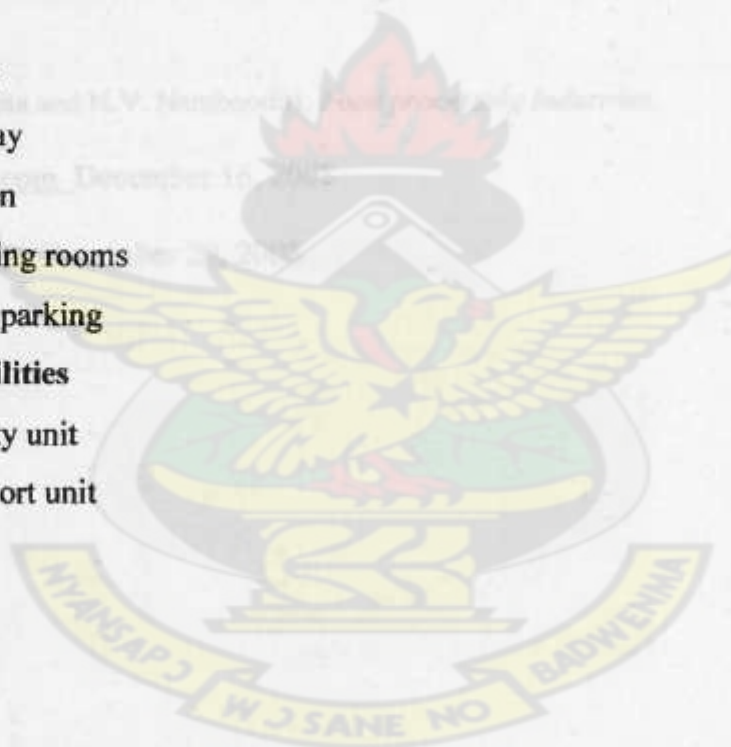
- General store
- Raw material store
- Finished products store
- Loading / Off – loading bays
- Factory waste store

4. Welfare unit

- Sick bay
- Canteen
- Changing rooms
- Public parking

5. Other facilities

- Security unit
- Transport unit



1.9 SOURCE OF FUNDING

- Ghana government support – Ministry of Food and Agriculture
- Yilo Krobo District Assembly /Mango Farmers Association

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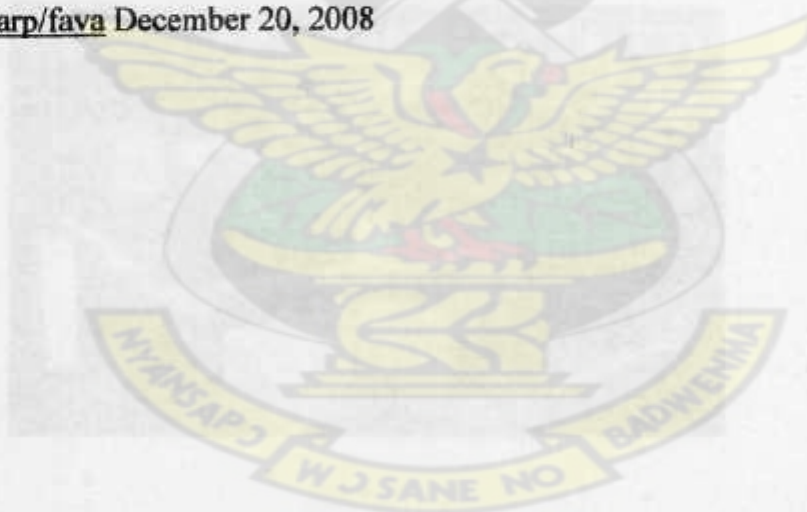


Figure 1 | Food Processing Industry (Source: Ghana Association of Machinery

Industry)

2.1 HISTORY

Food processing dates back to the prehistoric ages when crude processing incorporated sharpening, fermenting, sun drying, preserving with salt, and various types of cooking such as roasting, smoking, steaming, and oven baking. Salt-preservation was especially

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 FOOD PROCESSING

Processing is the set of methods and techniques used to transform raw ingredients into food or to transform food into other forms for consumption by humans or animals either in the home or by the food processing industry. Processing typically takes clean, harvested crops and uses these to produce attractive, marketable and often long-life food products. Similar process is used to produce fruit juice.



Figure 1: Food Processing Lines (Source: Korea Association of Machinery Industry)

2.2 HISTORY

Food processing dates back to the prehistoric ages when crude processing incorporated slaughtering, fermenting, sun drying, preserving with salt, and various types of cooking (such as roasting, smoking, steaming, and oven baking). Salt-preservation was especially

common for foods that constituted warrior and sailors' diets, up until the introduction of canning methods.. These tried and tested processing techniques remained essentially the same until the advent of the industrial revolution. Examples of ready-meals also exist from pre industrial revolution times such as the Cornish pasty and the Haggis.

Modern food processing technology in the 19th and 20th century was largely developed to serve military needs. In 1809 Nicolas Appert invented a vacuum bottling technique that would supply food for French troops, and this contributed to the development of tinning and then canning by Peter Durand in 1810. Although initially expensive and somewhat hazardous due to the lead used in cans, canned goods later became a staple around the world. Pasteurization, discovered by Louis Pasteur in 1862, was a significant advance in ensuring the micro-biological safety of food.



Figure 2. Florida's Food Processing Industry (Source, *Southern Gardens Citrus Trade Press Kit*)

In the 20th century, World War II, the space race and the rising consumer society in developed countries (including the United States) contributed to the growth of food

processing with such advances as spray drying, juice concentrates, freeze drying and the introduction of artificial sweeteners, colouring agents, and preservatives such as sodium benzoate. In the late 20th century products such as dried instant soups, reconstituted fruits and juices, and self cooking meals such as MRE food ration were developed.

2.3 BENEFITS

Benefits of food processing include toxin removal, preservation, easing marketing and distribution tasks, and increasing food consistency. In addition, it increases seasonal availability of many foods, enables transportation of delicate perishable foods across long distances, and makes many kinds of foods safe to eat by de-activating spoilage and pathogenic micro-organisms. Modern food processing also improves the quality of life for allergists, diabetics, and other people who cannot consume some common food elements. Food processing can also add extra nutrients such as vitamins.

Processed foods are often less susceptible to early spoilage than fresh foods, and are better suited for long distance transportation from the source to the consumer.

2.4 DRAWBACKS

In general, fresh food that has not been processed other than by washing and simple kitchen preparation, may be expected to contain a higher proportion of naturally occurring vitamins, fibre and minerals than the equivalent product processed by the food industry. Vitamin C for example is destroyed by heat and therefore canned fruits have a lower content of vitamin C than fresh ones.

Food processing can lower the nutritional value of foods. Processed foods tend to include food additives, such as flavourings and texture enhancing agents, which may have little or no nutritive value, or be unhealthy. Some preservatives added or created during processing such as nitrites or sulphites may cause adverse health effects.

Processed foods often have a higher ratio of calories to other essential nutrients than unprocessed foods, a phenomenon referred to as "empty calories". Most junk foods are processed, and fit this category. Processing food is a very costly process, thus increasing the prices of foods products.

2.5 PERFORMANCE PARAMETERS FOR FOOD PROCESSING

When designing processes for the food industry the following performance parameters may be taken into account:

- Hygiene, e.g. measured by number of micro-organisms per ml of finished product
- Energy consumption, measured e.g. by "ton of steam per ton of sugar produced"
- Minimization of waste, measured e.g. by "percentage of peeling loss during the peeling of potatoes"
- Labour used, measured e.g. by "number of working hours per ton of finished product"
- Minimization of cleaning stops measured e.g. by "number of hours between cleaning stops"

2.3 GENERAL INFORMATION

Fruits are a source of nutrients that stimulate digestion and keep us alive and healthy. For

2.6 TRENDS IN MODERN FOOD PROCESSING

2.6.1 Health

- Reduction of fat content in final product e.g. by using baking instead of deep-frying in the production of potato chips.
- Maintaining the natural taste of the product e.g. by using less artificial sweetener.

2.6.2 Hygiene

The rigorous application of industry and government endorsed standards to minimise possible risk and hazards. In the USA the standard adopted is HACCP.

2.6.3 Efficiency

- Rising energy costs lead to increasing usage of energy-saving technologies, e.g. frequency converters on electrical drives, heat insulation of factory buildings and heated vessels, energy recovery systems.
- Factory automation systems (often Distributed control systems) reduce personnel costs and may lead to more stable production results.

2.7 GENERAL INTRODUCTION

Fruits are a source of nutrients that aids digestion and keep us alive and healthy. For example, they contain many vitamins, especially vitamins A and C, and many minerals, such as calcium, potassium, and zinc. They also provide fiber for a healthy digestive system and carbohydrates that the body needs to make energy. They don't have a lot of calories to make us fat.

There are two main types of fruit: fleshy and dry. Fleshy fruits are soft and juicy.

Seedless fruit comes from special plants called hybrids. A hybrid is made by combining two varieties of a fruit to form a new variety. This hybrid grows and produces seeds. But the plants grown from these seeds are seedless. These plants cannot reproduce themselves. They can make fruit, but the fruit has no seeds.

2.8 FRUITS PRODUCTION IN GHANA

Fruits play an important role in providing the body with essential vitamins and minerals which when deficient, can cause malnutrition (Utete and Tembo, 1996). In Ghana, fresh fruits are available in large quantities in the wet season. When production exceeds the family consumption needs and demand levels of the local markets, producers face huge problems in trying to access urban markets. These include lack of market information and marketing intelligence, high perishability of horticultural commodities and lack of refrigerated transport services and poor road networks. More often than not, high value produce is put to waste.



Figure 3. Some Fruits Grown In Ghana (Source, *Alvan Blanch, Processing the Worlds Crops*)

A wide variety of fruits are processed into a variety of products. Preservation relies on an acid dip sulphur dioxide which may be used to reduce the number of contaminating micro-organisms (Fellows, 1997) but this is not commonly practised in Ghana. Dried products are obtained from apple, mango, guava, banana, paw-paw, etc. For a significant number of processors, processing is a traditional activity adopted to enhance fruit security during the agricultural off-season when access to fresh produce is limited. Some surplus may be sold locally to generate income.

There are, however, many constraints that may hinder development of small and medium-scale fruit processing enterprise. These include:

1. Reduced crop production levels as the costs of seed, fertilizers and chemicals have gone up. Small-scale producers also have limited access to fertile land and irrigation facilities

2. Lack of appropriate processing technology. Most of the processors use the usual home kitchen utensils as their basic equipment. Grading, peeling and cutting are done by basic hand tools. There is lack of cold storage facilities to store raw or semi-processed products for use in the off season.
3. Lack of access to appropriate packaging material for processed products especially for those enterprises who wish to market their products through the formal markets. Some enterprises resort to using recycled packaging materials but this raises food safety and hygiene concerns.
4. Poor marketing of products. Marketing of small-scale processed food products is largely informal. Enterprises located in rural areas rely on demand from local informal markets, which are small and unreliable. There is a general lack of marketing skills and information.
5. Lack of appropriate training in food processing. A few processors have received formal training in food processing techniques.
6. Failure to adhere to the general food safety requirements and hygiene practices as required by the food safety regulations.
7. Lack of working capital as most processors experience poor cash flows.

2.9 JUICE PROCESSING

Despite the high level of fruit production in many districts of Ghana, there is food insecurity, poverty, hunger and malnutrition at household level. There is little processing of fruits at small or medium-scale level and farmers are losing out as they often sell their fresh fruits within a few weeks of harvesting at give-away prices. Recent case studies

suggest that small-scale fruit processing has potential to provide improved returns to horticultural producers as long as appropriate processing equipment, processing skills, packaging materials and marketing information are made available.

Pulps/juices can be made from almost any fully ripened fruit, but common types include apple, pineapple, orange, grapefruit, passion-fruit, guava and mango. The pulping, filtering and pasteurising stages of the process should be monitored and controlled to produce a consistent product quality. As the product is acidic there is little risk of food poisoning, but normal hygiene practices should be enforced (Fellows, 1997). Currently juice extraction is being done by large companies. These big companies produce a juice concentrate which they sell to other companies for juice-making.

Most companies that produce the ready-to-drink juices operate at medium-scale level and procure the fruits directly from farmers. This operation does not require heavy investment in equipment. The equipment that is needed is mainly cold rooms, storage tanks and mixing tanks.

2.10 ORANGE JUICE PRODUCTION

BACKGROUND

Orange juice is defined in the United States Code of Federal Regulations as the "unfermented juice obtained from mature oranges of the species *Citrus sinensis* or of the citrus hybrid commonly called Amber sweet." True fresh squeezed juice is difficult to market commercially because it requires special processing to preserve it. Orange juice is commonly marketed in three forms: as a frozen concentrate, which is diluted with

water after purchase; as a reconstituted liquid, which has been concentrated and then diluted prior to sale; or as a single strength, unconcentrated beverage called NFC or Not From Concentrate. The latter two types are also known as Ready To Drink (RTD) juices.



Figure 4. The Processing Of Orange (Source, *Alvan Blanch, Processing the Worlds Crops*)

Citrus fruits, like oranges, have been cultivated for the last 4,000 years in southern China and Southeast Asia. One variety, the citron, was carried to the Middle East sometime between 400 and 600 B.C. Arab traders transported oranges to eastern Africa and the Middle East sometime between 100 and 700 A.D. and during the Arab occupation of Spain, citrus fruits first arrived in southern Europe. From there, they were carried to the New World by explorers where they spread to Florida and Brazil by the sixteenth century. By the 1800s, citrus fruits achieved worldwide distribution. In the 1890s, the demand for them greatly increased because physicians discovered that drinking the juice of oranges or other citrus fruits could prevent scurvy, a vitamin deficiency disease.

The popularity of orange juice dramatically increased again with the development of the commercial orange juice industry in the late 1920s. In its early days, the juice industry primarily relied on salvaged fruit, which was unsuitable for regular consumption because it was badly coloured or blemished. In the 1930s, development of porcelain-lined cans and advances in pasteurization techniques led to improved juice quality and the industry expanded significantly. Then, in 1944, scientists found a way to concentrate fruit juice in a vacuum and freeze it without destroying the flavour or vitamin content. Frozen concentrated juices were first sold in the United States during 1945-46, and they became widely available and popular. After World War II, most Americans stopped squeezing their own juice and concentrated juice became the predominant form. With the increase in home refrigerators, frozen concentrate became even more popular. The demand for frozen juices had a profound impact on the citrus industry and spurred the growth of the Florida citrus groves. Frozen concentrates remained the most popular form until 1985 when reconstituted and NFC juices first out-sold the frozen type.

In 1995, NFC juices were responsible for 37% of the North American market. This is in comparison to reconstituted juice, which held about 39% of the market. Today, commercial aseptic packaging allows RTD juices to be marketed without refrigerated storage. The current worldwide market for orange juice is more than \$2.3 billion with the biggest area being the United States followed by Canada, Western Europe, and Japan.

2.11 RAW MATERIALS

2.11.1 Fruit

The primary ingredient in orange juice is, of course, oranges. Oranges are members of the rue family (Rutaceae), and citrus trees belong to the genus *Citrus*. Oranges, along with all citrus fruits, are a special type of berry botanists refer to as a hesperidium. Popular types of oranges include navel, Mandarin, and Valencia. A blend of different types of oranges is generally used to provide a specific flavor and to ensure freedom from bitterness. Selection of oranges for juice is made on the basis of a number of factors such as variety and maturity of the fruit. The fruit contains a number of natural materials that contribute to the overall flavour and consistency of the juice including water, sugars (primarily sucrose, fructose, and glucose), organic acids (primarily citric, malic, and tartaric), and flavour compounds (including various esters, alcohols, ketones, lactones, and hydrocarbons.)

2.11.2 Other additives

Preservatives such as sulphur dioxide or sodium benzoate are allowed by federal regulation in orange juice although the amounts are strictly controlled. Similarly, ascorbic acid, alpha tocopherol, EDTA, BHA, or BHT are used as antioxidants.

Sweeteners may be added in the form of corn syrup, dextrose, honey, or even artificial sweeteners. More often, though, citric acid is added to provide tartness.

Manufacturers may also fortify juices with extra vitamins or supplemental nutrients such as vitamin C, and less commonly, vitamins A and E, and beta carotene. (Beta carotene is

naturally present in oranges, but only to a small degree.) There is some concern about the stability of these added vitamins because they do not survive the heating process very well. Calcium in the form of tricalcium phosphate, is also frequently added to orange juice.

2.12 THE MANUFACTURING PROCESS

2.12.1 Harvesting/collection

- Oranges are harvested from large groves. Some citrus growers are members of cooperative packing and marketing associations, while others are independent growers. When the mature fruit is ready to pick, a crew of pickers is sent in to pull the fruit off the trees. The collected fruit is sent to packing centres where it is boxed for sale as whole fruit, or sent to plants for juice processing. The oranges are generally shipped via truck to juice extraction facilities, where they are unloaded by a gravity feed onto a conveyor belt that transports the fruit to a storage bin.



Figure 5. Transporting Of Fruits to Be Processed (Source, Southern Gardens Citrus Trade Press Kit)

2.12.2 Cleaning/Grading

- The fruit must be inspected and graded before it can be used. An inspector takes a 39.7 lb (18 kg) sample to analyze in order to make sure the fruit meets maturity requirements for processing. The certified fruit is then transported along a conveyor belt where it is washed with a detergent as it passes over roller brushes. This process removes debris and dirt and reduces the number of microbes. The fruit is rinsed and dried. Graders remove bad fruit as it passes over the rollers and the remaining quality pieces are automatically segregated by size prior to extraction. Proper size is critical for the extraction process.



Figure 6. Grading and Sorting Of Fruits (Source, Southern Gardens Citrus Trade Press Kit)

2.12.3 Extraction

- Proper juice extraction is important to optimize the efficiency of the juice production process as well as the quality of the finished drink. The latter is true because oranges have thick peels, which contain bitter resins that must be carefully separated to

avoid tainting the sweeter juice. There are two automated extraction methods commonly used by the industry. The first places the fruit between two metal cups with sharpened metal tubes at their base. The upper cup descends and the fingers on each cup mesh to express the juice as the tubes cut holes in the top and bottom of the fruit. The fruit solids are compressed into the bottom tube between the two plugs of peel while the juice is forced out through perforations in the tube wall. At the same time, a water spray washes away the oil from the peel. This oil is reclaimed for later use.

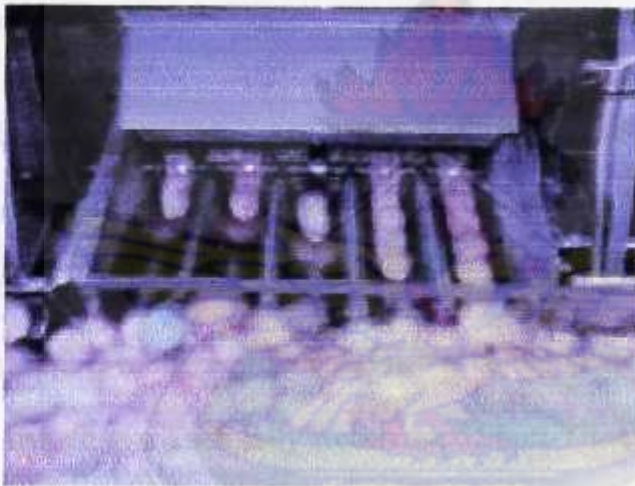


Figure 7 Extraction of Juice from Fruits (Source, *Alvan Blanch, Processing the Worlds Crops*)

The second type of extraction has the oranges cut in half before the juice is removed. The fruits are sliced as they pass by a stationary knife and the halves are then picked up by rubber suction cups and moved against plastic serrated reamers. The rotating reamers express the juice as the orange halves travel around the conveyor line. Some of the peel oil may be removed prior to extraction by needles which prick the skin, thereby releasing

the oil which is washed away. Modern extraction equipment of this type can slice, ream, and eject a peel in about 3 seconds.

- The extracted juice is filtered through a stainless steel screen before it is ready for the next stage. At this point, the juice can be chilled or concentrated if it is intended for a reconstituted beverage. If a NFC type, it may be pasteurized.

2.12.4 Concentration

- Concentrated juice extract is approximately five times more concentrated than squeezed juice. Diluted with water, it is used to make frozen juice and many RTD beverages. Concentration is useful because it extends the shelf life of the juice and makes storage and shipping more economical. Juice is commonly concentrated with a piece of equipment known as a Thermally Accelerated Short-Time Evaporator, or TASTE for short. TASTE uses steam to heat the juice under vacuum and force water to be evaporated. Concentrated juice is discharged to a vacuum flash cooler, which reduces the product temperature to about 55.4° F (13° C). A newer concentration process requires minimal heat treatment and is used commercially in Japan. The pulp is separated from the juice by ultra-filtration and pasteurized. The clarified juice containing the volatile flavourings is concentrated at 50° F (10° C) by reverse osmosis and the concentrate and the pulp are recombined to produce the appropriate juice concentration. The flavour of this concentrate has been judged to be superior to what is commercially

available in the United States and is close to fresh juice. Juice concentrate is then stored in refrigerated stainless steel bulk tanks until is ready to be packaged or reconstituted.

2.12.5 Reconstitution

- When the juice processor is ready to prepare a commercial package for retail sale, concentrate is pulled from several storage batches and blended with water to achieve the desired sugar to acid ratio, colour, and flavour. This step must be carefully controlled because during the concentration process much of the juice's flavour may be lost. Proper blending of juice concentrate and other flavour fractions is necessary to ensure the final juice product achieves a high quality flavour.

2.12.6 Pasteurization

- Thanks to its low pH (about 4), orange juice has some natural protection from bacteria, yeast, and mold growth. However, pasteurization is still required to further retard spoilage. Pasteurization also inactivates certain enzymes which cause the pulp to separate from the juice, resulting in an aesthetically undesirable beverage. This enzyme related clarification is one of the reasons why fresh squeezed juice has a shelf life of only a few hours. Flash pasteurization minimizes flavour changes from heat treatment and is recommended for premium quality products. Several pasteurization methods are commercially used. One common method passes juice through a tube next to a plate heat exchanger, so the juice is heated without direct contact with the heating surface. Another method uses hot, pasteurized juice to preheat incoming unpasteurized juice. The preheated juice is further heated with steam or hot water to the pasteurization

temperature. Typically, reaching a temperature of 185-201.2° F (85-94° C) for about 30 seconds is adequate to reduce the microbe count and prepare the juice for filling.

2.12.7 Packaging/filling

To ensure sterility, the pasteurized juice should be filled while still hot. Where possible, metal or glass bottles and cans can be preheated. Packaging which cannot withstand high temperatures (e.g., aseptic, multilayer plastic juice boxes which don't require refrigeration) must be filled in a sterile environment. Instead of heat, hydrogen peroxide or another approved sterilizing agent may be used prior to filling. In any case, the empty packages are fed down a conveyor belt to liquid filling machinery, which is fed juice from bulk storage tanks. The filling head meters the precise amount of product into the container, and depending on the design of the package, it may immediately invert to sterilize the lid. After filling, the containers are cooled as fast as possible. Orange juice packaged in this manner has a shelf life of 6-8 months at room temperature.



Figure 8. Packaging Of Fruit Products (Source, Alvan Blanch, Processing the Worlds Crops)

2.13 BY – PRODUCTS AND WASTE

By-products from orange juice production come from the rind and pulp that is created as waste. Products made with these materials include dehydrated feed for livestock, pectin for use in making jellies, citric acid, essential oils, molasses, and candied peel. Certain fractions of orange oil (known as d-limonene), have excellent solvent properties and are sold for use in industrial cleaners.

2.14 QUALITY CONTROL

Quality is checked throughout the production process. Inspectors grade the fruit before the juice is extracted. After extraction and concentration, the product is checked to ensure it meets a number of USDA quality control standards. The most important measurement in orange juice production is the sugar level, which is measured in degrees Brix (percentages by weight of sugar in a solution). The types of oranges used and the climate in which they were grown affect the sugar level. Manufacturers blend juices with different sugar levels together to achieve a desired sugar balance. The final juice product is evaluated for a number of key parameters include acidity, citrus oil level, pulp level, pulp cell integrity, colour, viscosity, microbiological contamination, mouth feel, and taste. A sensory panel is used to evaluate subjective qualities like flavour and texture. Lastly during the filling process, units are inspected to make sure they are filled and sealed appropriately.

2.15 THE FUTURE

Future processing improvements are likely to come from the use of computer controlled sizing and grading of fruit. Orange juice formulations will see changes as the trend toward adding more nutrition-oriented ingredients, such as antioxidants, continues. In addition, future formulas are likely to be blends of orange juice with other, more exotic, fruit flavors, like kiwi, or even vegetable juices, like carrot.

2.16 MANGO PROCESSING

Background

Mangoes, a fruit of the tropics, have gradually found their own niche in the production section of supermarkets and fruit stands, and now, mango nectar has followed the trend of new and healthy fruit drinks, setting up residency on our local supermarket shelves. Nutritional elements may vary depending upon the manufacturer and brands available, but you can usually count on an all-natural, delicately flavoured drink, boasting a large dosage of Vitamin C, and to a lesser extent, Vitamin A.

If you've never experienced the sweet-bitter taste of a mango before, it can be described as a highly refreshing blend of pineapple, apricot, and peach. Made from the pulp of mangoes, it is rather excellent drunk solely on its own or blended into smoothies and cocktails.

Fat free and cholesterol free, it is an excellent choice for low-fat and heart-healthy diets.

Rich with antioxidants, the mango nectar also aids the digestive process and is often

touted as a comfort drink and an energetic pick-me-up, as feelings of relaxation and contentment often ensue after drinking the nectar or eating the fruit.

A good brand of mango nectar will also provide most of our daily fibre requirement, as well as potassium and beta carotene, and is relatively low in calories and sodium.

2.17 THE PROCESSING

Mango is native to South and Southeast Asia. It is one of the most important tropical and subtropical fruits in terms of production, acreage and popularity. The largest production is in

India. Mangoes are climacteric. They are usually harvested in a mature but unripe stage.

They are not allowed to ripe on the tree. Tree ripe mangoes are inferior in taste; aroma and keeping quality to those ripen after harvest. In Mango fruit that is good for processing the flesh must be of good taste, colour and flavour and without a terpeney door. The peel constitutes a significant portion of the fruit. The peel may weigh 6.5-25% of the fresh fruit, while the edible pulp or flesh is 32-85%. Although there exists indication not to peel before pulp production it is highly recommended. Mangoes should be thoroughly washed to remove dirt.

Mango nectar can be made either directly from fresh mango fruit or from mango puree which has been conventionally canned aseptically packed or pasteurised and frozen. A typical mango nectar is one with 20-30% puree, 12-13 °Bx, (sugar added) Ph around 3.5 and acidity 0.2-0.3%. The ingredient of the recipe are thoroughly mixed (power stirrer or

homogenised) and after thermal processing filled into cans, glass or aseptically packed in cartons. Juice concentration is possible (serum pulp process)

2.18 PINEAPPLE JUICE PRODUCTION

Background

Pine apple juice ranks fourth on the juices consumed in the US after oranges apple and grape fruit. Thailand is the world's largest canned exporter in. (Philippines, US,

Malaysia) Thailand

continued to be the world's leading producer of pineapple juice concentrate. (Brazil)

There are two basic types of processing plants currently used to produce single strength and concentrated pineapple juice.

A: fresh fruit that do not pass quality specifications such as overripe are diverted to the processing plant for production of single strength juice or concentrate

B: This operation is canned fruit oriented consisting basically of canning solid pack pineapple products. Juice is a by-product. The juice processing in A is typically simpler than in B.

The fruits processed by GINACA (henry Gianaca 1913) deliver parts of the fruit that are processed top juice such as core, meat between fruit and shell and fruit cylinder and the top and bottom of the fruit. Speed of Gianaca depends on size 56/min large -96 small size) Juice is collected from the slicing and trimming operation. Small fruit may be extracted in a PINE-O-MAT. The fruit is cut into halves and are fed to an extraction drum. The extraction drum draws the fruit into a contracting chamber between the

extraction drum and a perforated grid. The meat is sheared and pressed from the shell.

Pineapple juice may be extracted from fruit pieces using

multistage screw press to maximise recovery to about 90%. Juices from liquid sources and solid fruit constituents are blended with agitation in tanks, to which up to 10pp anti foam may be added to reduce foaming due to the presence of gums. Preheating (60°C in plate or tubular exchangers) Centrifugation Should guarantee an content of 5-30% of insoluble solids. These

suspended solids are important to the mouth feel and improve the flavour. Single strength juice may be further processed: Hot filled into cans Cold filling Aseptic process. HTST and aseptical filling Concentrate: multiple effect plate or tube. Essence is separated in the first effects for optimal quality and added back to the final concentrate. Concentrate is produced as 61 to up to 72 °Bx. The concentrates are packed both aseptic and frozen. Heat resistant spore forming moulds *Bysochlamys fulva*.

2.19 PROCESSING PLANT OVERVIEW:

Orange processing plants are located in the vicinity of the fruit growing area. Fruit should be processed as soon as possible after harvesting because fruit deteriorates quickly at the high temperatures found in citrus growing areas. In the orange industry the basic unit of reporting crop and plant intake is commonly the fruit box: A box of oranges is defined as containing 40.8 kg (90 lb) of fruit. In Florida small/ medium size plants typically process 5-10 Mill boxes (200-400 000 tonnes) large plants up to 25 Mill boxes Citrusuco, Matao, Brasil (60 Mill boxes (2.4 Mill Tonnes) per season, Orange juice as defined is the

unfermented juice obtained from mature oranges of species citrus sinensis. Brix /acid ratio is used as an indicator for citrus maturity which is the ratio of the degrees Brix to percent acid as anhydrous citric acid. (min 8)

2.20 FRUIT RECEPTION:

Fruit is delivered in trucks, 20 tons capacity. The fruit may be prewashed to get rid of immediate surface dirt and pesticide residue before any leaves and stem still attached are removed. Then follows pre-grading by manual inspection to remove any unsuitable fruit. Sound fruit is conveyed to storage bins. Storage bins are of inclined (schräg abfallend) multilevel internal baffles, to prevent too much weight pressing on fruit up to 24 hours. A sample of fruit is taken for analysis from each truck (juice yield, °Brix, acidity, co sample

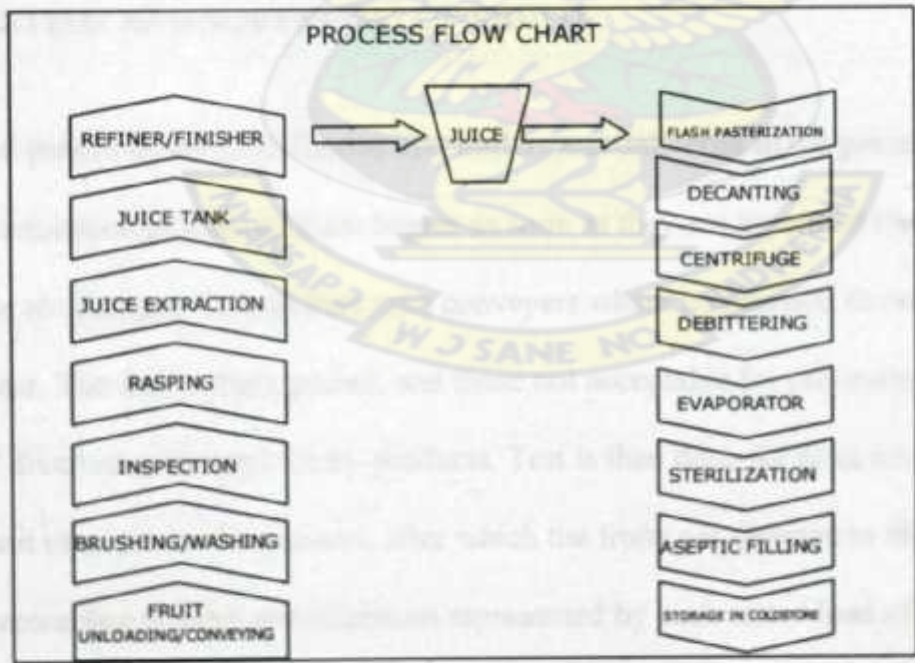


Figure 10.Fruit Processing Flow Chart (Source: Korea Association of Machinery Industry)

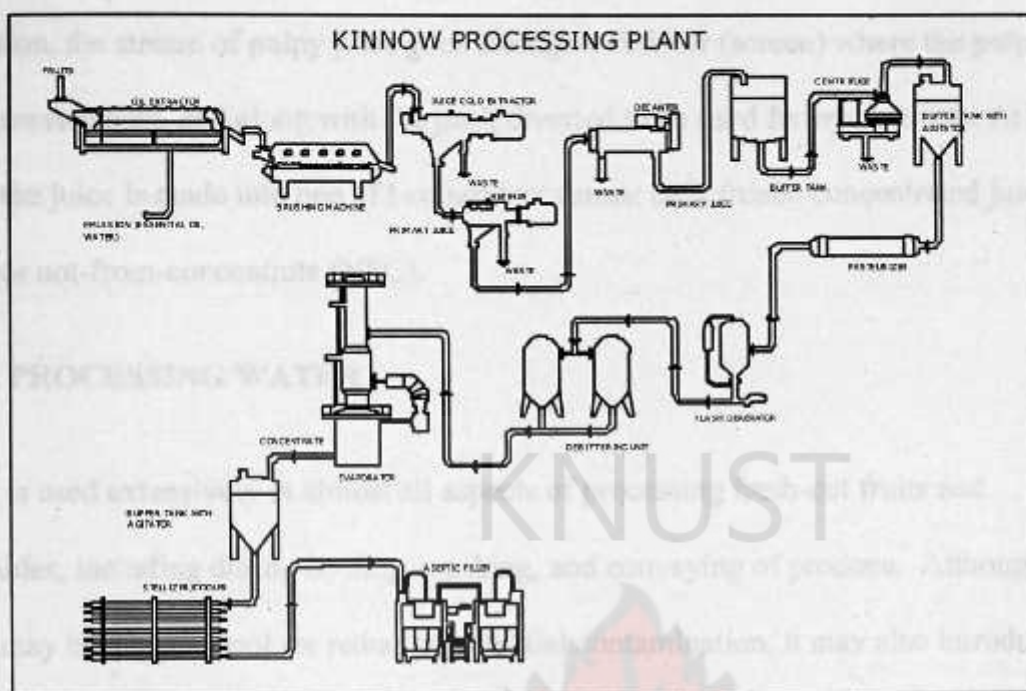


Figure 10a. **Fruit Processing Plant** (Source: Korea Association of Machinery Industry)

2.21 HARVESTING AND SQUEEZING OF FRUITS

Fruits are hand-picked in the field, loaded into trailers and delivered to the processing plant. The deterioration process of fruits begins as soon as they are separated from the tree. The fruits are dumped from trailers onto conveyers where it is carried through a washing process. The fruit is then graded, and those not acceptable for processing are separated and diverted to be used for by-products. Test is then done for juice and solids content, the unit of payment for growers, after which the fruits are diverted to storage bins labelled according to juice specifications represented by each tested load of fruit. The fruits are then selected from labelled bins to enable blending juice of optimal quality and transported by means of conveyor to juicing machines (extractors). After juice

extraction, the stream of pulpy juice goes through a finisher (screen) where the pulp and seeds are removed, and along with the peel, diverted to be used for by-products. At this stage, the juice is made into one of two product forms: bulk frozen concentrated juice (FCJ) or not-from-concentrate (NFC).

2.22.1 PROCESSING WATER

Water is used extensively in almost all aspects of processing fresh-cut fruits and vegetables, including during cooling, washing, and conveying of produce. Although water may be a useful tool for reducing potential contamination, it may also introduce or spread contaminants. When used for washing, cooling, rinsing, or conveying food, it is recommended that water comply with applicable national requirements.

In a fresh-cut processing operation, water quality changes as the water is used and, thus, maintaining the quality of processing water should be considered. Reusing processing water may present a risk of new or increased number of microbial populations, including human pathogens.

The following practices are recommended:

- Where water is reused in a series of processes, arranging water flow to be counter to the movement of produce through different operations, with the result that as produce is further processed, it is exposed to the cleanest water
- Monitoring and treating processing water for level of disinfectant chemical to ensure the water is maintained in a condition suitable for the application (e.g., washing, cooling, or transporting) and does not become a source of microbial contamination

- Routinely inspecting and maintaining equipment designed to assist in maintaining water quality, such as chlorine injectors, filtration systems, and backflow devices, to ensure efficient operation

It is recommended that ice used on fresh or fresh-cut produce be included in routine water quality testing.

2.22.2 WASHING FRESH FRUITS

Prior to arriving at the processing facility, fruits may be washed in the field or in a place such as a cooling facility. Fruits may also go directly from the field to the processing facility to be washed after receipt. Regardless of where the initial washing of the produce takes place, washing produce can reduce the overall potential for microbial food safety hazards because most microbial contamination is on the surface of the produce. If pathogens are not removed, inactivated, or otherwise controlled at this initial stage, they can potentially spread the contamination to additional produce during processing.

Washing fruits before any processing of the produce occurs may reduce potential surface contamination. However, washing, even with disinfectants, can only reduce, not eliminate, pathogens, if present. Washing has little or no effect on pathogens that have been internalized in the produce.

A number of post harvest processes, such as hydro cooling, use of dump tanks, and flume transport utilize a high degree of water-to-produce contact. It is recommended that fresh-cut processors use practices to maximize the cleaning potential during these processes and to minimize the potential for cross-contamination.

- The following practices are recommended:
- Using a series of washes, if appropriate

For some operations, a series of washes may be more effective than a single wash. An initial wash treatment may be used to remove the bulk of field soil from produce followed by an additional wash or washes containing an antimicrobial chemical.

- Using appropriate wash methods

Vigorous washing of produce not easily bruised or injured increases the likelihood of pathogen removal. Different methods may be used to wash different types of produce, including submersion, spray, or both. Regardless of the method used, maintaining the quality of the wash water is important in order to minimize the potential for contamination.

- Maintaining the efficacy of wash treatments
- Using wash water of an appropriate temperature

Produce is susceptible to infiltration of wash water if warm produce is placed in water that is cooler than the produce. Such infiltration occurs when the temperature difference creates a pressure differential causing air spaces inside the fruit or vegetable to contract, thereby allowing water to be pulled into the fruit or vegetable. If pathogens are present in the cooling/wash water, they may infiltrate the produce, and subsequent washing will not reduce levels of these pathogens. Therefore, water used for washing or cooling produce should contain sufficient levels of disinfectant to reduce the potential for pathogens to persist in such water. When it is not practical to reduce the temperature differential between the

wash/cooling water and the produce, it is especially important that processors follow practices to minimize pathogens in the water or on the surface of produce. Such practices may include using antimicrobial chemicals in the wash water or using spray type wash treatments instead of submerging produce. Alternatively, produce may be cooled by means other than hydro cooling and then washed with water that is warmer than the produce.

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CHAPTER THREE

3.0 CASE STUDIES

3.1 (NOURISHER PROCESSING LTD –ACCRA - NORTH)

3.1.1 LOCATION

Nourisher Processing Limited is located at Accra - North opposite the old White Chapel building in the Greater Region of Ghana.

3.1.2 BACKGROUND

This company was established in 1995 and deals in the processing of orange, pineapple and banana and has a production capacity of 8 tons per day. These raw materials are obtained from Nsawam, Aburi and Akwapim areas; the company was established in Accra because of the availability of services. The price of the raw materials is determined by the company, these raw materials are brought to the factory by the farmers themselves and they are paid every weekend and the distance from the raw material to the factory is about 50 to 60km thus about one hour drive. The company's capacity for raw material storage is 64 tons but most often than not raw materials are processed as soon as they are brought from the farm. The prices of finished products are fixed based on the cost of production and the total number of labour is 25 and the distribution is 14 female and 11 male. The finished products are delivered to customers by the company.

The waste generated are mostly the pulps, peels and water, the solid wastes are carried away by the A.M.A on contract basis and the sanitation situation of the company must

conform to EPA standards. Water for the factory is obtained from Ghana Water Company and is stored in storage tanks for use when taps are not flowing. The source of power to the company is obtained from the Electricity Company of Ghana. The company hopes to process mixed fruit juice in future.

MERITS

- The location of the factory is very strategic because of its proximity to labour and market.
- The various units of the factory have been well linked to each other.
- The factory is close to a public sewer.
- The factory is located in an industrial area.

DEMERITS

- The security post is too far away from the main entrance.
- The parking area is not well defined
- The waste disposal unit is too open to public view.
- Service area is not well defined.



Figure 11. Fruit Receiving, Selection and Weighing Area (Source: Nourisher Processing Ltd Accra - North)

The receiving, selection and weighing of fruits is done under an open shed close to the production floor. This is done to make sure that fruits of acceptable quality are selected and processed.



Figure 12. Fruit Washing Area (Source: Nourisher Processing Ltd Accra - North)

The washing of fruits take place in the production floor and this is done in big tanks fill with water and chlorine. This is done manually and the floor and the wall have been tiled for easy cleaning.



Figure 13. Fruit Peeling and Cutting Area (Source: Nourisher Processing Ltd Accra - North)

The peeling and cutting area is also located within the production floor and peeling and cutting is done here before the extraction of the fruit juice is done.



Figure14. Crushing and Pressing Area (Source: Nourisher Processing Ltd Accra - North)

The crushing and pressing area is done after washing of the fruit and this is the process whereby the juice is extracted from the fruits. This area is also located within the factory floor.



Figure15. Juice Filtration Section (Source: Nourisher Processing Ltd Accra - North)

The juice filtration section is also located within the production floor and this is the section where the pulp is filtered from the juice.



Figure16. Electric Pasteurization Section



Figure 17. Gas Pasteurization

(Source: Nourisher Processing Ltd Accra - North)

The pasteurization section is the stage where heat is applied to the fruit juice to make it wholesome for consumption and also to make it stable for storage for a longer length of time.



Figure 18. **Filling Area** (Source: Nourisher Processing Ltd Accra - North)

The filling area is also located within the production floor and at this stage the processed fruit juice is filled into sachets and bottles ready to be packaged.



Figure 19. **Packaging Section** (Source: Nourisher Processing Ltd Accra - North)

The packaging section is located close to the production floor and at this stage the finished products are packed into cartons and crates ready to be sold to consumers.



Figure20. Raw Material Storage Area (Source: Nourisher Processing Ltd Accra - North)

The raw material store is located close to the production floor and this is the area where the raw materials which are yet to be processed are kept waiting processing.



Figure21. Finished Goods Storage Area (Source: Nourisher Processing Ltd Accra - North)

The finished products storage area is also located close to the production floor and it is the area where the finished products are kept till they are sent to the market centres.



Figure22. The Central Vat Machine (Source: Nourisher Processing Ltd Accra - North)

The central vat machine is located within the production floor and it is used to store the pasteurized juice till it is pumped to the filling machine.



Figure23. The Bottle Filling Machine (Source: Nourisher Processing Ltd Accra - North)

The bottle filling machine is also located within the production floor and this is where the centrifugal pump pumps the juice to, the machine containing the juice is used to fill the bottle.



Figure24. Finished Products to Be Sent To Storage Area (Source: Nourisher Processing Ltd Accra - North)

The finished products packed into cartons are temporary stored here ready to be sent to the storage area. This space is located at the packaging unit.



Figure25. Drainage System (Source: Nourisher Processing Ltd Accra - North)

The drainage system is located behind the production block and it is a gutter which runs at the whole length of the block with waste water pipes connected from the production floor into it. This waste water drains into a public waste water disposal unit.



Figure26. Standby Generator (Source: Nourisher Processing Ltd Accra - North)
The standby generator is also located behind the production block and it is used when the power from the electricity company of Ghana is off to give power for the operation of the company.



Figure27. The Centrifugal Pump Fixed To the Central Vat (Source: Nourisher Processing Ltd Accra - North)

The centrifugal pump fixed to the central vat to enable the pasteurized juice to be pumped to the bottle filling machine and this is also located within the production floor.



Figure28. Water Storage Tank (Source: Nourisher Processing Ltd Accra - North)

The water storage tank is used to store water to be used when the water supplied from the Ghana water company is not flowing.



Figure29. Gas Storage Tank (Source: Nourisher Processing Ltd Accra - North)

The gas storage tank is also located behind the production floor and supplies gas to the pasteurizing system that uses gas in the absence of the electrically powered one.



Figure30. Air Compressor (Source: Nourisher Processing Ltd Accra - North)

The air compressor is located behind the production floor and it supplies air to the filling machine to enable it to pump the juice to fill the bottles and sachets.



Figure31. Waste Disposal Unit (Source: Nourisher Processing Ltd Accra - North)

The waste disposal unit is located close to the main entrance to the company and it is where all the production wastes are disposed off to be collected by the A.M.A on contract basis.



Figure32. **Parking Area** (Source: Nourisher Processing Ltd Accra - North)

The parking area is located in front of the factory building and it is where all the vehicles for the staff and customers are parked but the space is not well defined.

3.2 OPERATIONS AND GOOD MAINTENANCE PRACTICES OF A PROCESSING PLANT

Washing Tank

- Wash and drain the tank clean.
- Fill with water to about $\frac{3}{4}$ fill and add 4 tabs of 10g chlorine.
- Fill each with 100kg of fresh fruits at a time.
- Wash fresh fruits with brush, drain and refill tank with water after every $\frac{1}{2}$ ton of fresh fruit.
- Wash and clean tank after the day's use.

Working Table

- Wash the table before and after use with food grade detergent.

Holding Tanks

- Wash the tank before and after use.

Crushing Machines

- Rinse and wash machine before and after use.
- Fill the peeled and cut pieces of the pineapple into the hopper.
- With a plunger, push the pieces of the pineapple down the hopper for crushing and receiving the crushed pulp from the outlet.

Pasteurizer

- Flash the machines with chlorinated water before use.
- Fill the plant with water by means of the water pump. Heat the water and circulate the heated water through the plant.
- At temperature 100%, pump the yielded fresh fruit juice into the machine from the juice tank.
- Circulate the juice through the heat exchange arrangement for ten minutes and discharge to the central tank at a temperature of 95°C.
- After use, flush or wash the piping system of machine with caustic soda solution at a temperature of 75°C.

Doypack Filling Machines

- Remove the cover of the hopper and wash inside the hopper.
- Refix the head, check and clean the strainers.

- Pump in water to flush the container whiles using the same water to set the correct level of the plunger to deliver either 300ml or 1 liter depending on whatever is the packaging for the day.
- Set the welding jaw to a gap of 4mm.
- Set the welding jaw to a temperature of 75°C, and then start the operation when the green bulb glows.
- Load the pouch compartment with pouches about 300pcs (3 boundless) at a time.
- Set the dosing volume to either 300ml or 1 liter as the case might be.
- Fill one pouch at a time whiles the sealer also does the same.
- After use, flush the system with warm water first and flush with caustic soda at a temperature of 75°C.

Bottle Filling Machine

- Wash bottle machine before and after use.
- Fill the machine by pumping the hot juice from the center jacket vat.
- Prime each of the nozzles to get juice flowing units into the bottles.
- Remove and replace filled bottles with empty ones, one station after the other.

Bottle Sealing Machines

- Check and secure height adjustment to the bottle height.
- Check lubrication on bevel gear system.
- Check that the pressure handle is well tightened.

Air Compressor

- Check hydraulic oil level.

- Drain out all condensed water, periodically, indicate the discharged valve to release any trapped condensed water.
- Check belt for breaks and good tension.
- After use, drain out completely.

Factory Floor

- The floor is washed clean with food grade detergent dozed with some detol after close of work every day.
- Cobwebs are removed once every week. Painting to be done once every year.

3.3 (BOMARTS FARMS LIMITED – NSAWAM)

3.3.1 LOCATION

Bomarts Farms Limited is located at Nsawam, Doboro to be precise in the Eastern Region of Ghana off the Accra – Kumasi road.

3.3.2 BACKGROUND

Bomarts Farms Limited was established in 1985 and sells pineapples and mangoes to the local and international market. It exports 50% of its MD 2 pineapple to the UK, 30% to Italy and 20% to Switzerland. Bomarts produce both smooth cayenne and MD 2 (Extra Sweet or Golden variety) pineapple varieties. The introduction of the MD 2 has pushed the traditional Ghanaian export variety (smooth cayenne) out of the international market, putting farmers in a very difficult situation. The World Bank is sponsoring an initiative which seeks to assist smallholders to convert their smooth cayenne fields to MD 2 by providing access to planting materials in collaboration with the ministry of agriculture.

The company is planning to go into the processing of these fruits since not all of the fruits can be exported or sold in the local market.

MERITS

- The storage facility is well linked to the production floor.
- The loading and off-loading bay has been strategically positioned to facilitate easy loading and off-loading of goods.
- The administration is well linked to the production floor.

DEMERITS

- No provision of canteen for working staff.
- The parking space provided is not well defined.
- Service yard is too far away from the main entrance.
- No storage facility for raw material has been provided.

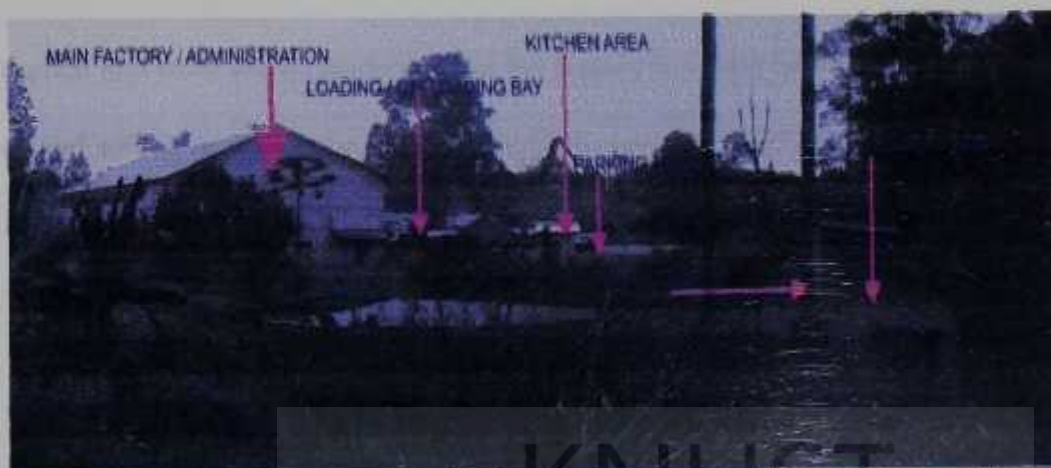


Figure 33. **The Factory in Relation with Its Environment** (Source: Bomarts Farms Limited – Nsawam)



Figure 34. **Outdoor Canteen for Workers and Customers** (Source: Bomarts Farms Limited – Nsawam)

The canteen is located at the central part of the site close to the kitchen. It is an open shed roofed with thatch and is meant to serve both the staff and customers.



Figure 35. **Kitchen and Store Area** (Source: Bomarts Farms Limited – Nsawam)

The kitchen and store are located between the factory building and the canteen. Here food cooked and served to staff once a day and sold to customers and other visitors.



Figure 36. Parking Area (Source: Bomarts Farms Limited – Nsawam)

The parking area is located just in front of the main factory building and it is meant for staff, customers, for off – loading raw materials and loading finished goods. The parking area is not well defined.



Figure 37. Loading And Offloading Bay (Source: Bomarts Farms Limited – Nsawam)

The loading and the off-loading bay is located close to the main entrance to the production floor. The production floor has been raised in such a way that it is of the same level as the base of the vehicle, this allows easy loading and off-loading of finished goods and raw materials.



Figure 38. Main Factory Building (Bomart) (Source: Bomarts Farms Limited – Nsawam)

The main factory building is located close to the main service entrance for easy flow of raw materials and finished goods. The main factory building contains the administration and the storage facility of the factory.



Figure 39. Main Production Area (Source: Bomarts Farms Limited – Nsawam)

The main factory floor is the place where the preparations of the fruits are done.



Figure 40. Packaging Area (Source: Bomarts Farms Limited – Nsawam)

The packaging area is the place where the finished goods are packed into boxes and sent to the storage area ready to be sent to the port for export. This area is located close to the storage area for easy movement of finished goods to the storage area.



Figure 41. Grading And Sorting Out Of Fruits (Source: Bomarts Farms Limited – Nsawam)

Grading and sorting out of fruits is done after washing and waxing of the fruit has been done. The grading and sorting are done by weight and colour followed by packing into boxes.



Figure 42. Storage Area (Cold Room) (Source: Bomarts Farms Limited – Nsawam)

After the fruits are packed into boxes, they are then sent to the storage area which has a temperature of 7 – 8°C but 8°C is the ideal temperature.



Figure 43. Fork Lifts For Carrying Fruits (Source: Bomarts Farms Limited – Nsawam)

These forklifts are used for carrying fruits from and to the vehicles. This is done so as to reduce the number of labour required to load and off-load the fruits.



Figure 44. Main Entrance / Security Post (Source: Bomarts Farms Limited – Nsawam)

The security post is located at the main entrance, this is to check whatever goes in and out of the factory premises are checked.



Figure 45. Power Supply To The Factory (Source: Bomarts Farms Limited – Nsawam)

The source of power to the factory is from the electricity company of Ghana but there is also a standby generator which supplies power to the factory when there is a power failure.

3.3.2 FRUIT PREPARATION STEPS

- Harvesting and transportation of fruits from the farms.
- The fruits are brought to the storage facility.
- Washing and waxing of fruits then take place. Washing water is mixed with chlorine, thus 65,000 liters of water is mixed with 700 grams of chlorine. Also 4 liters of wax is mixed with 60 liters of water for waxing.
- After washing and waxing grading and sorting follows. This is done by colour and weight
- The fruits are then packed into boxes and then sent to the storage facility which has a temperature of 7 – 8C but 8C is the ideal.
- Fruits which are not good for export are sent to processing plants to be processed.

3.4 (PAPSO GHANA. LTD – OFF SPINTEX ROAD ACCRA)

3.4.1 LOCATION

Papso Ghana Limited is located at Accra off the spintex road of the Greater Region of Ghana.

3.4.2 BACKGROUND

This company was established in 2004 and deals in the processing of orange, pineapple and mango and has a production capacity of 800 cartons per day. These raw materials are obtained from Nsawam, Aburi and Akwapim area, the company also has its own farm

which supplies part of the raw materials. The price of the raw materials is determined by the company.

The company has no storage facility for the raw material this is because the raw material is processed immediately it arrives from the farm also storing this fruits before processing is an additional cost and is therefore avoided.

The products are sold locally and are in high demand during the festive seasons. The company has a laboratory where tests such as quality control, analysis, testing of ph level, testing of sugar levels and taste etc. The labour force for the company is 35 and in – service training is organized for the workers from time to time to update them on emerging technologies.

Electricity supply is by Electricity Company of Ghana and there is a standby generator for power supply in case of power failure. Water is supplied from Ghana Water Company which is stored in storage tanks. The waste is given to pig farmers and there is space for future expansion.

MERITS

- The storage facility is well linked to the production floor.
- The loading and off-loading bay has been strategically positioned to facilitate easy loading and off-loading of goods.
- The administration is well linked to the production floor.

DEMERITS

- No provision of canteen for working staff.
- The parking space provided is not well defined.
- Service yard is too far away from the main entrance.
- No storage facility for raw material has been provided.



Figure 46. **Entrance Gate / Security Post** (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The security post is located at the main entrance, this is to check whatever goes in and out of the factory premises are checked.



Figure 47. **Parking Area** (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The parking area is located just in front of the administration block and it is meant for staff and customers, the parking area has been paved but not well defined.



Figure 48. Reception Area (Source Papsa Ghana, Ltd – Off Spintex Road Accra)

The reception is located within the administration block and it is the first point of call for each and everyone who visits the factory. It is also the place where all enquiries are made.



Figure 49. Conference Room (Source Papsa Ghana, Ltd – Off Spintex Road Accra)

The conference room is located close to the managing director's office and it is the place where all meetings regarding to the day to day administration of the company are held.



Figure 50. Administrative Offices (Source Papsa Ghana, Ltd – Off Spintex Road Accra)

The administrative offices are offices which are used by the executives of the company to run the affairs of the company and are located close to the reception for easy accessibility.



Figure 51. **Administration Block** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

The administration block is located close to the main entrance and the parking area and it contains the reception, offices and storage facilities. It is the first point of call for the every visitor who visits the place and also serves as a place where enquiries are made.



Figure 52. **Production Block** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

The production block is located behind the administration block and it contains the production floor, storage facilities, laboratory and changing rooms. It also has a loading and off-loading bay at the back of the block where raw materials are received and finished goods are taken away.



Figure 53. **Finished Product Showcase Area** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

The finished product showcase area is a recessed created in front of the reception; it is located here because that is the first point of call for all visitors and the can all see and appreciate it.



Figure 54. **Loading / Off-Loading Area** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

The loading and off – loading bay is located behind the production block and it serves as a place where off – loading of raw materials and loading of finished goods are done.



Figure 55. **Packaging Unit** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

The packaging unit is located within the production block and it is within this that the finished products are packaged and arranged ready to be sent to the market centres.



Figure 56. **Bottling Unit** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

The bottling unit is located within the production floor and this is the place where the finished fruit juice is filled into bottles ready to be packaged.



Figure 57. **Peeling Unit** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

The peeling unit is the place where all fresh fruits to be processed are peeled before the juice is extracted from them, it is also located within the processing floor.



Figure 58. Bottles Washing Area (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The bottles washing area is an area where the bottles to be filled with juice are washed.



Figure 59. Main Entrance to the Facility (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The main entrance is the main access way to the facility where all vehicle and pedestrians enter or go out of the factory. The pedestrians access has been separated from that of the vehicles.



Figure 60. Washing Of Fruits (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The area for the washing of fruits is located in the production floor and at this stage fruits are washed in a washing tank with water mixed with chlorine for disinfection.

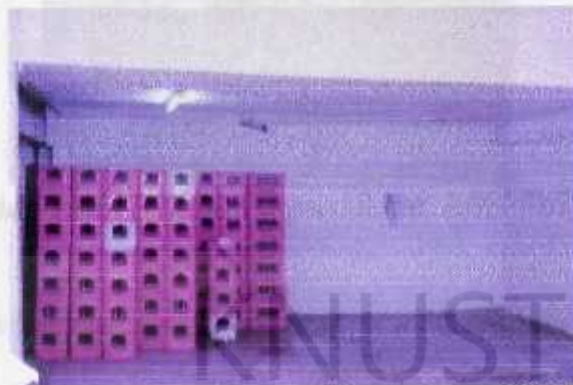


Figure 61. Storage Area (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The storage area is located within the production block and it is the place where the finished and packaged are stored ready to be sent to the market centres.



Figure 62. Storage Area for Fruit Concentrate (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The storage area for concentrate is used to store concentrate of fruit juice which has been imported to be used to prepare the fruit juice.



Figure 63. **Production Floor** (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The production floor is the place where all the processing activities take place from sorting and grading of the fruit to the filling of the juice into the bottles and sachets.



Figure 64. **Laboratory for Quality Assurance** (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The company has a laboratory where tests such as quality control, analysis, testing of pH level, testing of sugar levels and taste etc. are performed. This is located close to the production floor.



Figure 65. **Waste Disposal Unit / Treatment** (Source Papso Ghana. Ltd – Off Spintex Road Accra)

The waste disposal unit is located behind the production block and the peels are given to the pig farmers around the area, the other waste is burnt at the disposal unit.



Figure 66. **Lighting System in the Production Area** (Source Papso Ghana, Ltd – Off Spintex Road Accra)

For the lighting system transparent roofing sheets has been arranged in various intervals to admit natural light into the space and this is complemented with light generated by electricity.



Figure 67. **Ventilation System in the Production Area** (Source Papso Ghana, Ltd – Off Spintex Road Accra) (2009)

The ventilation system in the production floor is a honey comb used to admit natural light into the space and this is complemented with fans.



Means Of Admitting Daylight Into The Production Unit



Landscape And Sun shading Systems

Figure 68. (Source Papso Ghana, Ltd – Off Spintex Road Accra)

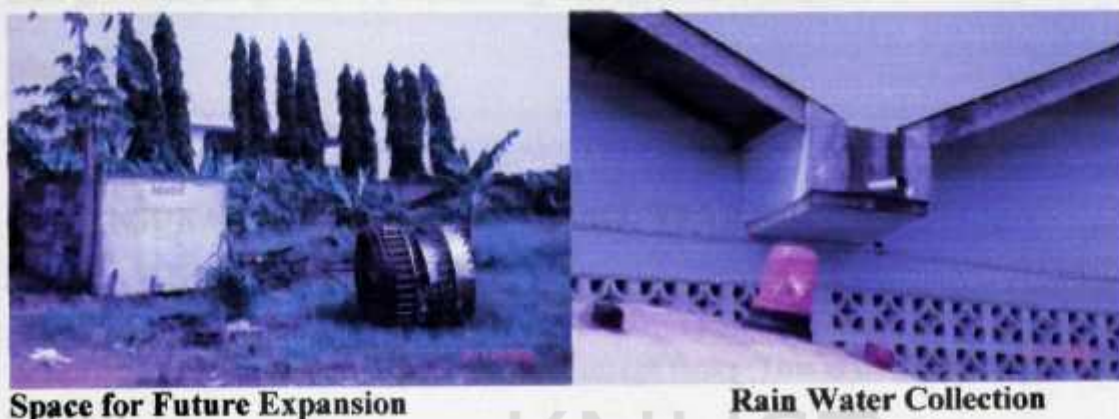


Figure 69. (Source Papso Ghana. Ltd – Off Spintex Road Accra)

3.5 (SOUTHERN GARDENS CITRUS COMPANY – SOUTHERN FLORIDA)

3.5.1 Background

Southern Gardens Citrus Processing Plant, the first new juice processing facility in Florida in over two decades, opened in January 1994.

Southern Gardens Citrus is located in Southern Florida in Hendry County near Lake Okeechobee. This area has milder winter weather, making it less prone to damaging winter freezes. Hendry County is fast becoming Florida's most important citrus producing region.

With three million trees on 30,000 acres of groves, Southern Gardens Citrus is one of Florida's largest citrus growers. Nearly all of these fruit-bearing trees were raised in the company's own nursery.

Today, Southern Gardens Groves produces over seven million boxes of Valencia and Hamlin oranges each season, enough to produce about 42 million gallons of juice. The

fruit grown in the groves is processed by our adjacent state-of-the-art citrus processing plant.

3.5.2 ENSURANCE OF FRUIT JUICE ALL YEAR ROUND

To ensure that fresh Florida orange juice is available year-round, Southern Gardens has constructed 56 one million gallon aseptic storage tanks. This is one of the largest NFC storage campuses in the world, second only to Tropicana.

3.5.3 PRODUCTION CAPACITY

During the October-to-June harvest season, the citrus plant processes over 20 million boxes of oranges, producing more than 120 million gallons of not-from-concentrate and frozen premium quality orange juice annually. Using state of the art technology and assuring consistently high quality juice, Southern Gardens supplies more than 50% of the nation's private label not-from-concentrate juice.



Figure 70. The Processing Plant and Its Environment (Source, Southern Gardens Citrus Trade Press Kit)

3.5.4 FRUIT RECEIVING

Oranges are delivered in trailers, which are elevated so that the fruit can be gently unloaded.

The oranges are washed to remove dirt, leaves and twigs. After any remaining stems are mechanically removed, the fruit goes through the first grading process to remove damaged fruit.

MERITS

- The various departments are well linked to each other.
- The availability of aseptic storage facility ensured that there is available all year round.
- The use of waste management plant to process the waste ensured that revenue is generated for the smooth running of the plant. It also helps to keep the surrounding environment clean and healthy.

DEMERITS

- The plant is far away from the labour force or settlements.
- The company processes only citrus fruits.
- Most of the operations in the company are mechanized.



Figure 71. Trucks Off-Loading Fruits (Source, *Southern Gardens Citrus Trade Press Kit*)

3.5.5 FRUIT BINS

Then the fruit is carried by conveyor and bucket elevators to storage bins. Each bin holds one trailer of fruit. On its way to the bins, a required sample of fruit is taken by the Florida

Department Agriculture (FDA) for testing to ensure Florida's high quality standards are maintained.



Figure 72. Storage of Fruits (Source, *Southern Gardens Citrus Trade Press Kit*)

3.5.6 FINAL WASHING AND GRADING

After the fruit passes state inspection, it is released from the bins by quality control to final washing and grading.



Figure 73. **Washing / Grading Of Fruits** (Source, *Southern Gardens Citrus Trade Press Kit*)

3.5.7 JUICE EXTRACTION

After washing, the fruit is automatically sorted by size as it enters one of the three juice extractor lines. The extractor lines run 23 hours-a-day and squeeze the juice out of 23,000 oranges every minute, resulting in 650,000 gallons of orange juice every day.

The juice extractors separate the juice and pulp from the peel, seeds and membrane. At the same time, orange oil is squeezed from the peel. The recovered orange oil is used in flavorings and chemical applications. The peel, seeds and membranes are conveyed to the feed mill to be converted into cattle feed.



Figure 74. **Extraction of Fruits** (Source, Southern Gardens Citrus Trade Press Kit)

3.5.8 JUICE FINISHING

The juice and pulp continue to the juice finishers. The finishers tailor the juice's pulp content to

customer specifications. Pulp cells and pulp wash are separated and recovered as by-products that are used in fruit beverages.



Figure 75. **Juice Treatment Machinery** (Source, Southern Gardens Citrus Trade Press Kit)

3.5.9 NOT - FROM - CONCENTRATE ORANGE JUICE

At this point, the juice processing splits into production of natural strength and concentrated orange juice. Not-from-concentrate (NFC) juice is pasteurized, quickly heated to destroy bacteria and then quickly chilled to 32 degrees.



Figure 76. Juice Treatment Machinery (Source, Southern Gardens Citrus Trade Press Kit)

3.5.10 ORANGE JUICE CONCENTRATE

For concentrated orange juice, 85 percent of the water is removed by evaporation units. Each of the three units can remove nearly 25,000 gallons of water per hour. The essence and aromas, major-by-products, are recovered in this step to be used in the flavor and fragrance industries.



Figure 77. Juice Concentrate Process (Source, Southern Gardens Citrus Trade Press Kit)

3.5.11 BLENDING

The concentrate moves through a chilling process, where it is cooled to 34 degrees. By now, the juice has been reduced to one-sixth its former volume. Then the concentrate is blended to the specifications of each customer. After blending the juice is further chilled to less than 20 degrees and transferred to tank farm storage.



Figure 78. **The Blending Process** (Source, *Southern Gardens Citrus Trade Press Kit*)

3.5.12 COLD STORAGE

In the concentrate tank farm, five million gallons of concentrated orange juice are stored in 200,000-gallon bulk tanks at a constant temperature. In addition, the tank farm can store cold pressed oil and essence. The NFC juice is stored in one of the plant's 56 one-million gallon indoor tanks. Juice from both the NFC and concentrate tanks can be directly loaded into tanker trucks for transportation to the customers.



Figure 79. **Cold Storage System** (Source, *Southern Gardens Citrus Trade Press Kit*)

3.5.13 FEED MILL

Whatever is remaining after the juice, essences, oils and pulp wash are recovered is transferred by conveyor to the feed mill. The product is pressed and heated to remove moisture in a large dryer. Waste heat from the dryer is used to evaporate the liquid removed in the presses. In this process, Di'Limonene, a valuable, natural solvent, is recovered. Citrus molasses is added to the dried pulp and peel to make cattle feed.

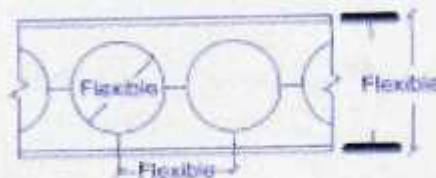
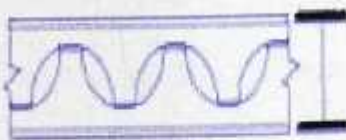


Figure 80. Feed Milling Machinery (Source, Southern Gardens Citrus Trade Press kit)

3.6 SPECIAL STUDY

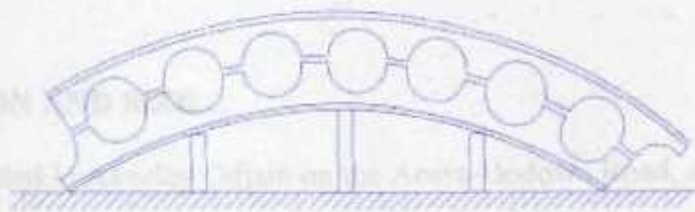
3.6.1 CELLULAR BEAM CONSTRUCTION

Cellular beams have good structural efficiency and are up to 1.6 times deeper than universal beam. It is also up to 7 times deeper.



In curved applications the benefits of cellular beams are multiplied by the simplicity of

curving. With only an insignificant modification to the production process, the cellular beam is quickly curved to the required radius.



Cellular beams can span up to 36m depending on the depth of the beam. Thus it increases in depth as the span increase.

SPAN	CELLULAR BEAM DEPTH	CELL DIAMETER	CELL SPACING
12m	400mm	300mm	400mm
16m	550mm	350mm	425mm
20m	600mm	400mm	500mm
24m	700mm	450mm	550mm
28m	800mm	550mm	650mm
32m	900mm	600mm	750mm

CHAPTER FOUR

4.0 SITE STUDIES

4.1 LOCATION AND SIZE

The site is located in Akorley Odjam on the Accra-Dodowa Road, a village in the Yilo Krobo District in the Eastern Region of Ghana. Akorley Odjam is about 6 minutes drive from Somanya the District Capital and 1 hour 15 minutes drive from Accra the Nation's Capital.

The Yilo Krobo District is one of the fifteen districts in the Eastern Region. It lies approximately between latitude $6^{\circ}.00'N$ and $0^{\circ}.30'N$ and between longitude $0^{\circ}.30'$ and $1^{\circ}.00'W$. It covers an estimated area of 805sq.km, constituting 4.2 percent of the total area of the Eastern Region. The district is bounded in the north and east by Manya Krobo District, in the South by Akwapim North and Dangme District and on the West by New Juaben, East Akim and Fanteakwa Districts. There are however, conflicts over some resources among Manya, Yilo and Akwapim North Districts due to unclear demarcation of boundaries.

The district has about two hundred settlements out of which only the district capital (Somanya) has a population of above 5,000. The district is divided into seven area councils namely, Somanya, Oterkpolu, Boti, Nkurakan, Nsutapong, Klo-Agogo and Obawale.

Source Yilo Krobo District Town and Country Planning Unit



Figure 81: Site Location Map

Source Yilo Krobo District Town and Country Planning Unit

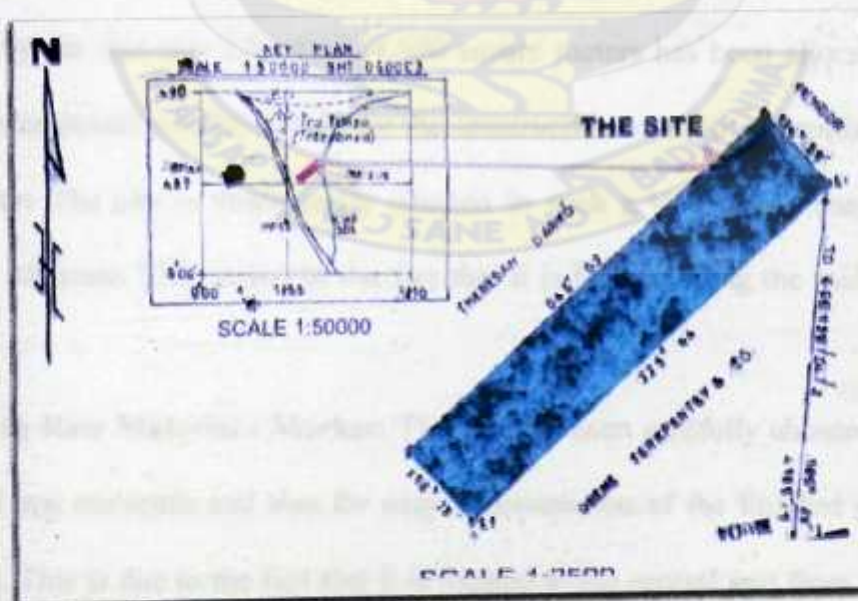


Figure 82: Site Plan

4.2 SITE SELECTION AND JUSTIFICATION

The selection of site was based on the following considerations:

1. **Topography and Drainage:** The area is predominantly mountainous. The Akwapim Ranges stretch into the district from southwest to northeast across the district. The low lands are the southeastern part of the district where the site is located. The rocks forming the ranges are called the Togo series, which include quartzites, phyllites, sandstones, phyllonites and sandy-shales.

There are two main watersheds forming three river basins in the district. One of the watersheds is located on the Akwapim Ranges where rivers flow in the eastward direction on the lowlands into the Volta River. On the west of the ranges, the rivers flow into the Ponpong River, which empties into the Volta Lake. The highlands on the western part of the district also create another watershed. Hence the rivers flow through New Juaben to join the Densu River.

2. **Land Size:** The District has vast stretch of land which fits into this purpose. This can be buttressed by the fact that a land of 24,990 square meters has been allocated by the mango farmers association in the district for the construction of a fruit processing plant.

3. **Accessibility:** The site is strategically situated in such a way that it can easily be accessed from all areas. This is due to the fact that it is located along the main Accra – Dodowa road.

4. **Proximity to Raw Material / Market:** The site has been carefully chosen to enable easy access of raw materials and also for easy transportation of the finished product to market centres. This is due to the fact that it is located in the central part from where the various raw materials for the processing plant will be coming from.

5. Availability of Labour: There is abundant availability of labour in the district in which the processing plant will be located. This will help in getting enough labour for the effective operation and sustainability of the plant.

4.3 SITE INVENTORY

Topography, vegetation, wind direction, soil types, and other existing features on site and their relationship to each other have been showed on the site inventory map below. This was achieved by physical inspection of the site.

4.3 .1 Area

The site is rectangular in shape, and it measures a total area of 24,990 square meters. The breaks down measurements of the boundaries are; the north-east boundary measures 98m; that of south-east is 245m; north-west is 244m and south-west is 102m.

4.3 .2Access to Site

Vehicular access to the site will be taken from a minor road along the north-eastern boundary. This road will be reoriented to serve as the main access to the site.

4.3 .3Topography

The site is fairly flat in nature, and this can be attributed to the fact that, that area of the district is a low laying area. The site rises approximately 100m above sea level.

4.3 .4 Soils and Geology

Predominant soils in the district can be divided into three major groups. These are,

- Soils developed over sand stone (Yaya-Pimpimso-bejua Association)
- Soils developed over Buem (Dewasi-Wayo Association)

- Soils developed over Togo rocks Menfe-Fete-Salom complex and the Oyarifi-Krobo-Memfe-Nyire complex.

Soils developed over sandstone are predominant in the district as pertains in the Manya Krobo district. This is made up of the Yaya-Pimpimso-Bejua Association. These soils are found north-west of Huhunya right to the border between the district and Fanteakwa District. These soil associations are developed from the Voltarian sandstone under forest and consist of very shallow, eroded, litholols on summits and upper slops of scarps and hills. This is a characteristic of the Yaya series. The Pimpimso series consist of moderately shallow, reddish brown well-drained loose, concretionary overlying ironpan or sandstone rock on steep upper slopes. The Bejua series on the other hand consist of moderately deep poorly drained, grey loose loamy sands on narrow valley bottoms. These soils saturated with water in the rainy seasons but dry out in the middle of the dry season. With suitable drainage the soils are considered suitable for all sort of constructional works.

EXISTING CONDITIONS ON SITE



Figure 83: Site Inventory Map (2009)

4.4 CLIMATE

The area lies within the dry equatorial climatic zone which experiences substantial amount of precipitation. This is characterised by a bi-modal rainy season, which reaches its maximum during the two peak periods of May – June and September – October. The annual rainfall is between 750mm in the southeast and 1600mm in the northwest. Temperature ranges between a minimum of 24.9°C and a maximum of 29.9°C . A relative humidity of 60 – 93 percent is characteristic of the district.

4.5 SERVICES

Electricity

There are connections of the Electricity Company mains along the main Accra – Dodowa road which can easily be connected to the site.

Water

The site may depend on bore hole which will be pumped mechanically to overhead storage tanks for usage. This is because the Ghana Water Company's mains are quit far away from the site. This source of water supply to the plant, it is believed will be cost effective and reliable.

Drainage

The land slopes gently towards the north-eastern part into a stream. This will help in the direction of drains of the plant with less difficulty.

Telecommunication System

Telephone service already exists in the district capital Somanya and can easily be extended to the site, as Ghana Telecom phone poles are of close range.

4.6 SITE ANALYSIS

The site has a lot of trees and some of these trees would be maintained and incorporated into the design and to serve as climate modifier on site. The site also slopes gently towards north-eastern part of the site where the stream is located; this in turn helps to improve the drainage system on site.

The fairly flat nature of the site makes it advantageous to industrial design. This is due to the fact that machineries that are used for the processing of fruits vibrate a lot and needs a firm ground to in order to minimise this vibration. It would also help to facilitate the free flow of goods and services to and from the site.

Existing minor road along the north-eastern boundary will be developed and used as one of the accesses to site. As a security measure, secure fencing would be introduced all around the site to keep off intruders.

See the diagram below for site analysis in relation to the site.

4.7 PERIPHERAL STUDY

The study captures activities surrounding the site since they directly or indirectly influence design considerations and planning. The south-east and north-west of site is bounded by mango and cashew farms respectively. A shot towards south-west is the Accra-Dodowa Road and to the north-east is a stream.

These farms form part of the various sources of raw materials which will service the processing plant. The stream to the north-east part of the site helps to drain water from the site since the site slopes gently towards this part of the site.



Figure 84: The Current State of the Site (2009)



Figure 85: The Site In Relation To Its Peripheries (2009)



Figure 86: Cashew farm at North – Western part of the site (2009)



Figure 87: A road leading to farms and settlements at South – Eastern part of the site (2009)



Figure 88: Mango farms at South–Western part of the site across the Accra–Dodowa road (2009)

CHAPTER FIVE

5.0 PLANNING AND DESIGN

5.1 BRIEF DEVELOPMENT

This stage was arrived at through a comprehensive research together with a study of existing fruit processing facilities both locally and internationally. A conclusion was reached by a careful analysis of the clients brief and all the above mentioned factors together with the objectives of the study.

In order to facilitate easy understanding of the scheme and to come out with a design which will satisfy the purpose of the project, a developed brief has been outlined under the following headings: 1. Administrative Unit. 2. Production Unit. 3. Service Unit. 4. Welfare Unit. 5. Ancillary Facilities.

ADMINISTRATIVE UNIT

This comprises of facilities that help in the day to day administrative running of the processing plant and these include the following:

- Car park (customers and staff)
- Reception lounge
- General office
- General manager's office
- Secretary's office
- Human resource manager's office
- Conference room
- Marketing / sales department
- Procurement department
- Accounts / financial department
- Exhibition hall

- Sanitary facilities

PRODUCTION UNIT

This comprises of facilities that are directly concern with the processing of the raw material and the handling of the finished product and these include the following:

- Production floor
- Production engineer's office
- Production manager's office
- Laboratory
- Packaging department
- Raw material store
- Whole sale / dispatch area
- General storage area
- Switch room
- Sanitary facilities

SERVICE UNIT

This comprises of facilities that help in keeping the equipment used for the processing in shape, it also includes the supply of water and electricity. These include the following:

- Loading / Off – loading bays
- Maintenance area
- Garage
- Engineer's office
- Standby generator store
- Water treatment/storage area

WELFARE UNIT

These include facilities which support the personnel who work in the processing plant and it includes the following:

- Clocking area
- Changing rooms
- laundry
- Canteen
- Kitchen / kitchen yard
- Matron's office
- Changing room for kitchen staff
- Store
- In-service training room

ANCILLARY SERVICES

These include additional facilities which support the processing plant and it includes the following:

- Security post
- General parking space
- General circulation areas

5.2 SCHEDULE OF ACCOMMODATION

NOTE: All Area Dimensions stated against spaces are in Square Metres (m²).

ADMINISTRATION

Ground Floor

- Car park (customer and staff) -1698
- Reception - 270
- Sanitary Areas - 26

First Floor

- Enquiry / Waiting - 200
- Exhibition Hall - 2116
- Staff Common Room - 77
- General Office - 96

Second Floor

- Enquiry / Waiting- 220
- Procurement Unit-198
- Human Resource Manager's Office - 168
- Secretary's Office - 30
- Accounts Office - 154
- Board Room - 77
- General Managers Office - 30
- Managing Director's Office - 30
- Sanitary Areas - 28
- Sales / Marketing Office- 30
- Sanitary Areas - 28

PRODUCTION UNIT

Ground Floor

- Production Floor - 1408
- Changing Rooms - 169
- Raw Material Storage Area - 714
- Finished Goods Storage Area - 561
- Quality Check Area - 60
- Packaging Area - 196
- General Storage Area - 81
- Switch Room - 24

- Laundry - 36
- Laboratory - 30
- Cloak / Tool Store - 66

First Floor

- Production Engineer's Office -64
- Procurement Unit - 45
- General Office - 50
- Storage Area - 40
- Activities Monitoring Room - 56
- General Storage Area - 90

WELFARE UNIT

Ground Floor

- Clocking Area - 18
- Canteen - 270
- Kitchen / Kitchen Yard - 142
- Store - 20
- Matron's Office - 15
- Changing Rooms for Kitchen Staff - 40
- In – Service Training Hall - 204
- Snack Joint - 194

SERVICE UNIT

Ground Floor

- Loading / Off – Loading Bay - 2142
- Maintenance Area- 672
- Engineer's Office - 64
- Standby Generator Store - 48
- Waste Treatment / Storage Area-154

ANCILLARY SERVICES

- Security Post - 22
- General Circulation Areas - 323

5.3 DESIGN PHILOSOPHY

The evolution of this design has been influenced by the design philosophy: ***“Model of Efficiency and Speed While Meeting the Highest Standards of Worker Safety, Food Quality and Environmental Protection”***.

An industrial environment that considers: circulation pattern, accesses to the facility, security, sanitation, proximity to raw materials and market for finished products is able to achieve this philosophy.

5.4 DESIGN CONCEPTS

To achieve this philosophy the following concepts will be employed:

ENVIRONMENTAL PROTECTION: The recycling of waste water to irrigate the nearby farms and peels of fruits dried, grinded and used as feed for animals. The peels of the oranges when dried and grinded can also be used as mosquito repellent.

SECURITY: Provision of CCTV cameras to monitor all activities that go on in and around the processing plant.

SAFETY: Provision of laboratory to ensure that all fruits and fruit juices are of highest standards and satisfy the laid down rules and regulation. Also the provision of fire extinguishers to check the out-break of fire.

EFFICIENCY: Provision of aseptic tank to store partially processed fruit juice (**Juice Concentrate**) for the lean season so as to enable all year processing of fruit juice. This juice concentrate can also be sold to other fruit processing companies. Also there will be the assurance of good lighting and ventilation systems to boost efficiency.

SPEED: Provision of linear circulation pattern to enhance flexibility in movement, service distribution and monitoring.

5.5 CONCEPTUAL SITE PLANNING

The conceptual site planning was influenced by the careful analysis and consideration of the interrelationships various facilities of the design. The location of the site in relationship to wind and sun direction, thus orientation of the site was taken into consideration. Also the size and shape of the site and the surrounding environmental conditions actually influenced the positioning of the various elements of the design. All these considerations were done to ensure that natural light is admitted into the various spaces to reduce the use of artificial lighting.

Functional Relationship Diagram

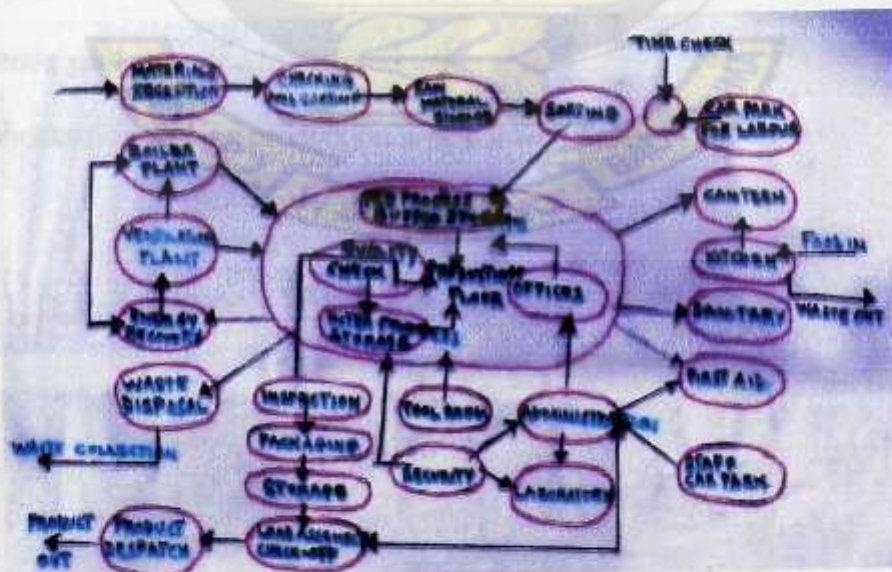


Figure89

Option One

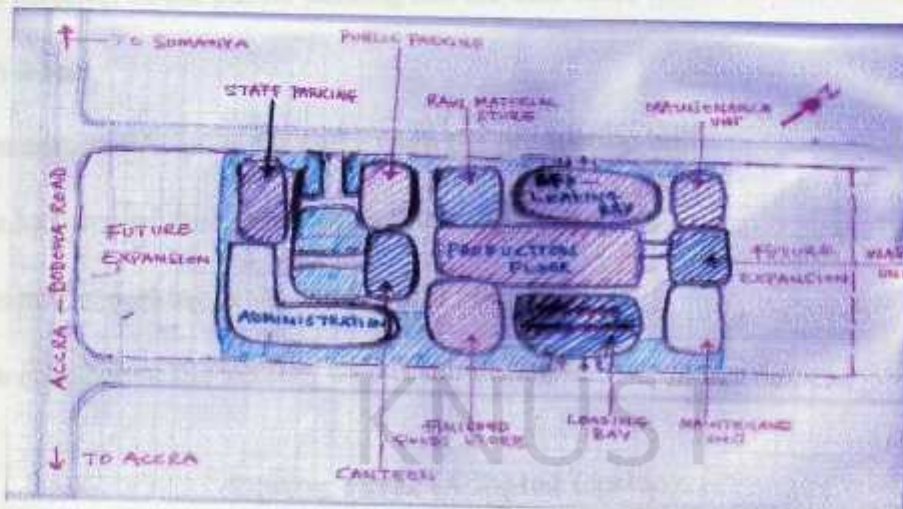


Figure 90

Demerits

- Multi directional expansion not good enough. This is because the expansion at the administration area is unnecessary since in times of expansion the administration will not expand that much.
- Loading and off-loading areas are of different locations and this has security implications.
- Maintenance yard too close to the production area.
- The administration and the production area not well linked.

Option Two

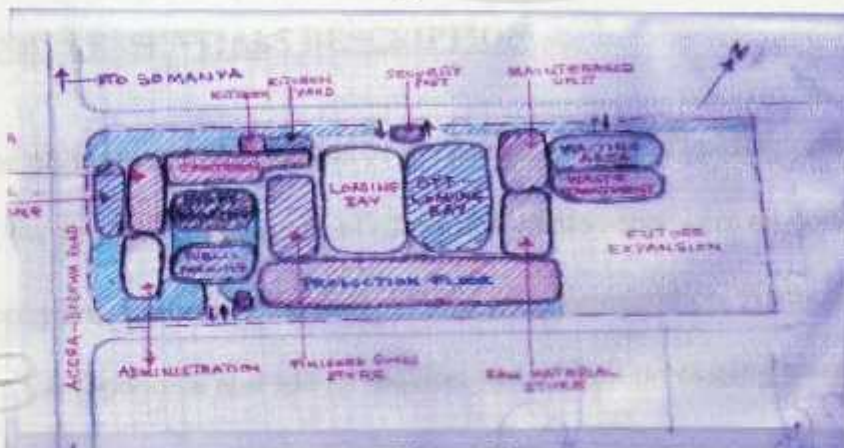


Figure91

Demerits

- The location of the public parking not the best since it will interfere with free movement.
- The administration is far away from the production unit.
- The location of the maintenance unit is still not the best.
- The public parking at the road side is not necessary.
- The entrance to the waiting area is not the best.

Option Three (Adopted Option)

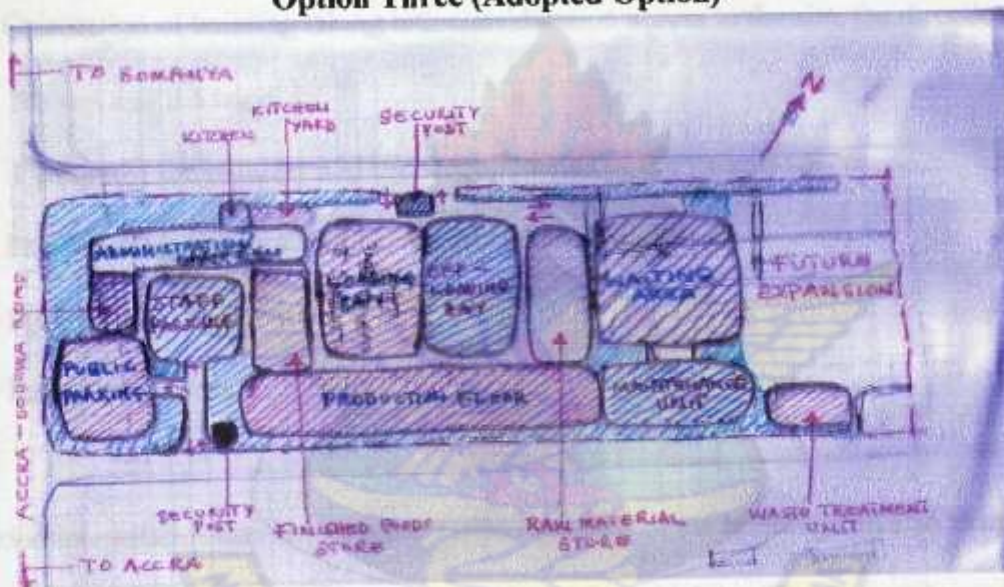


Figure 92

5.6 DESIGN ESSENTIALS DESCRIPTION

With the philosophy and concepts of the design serving as guiding principles for the design, the forms and arrangement of the design elements were all done with the philosophy and concept of the design taken into consideration. Also consideration was given to the functional and spatial requirement of fruit processing plant, this was done by

researching into and analyzing standards of processing plant design and the various standards available.

5.7 SITE PLANNING AND LAYOUT

Upon a systematic analysis of the conceptual site planning, the planning considerations for The design layouts are as follows:

Interrelationship of various spaces

Orientation of building taking into consideration access to the site, the direction of the sun and the wind.

Purpose of the building and user requirements of the various spaces

Parking areas (customer, staff, loading and off-loading bay)

Flow of various activities.

landscaping areas

For a good interrelationship between the various sections of the building and also to make sure that the main theme of the philosophy of the design which is *efficiency and speed* is carried through the design successfully, the facility has been zoned into four main sectors namely, **THE ADMINISTRATIVE UNIT, THE PRODUCTION UNIT, THE MAINTENANCE UNIT AND THE WASTE TREATMENT UNIT.**

ACCESSES: The site has two accesses, one leading to the administration and the other to the production area. The accesses are in different directions (North West for the production area and South East for the administrative area). This has been done to avoid vehicular traffic so as to facilitate efficiency and speed in line with the design philosophy.

ADMINISTRATION: The administration has been positioned in such a way that it is easy to access thus close to the main Accra-Dodowa road. The administration has been linked to the production unit to enable easy coordination of processing activities to facilitate efficiency and speed.

PRODUCTION UNIT: This comprises of the production floor, the raw materials and finished goods storage areas and other supporting facilities. These facilities have been arranged in such a way that it allows the smooth flow of the processing activities. The raw materials and finished goods storage areas have been positioned in accordance with easy flow of the processing process to facilitate efficiency and speed.

MAINTENANCE UNIT: The maintenance unit has been located in the north – eastern part of the site and it has been provided to take care of the maintenance of the company's loading and off – loading trucks. Also it is to take care of the repairing of the processing machineries.

WASTE TREATMENT UNIT: This unit has been provided to take care of the treatment of all wastes both liquid and solid that will be generated through the processing process. It has been sited about 30 metres away from the production unit to avoid contamination.

PARKING SPACES: The administration has two parking spaces, one for staff of the factory and the other for customers. The production unit has loading and off-loading bay for the off-loading of raw materials and loading of finished goods to the market centres.

STRUCTURAL FORM

Due to the wide spans and high volumes of the production block, the columns of these areas are slightly bigger than that of the administration block. Thus the column size of the production area and that of the external ones of the administration block are of the same

size (450mm x 300mm) whiles the internal columns of the administration block are of the size (250 x 250). However, all roof members are made up of cellular beams with tubular framed purlins.

MATERIALS AND FINISHES

The main roofing system and materials of the facilities is of barrel roof, the barrel roof is an industrial i.d.t roofing sheets and there are flat roofs at some portions to fulfill some performance requirements.

5.8.0 SERVICES

5.9.1 WATER SUPPLY

The processing plant will have its own water supply system since Ghana water company mains are far away from the site and as such will be uneconomical to extend it to the site. As such a borehole will be dug on site and mechanized to pump water into to underground storage tanks. The water from the bore hole would be treated by an onsite water treatment unit before it is pumped into the overhead tanks for usage. Both the direct and indirect systems shall be employed. As a safety measure, there would be the provision of filters which will be attached to all water outlets.

5.10.2 DRAINAGE

Drainage of soil and wastewater will be through pipes and gutters to septic tanks located at the lowest part of the site (North-Eastern part). This waste water would be treated at the onsite waste treatment plant and used to irrigate nearby farms.

5.11.3 ELECTRICITY

There is a transformer about 100m away from the site with a supply of 240volts of electricity from VRA which will be tapped into the site. The main line shall be tapped to a cutout and subsequently connected to meters through TPN. Consumer unity shall be such that it gets to various main spaces. This is to ensure maximum protection of equipment and isolation of faults.

Standby generators are also installed in a power room. There are two standby diesel generators each rated at 450kVA giving a total of 900KVA. The two generators are synchronized on to a synchronizing panel to enable them run in parallel.

5.12.4 SWITCHES AND SOCKETS

British standard switches and sockets will be provided. There will be 13amp sockets in offices, waiting areas, all administrative areas etc and 15amp switches in the kitchen and other service areas.

5.13.5 LIGHTING

The lights installed in the general areas are 1200mm x 36W fluorescent. This arrangement is distinct from the special lighting requirements for factory floors. Also, the design employs the admission of natural lighting through the roof system to complement factory floor illumination.

Outdoor lights have also been provided for car park and general lighting of the surroundings. The external lighting is thus adequate and meets the required illumination level of 50 lux. Photoelectric cell/timer switches is provided to control the outdoor lights.

Power cables of adequate current carrying capacity have been laid and terminated in various equipment including the transformers, generators, change-over switches and distribution panel.

5.14.6 SECURITY CONTROL

Closed Circuit Television (CCTV) is used to ensure security especially within the factory, by means of security cameras positioned at vantage points and monitored by security personnel.

5.15.7 SOFT LANDSCAPING

Certain parts of the facility would be soft landscaped to foster the needed beauty and to create a microclimate against the harsh weather conditions. Some of the trees on the site would be incorporated into the overall landscape with the introduction of additional trees of different varieties. Open spaces will also be landscaped with lawns, Parking areas would be provided with shady trees.

5.16.8 HARD LANDSCAPING

The driveways would be finished with asphalt while the car park and pedestrian walks shall be finished with interlocking pavement blocks. The pavers would be blended with the rest of the landscape in both colour and texture. This is aimed at achieving by the principle of rhythm and repetition to foster better design.

5.17.9 COSTING

This is an estimate to give the client an idea of the total cost of the project. The estimated cost per square meter is GH ¢ 350

NOTE: All Area Dimensions stated against spaces are in Square Metres (m²).

ADMINISTRATION

Ground Floor

Car park (customer and staff)	1698 = GH ¢ 594,300
Reception	270 = GH¢94,500
Sanitary Areas	26 = GH¢ 9,100

First Floor

Enquiry / Waiting	200 = GH¢ 70,000
Exhibition Hall	2116 = GH¢ 740,600
Staff Common Room	77 = GH¢ 26,950
General Office	96 = GH¢ 33,600
Sales / Marketing Office	30 = GH¢ 10,500
Sanitary Areas	28 = GH¢ 9,800

Second Floor

Enquiry / Waiting	220 = GH¢ 77,000
Procurement Unit	198 = GH¢ 69,300
Human Resource Manager's Office.....	168 = GH¢ 58,800
Secretary's Office	30 = GH¢ 10,500
Accounts Office	154 = GH¢ 53,900
Board Room	77 = GH¢ 26,950
General Managers Office	30 = GH¢ 10,500
Managing Director's Office	30 = GH¢ 10,500
Sanitary Areas	28 = GH¢ 9,800
Total	<u>GH¢ 1,916,600</u>

PRODUCTION UNIT

Ground Floor

Production Floor	1408 = GH¢ 492,800
Changing Rooms	169 = GH¢ 59,150
Raw Material Storage Area	714 = GH¢ 249,900
Finished Goods Storage Area	561 = GH¢ 196,350
Quality Check Area	60 = GH¢ 21,000
Packaging Area	196 = GH¢ 68,600

General Storage Area	81 = GH¢ 28,350
Switch Room	24 = GH¢ 8,400
Laundry	36 = GH¢ 12,600
Laboratory	30 = GH¢ 10,500
Cloak / Tool Store	66 = GH¢ 23,100

First Floor

Production Engineer's Office	64 = GH¢ 22,400
Procurement Unit	45 = GH¢ 15,750
General Office	50 = GH¢ 17,500
Storage Area	40 = GH¢ 14,000
Activities Monitoring Room	56 = GH¢ 19,600
General Storage Area	90 = GH¢ 31,500
Total	<u>GH¢ 1,291,500</u>

WELFARE UNIT

Ground Floor

Clocking Area	18 = GH¢ 6,300
Canteen	270 = GH¢ 94,500
Kitchen / Kitchen Yard	142 = GH¢ 49,700
Store	20 = GH¢ 7,000

Matron's Office	15 = GH¢ 5,250
Changing Rooms for Kitchen Staff	40 = GH¢ 14,000
In – Service Training Hall	204 = GH¢ 71,400
Snack Joint	194 = GH¢ 67,900

Total **GH¢ 316,050**

SERVICE UNIT

Ground Floor

Loading / Off – Loading Bay	2142 = GH¢ 749,700
Maintenance Area	672 = GH¢ 235,200
Engineer's Office	64 = GH¢ 22,400
Standby Generator Store	48 = GH¢ 16,800
Waste Treatment / Storage Area	154 = GH¢ 53,900

Total **GH¢ 1,394,050**

ANCILLARY SERVICES

Security Post	22 = GH¢ 7,700
General Circulation Areas	323 = GH¢ 113,050

Total **GH¢ 120,750**

Grand Total **GH¢ 5,038,950**

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Due to the huge cost of the project which cannot be borne by the clients at a go, the project would be executed in four phases so as to grant relief to the clients by spreading the financial burden over a period of time.

The phasing would be done as follows:

1. **Phase one** – This phase comprises of four different activities:
 - (a) Preliminary site preparation to enable construction work to start.
 - (b) Fencing of the entire site to secure the site for construction work to start.
 - (c) Construction of access roads to the site.
 - (d) Extension of main service lines such as telephone, electricity etc. to the site.
2. **Phase two** – For processing to start, the following facilities would be constructed in this phase:
 - (a) The factory building. This includes the production floor, the raw material and finished goods storage areas and other offices.
 - (b) Waste treatment unit.

This would be done to enable production to start so that the factory can raise additional funds to continue the other phases of the project.

3. **Phase three** – This phase would involve the construction of the following:
 - (a) Administration block.
 - (b) Car park for both the staff and customers as well as landscaping of the site.

4. **Phase four** – At this stage it is envisaged that some machineries of the factory would need maintenance or replacement hence the need for the construction of this facility.

6.2 Summary

When this facility is able to take off effectively, the following objectives would have been met;

1. There would be an alternative to sustain the fruit processing industry thereby reducing the dependency on importation of fruit juice.
2. Contribution would have been made directly to the development and sustainability of the Agricultural industry by providing ready market for the fruits which would in turn improve the economic wellbeing of the farmers.
3. Postharvest losses would be prevented and also high quality fruit juice would be available for both local and international market.
4. Finally, the nutritional and medicinal benefits of these fruits juice would be made available to all consumers throughout the year.

6.3 Recommendations

Two major limitations to this scheme have been site restriction and the absence of a local case study prior to the design.

In planning industrial schemes, future expansion should not be overlooked. As in the case of this scheme, though future expansion had been considered and subsequently planned

for, it is inadequate. It is therefore recommended that during future expansion, projections must be as to how the factory would expand for given number of years.

Finally, it is highly recommended that extra facilities of this nature should be developed at other prominent locations. This would set competition among these facility which would serve as checks and balances for quality, price control and sustainability.

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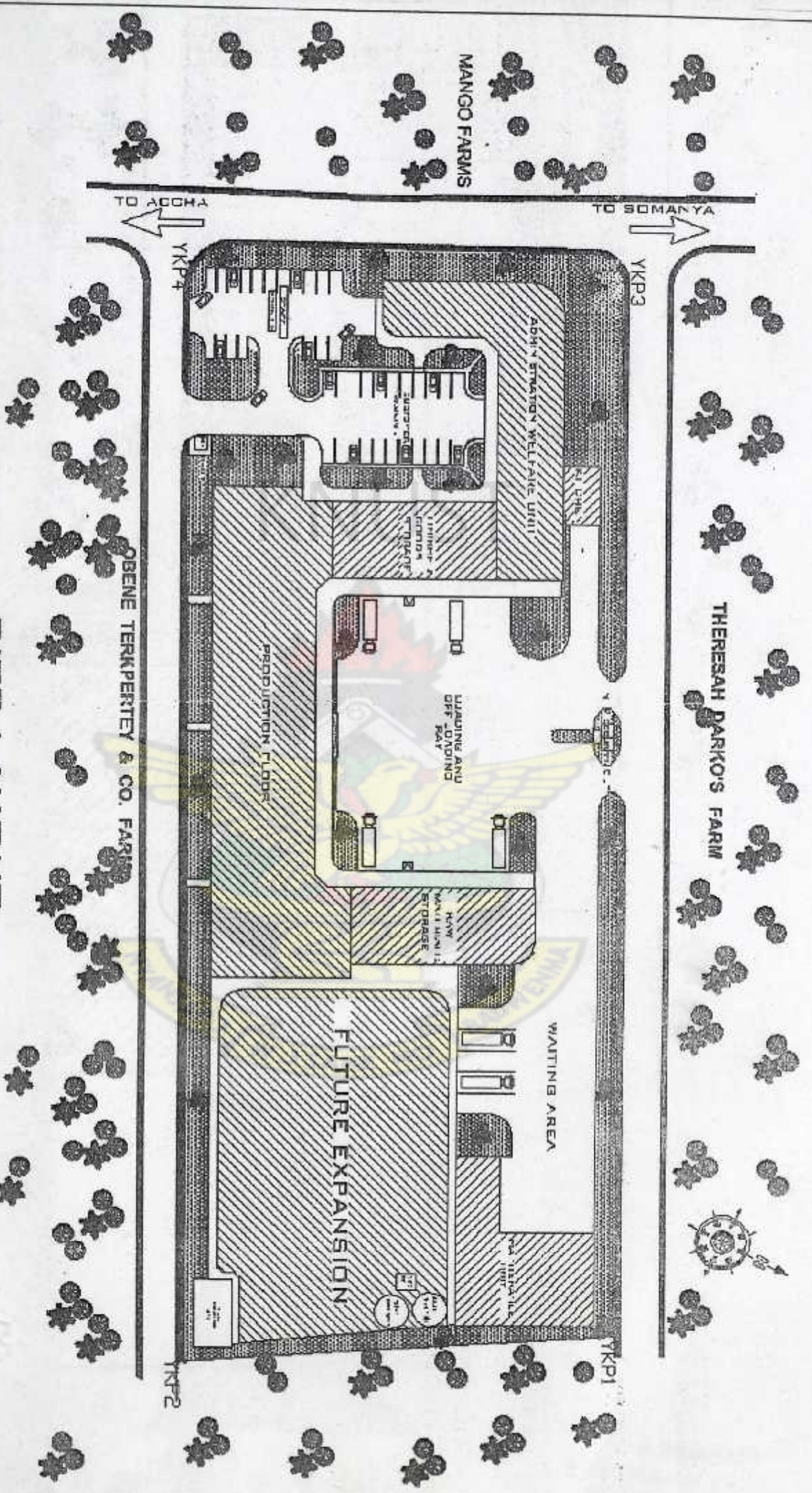


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APPENDIX 1

SITE LAYOUT



MANGO FARMS

TO SOMANYA

TO ACCRA

THERESA DAKO'S FARM

BENE TERKPERTEY & CO. FARM

1-NIGHT APT
DEVELOPING
PLAN

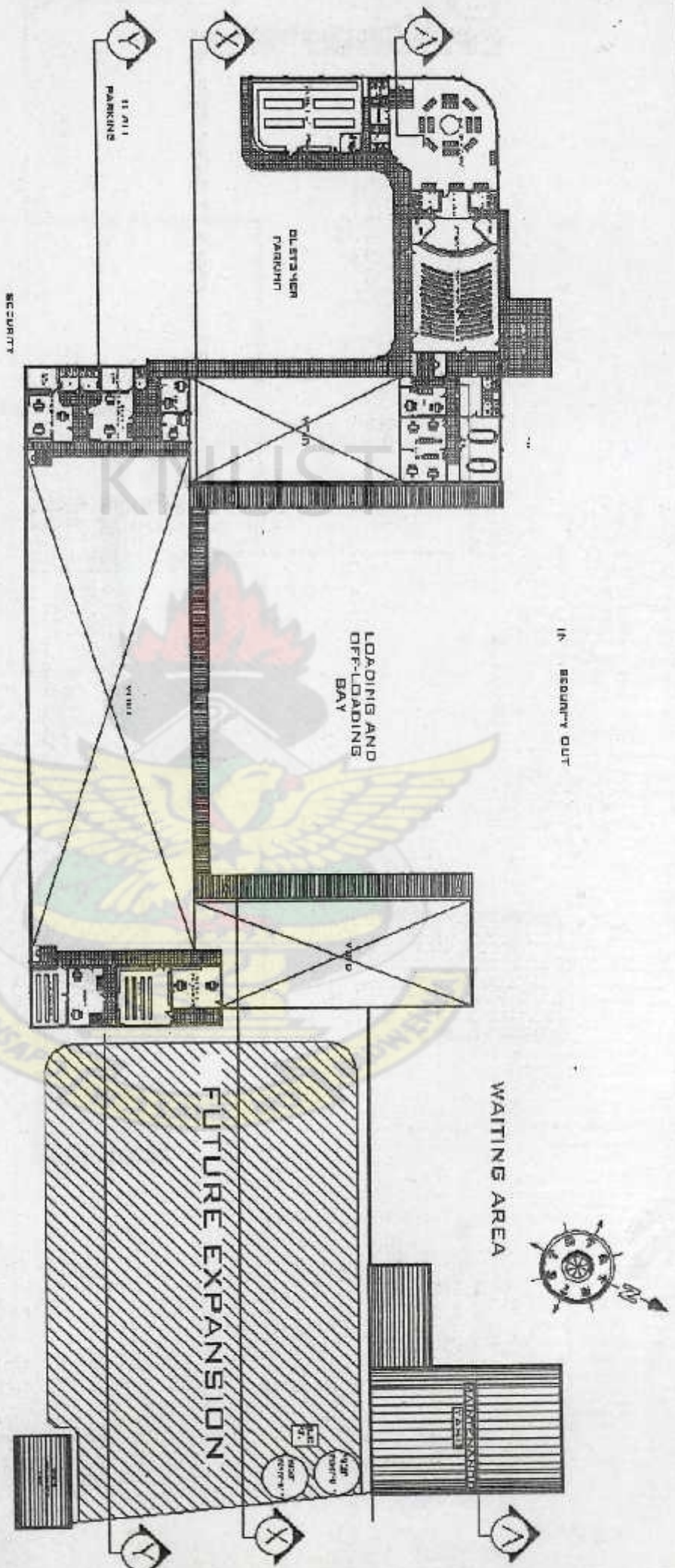
FUTURE EXPANSION

WAITING AREA

BLOCK PLAN

APPENDIX 2

111



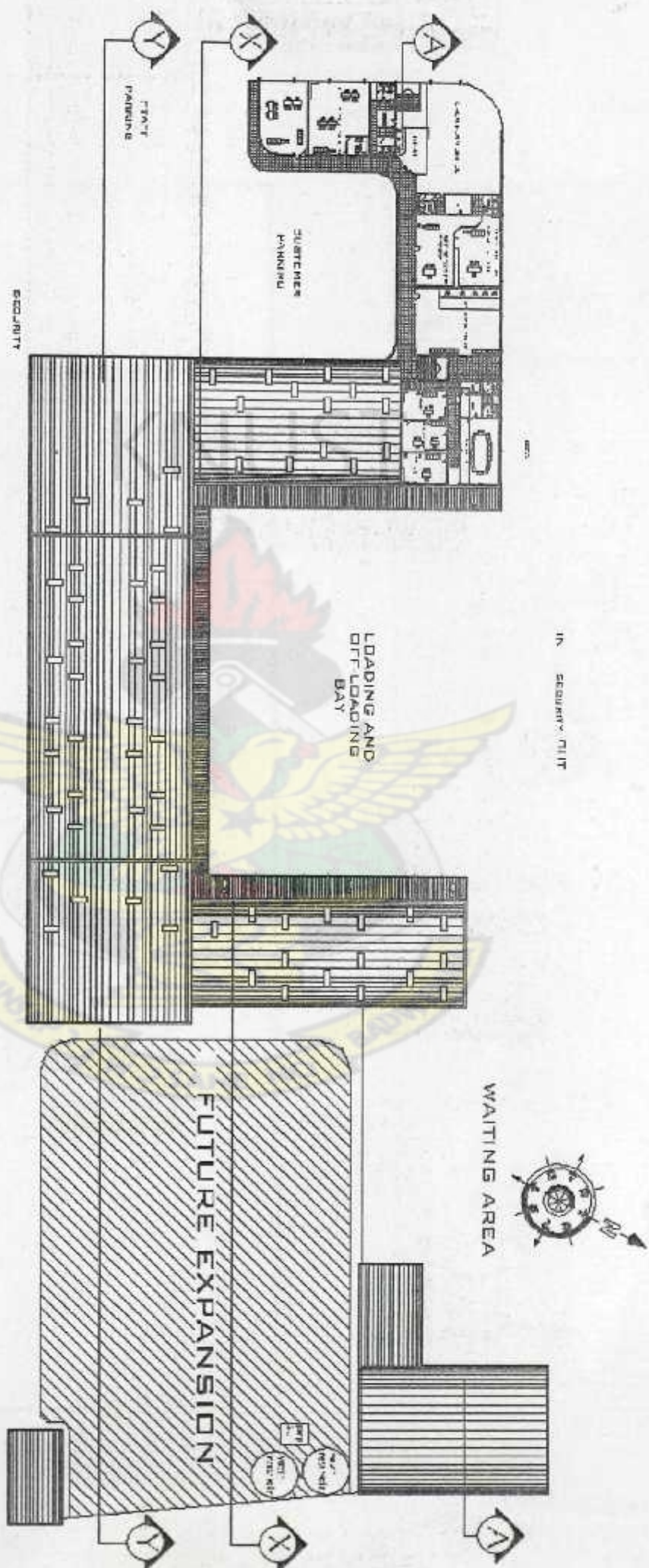
APPENDIX 4

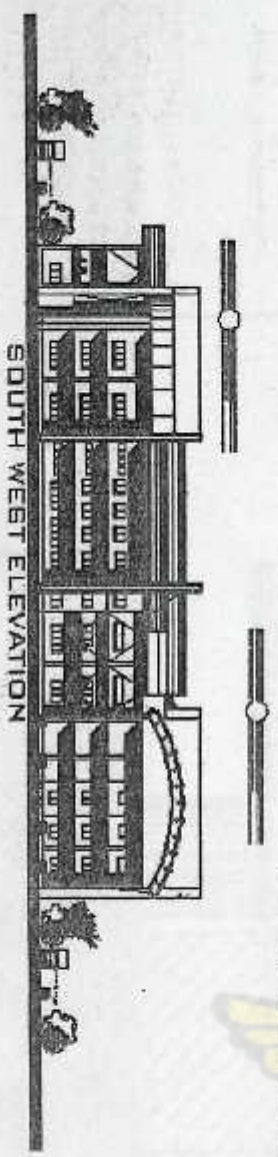
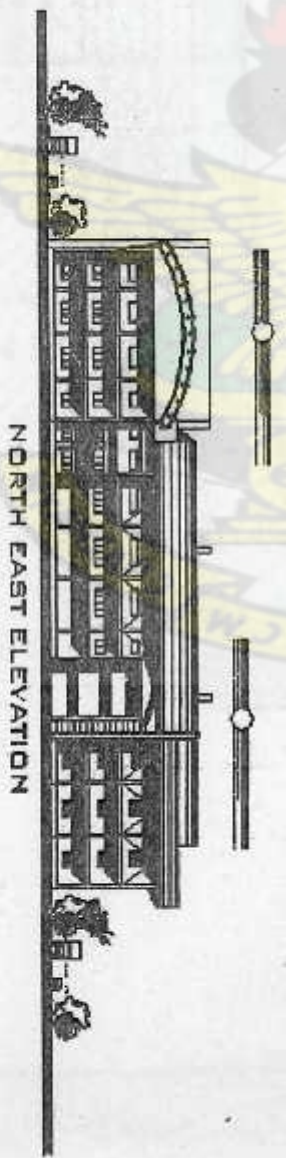
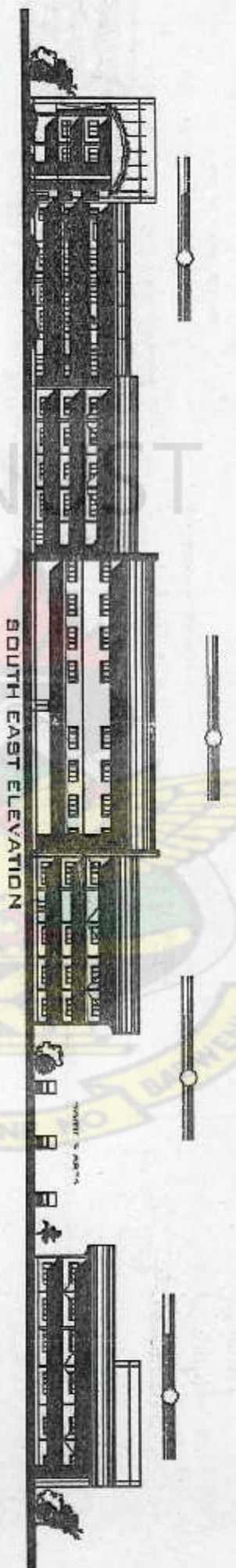
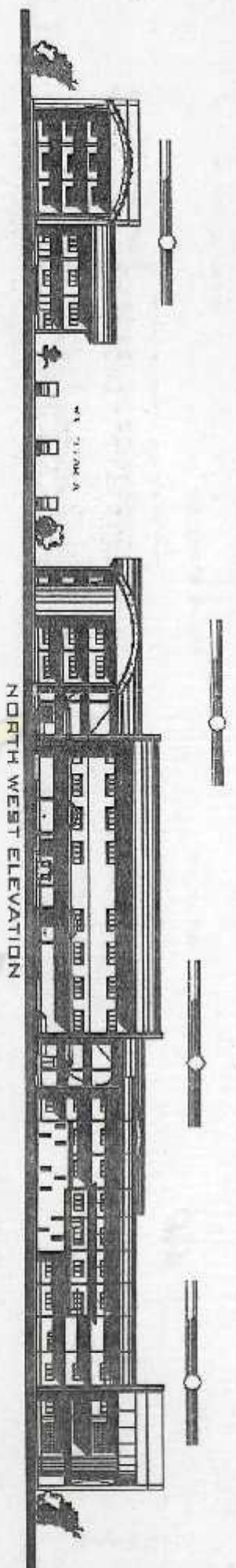
FIRST FLOOR PLAN

113

APPENDIX 5

SECOND FLOOR PLAN





APPENDICES

SKETCH DESIGN DRAWINGS AND PERSPECTIVES



PERSPECTIVE FROM SOUTH - WEST

Appendix 7.



ARIEL PERSPECTIVE FROM SOUTH-EAST

Appendix 8.



PERSPECTIVE FROM NORTH-EAST

Appendix 9.



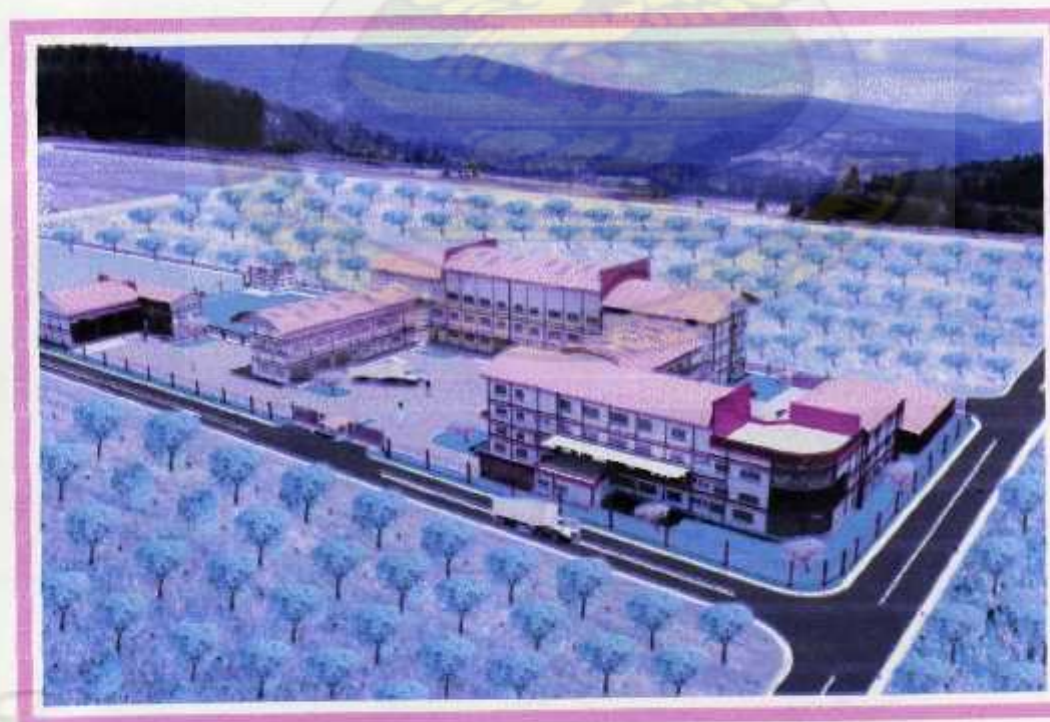
AREAL PERSPECTIVE FROM NORTH-EAST

Appendix 10.



PERSPECTIVE FROM NORTH-WEST

Appendix 11.



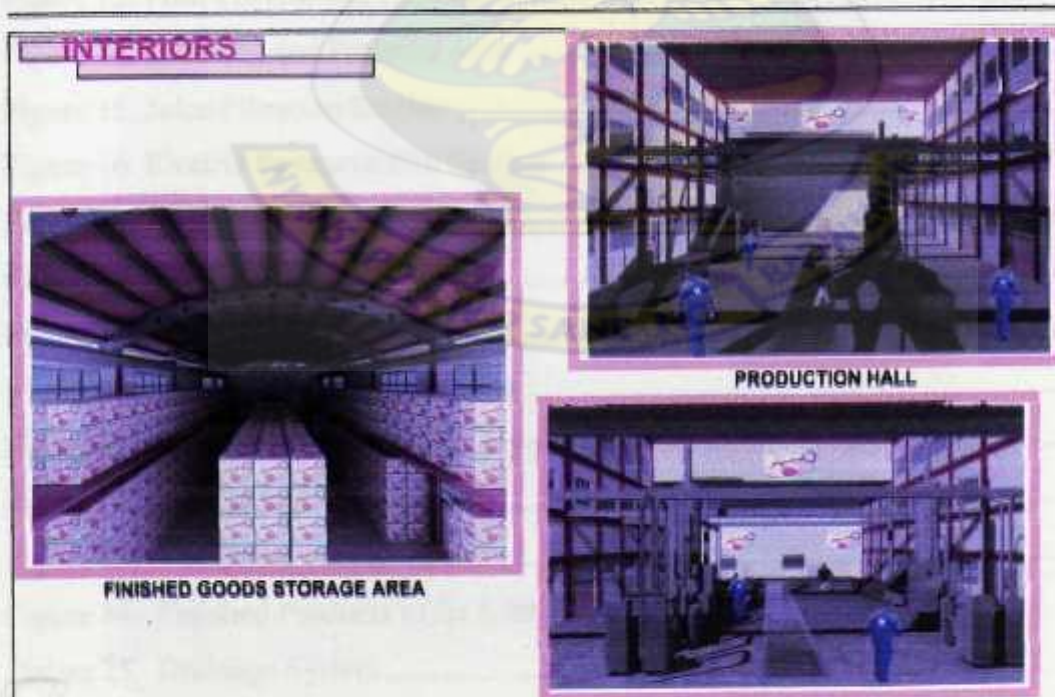
AREAL PERSPECTIVE FROM NORTH-WEST

Appendix 12.



PERSPECTIVE VIEW OF THE CUSTOMER PARKING/ADMINISTRATION BLOCK

Appendix 13.



Appendix 14.

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