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FRUIT PROCESSING PLANT

TSETSI, ABURA DUNKWA.

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By

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May 2009.

DECLARATION

I hereby declare that this submission is my own work towards the Master of Architecture and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

This design thesis is dedicated to the Almighty God who gave me the needed strength throughout my stay on campus and to my uncles Rev. K. A. Dickson and Mr. Kobina Dickson and their families for their support.

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My first and utmost gratitude goes to God the Father Almighty for the gift and sustenance of life and for bringing me this far. I also express my heartfelt thanks for my mum and siblings for their support.

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ABSTRACT

The main objectives of this study were to design a well structured fruit processing plant to process oranges and pineapples into fresh juices and concentrates and to stimulate agricultural production by creating a ready market for the orange and pineapple farmers.

The study was implemented through a review of literature focusing on commodity-specific cases of agro-processing enterprises. Case studies and informal discussions with key players in agro-processing were also conducted.

The study found that the current market forces and the prevailing economic environment tend to favour more growth of medium-scale enterprises. It was therefore necessary to design a simple processing plant which is sensibly laid out and where one requirement co-relates to another with a lower initial cost.

TABLE OF CONTENT

CHAPTER THREE

Research Methodology

LIST OF FIGURES

FIGURE PAGE

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.0 PREAMBLE

Agro-processing is now regarded as the sunrise sector of the economies of most developing countries in view of its large potential for growth and likely socio economic impact, specifically on employment and income generation. As the patterns of food consumption in developed economies are evolving, demand for organic produce and functional foods is on the increase. This, coupled with an increasing concern for health and fitness are causing a significant decline on food consumption of sugar, and therefore, fruits and vegetable products are increasingly becoming substitutes and these trends are expected to continue in future years.[1]

Food processing in all its various forms brings immeasurable benefits in terms of availability, shelf life, and safety of various products. This is important for safely feeding nations, especially those in which food spoilage and other forms of damage and deterioration pose serious problems.

Ghana has great potentials in food processing, particularly of fruits and vegetables, spices and root crops, on account of the abundant horticultural and root crops grown.[2] However, the food processing industry is still underdeveloped. Much of what farmers produce is lost at farm level and throughout the food chain for lack of appropriate marketing strategies and non-availability of post harvest handling facilities. If properly developed, the food processing sector can make Ghana a major player at the global level for marketing and supply of processed food, feed and a wide range of other plant and animal products. It is in this regard that the establishment of a fruit processing plant to

utilize locally produced raw materials to produce high value products for the local, regional and global markets would contribute immensely to the growth of the local economy.

1.1 PROBLEM STATEMENT

Ghana is an agrarian country with agriculture contributing at least 37% of total gross domestic product (GDP), compared to manufacturing or industry which accounts for 25%.[3] The country is endowed with varied ecological zones, which favour agricultural production of a wide variety of produce.

However, in this country, farming is usually the" preserve" of the rural population which practice small holder farming and yet manage to provide much of the national food basket and contribute to the economic development of the country. Nevertheless due to insufficient demand, inadequate post-harvest handling and processing facilities, poor transportation and the perishable nature of the agricultural produce, the grower sustains substantial losses, especially during the post-harvest glut, when most often than not some of the produce has to be fed to animals or allowed to rot.

This has adverse effects on the ordinary rural farmer who might not be able to make any gains out of his farming activity owing to such losses and thereby not be able to meet the everyday needs of his family. Moreover, farmers loose the urge to increase their food production capacity due of the lack of appropriate marketing strategies and non-availability of post harvest handling facilities. And as a result, the economy of the country is affected as the need to import food items to meet the short fall becomes eminent.

1.2 OBJECTIVES

- To design a well structured fruit processing plant to process oranges and pineapples into fresh juices and concentrates.
- To stimulate agricultural production by creating a ready market for the orange and pineapple farmers in the catchment area and beyond.
- To create an avenue for rural development by the generation of employment and income to farmers and develop a sustainable fruit industry.
- To develop value-added products and thereby supply wholesome, safe, nutritious and acceptable food to consumers throughout the year.

1.3 JUSTIFICATION

Food processing, especially, for fruits has great potential in the country on account of the abundant horticultural crops grown. In order to ensure food security, increased employment and income, processing of agricultural produce cannot be taken for granted. Ghana has been exporting primary produce such as cocoa beans and fresh horticultural produce yet, unemployment keeps on increasing and rural incomes are low. Increased processing of this produce will increase their value and offer more differentiated products to the emerging market for processed foods locally and internationally.

These facts coupled with the country's drive to industrialize provides the bases for the establishment of a fruit processing factory which will mainly depend on local supply of fruits grown in the locality as well as the neighbouring regions.

A project of this nature will also have a positive impact on the economy. It will create jobs, assure the farmers market for their produce and add value to agricultural produce

which are otherwise left to rot; thereby stimulating more production and hence raising rural incomes and standards of living.

Finally, setting up a processing facility is a first step towards stimulating both consumer demand for the processed product and an adequate supply of the raw material, while the provision of transport, power and other infrastructure facilities required for the industry also benefits agricultural production.

1.4 LOCATION

The proposed fruit processing factory is to be located in Abura Dunkwa in the Abura-Asebu-Kwamankese district of the Central Region, which is a production catchment to minimize transport cost; make use of lower cost of land and more abundant water supply, create employment opportunity in the rural sector.[4]

1.5 SCOPE

The thesis will involve a detailed architectural design of a fruit processing factory with all its ancillary facilities in international standards to process pineapples and oranges into fresh juices and concentrates for both the local and international markets

1.6 TARGET GROUP

The target group for the facility include farmers who would be relied upon for the supply of raw materials, workers of various professions whose services would be employed, shops and other companies which will become distributers for the final product and the general public which would provide the potential market for the products.

1.7 CLIENT

The client for the project includes:

- The Ministry of Trade and Industry
- Abura-Asebu-Kwamankese District Assemblies
- Industrial Entrepreneurs
- Private Individuals

1.8 CLIENT'S BRIEF

- Administrative offices
- Canteen/changing rooms
- Storage yard for temporary storage of the fresh fruits
- Storage area for finished goods
- The Production area
- Quality Control laboratory
- Ancillary Facilities
- Security area

1.9 FUNDING

Funds for the project would be provided by:

- The Ministry of trade and industry through the District Assembly
- Agricultural Development Bank
- Private investors

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CHAPTER TWO

LITERATURE REVIEW

2.1 OVERVIEW OF AGRO-FOOD PROCESSING IN GHANA

Agro-food processing is one of the most significant manufacturing activities in the world. In Ghana, it is still rudimentary and artesian to a large extent, with little growth or development over the last three decades.[1] Companies in this sector typically rely on imported inputs for production and packaging materials and look to capitalize on increased local demand for higher value foods, a trend driven by rising incomes and increased urbanization. At the same time, consumer-driven changes are increasingly pushing food suppliers to meet consumer demand and preferences at a local level. This requires food suppliers to be capable of tailoring their products to the unique characteristics of consumer demands in each market that they serve.

Most of the food and beverage processing companies in Ghana produce exclusively for the local and West African markets which have grown in recent years. From 1994 – 2002, investments in the food processing sector represented 19.5 percent of all registered investment projects in the country. Surveyed companies in the Ghanaian food and beverage processing sector employ up to 2,000 workers.[2] There are local establishments such as Cowbell and Fan Milk which produce dairy products and juices. More recently Athena Foods and Pinora have set up pineapple and orange concentrate juice factories. There are also multinational and regional foods processors such as Nestle and Cadbury.

2.2 FRUIT PROCESSING IN GHANA

The fruit processing sub-sector is emerging as one of the most attractive investment sectors in Ghana. The growth of the sector is driven by growth in the supermarket sub-sector with its high-value food products. Improved living standards, together with a growth in expatriate population, are seen as the main drivers behind the increasing demand for high-value food products.

There is a large volume of fruits available all year round in southern Ghana. The share of fresh fruit exported is still much higher than that processed, though local manufacturing is expected to increase. It is expected that soon such processing will be undertaken in Ghana and shipped ready-to-eat to European destinations. The prospect of the potential margins to be gained from processing is a strong incentive for companies. After the expansion of exports, production, which was originally entirely of fresh fruits, moved to processed products. Furthermore the anticipated continued growth in production combined with the need for producers to get a minimum value for fruit that does not meet the export requirement will provide strong incentives for investment in additional processing capacity.

2.2.1 OPPORTUNITIES

Ghana currently exports a number of unprocessed horticultural products. Opportunities exist in the food processing sector for manufacturing industries to add value to local unprocessed agricultural products, such as oranges, pineapples, cashew and other tropical fruits and vegetables. With the emphasis of Ghanaian exports shifting from raw exports to processed exports, investment opportunities are endless. The fruit processing sub-sector is emerging as one of the most attractive investment sectors. There is, in fact,

a large volume of fruit available all year round in Ghana. The processing of fruits into juices and many other ready-to-eat forms present an excellent opportunity for investors interested in the agro-processing industry.

In addition, Ghana has well-established democratic dispensation which makes it a bright investment destination.

2.2.2 PRODUCTION OF FRUITS

Fruit cultivation in Ghana is currently mostly located in the southern part of the country. The production of most fruits, especially Pineapples, has been benefiting from government and donor support through their efforts to promote agricultural diversification. A high point in Ghana's fruit production is the involvement of large-scale farms that mostly produce for the international fresh fruit export market.

Despite the high concentration of activities among large-scale fruit producers, the smallholders also represent an important group because of their sheer size in number. They represent the whole group of small-scale and family producers. The bulk of their production is geared towards the local market and is also informally sold to large farms. In Ghana, smallholders and out-growers are distinguished, though they both typically cultivate from 1 to 20 acres of land per outfit and often have limited access to inputs, mechanical equipment, and training.[3]

Table 1. Production (1,000 metric tons) and area harvested (thousand hectares) for selected crops and selected years in Ghana.

	2001		2003		2005		2007	
	Quantity	Area	Quantity	Area	Quantity	Area	Quantity	Area
Fruit								
Banana	10	4	10	4	53	7	56	7
Pineapples	60	10	60	10	71	12	66	11
Oranges	300	42	300	42	500	54	470	59

(Source: Ministry of Food and Agriculture, 2008)

Prices of fruits are normally determined by the processor in consultation with the farmer. In some cases, prices vary from day to day, according to prevailing market prices.

Difficulties in establishing and maintaining reliable and sustainable supply relationships between farmers and processors can lead to poor business planning and management. Off-season supplies are particularly difficult to maintain in rain fed farming systems as practiced by the small-scale farmers and out-growers in Ghana. However, gluts of raw fruits during harvest time are common and with lacking storage and processing facilities, farmers are compelled to sell their produce "cheaply" to avoid spoilage.

Socio-economic discrepancies between farmers and the processors create difficulties in establishing long-term business relationships. Many processors see farmers as simply a source of raw materials and have no interest or no financial resources in supporting or developing them. Others have little respect for farmers and regard them as inferior partners in an agreement. This creates tension and leads to breakdown of agreements, with farmers feeling exploited and reneging on their commitments. Additionally, the

lack of trust between farmers and the lack of organizations to work together to meet a processor's requirements, result in insufficient volumes of crops for processors.

2.2.3 MARKET OVERVIEW

Global market growth for processed food and beverages has been strong in recent years, with sales totaling an estimated USD 3.2 trillion, or about three-fourths of total world food sales.[4]

Fruits such as oranges and pineapples are some of the fastest developing crops and are now in significant demand in the regional market. Processed pineapple and orange products, such as juices, largely dominate this market, accounting for 80 percent of the trade.

The demand for fruit juice in Ghana is significant with an estimated market value in the region of US $50 million. Although official statistics appear unreliable in absolute terms, the available data, taken together with market evidence indicates a significant growth trend in fruit juice demand; with a potential to growth of 5 percent per annum between 2007 and 2010.[5]

2.2.4 LOCATING A FRUIT PROCESSING PLANT

The main objective of any fruit processing plant is to choose the location which minimizes the average production cost, including transport and handling. It is therefore advantageous, all things being equal, to locate a processing factory near the fresh raw material supply. This is a necessity for proper handling of the perishable raw materials and allows the product to reach its best stage of maturation and lessen injury from handling and deterioration from changes during long transportation after harvesting.

An adequate supply of good water, availability of manpower, proximity to transport facilities and adequate markets are other important requirements.

However, in Ghana, agro-processing enterprises that use local agricultural raw materials as the main input shall have corporate tax rates based on location as follows:[6]

- Accra-Tema - 20%
- Other Regional Capitals - 10%
- Outside Regional Capitals - 0%

2.3 FRUIT PROCESSING SYSTEMS

Three main processing systems are identified as per FAO's agricultural service bulletin no.119.[7]

2.3.1 SMALL-SCALE PROCESSING

This is done by small-scale farmers for personal subsistence or for sale in nearby markets. In this system, processing requires little investment: however, it is time-consuming and tedious. However, with the rising rates of population and urbanization growth and their more diversified food demands, there is need for more processed and diversified types of food.

2.3.2 INTERMEDIATE-SCALE PROCESSING

In this scale of processing, a group of small-scale processors pool their resources together. This can also be done by individuals. Processing is based on the technology used by small-scale processors with differences in the type and capacity of equipment

used. The raw materials are usually grown by the processors themselves or purchased on contract from other farmers. These operations are usually located on the production site of the farm in order to assure raw materials availability and reduce cost of transport.

2.3.3 LARGE-SCALE PROCESSING

Processing in this system is highly mechanized and requires a substantial supply of raw materials for economical operation. This system requires a large capital investment and high technical and managerial skills. The high demand for processed foods in recent years has led to the establishment of large-scale factories in some developing countries.

2.4 FRUIT JUICE PROCESSING

Juice is an important liquid food. It is a major carrier of nutrients, e.g., vitamins and minerals, in our diet and refreshes our life and plays a significant role in social events. A school of thought is of the opinion that the per capita consumption of juice correlates well with the prosperity of a nation.

In the modern ages, taste is more diversified in the world and "exotic" becomes a preference. Consequently, more and more tropical and subtropical fruits, such as oranges and pineapples have joined the list of popular raw materials for juice making.

2.4.1 WHEN TO PICK THE FRUITS

The proper time to pick fruit depends upon several factors; these include variety, location, weather, ease of removal from the tree (which change with time), and purpose to which the fruit will be put. For example, oranges change with respect to both sugar and acid content as they ripen on the tree; sugar increases and acid decreases. The ratio of sugar to acid determines the taste and acceptability of the fruit and the juice. For this reasons, in some instances there are measures that prohibit picking until a certain sugar-acid ratio has been reached. Furthermore, since many types of fruit continue to ripen off the tree, unless they were to be processed quickly, some would become over-ripe before they could be utilized if picked at peak ripeness.

2.4.2 HARVESTING

The maturity, ripeness and other measurements, plus experience, indicate when fruit is ready for harvesting and subsequent processing. A large amount of the harvesting of most fruit crops is done by hand; this labour may represent about half of the cost of growing the fruit. A correct manual harvesting includes some simple but essential rules.

- The fruit should be picked by hand and placed carefully in the harvesting basket;
- The harvesting basket and the hands of the harvester should be clean;
- The fruit should be picked when it is ready to be processed into a quality product depending on the treatment which it will undergo.

2.4.3 RECEPTION

Fruit reception at the processing plant is performed mainly for the following purposes:

- Checking of sanitary and freshness status;
- Control of varieties and fruit wholeness;
- Evaluation of degree of maturity;
- Collection of data about quantities received in connection to the source of supply.

Variety control is needed in order to identify that the fruit belongs to an accepted variety as not all are suitable for different technological process. Special attention is given to size, appearance and uniformity of fruit to be processed.

2.4.4 QUALITY MEASUREMENTS

Many quality measurements are be made to determine if proper maturity or degree of ripeness has developed. Colour may be measured with instruments or by comparing the colour of fruit with standard picture charts.

2.4.5 TEMPORARY STORAGE BEFORE PROCESSING

This step has to be as short as possible in order to avoid flavour losses, texture modification, weight losses and other deterioration that can take place over this period.

Some basic rules for the step are as follows:

- keep products in the shade, without any possible direct contact with sunlight;
- avoid dust as much as possible;

- avoid excessive heat;
- avoid any possible contamination;
- store in a place protected from possible attack by rodents, insects, etc.

2.4.6 WASHING

Harvested fruit is washed to remove soil, micro-organisms and pesticide residues. Fruit washing is a mandatory processing step; it would be wise to eliminate spoiled fruit before washing in order to avoid the pollution of washing tools or equipment and the contamination of fruit during washing.

- Washing efficiency can be gauged by the total number of micro-organisms present on fruit surface before and after washing. Fruit washing can be carried out by immersion, by spray/showers or by the combination of these two processes which is generally the best solution: pre-washing and washing.

Some usual practices in fruit washing are:

- addition of detergents or 1.5% HCL solution in washing water to remove traces of insect-fungicides;
- use of warm water (about 50°C in the pre-washing phase;
- higher water pressure in spray/shower washer.

2.4.7 SORTING

Fruit sorting covers two main separate processing operations:

1. removal of damage fruit and any foreign bodies (which might have been left behind after washing);
2. qualitative sorting based on maturity stage.

2.4.8 EXTRACTION

Extraction is an important step in juice making. It can be done by way of blending, milling, pressing, centrifugation, or a combination of these treatments depending on the equipment available. An ideal extraction process shall obtain maximum quantity of juice material at the best quality.

2.4.9 FINISHING

Juice coming out of the extraction treatment often contains coarse particles that tend to precipitate before or after packing. The main purpose of finishing is to separate these particles from the juice as a preventive measure for undesirable precipitation.

Finishing can be done by way of screening through sieves, which often goes immediately after extraction in the same piece of machinery called pulper-finisher, filtering through a filter-press, or centrifugation.

2.4.10 BLENDING AND FORMULATION

Blending is one of the key steps in the making of high-quality single-strength juice. Since the composition of fresh fruit varies with the ripeness, the harvesting season, the locality of production, etc., blending of different batches of juice is necessary for standardization and for achieving the best quality.

In the making of syrup juice or diluted juice, formulation is done by blending the ingredients together in the proper ratios. The additives commonly used include sugar, salt, citric acid, water, artificial colorants, flavors and thickening agents.[8]

2.4.11 DE-AERATION AND DE-OILING

Extraction, finishing and blending treatments often involve a great deal of agitation that entraps air as suspended bubbles or in dissolved form in the juice. The entrapped air may escape or reduce the efficiency of the heat exchanger during thermal processing. Therefore, de-aeration is carried out in many juice plants. The principle of de-aeration is to vacuum the juice. Usually, spraying or filming technique is applied onto the juice to accelerate the de-aeration rate by increasing the surface area for mass transfer.

Excessive peel oils may leak into the juice during extraction. The juice may taste too irritating, especially when consumed by minors. Under such circumstances, de-oiling becomes a necessary treatment. It is done in much the same way as de-aeration because these oils can easily be volatized under a vacuum.

2.4.12 THERMAL PROCESSING AND PACKING

Single-strength juice, diluted juice and syrup juice shall all be thermally processed in the juice packing plant. The purpose of thermal processing is to inactivate the spoilage microorganisms as well as the native enzymes. Normally, a hot-fill temperature no lower than 87°C, a center temperature no lower than 85°C during in-can sterilization, or a holding time-temperature combination equivalent to 92°C in 40 seconds shall constitute an adequate thermal process for high-acid juice. A high-quality pasteurized juice, which is called "freshly squeezed juice not-from-concentrate" on the market, can thus be

obtained.[9] In conventional packaging, metal or glass containers are usually used, whilst, in continuous thermal processing, containers made of glass, plastics or laminated composite materials are used, among them Tetra Pak packages as the most famous example.

2.4.13 CONCENTRATION

Some of the juice may be concentrated for long-term storage, long-distance transportation, or for selling as a semi-product. The common methods for juice concentration includes vacuum concentration, freeze concentration and reverse osmosis concentration. Among them, vacuum concentration is the most common one. The use of temperature-accelerated-short-time-evaporator (TASTE) in making orange juice concentrate has become a conventional illustration for vacuum concentration. Freeze concentration produces high-quality product, at the expense of high energy consumption and to some extent reduced yield. Reverse osmosis concentration is good only for clear juice to a concentration not too high concentration.

The concentrate may be packed and sterilized or sterilized and packed or frozen into slush in a heat exchanger.

2.5 CASE STUDIES

2.5.1.0 FRUITS AND FLAVOURS LIMITED - ASEBU

2.5.1.1 LOCATION

The factory is located in Asebu on the Cape Coast to Kumasi high way- in the Abura-Asebu-Kwamankese district of the Central Region of Ghana.

2.5.1.2 BACKGROUND

The company, was established as far back as 1929 under a private ownership, then called 'L. Rose and Company'. The name was later changed to Emil Ghana Limited in 1980.It was liquidated in 1987, and was revamped in 1993, and became 'Fruits and Flavours' Limited.[10] Fruits and flavor limited is a fruit processing company which specializes in the production of lime juice concentrate and dried lime peels for the international market. The factory, which has about 5,000 out-grower lime and orange farmers and more than 108 employees, also produces 'orange flavoured' drinks in sachets, alongside cola drink for the local market. Using capital-intensive technology, it is the largest company of its kind in Ghana. The company processes 30,000 metric tons of lime fruits per annum.

Fig.1 Entrance road to the factory

2.5.1.3 REASONS FOR STUDY

The purpose of the study of the Fruits and Flavours Limited was to enable the author underline the positive and negative aspect of the design of that factory in the development of a similar factory, the effect on users and stakeholders with the objective to create an environment that stimulates the sense of users and staff and optimisation of operational aspects and well being.

2.5.1.4 FACILITIES

Facilities at the factory includes, the administration block, production hall, canteen, welfare area, laboratory, water treatment plant, maintenance area,

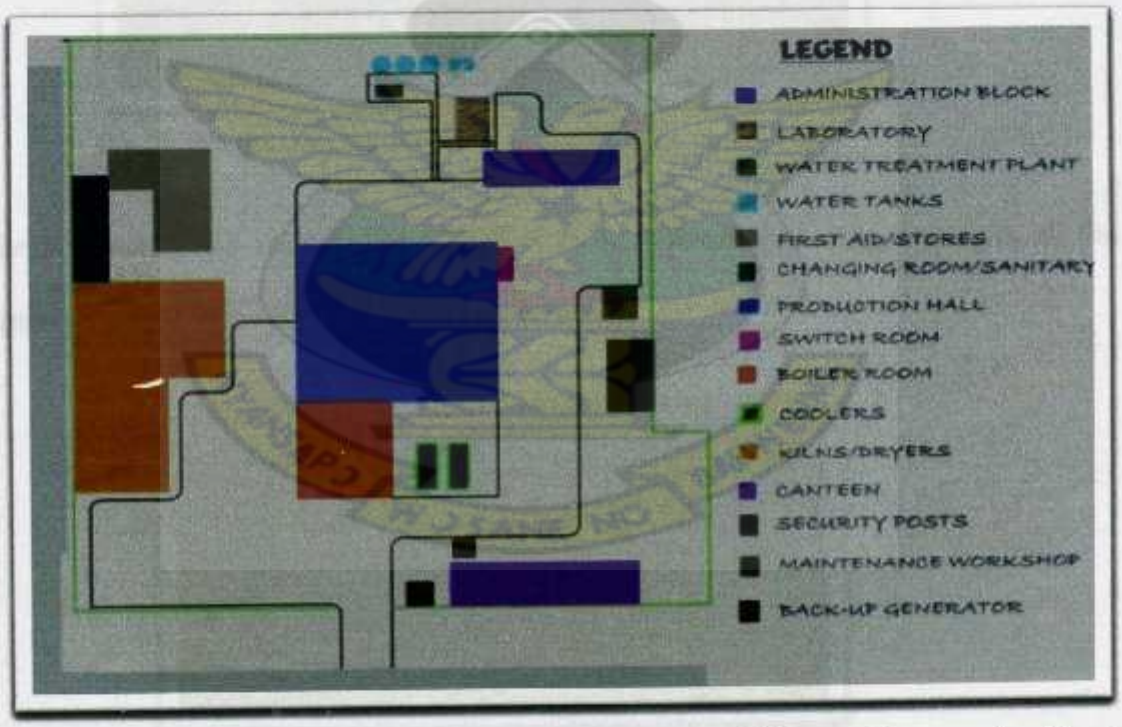


Fig. 2 A schematic layout of the factory showing lack of linkages between functional areas of the plant.

2.5.1.5 ARCHITECTURE

The massing, scale and volume of the various structures and spaces give a clear indication of the type of facility. The buildings are isolated from each other with no well defined linkages.

The administration is a single storey structure housing the reception, the manager's office, account, sales, purchasing and general offices.

Fig. 3 The administrative block of the factory

The production hall is basically a shed with no external enclosure. It houses all the equipment used in the processing of the fruit juice.

Fig. 4 The exterior view of the production area.

Fig. 5 The open production hall, where the processing takes place.

The power control room which is attached to the production hall has all the electrical switches that control the machinery in the production hall.

Fig. 6 The electrical switch room attached to the production hall.

Quality control analysis of the products at the various stages of production and of the treated water that is used in the production are conducted in the laboratory which is set up closer to the water treatment plant than the production hall.

Fig.7 The exterior and interior views of the quality control laboratory.

Fig. 8 The first aid and changing rooms respectively.

2.5.1.6 ENGINEERING SERVICES

No fruit processing plant can operate functionally without engineering infrastructure like electricity, water and other mechanical systems like plumbing and sewage. It is in this regard that Provision has been made to provide adequate support services for the operations of the factory. Electricity is sourced from the national grid with back up diesel generators which are relied upon when the need arises.

Although the factory has water supply from the Ghana Water Company Limited; a dam has been constructed on a nearby stream (Opan) to ensure constant water supply. Water from the "opan" river is treated and used for the production. With five over-head storage tanks the water treatment plant is able to meet the water needs of the factory.

Fig.8 The water treatment plant and generator house at fruits and flavour limited

2.5.1.7 WASTE DISPOSAL

A strong recycling of residual products takes place in this processing factory; the lime peels are dried and exported.

On the other hand, burning is used in the disposal of other solid waste after drying. Waste water is discharged directly into the nearby stream.

2.5.1.8 MERITS

- Floor drains in the production area enables floors to be drained easily in times of cleaning.

- The sourcing of water from the near-by river which is treated ensures constant water supply needed in fruit processing.

2.5.1.9 DEMERITS

- Poor planning- lack of linkages between blocks which are scattered on the site.
- The open production area encourages rodents and birds to habitate there and does not provide barrier for inclement weather.
- Improper functional relationship between sanitary room and worker's changing rooms.

2.5.2.0 PAPSO GHANA LIMITED - ACCRA

2.5.2.1 LOCATION

Papso Ghana Limited is located at plot number 17, on the Spintex road in Accra, Ghana.

Fig. 9 Entrance to Papso Ghana Limited

2.5.2.2 BACKGROUND INFORMATION

Papso Ghana Limited started operations in 2004, with the processing of pineapples, oranges and mangoes into fruit juices as well as reconstituting imported fruit juice concentrate for the local market.

2.5.2.3 REASONS FOR THE STUDY

- To identify various activities and facilities that will impact positively on a fruit processing plant.
- To identify how functional relationship of space impact on productivity of labour in a processing factory.

2.5.2.4 FACILITIES

Fig 10 Functional relationship diagram illustrating the spaces in the factory

The facilities at the factory include the following;

- Reception area
- Manager's office
- Account office
- General office
- Board room
- Welfare area
- Production area
- Packaging area
- Finished products storage area

Fig. 11 The factory block of Papso Ghana Limited

2.5.2.5 SPATIAL PLANNING

The administration is located in the main frontage of the facility indicating the first place of call by users, staff etc. the parking lot is located close for usage of visitors and staff alike

Partitions separate wet and dry areas in the production unit in accordance with production technology.

The service area is isolated and well screened from the public view.

Fig. 12 A typical process flow at Papso Ghana Limited indicating how raw materials are handled in production areas.

2.5.2.6 ENGINEERING SERVICES

These are essential services for the smooth operation and sustainability of the processing factory.

Electricity: Over head cables are used for supply of electricity to the facility.

Fig.13 Overhead electricity cables serving the factory

Water: Pipe borne water from Ghana Water Company is the main source of water and these pipes have been connected to steel water tanks have been provided in facility to serve as water reservoir to enhance constant supply of water.

Fig.14. One of the steel water tanks-this indicates the indispensability of water collection and preservation as input to production.

Waste: Solid waste from the processes such as fruit peels are disposed off through a waste management company, whilst the liquid waste is discharged into the central drains.

Fig.15 Waste collection- wastes of fruits are packed for collection and safe disposal in selected destination.

2.5.2.7 MERIT(S)

- Well screened service area

2.5.2.8 DEMERIT(S)

- Inadequate storage space for ancillary materials such as bottles and crates.

- Improper ventilation of the production area due to inadequate openings.

2.5.3.0 SOUTHERN GARDENS CITRUS, FLORIDA, USA

2.5.3.1 LOCATION

Southern Gardens Citrus is located in Hendry County, Florida, USA.

2.5.3.2 BACKGROUND INFORMATION

The plant was opened in 1994 with a production capacity of approximately 120 million gallons of orange juice per annum. Southern Gardens Citrus combines the most efficient and progressive farming techniques available in the world with state of-the-art processing and packaging technology. It is one of the most efficient and environmentally friendly juice-processing plants in the United States.

Fig. 16 A view of the factory

2.5.3.3 REASONS FOR STUDY

- To study how the production technology impact on factory space.
- To study the various machines and parameters influence labour productivity in processing.

2.5.3.4 PROCESSES AND MACHINERY.

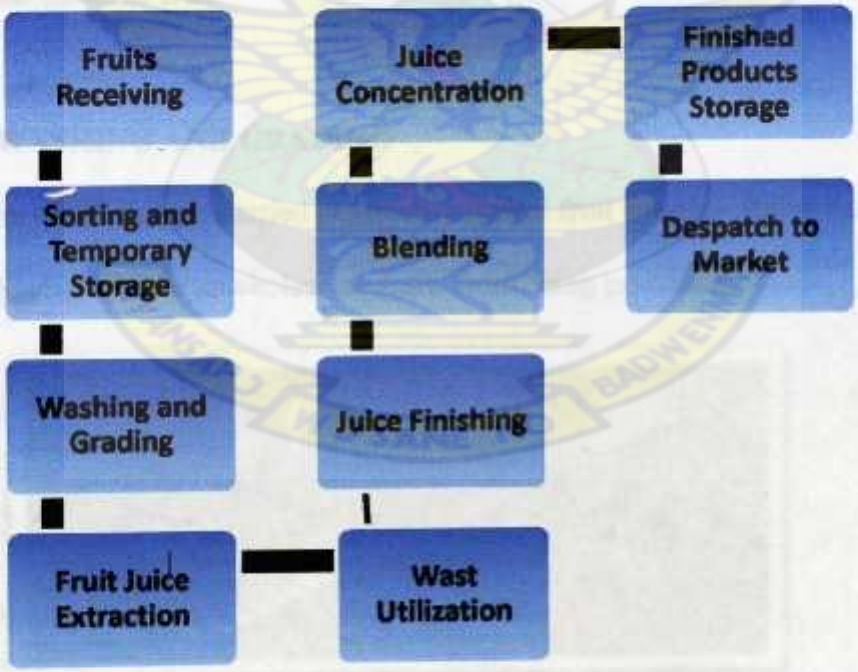


Fig 17 Production flow diagram for fruit juice production

2.5.3.4.1 FRUIT RECEPTION

Oranges are delivered at the factory in trailers, which are elevated so that the fruit can be gently unloaded. Leaves, twigs and stems are mechanically removed with hovers,

Fig. 18 Fruit reception point at the factory

2.5.3.4.2 TEMPORARY STORAGE

The fruits are carried by conveyors and bucket elevators to temporary storage bins. Each bin holds one trailer of fruit.

2.5.3.4.3 WASHING AND GRADING

The washing of the fruits is carried out by mechanical fruit washers whiles the grading is manually done to remove unwholesome fruits from being processed.

Fig. 19 Sorting of fruits on conveyor belt at the factory After which grading is done.

2.5.3.4.4 JUICE EXTRACTION

The fruit is automatically sorted by size as it enters the juice extractor lines. The juice extractors separate the juice and pulp from the peel, seeds and membrane.

Fig 20 The inside of the production hall where the juice is extracted from the fruit

2.5.3.4.5 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.

Fig 21 The Juice finishers

2.5.3.4.6 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 cooled to 32 degrees.

Fig 22 Juice pasteurizers at the factory

2.5.3.4.7 CONCENTRATE ORANGE JUICE

For concentrated orange juice, 85 percent of the water is removed by evaporation units.

Fig 23 Juice evaporators.

2.5.3.4.8 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.

Fig 24 Juice tanks.

3.3.5.9 FINISHED PRODUCT (STORAGE)

In the concentrate tank farm, the concentrated orange juice is stored in the 200,000-gallon capacity bulk tanks at a constant temperature.

The NFC juice is stored in one of the plant's 56 one-million gallon capacity indoor tanks. Juice from both the NFC and concentrate tanks can then be directly loaded into tanker trucks for transportation to the customers

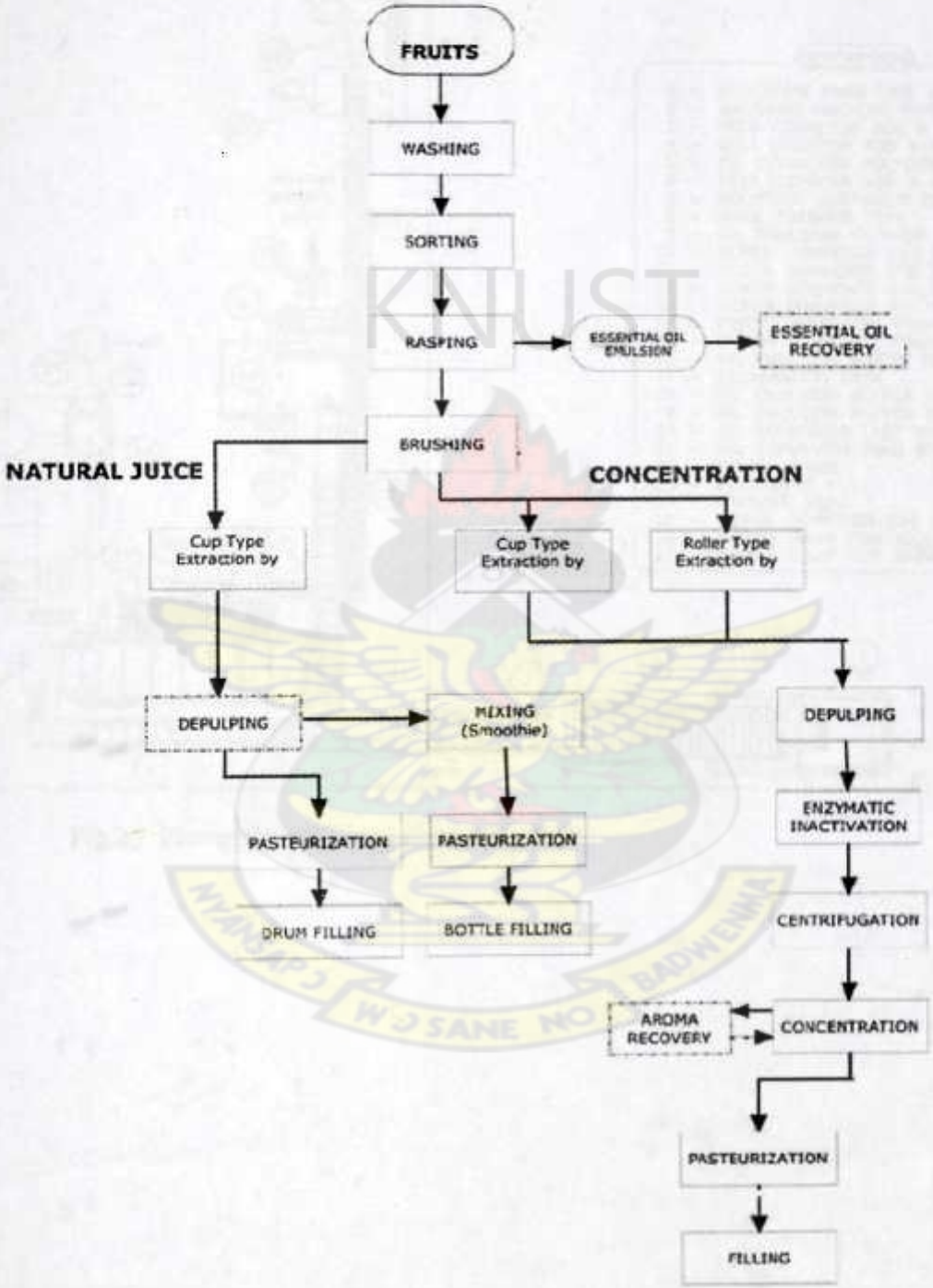
2.5.3.5.10 WASTE UTLIZATION AND MANAGEMENT

The residual products, oil, pulp etc are fed into a feed mill where the the product is pressed, heated and dried. The remains are used for cattle feed

Water used at the plant is recycled through an elaborate on-site cleaning and filtering system and is used to irrigate nearby orange grove.

2.6.0 TECHNICAL AND SPECIAL STUDIES

2.6.1 PROCESS FLOW CHARTS FOR FRUIT JUICE PRODUCTION



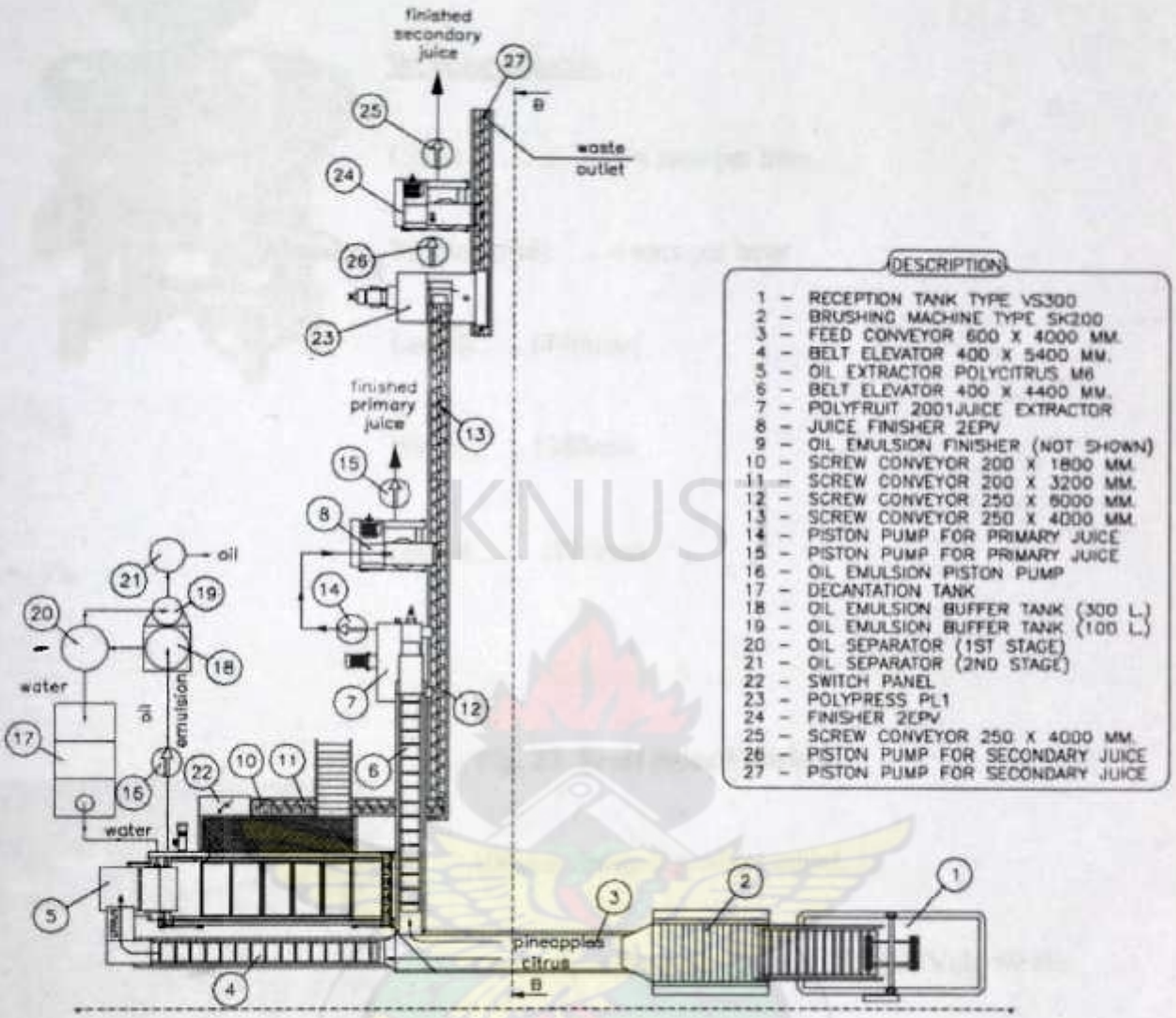


Fig.25 Pineapple and Citrus processing line

Fig. 26 Polyfruit Juice Extractor

Working capacity

Citrus .....6 to 8 tons per hour

Tropical fruit.....4 tons per hour

Length 1740mm;

Width..... 1380mm;

Height..... 1710mm.

Fig. 27 Fruit Juice Finisher

100mm finished product outlet.

Motor Specifications: 20 hp, 230/460 Volt, 60 Hz.

Overall Dimensions:

Width 675mm

Length 2100mm

Height 1200mm

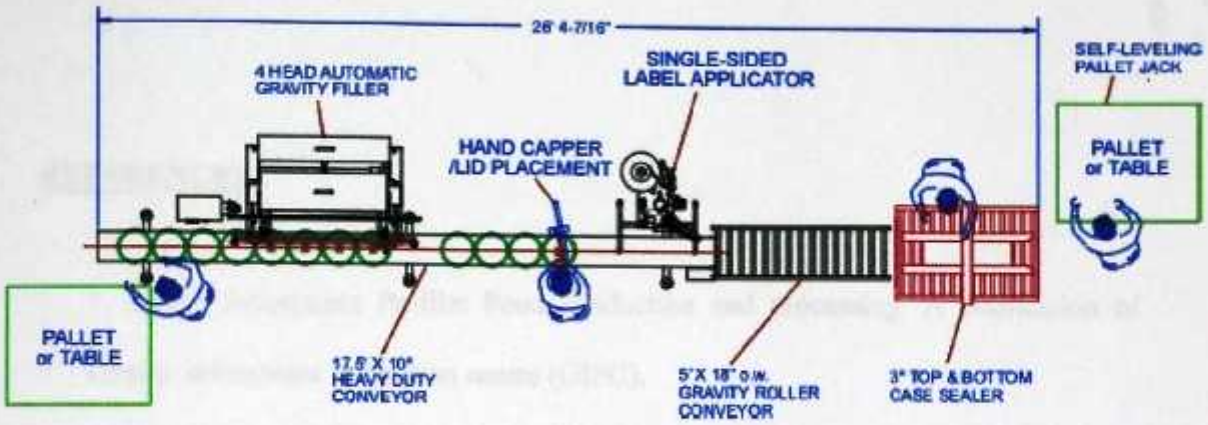
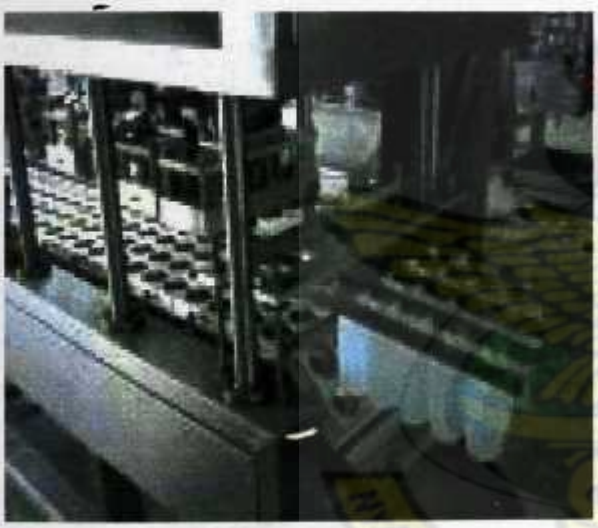


Fig 28 Galon liquid filling line



Production capacity: 8000b/h based on 100ml bottle

Total power : 6kw

Air consumption :0.6m3/min(0.5--0.7Mpa.

Overall dimension : 4000x800x2400mm

Weight : approx.1200kg

Fig. 29 Filling and Sealing Machine for PET Bottles

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CHAPTER THREE

RESEARCH METHODOLOGY

3.0 INTRODUCTION

Writing this report required different methods of data collection. The methods are grouped under two sources: primary and secondary sources. The information gathered was carefully evaluated to ensure that only the ones that are relevant to the topic were used.

This chapter gives a description of the methods used in gathering this information as well as the limitations encountered.

3.1 PRIMARY SOURCES

The primary sources consist of interviews, visual observation, measured drawing, photographs, and case studies.

3.1.1 INTERVIEWS

Interviews were conducted with various stakeholders in the fruit processing industry such as the marketing manager of Papso Ghana Limited, the operation manager of Fruits and Flavours Limited

Interviews, in the form of interactions, were conducted with people who were either directly or indirectly involved in the fruit processing industry at Papso Ghana limited at

Accra and Fruits and Flavours Limited at Asebu. A cross section of farmers in the targeted area was also interviewed on their views and impression on establishing a processing plant in the area. Interactions were also held with the district agricultural officers of Abura-Asebu-Kwamankese and Mfantseman Districts on the fruit production potentials in their respective districts.

3.1.2 VISUAL OBSERVATIONS

Some of the information used came about through careful personal observations and visual surveys made by the author during visits to some fruit processing facilities. This was important because the taking of photographs was not allowed in some areas visited. Critical observation was made in and around these facilities and this aided in documenting the spatial organization and their inter-related activities. The various materials used for construction were also recorded by visual observation. These facilities were also observed in relation to the surrounding physical environment.

3.1.3 PHOTOGRAPHS

Photographs were taken by the author as another means of documenting information. It served as a library of information that was readily available and captured details such as floor and wall finishes of the facilities visited. This made it easy to recollect some of the information that may have been forgotten along the line. They were also used to complement some sketches made during the process. Among photographs taken were

existing conditions at the selected site as well as some critical and important facilities that aided in the design.

3.1.4 MEASURED DRAWINGS

Measurements were taken of certain spaces visited. This was to ascertain their adequacies in relation to the machineries that inhibit them and their functional disposition and to enable the author draw useful conclusions.

3.1.5 CASE STUDY

A much detailed study of some local and foreign fruit processing facilities that serve some or all of the functions of the project to be undertaken was undertaken to enable the author draw conclusions on design decisions to be taken in tacking the scheme. It is also during the case studies that visual observations, photographs and sketches were made. Most of the outcome of this research is as a result of the revelation made during the case studies, as situations on the ground presented a realistic assessment of the spatial requirements of project to be undertaken compared to prescribed and well known standards.

3.2.0 SECONDARY SOURCES

Secondary sources consist of the literature readings from library and the internet.

3.2.1 LIBRARY

Most of the information for the literature review was obtained by reading both published and unpublished literature on the topic from the library. This involved the examination written materials such as books, journals, periodicals, video recordings etc.

3.2.2 INTERNET SEARCHES

A lot of literature was also gathered from various web sites associated with fruit processing. It provided some insight into some problems encountered whilst undertaking the project and their possible solutions.

3.3 LIMITATIONS

This project has not been undertaken without limitations. The unavailability of data at the various government institutions such as the Ministry of Food and Agriculture and the unwillingness of officials to disclose information made the study painstaking and burdensome. Data collection through interviews posed the greatest problems since some people were not forth coming with information.

Some fruit processing plants did not allow their facilities to be used for a case study as they assumed that the presence of the author would interfere with their production.

CHAPTER FOUR

FINDINGS AND DICUSSIONS

4.1 FINDINGS

From the various studies conducted and the literature reviewed, it was deducted that most large-scale Agro-processors are faced with problems of:

- Poor equipment back-up service rendered by dealers,
- Limited access to appropriate packaging material
- Erratic supply and increased cost of fuel coupled with frequent power cuts;
- Unreliable supply of raw materials,
- High cost of processing equipment;

This has led to a situation where opportunities currently tend to favour the development of medium-scale processing industries that match the current production levels and the distortions in marketing of produce.

It would therefore be prudent to develop a medium-scale plant, as it would be more sustainable compared to a large-scale one.

It was also realized that a well planned fruit processing plant should be designed to operate for as many months of the year as possible. This means the facilities; buildings and equipment must be inter-linked and coordinated properly to allow as many products as possible to be handled at the same time.

Besides, common utilities such as roads, electricity, water and communication were noted to be vital to the development of a fruit processing plant. For that reason it is

necessary to locate any proposed development of such nature at a place where such services are available.

It was also recognized especially from the case studies that is also an advantage, all things being equal, to locate a processing plant near the source of fresh raw material supply. It is necessity for the proper handling of the perishable raw materials.

4.2 .0 SITE STUDIES

4.2.1 LOCATION

The site is located in Abura Dunkwa in the central region of Ghana. It is 50 meters from the Kumasi - Cape Coast road; along the Tsetsi – Mankesim road. The site is bordered on the north by the Tsetsi – Mankesim road, on the east and south by farmlands and on the west by some isolated residences and a small scale oil palm processing plant.

It covers a land area of 9.6 acres (39,000 $m^{2)}$.

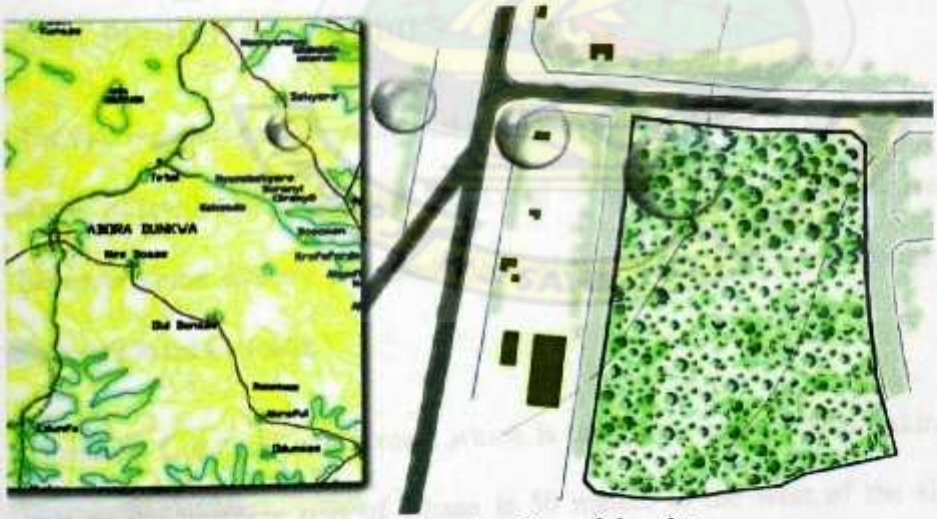

Fig. 30 A map showing the location of the site.

4.2.2 CHOICE AND JUSTIFICATION OF SITE

The basic objective was to choose a location which minimizes the average production cost, including transportation and handling. Other considerations included selecting a site;

1. near the source of fresh raw material supply,
2. with adequate supply of good water,
3. close to good road transport facilities

The above site was chosen as a result of it satisfying the above considerations better than other sites that were examined. In addition to that were the following reasons which were deducted from the interviews with some of the stake holders in the industry

1. favourable climate and soil for the cultivation of the raw materials,
2. availability of abundant and inexpensive labour,
3. willingness of fruit growers to increase fruit production

4.2.3 PERIPHERAL STUDIES

The site is encompassed on the east and south by farms, and on the west and the north by some isolated residences and the Tsetsi – Mankesim road respectively. There are however some already proposed roads which when constructed would make the site fully enclosed by roads.

The Cape Coast – Kumasi road, which is one of the major roads linking the southern part to the northern part of Ghana is 50 meters to the west of the site. Some light economic activities including selling of Fanti kenkeys, oranges, food stuffs does take place at the junction between the two roads mentioned above.

Fig 31 the economic activities

Fig 32 electricity lines close to the site

4.2.4.0. SERVICES

4.2.4.1 ELECTRICITY

Electricity to the site could be sourced from the nearby transformer which located about 20 meters to the east of the site along the Tsetsi – Mankesim road.

4.2.4.2 WATER

There is a Ghana Water Company main line running parallel to the Cape Coast – Kumasi road which is approximately 50 meters from the site. Moreover, a bulk water reservoir belonging to the same company is also located not so far from the southern boundary of the site.

4.2.4.3 ACCESS

The site is accessible by Tsetsi – Mankesim road from the northern side.

Fig 33 The access road to the site

4.2.4.4 DRAINAGE

Most of the surface water on the site finds its own path towards the north - western side of the site since there are no gutters or well designed drainage to take off surface water from the site. However, there are no visible signs of any gullies.

4.2.5.0 NATURE OF SITE

4.2.5.1 TOPOGRAPHY

The site slopes downwards towards the north-western side by an elevational change of 1.5 meters. The main erosion potential area is on the western side of the site.

4.2.5.2 SOIL

The characteristics of the soil on the site can be described between sandy-loam and laterite; with a very fertile tops soil.

4.2.5.3 VEGETATION

The northern part of the site is covered by secondary thick bushes with some isolated trees, whilst oranges and food crops cover the rest of the site.

4.2.5.4 CLIMATE

There are two rainy seasons, the major season starting at the end of April, peaking in May-June and declining in July. The minor rainy season begins in October and reaches a peak in November, declining by the middle of December, followed by a spell of dry, cold weather (the harmattan) in the latter part of December through the end of February. The months of August and September are relatively dry. Annual rainfall in the area ranges between 110cm and 170 cm. The area has mild temperatures ranging between 23 °C and 28 °C and a relative humidity of approximately 70 percent.[1]

4.2.6.0 SITE ANALYSIS

4.2.6.1 STRENGTH

- The site has very good accessible roads on two sides of the site. the Kumasi-Cape Coast road and the Tsetsi-Mankesim road.
- Electricity and water sources exist close to the site.
- The site is within the production catchment area for oranges and pineapples which are the primary raw materials.

4.2.6.2 WEAKNESS

- No fixed telecommunication lines close to the site.
- The gentle slope of the site in the north-eastern direction may have a cost implication on the project: as the need for cutting and filling of some sections of the site may arise.

4.2.6.3 OPPORTUNITIES

- Possibility of future expansion due to the availability of land.
- Electricity and water could easily be sourced from the lines that are close to the site

4.2.6.4 THREATS

- The existence of some isolated residences close to the site which has led to an encroachment of the site.

REFERENCES

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CHAPTER FIVE

PLANNING AND DESIGN

5.1 DESIGN BRIEF / ACCOMMODATION SCHEDULE

Based on the technical, special and case studies as well as the analysis of the client and target group's needs, the following brief and accommodation schedule has been developed in order to facilitate the design process. All Area Measures stated against spaces are in Square Metres (m^2).

SPACE	NO	AREA M^2
ADMINISTRATION		
RECEPTION / WAITING AREA	1	24
PERSONEL MANAGER'S OFFICE	1	12
ACCOUNT OFFICE	1	12
GENERAL OFFICE	1	30
MARKETING AND SALES DEPT	1	15
GENERAL MANAGER'S OFFICE	1	15
SECRETARY'S OFFICE	1	9
PROCUREMENT OFFICE	1	25
BOARD ROOM	1	30
ARCHIVES	1	6
SANITARY FACILITIES	2	18

SPACE	NO	AREA M^2
CANTEEN		
EATING AREA	1	100
SERVERY	1	9
KITCHEN	1	25
STORE ROOM	2	12
OFFICE	1	10
SANITARY	2	15
WELFARE		
CHANGING ROOMS	2	120
FIRST AID TREATMENT ROOM	1	20
RECOVERY ROOM	1	25
WORKER'S LOUNGE	1	25
LAUNDRY	1	15
BACK YARD	1	15
PRODUCTION AREA		
OFF-LOADING BAY	2	190
FRUIT RECEPTION/WASHING AREA	1	460
QUALITY CONTROL	1	12
TEMPORARY STORAGE	2	100

SPACE	NO	AREA M^2
PROCESSING HALL	1	1500
PACKAGING MATERIAL STORE	2	350
PACKAGING AREA	1	700
FINISH GOODS STORE	2	800
STORE KEEPER'S OFFICE	1	9
PRODUCT DESPATCH AREA	1	250
PRODUCTION ENGINEER' OFFICE	1	12
PRODUCTION MANAGER'S OFFICE	1	12
LABORATORY	1	32
CLOCK IN AREA	1	9
SWITCH ROOM	1	12
SERVICE AREA		
MAINTENANCE WORKSHOP	1	70
ENGINEERS OFFICE	1	12
STORAGE SPACE	1	25
STAND-BY GENERATOR	1	65
BOILER HOUSE	1	70
WATER TREATMENT PLANT	1	45
WASTE WATER TREATMENT PLANT	1	35
GENERAL STORAGE SPACE	1	400

SPACE	NO	AREA M^2
FEED MILL		
PEEL RECEIVAL AREA	2	70
PEEL DRYING AND MILLING	1	180
ANCILIARY FACILITIES		
SECURITY POSTS	2	35
STAFF/ VISITORS PARKING AREA	1	495
TRUCKS PARKING AREA	1	240
TRUCKS MANOEUVRING AREA	1	2680

Table. 2 this table shows the accommodation schedule

5.2 PHILOSOPHY AND CONCEPT OF DESIGN

5.2.1 DESIGN PHILOSOPHY

The physical setting inevitably affects how people live and work. It is desirable, not only for productivity but also for personal satisfaction that the work environment be stimulating. It is in this regard that the design of a fruit processing plant with a philosophy of "**efficiency and cohesiveness**" was envisaged from the very beginning.

5.2.2 DESIGN CONCEPTS

To achieve the design philosophy, certain concepts would critical be incorporated in the design. Firstly, the integration of the various structures and spaces in a logical and

coherent manner will be very paramount in the design as this would help to create a resourceful movement of labour within the facility.

Creating effective use of spaces and efficient air distribution coupled with good shading and orientation to minimize solar gain and maximize daylight harvesting would also be a prerogative in designing the facility.

Finally, the introduction of current technology would greatly improve the effectiveness of the production process.

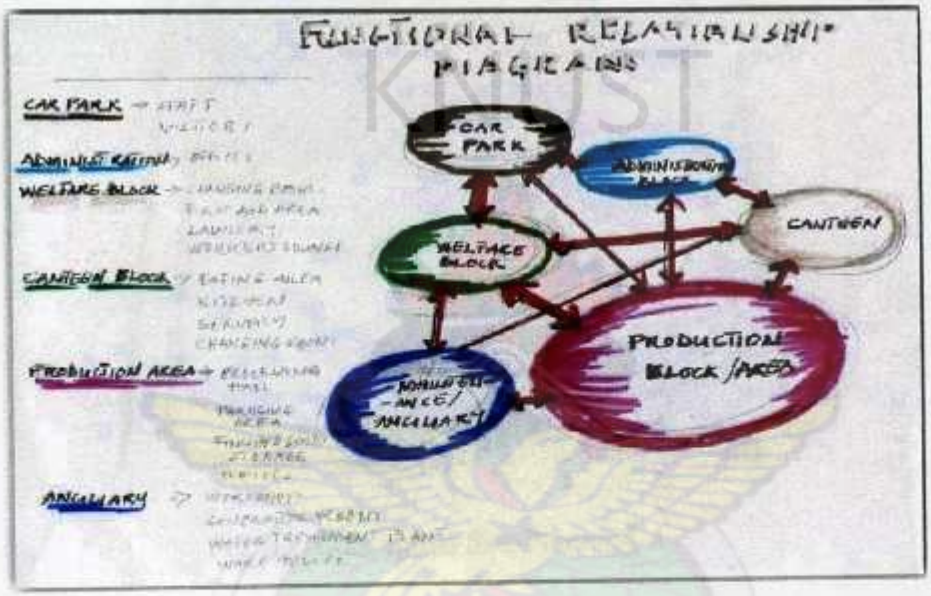

Fig. 34 Functional Relations Diagram

5.2.3 CONCEPTUAL DEVELOPMENTS AND PLANNING

The site was conceptually zoned, taking into consideration, the topography of the site as well as the prevailing wind direction. As many fruit juice processing operations involve the generation of heat by the machinery, good ventilation is essential. As such the initial site planning configuration and orientation of buildings was carefully done to enhance

natural ventilation, reduce solar heat gain, and maximize day lightening to reduce energy cost.

OPTION 1

Fig. 35 Conceptual Site Planning A

Merits

- Well compact layout
- Production area is well enclosed and screened from the main road.

Demerits

- Welfare block is quite far from the production area.

- Location of service yard could impact negatively on other structures in terms of heat build up due to the prevailing wind direction.
- The structures are scattered and not well linked.

OPTION 2

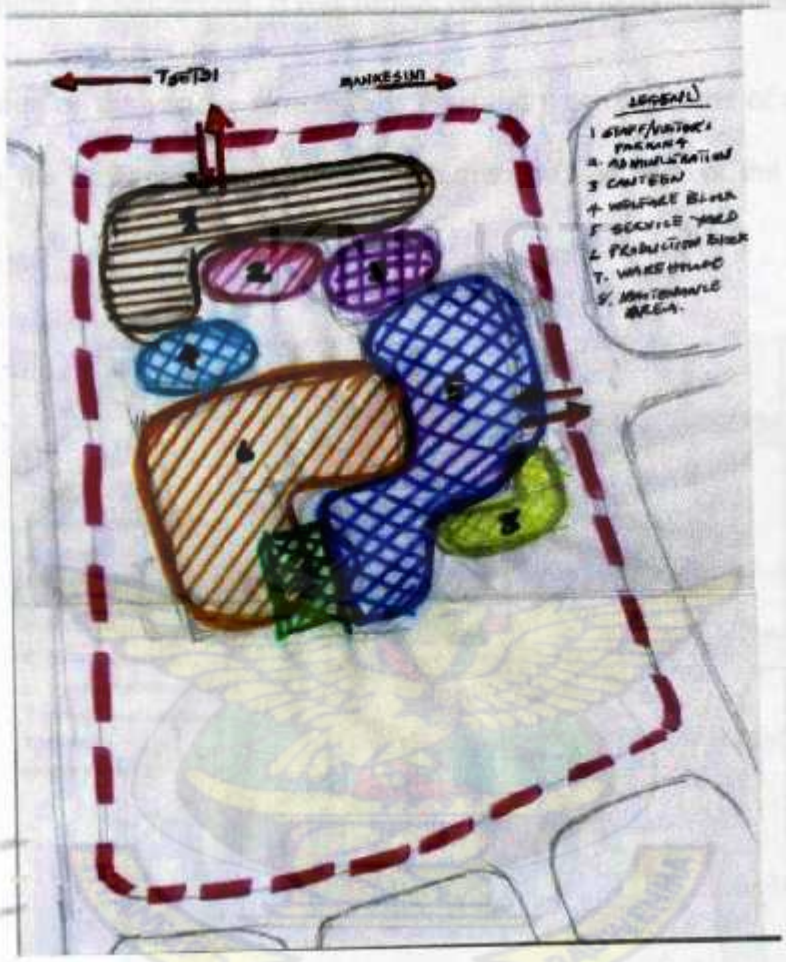

Fig. 36 Conceptual Site Planning B

Merits

- Good link between welfare area and the production area.
- Well secluded service area

- There is a clear distinction between public and private areas of the facility.
- Good location of administration area in terms of views onto the site.

The desire was to have a compact layout with well linked structures led to the adoption of Option 2 for further development. It was further chosen due to its numerous merits.

The general design of the various structures is essentially compositions of rectangular forms satisfying the functional requirements of movement and flow of the production process.

Fig 37 Site Plan

5.3 DESCRIPTION OF THE DESIGN ESSENTIALS

The building forms were influenced by the functional and spatial requirements of industrial facilities as deduced from the various studies undertaken.

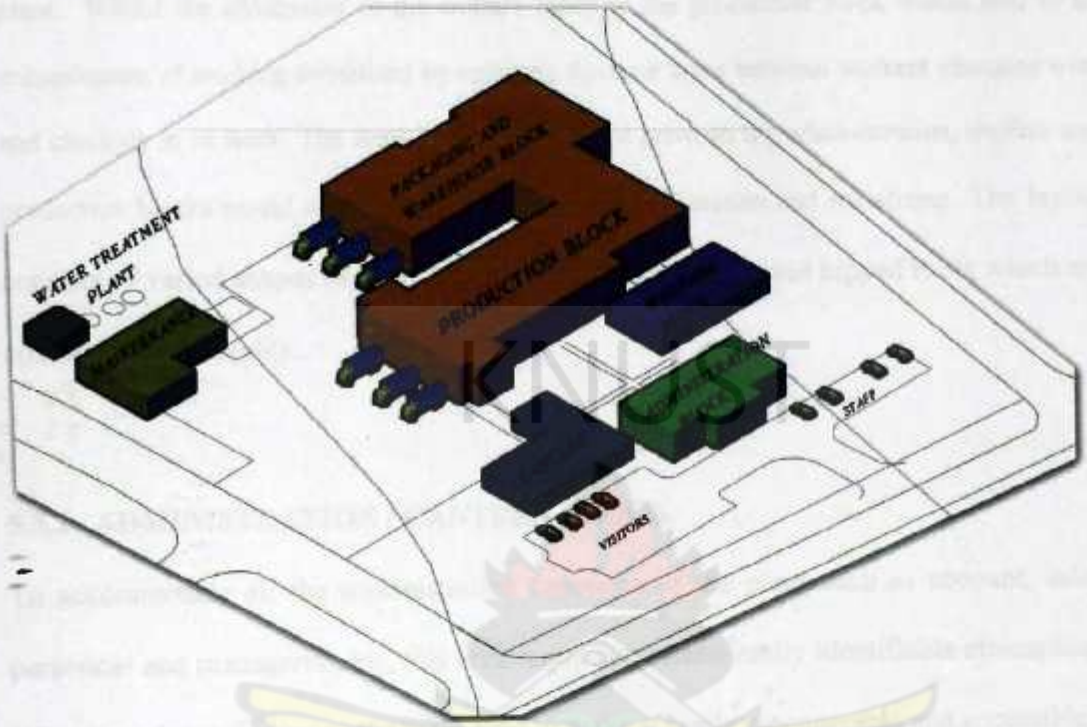

Fig 38 Conceptual Massing

5.3.1 SITE PLANNING AND LAYOUT

With careful analysis of the conceptual site planning, issues such as Orientation of buildings, interrelationship of spaces, parking areas, and service areas were given considerable attention in the course of the design. The orientation of the various blocks on the site was dictated mostly by the solar path to reduce solar ingress and enhance cross ventilation.

The separation of the administration block – which also accommodates the canteen- from the plant's production block helps to create a distinction between the private and public areas of the plant. Whilst the attachment of the welfare block to the production block would lead to an enhancement of working conditions by reducing the time lapse between workers changing over and clocking in to work. The semi-enclosed courtyard between the administration, welfare and production blocks would act as a ground for meetings, relaxation and socializing. The layout consists of varied shapes of different sizes with simple gable and hipped roofs which are common in the locality.

5.3.2 ADMINISTRATION / CANTEEN BLOCK

To accommodate all the administrative functions of the plant such as account, sales, personnel and managerial, etc, this area requires a serene easily identifiable atmosphere. It has been located close to the main road to make it easily recognizable and accessible. The block has the reception, sales office, store, and the canteen on the ground floor whilst the first floor houses the manager's office, board room, personnel, procurement and general offices.

It has been architecturally designed to 'stand out' and be easily recognized from the rest of the facility.

5.3.3 WELFARE BLOCK

This structure which is basically a workers unit contains two changing rooms for the male and female workers. There is also the infirmary which has the treatment and rest rooms to offer first aid to workers on site. A workers lounge and a laundry have also

been provided to cater for their relaxation and laundry needs respectively. The location makes it easily and directly accessible from the drop-off zone for workers.

5.3.4 PRODUCTION AREA

The production block is designed as an open hall with few internal structural members to give freedom to the production process and also allow for easy modification in technology. It covers a substantial proportion of the total land area. The block consists of the raw material reception area, the fruit washing area, the juice extraction area, juice pasteurization and concentration area, the packaging area and the finished products storage area. The areas have been so designed to flow into each other in order to achieve an efficient flow of activities.

5.3.5 MAINTENANCE BLOCK

The maintenance block, which has been designed to partially screen off part of the service yard, consists of maintenance workshop -with a parts store, office and sanitary space, - fresh water and waste water treatment plants.

5.3.6 LANDSCAPING

Green areas and foliage will cover all the exposed areas of the factory. Large trees will be responsible for the provision of shades at the factory areas especially at the eastern and western sides.

There will be an on-site nursery of citrus plants which will later be given out to the farmers so as to secure the future supply of quality raw materials. The treated waste water collected could be used to irrigate the nursery and the landscaping.

5.4 THE STRUCTURE

The varied building heights coupled with the functional requirements of the various facilities have made it necessary for the use of different structural forms. However, all roof members are made up of simple steel truss with the exception of the security posts which uses timber rafter and purlin system. Majority of the facilities are built entirely on the principle of post and beam structural system.

5.5 MATERIAL

5.5.1 SUBSTRUCTURE

The substructure of the production block will be made with reinforced concrete strip foundation with intermediate pad foundation for the structural columns. A tie beam just beneath the reinforced concrete floor slab would be introduced to provide stiffening for the columns.

5.5.2 SUPERSTRUCTURE

Reinforced concrete columns will be used in the outer envelope of the building with I-section steel beams introduced as central columns in the interior spaces. The building envelope shall be constructed with sand-crete block work. Reinforced concrete tie beams will be used to keep the building together.

5.5.3 ROOFING

The roofing material is a deep trough industrial aluminium roofing sheets fixed with 8mm diameter aluminium alloy hook bolts to mild steel channel purlins with aluminium and bituminous felt washers.

5.5.4 FINISHES

The factory floors will be screed and washed concrete to help withstand the spillages and the dropping of tools and machine parts.

All walls and claddings will be painted with a bright but low gloss paint to help aid visibility in the factory.

Non slip tiles will be used for the floors at the administration block.

5.6 SERVICES

5.6.1 ELECTRICITY

Electrical power from the mains will be brought to the factory through overhead cables at 11000V. This is will then be stepped down to 415V/240V by the on-site transformer on three phase 4 wire supply system through the generator plant to the factory floor and the various sectors of the factory through the distribution board.

5.6.2 LIGHTING

In a bid to cut down on the usage of artificial lighting, large openings have been created on the northern and southern facade to bring in as much daylight as possible. Natural lighting shall also be introduced through Perspex material distributed within the roof framework. However suitable levels of artificial lighting will be provided from fluorescent luminaries to supplement the day lighting, especially within the administration, canteen and welfare blocks.

The whole premises shall be adequately lit for security reasons. Localised site lighting has been provided. Post top lanterns with mercury fluorescent lamps shall be used to light the roads. Other areas requiring special lighting shall be provided in consultation with authorities concerned.

5.6.3 VENTILATION

Natural ventilation will be used as much as possible. However areas to be air conditioned shall be provided with the split unit system. This would have the cooling coil housed within the building whiles the condensing unit would be installed outside and connected through a pipe to save space. Electric fans will be used to improve the air circulation of spaces when the need arises.

5.6.4 WATER

Water is tapped from the Ghana Water Company main line along the Kumasi-Cape Coast high way for use by the plant. This will be pumped into reservoirs before distribution into the various units. Two underground tanks and three overhead tanks shall be provided to store water in the event of water shortage.

Rain water from the roofs will also be harvested and used for the flushing of toilets

5.6.5 WASTE WATER

Waste water from the plant would be treated and used for the irrigation of the seedling nursery as well as for the flushing of toilets

5.6.6 DRAINAGE

Surface covered drains will be provided to channel all surface water to the public drains.

5.6.7 SEWAGE DISPOSAL

Waste is conveyed through soil and waste pipes from the sanitary appliances through the manholes to the septic tank which is located on the low side of the site to ensure smooth flow. This would be emptied at regular intervals.

5.6.8 REFUSE UNIT POINT

These are to be located at vantage points within the premises. They are to be sited away from public view but within accessible areas for waste disposers and collection vehicles.

5.6.9 FIRE CONTROL

Fire hydrants and extinguishers will be placed at vantage points and close to fire prone areas. Besides, fire alarm communication system including fire and smoke detectors and sprinklers would be installed to trigger on the detection of such hazards, whilst emergency exits are provided in the production area to give unobstructed access to people for escape in times of danger.

5.6.10 SECURITY

Security is one of the major areas of factory buildings and as such my design has two major security check points. The first one at the main entrance of the factory leading to the administration area to checks all the cars coming into the factory. The other post checks the service entry and exit points of the factory to ensure that no pilfering occurs.

5.7 COSTING

The cost of this project as shown below is determined by the approximate estimation method of costing a building. This is to give the client an idea of the approximate financial investment needed to undertake the project.

The cost per square meter of construction for this project would be GH¢300

FACILITY	AREA ($M^{2)}$	AREA X COST PER METER SQUARE	TOTAL COST
Administration	196	196 x Gh¢ 300	GH¢ 58,800
Canteen	169	169 x Gh¢ 300	GH¢ 50,700
Welfare Unit	220	220 x Gh¢ 300	GH¢ 66,000
Production Area	4448	4448 x Gh¢ 300	GH¢ 1,334,400
Service Area	722	722 x Gh¢ 300	GH¢ 216,600
Feed Mill	250	250 x Gh¢ 300	GH¢ 75,000
Ancillary Facilities	3449	3449 x Gh¢ 300	GH¢ 1,034,700
APPROXIMATE TOTAL COST OF THE ENTIRE PROJECT			**GH¢ 2,836,200**

Table 3 Costing for the project.

5.8.0 CONCLUSION AND RECOMMENDATION

5.8.1 CONCLUSION

Many fruits are wasted as a result of post harvest losses and lack of storage facilities. To resolve this problem, it is necessary to add value to the farm products. This can be done by encouraging the construction of processing plants to add value to such products. It will also facilitate the development of entrepreneurship in the country.

In pursuance of the objectives of the this design, it is hoped that the fruit processing plant when constructed will help rekindle the interest of farmers in the cultivation of fruits and serve as a catalyst for other industrial development in the area.

5.8.2 RECOMMENDATION

The locals should be made active stakeholders in industrial development. Their active participation from the inception to completion would go a long way in helping to develop their sense of ownership.

It is also recommended that the project be carried out in phases as described below;

Phase 1: The Welfare and Production Blocks

Phase 2: Administration and Canteen Block

Phase 3: Maintenance and Warehouse Block

Phase 4: Feed mill

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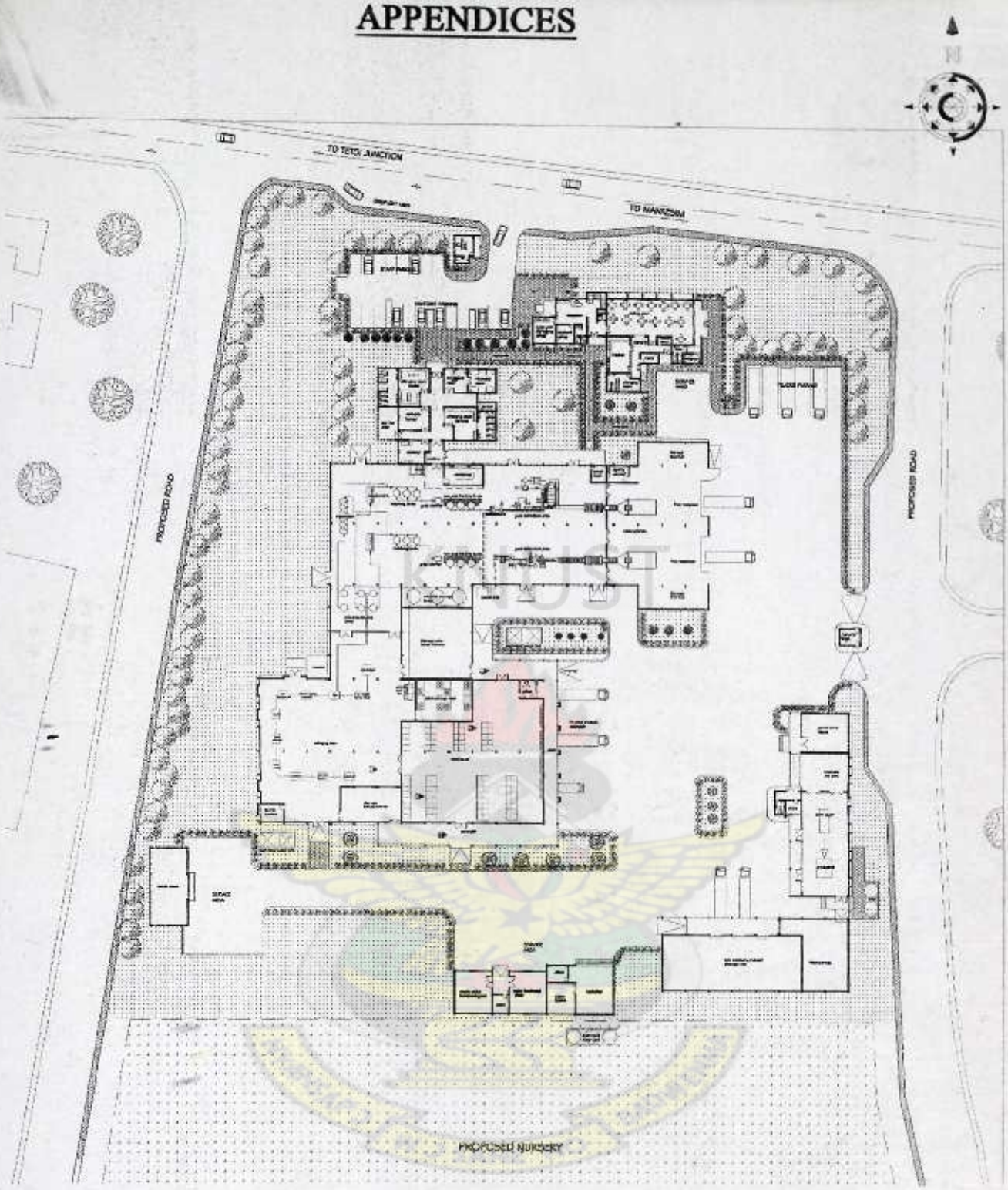
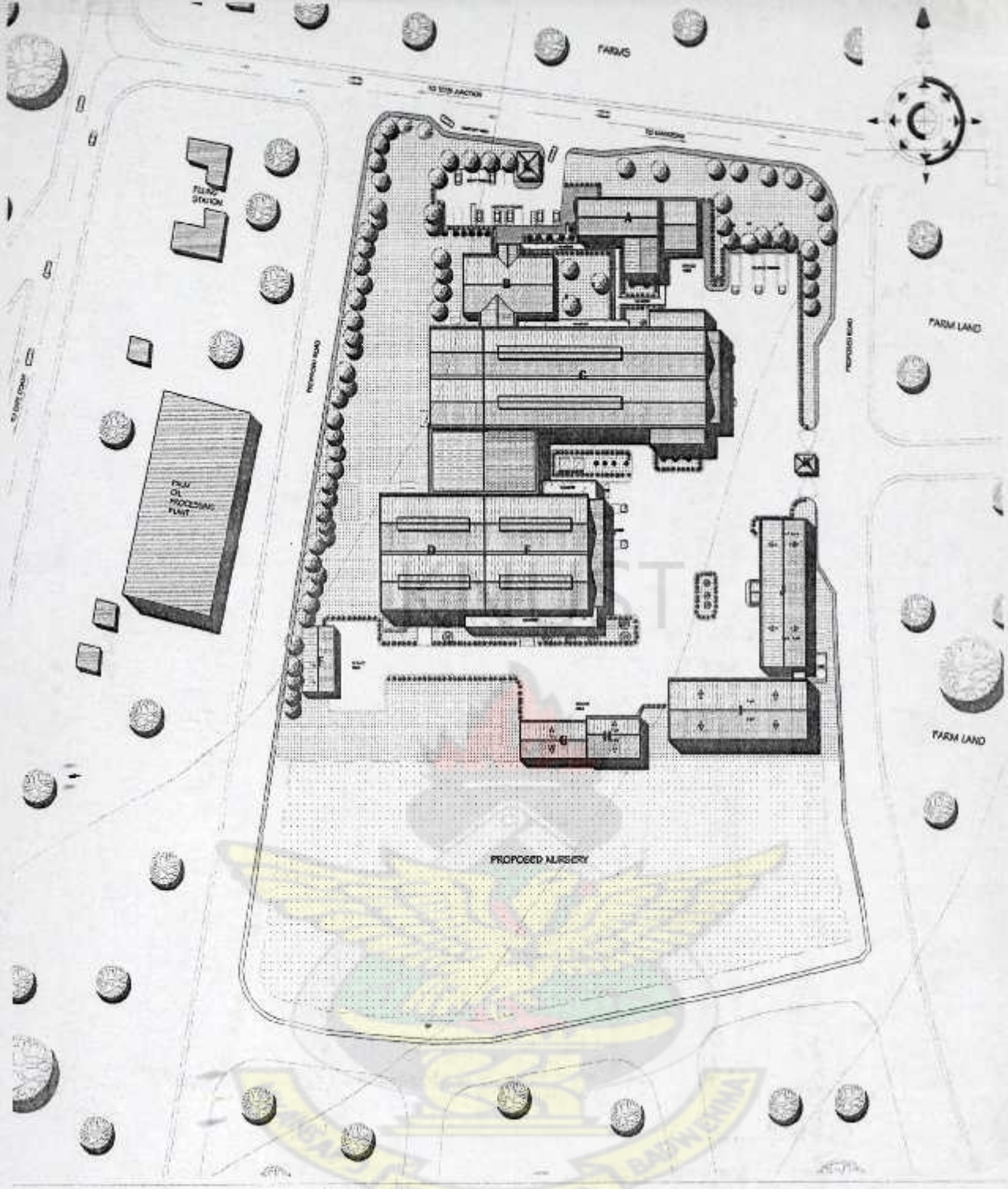
APPENDICES



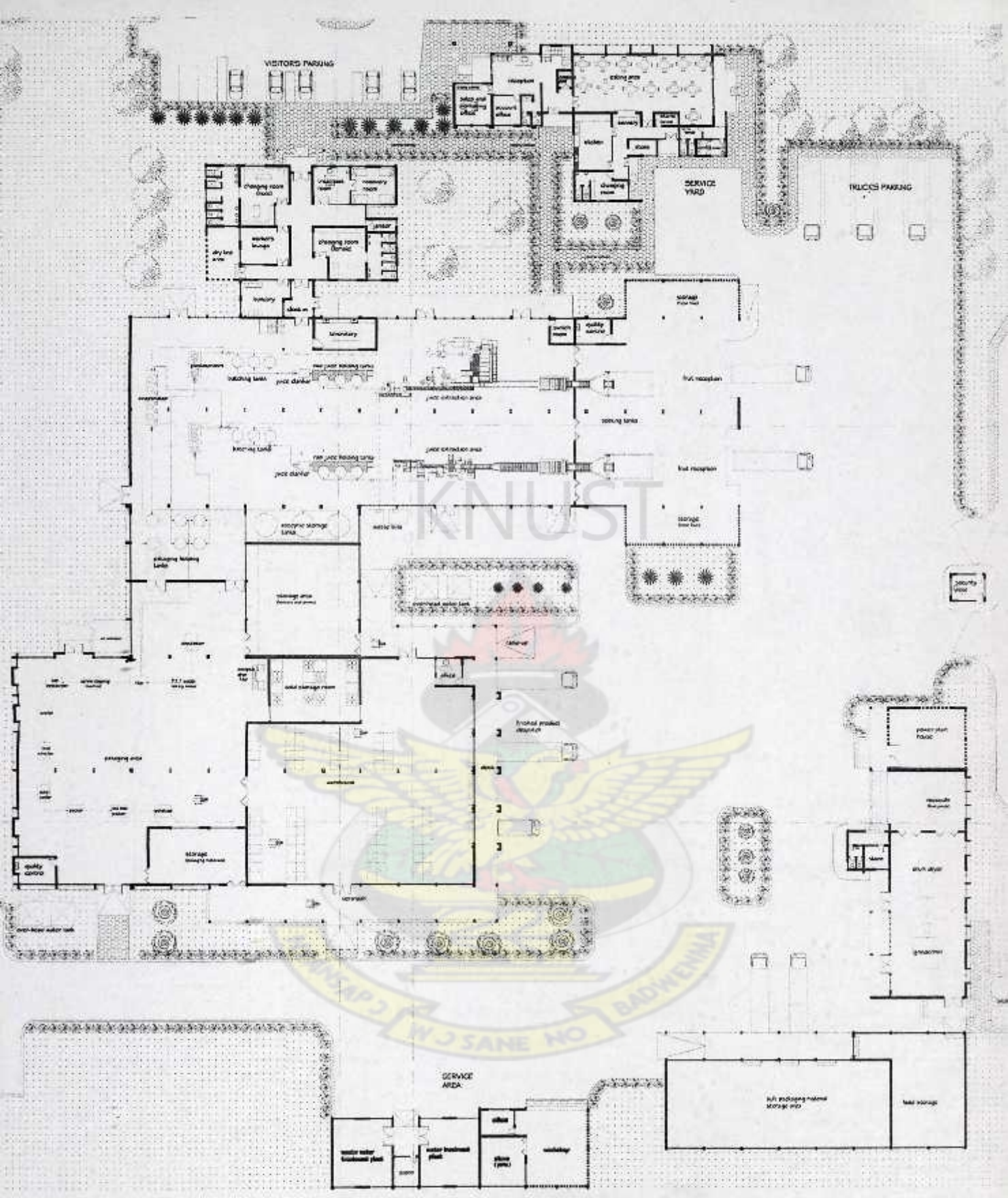
Appendix 1 Site Layout



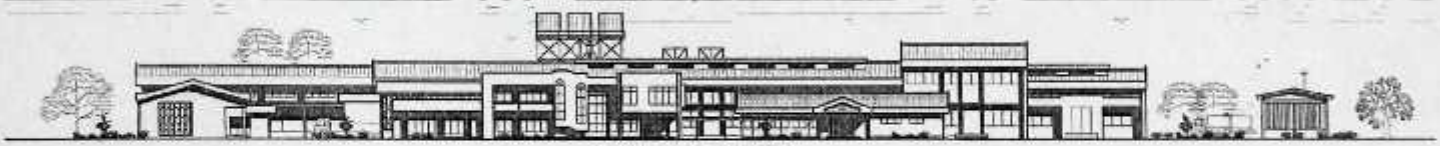
LEGEND

A ADMINISTRATION / CANTEEN BLOCK	B WELFARE BLOCK	C PRODUCTION BLOCK	D PAKAGING AREA
E WAREHOUSE	F BOILER HOUSE	G WATER TRATMENT PLANT	H MAINTENANCE
I BULK STORAGE AREA	F FEED MILL	F SECURITY POSTS	

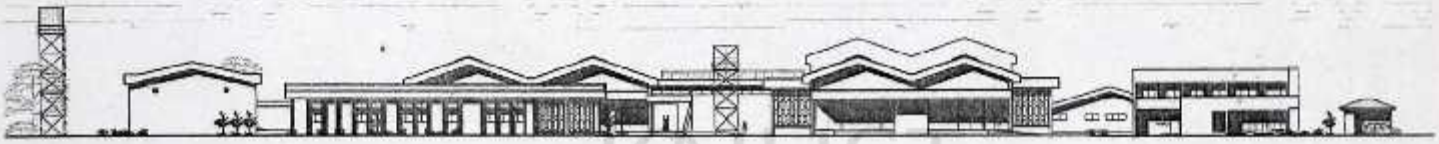
Appendix 2 Block Plan



Appendix 3 Floor Plans of the Facility



NORTH ELEVATION



EAST ELEVATION

SOUTH ELEVATION

WEST ELEVATION

Appendix 4 Elevations of the Facility