OIL PALM PROCESSING INDUSTRY, ANKPA

TOWARDS EFFECTIVE PLANNING FOR SANITATION IN EDIBLE OIL INDUSTRIES

BY

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(M.Sc. Architecture).

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DECLARATION

I, Omata, Mercy Inikpi of the Department of Architecture, Faculty of Environmental Design, Ahmadu Bello University, Zaria, hereby declare that the work presented in this thesis is a personal academic undertaking executed under the supervision of my mentor, Arc. A.K. Yeboah of the Department of Architecture, Ahmadu Bello University. It has not been accepted wholly or partially in any previous application for a higher degree and all quotations, information utilized and their sources have been dully acknowledged by way of reference.

Omata 26/01/2000

Students Signature Date

CERTIFICATION

This thesis entitled Oil Palm Processing Industry, Ankpa. Towards effective planning for sanitation on edible oil industries, by **Omata, Mercy Inikpi**, meets the regulations governing the award of **Master of Science in Architecture (M.Sc. Architecture)** of Ahmadu Bello University, and is approved for its contribution to knowledge and literary prostration.

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DEDICATION

This thesis is dedicated to my creator, the MOST HIGH GOD who made it possible for me to attain this level. And also to my late dad Hon J. B. Omata, who did not live to see the completion of the course, to my mum Mrs R.I. Omata and my siblings, whom encouraged and cared so much for me.

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ABSTRACT

Industrialization is a major process for economic development of any Nation. The present economic situation has prompted the Federal Government to seek for ways of diversifying the economy base, hence the emphasis on industrialization and agricultural development.

Oil Palm, (Elaeis guineensis) thrives in the tropics. From Senegal, Nigeria, Serra Leone to Zaire and wherever the average annual rainfall amounts to 150m distributed over not less than eight months of the year. An oil palm is best known for its commercial products; palm oil and palm kernel. This edible oil is indigenous and is mostly produced using local skills and resulting in variable quality and quantity.

The research is on proposing a comprehensive oil palm industry towards effective sanitation in the processing of this oil. This is to minimize the enormous amount of wastage and unhygienic processing methods. The primitive methods are not economically viable for the country. The proposed industry is to extract and refine palm oil and palm kernel oil for domestic use and also with the ultimate goal of exporting to foreign markets. Its immediate market is Ankpa.

To carry the citizens along with the agricultural programs, there should be a ready market and a good one for that matter, for any agricultural product right where it is produced or where the potentials for producing then exist. This will help in stimulating the production, as well as serve as a dual purpose of industrial and agricultural developments.

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Source: 6A-6P Equipment manufactures catalogue.

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CHAPTER ONE

1.0 INTRODUCTION

An oil palm tree (Elaeis guineensis) in appearance is like a date palm tree, having a large head of pinnate feathery fronds. The fruits consist of the outer pulp which is the source of the crude palm oil, an inner shell which is used as fuel, and kernel which is the source of palm kernel and meal. Palm kernel oil is refined into edible Vegetable oil.

Production of palm produce takes place largely in the Eastern, Southern and middle belt areas of Nigeria. Most of the production comes from the wild palm grooves of Dura species, but there has been a great break-through in the replacement of this low yielding specie with a high yielding and fast mature tennera specie developed by the Nigeria institute for oil palm research, (NIFOR) Benin.

Hundreds of thousand tons of palm oil and palm kernels enter into World trade every year. It is important to note that these quantities represent only a few percentage of the total World trade in vegetable oil. While it is true that each vegetable oil has its own special use, there is a good deal of interchangeability, which undoubtedly increases as scientific research progresses. In the World market it is seen that the commercial products of the oil palm

are up against a considerable amount of competition from other vegetable oils.

Although the oil palm has many competitors, its great strength lies on the very high yield of oil, which it can produce. An oil palm stands out as the most efficient producer of vegetable oil when compared to other important vegetable oil plants grown. This is judged by the yield of oil obtainable from an acre of land. The oil palms only rival is the coconut palms which when grown under the best conditions can give yields of oil equivalent to what is obtainable from the oil palm.

1.1 PROBLEM STATEMENT

The chosen site (Ankpa) lies ostensibly in an oil palm belt. There is availability of raw materials and there is need to enhance the processing of oil palm products. It is deduced from the demand and supply table of oil palms (table 2.0) in Nigeria 1982-1990 that the domestic production is incapable of meeting the consumption requirements of the country. Admittedly the bulks of the production of oil available in our markets are far cries from the desired standard and level required meeting general demands. Therefore, there is need to attract modern technique to exploit the vast oil.

Existing oil industries face some sanitation problems and if not well tackled could finally lead to the contamination of the finished product. Palm oil industries process edible oils which is classified under food, one of the basic essentials of life. If it is not processed in a healthy environment it may get contaminated and become dangerous for human consumption. Sanitation in food industries involves the control of environment in which raw foodstuff is processed to prevent contamination of the finished product, thereby promoting the maintenance of good health. Therefore, a food industry that has sanitation problems will also face hygiene problems.

An Architects role in encouraging good sanitation practices in oil palm industries cannot be overemphasized. Sanitation and hygienic oriented planning and construction is more important than sanitation methods since it encourages sanitation practice.

This thesis therefore takes a study of various processing activities within the country with the aim of solving the sanitation problems.

1.2 STATEMENT OF INTENTIONS

1.2.1 AIM

The thesis is an attempt to solve sanitation problems encountered in edible oil processing industries through Architecture.

1.2.2 OBJECTIVES

1. To identify the existing sanitation problems in other relevant industries and creating architectural solutions to them
2. To create a comfortable, hazard free and conducive occupational environment.
3. To develop facilities which will maximize available local resources.
4. To use Nigeria=s, vast wild palm grooves and plantation potentials to aid in revamping the economy.
5. Developing an adequate planning scheme for effective spatial and functional organization.

1.3 MOTIVATION

The researcher is motivated by the agricultural outputs of oil palms which is on the increase yearly due to improvement in agricultural research, and the

yield for increase in food output in developing countries. An enormous amount of wastage occurs due to lack of good processing techniques.

Furthermore, little attention has been paid to simple mass-market items such as edible oil, soaps, margarine and animal feeds. It is high time therefore that research for few industrial projects toward the production of simple but essential industrial agriculture based products are oriented so as to stop their importation.

According to recent research findings, oil palms are indigenous to Nigeria. It is well cultivated and yields more in the eastern part and middle belt where Kogi is located. Due to the high yield of these oil palms in this region, and without a comprehensive processing oil industry the inhabitants have taken to the traditional methods of processing. These primitive methods are economically not viable for the country and are inadequate to meet the low paid increasing demand by the growing population. This is because up to 20% of the oil content is left in its by-products. Therefore, it will be more viable to introduce mechanical means for maximum efficiency.

The provision of such an industry in a state like Kogi will make it be on a more stable foundation toward

self-sufficiency in food and agro-allied product. In addition, this type of industry at this crucial stage of economic development in the country will help in conserving and at the same time earn foreign exchange for the country. It will also provide job opportunities for the indigenes in the locality.

1.4 METHODOLOGY

The methodology for this research comprised of the following:

i. Printed data: This involved gathering literatures relevant to the research. Such as journals, published and unpublished text.

ii. Field work: This involved site visits to existing relevant industries on the country. There was also a visual survey of the proposed site.

iii. In-depth interviews: Gathering information through interviews with experts in the field.

1.5 CONSTRAINTS AND LIMITATIONS

i. Inadequate and poor documentation on oil palm produce in Nigeria.

ii. Owners of existing oil mills are difficult to contact, especially the private owned. The equally gave limitations on the level of

information to be given. Photography was strictly forbidden in the industries.

iii. Finance was also a serious constraint that limited other research areas.

iv. The time limit for the thesis work was of great disadvantage.

1.6 SCOPE OF WORK

The scope of study covers the history and economical importance of oil palms. Also the design of comprehensive oil palm processing industry incorporating the extraction and refinery of palm oil and palm kernel. Emphasis is on effective planning for sanitation in the production hall.

The industry comprises of the following:

i. Administrative block

ii. Workers facilities

iii. Production hall

iv. Parking spaces

v. Auxiliary/ancillary facilities

1.7 ARCHITECTURAL CONTRIBUTION

The architectural contribution is firstly the provision of the space envelope, which is functional, and also creating a comfortable and hazard free environment for the maximum efficiency of workers.

Secondly, the design provides a properly organised production process and zoning of units to ensure effective sanitation. This will promote the production of uncontaminated edible oil on a large scale.

CHAPTER TWO

2.0 INTRODUCTION: PALMAE

Palm trees belong to the family Palmae, in the order palmate, under the tribe cocoineae.

The Palmae are the smallest angiosperm subclass known as arecidae. The Palmae are structurally the most diverse and also the most distinctive group in the subclass.

The great centres of palm distribution are in America and in Asia from India to Japan and South to Australia and the Islands of the pacific and Indian oceans. With Africa and Madagascar as a third but much less important palm region.

The mean annual temperature needed for its survival is 150°- 21° (60-70"F) and a minimum of 50cm rainfall per year.

Table 2.0 Palm Trees

	Palm trees	Botanical names	Country
1	Fan Palm	Chanaerops humilrs	Europe / North Africa
2	Nikau Palm	Rhopalostylis sapida	New Zealand/Chathan Islands
3	Coconut palm	Cocos nucifea	Europe / Africa
4	Oil Palm	Elaes guineesis	Africa / America
5	Raffia Palm / jupati	Raphia	Africa / America
6	Betel palm	Areca catechu	Africa / Asia
7	Palmyra Palm	Borassus aethiopum	Africa / Asia
8	Ratten Palm	Calamus	Africa / Asia
9	Doum Palm	Hyphaene compressa	Africa / Asia
10	Date palm	Phoenix dactylifera	Africa / Asia
11	Sugar Palm		Africa / Asia

The palms with the greatest importance in the world commerce are the coconut and the African oil palm both are prime sources of vegetable oil and fat.

In Nigeria the oil palm are of three species

1. Tennera specie
2. Dura specie

Pisefera specie

2.1. HISTORY OF OIL PALM

The oil palm (Elaeis guineenis) is one of the important oil-bearing plantation Crops grown in the regions of equatorial topics. Palm oil is derived from the frond of the oil palm tree, which in appearance is rather like the date palm with a sturdy trunk. The fruit grows in bunches weighing 18.14kg to 23.00kg with 400-1500 individual fruits. The fruits consists of the outer pulp which is the source of the crude palm oil, an inner shell which is used as a fuel, and a kernel which is the source of palm kernel oil and meal.

A tennera specie palm tree starts bearing fruits between three to four years old. It reaches its peak yield at about ten years and produces about 136.07kg of oil per hectare. It is replaced when it is about 30-35 years old when the fruit bunches get too high for economic harvesting. This height is mostly 13 meters.

The Dura specie (wild palm) has duration of about three times that of the tennera specie before it produces fruits it grows upward at the expense of grith, so that the fruit can only be reached by climbing the trunk. While that of the tennera specie can be reached by chisel or long poles while standing.

(a) **HARVESTING**

Harvesting of palm fruit is continuous throughout the year with a seasonal peak between March to May.

The initial harvesting of oil palm fruits begins 3.5 years after planting. Harvesting should ideally be carried out when the maximum quantity of high-quality palm oil (as judged by the free fatty acid content) would be produced from the harvested fruits. The harvesting round in the oil palm must not be so infrequent that the bunches become overripe and most of the fruit drops out or gets damaged. The harvested bunches are transported to the place of extraction.

(b) **STORAGE OF OIL PALM SEED**

Oil palm seed can be conveniently stored on a large scale in 44-gallon drums covered with wooden lid. The viability of oil palm seed can be maintained at ambient temperatures at moisture contents too low for germination or at low temperatures under high moisture conditions.

472791

(c) **STORAGE OF PALM OIL**

The refined palm oil containing low free fatty acids (FFA) stores well if it is stored in nonmetallic containers and is not exposed to light. Hartley (1967), stated the following requirements for the production of low-FFA palm oil having good storage property:

(a) Minimum bruising of the fruit during harvesting, carriage, and movement at the mill site.

(b) Minimal time between harvesting and sterilization

(c) Fruits or extracted oil does not cool down; avoids contact with apparatus or materials causing recommencement of Iypolysis during extraction.

2.2. THE VALUE OF THE OIL PALM

Oil palm products are considered as the first and foremost good crop in the West African setting. Large quantities of palm oil are consumed locally in Nigeria. Palm oil besides contributing to a balanced diet by the provision of vegetable fat has the added value of being rich in vitamin A. Palm wine which is also a product, is recognised as having a certain dietetic value because of its vitamin content.

The oil palm furnishes many other things, which assume importance in the domestic economy of the people. The leaves may be used to make roof thatches.

The leaf petioles for fencing or protecting the top of mud walls. The palm cabbage is occasionally eaten as a vegetable. It oil extracted for making soap. All these uses combine to make oil palms a most valuable plant in the regions where it in cultivated.

2.3. THE NIGERIAN OIL PALM INDUSTRY-HISTORICAL DEVELOMENT

With the world shortage of animal fats, Western Europe had to depend on the tropics for vegetable substitutes. Margarine, soaps and cooking fats are manufactured from oils in the tropics, which those expressed from the fruits and kernels of the oil palm form a large part. The trade dates back to the beginning of the nineteenth century, When less than 200 tons of palm oil was shipped continually from the Niger Delta. By 1834, when the McGregor Laird expedition was endeavouring to open up the Niger valley trade in order to provide on alternative to slave-traffic, it was estimated that over 13,000 tons of palm oil were exported to the United Kingdom alone. Demand grew as population densities in Western Europe increased. By 1890 the intervention of oil seed crushing machinery stimulated the export of palm kernel and 1903 had completed the hydrogenation process for deodorising and solidifying liquid oils. Southeastern Nigeria was aptly

named the oil river protectorate. In 1953, palm produce formed 28% by value of Nigeria export amounting to 201, 000 tons of oil and 403,000 tons of palm kernels. It is estimated that an additional 500,000 tons of oil was consumed in the producing area that same year.

Exports from the countries in which the oil palm has received extensive plantation development, namely, Indonesia and the Belgian Congo, have been relatively low and show no tendency to rise in keeping with the increase in palm oil exports. This is because the plantation countries lay more emphasis on the production of palm oil at the expense of palm kernels. The great bulks of the kernels exported from Nigeria are obtained from wild tree, so there is need for more plantation schemes. Nigeria is the largest produce of kernels in West Africa and it is produced by tedious methods of cracking the nuts and extracting the kernels by hand.

Table 2.1

Demand and Supply of Palm oil in Nigeria 1982 - 1990.

Year	Estimated	Estimated Consumption	Estimated Demand	Estimated Supply	Supply
1982	81.40	8.77	713900	581000	132900
1983	83.50	9.03	754000	575000	179000
1984	85.58	9.30	795900	569000	269000
1985	87.79	9.58	841000	563000	278000
1986	89.98	9.87	880100	557000	323100
1987	92.23	10.17	938000	551000	387000
1988	94.54	10.48	990800	545000	445800
1989	96.90	10.79	1045500	539000	506500
1990	99.32	11.11	1103400	533000	570400

Source: Feasibility study for the establishment of processing and refining mills. Kogi state.

From the above table 2.1, it is deduced that the prevailing market outlook indicates that domestic production is incapable of meeting the consumption requirements of the country. This is because the oil palm industry has during and after the Nigerian civil war suffered total neglect of maintenance, rehabilitation and development due to the war emergence of oil boom in the early seventies which attracted labour from agricultural activities to non-agricultural jobs which guaranteed quicker and higher income opportunities.

Infact before the civil war and for 15 years, 1950-1965, Nigeria was the world=s largest producer and exporter of palm oil. The volume of export between 1960-1966 is as below.

Table 2.2

Year	Export (Tons)
1960	186000
1961	167000
1962	121000
1963	128000
1964	136000
1965	152000
1966	146000

Source: Statistical publication by Lever Brothers

The fall in export started during the Nigerian civil war. Export during the war years was as below.

Table 2.3

Year	Export (Tons)
1967	17600
1968	3000
1969	8000

Source: Statistical publication by Lever Brothers.

Even though the civil war ended in 1970, the export volume of palm oil never returned to the pre-war level. Exportation of palm oil ceased from 1971. The production of oil palm suffered a great decline in the 70's, but despite the decline the volume of vegetable oil produced locally was nearly equal to the country's demand for industrial and domestic consumption. During this period there was neither import nor export of vegetable oil.

There was a remarkable revival of palm oil production from 1980. There has been a steady annual increase up to date. The remarkable revival of palm oil production could be attributed to few private investors and investment by Federal Government in the rehabilitation of old estates and establishment of new ones in oil palm growing areas.

Table 2.4

AREA AND PRODUCTION FIGURE FOR OIL PALM BY PRODUCING STATES.

Year	1992		1993		1995		1996		1997	
	Area ('000 Ha)	Production ('000 Ha)	Area ('000 Ha)	Production ('000 Ha)	Area ('000 Ha)	Production ('000 Ha)	Area ('000 Ha)	Production ('000 Ha)	Area ('000 Ha)	Production ('000 Ha)
ABIA	215	112	240	120	166	59	166	59	166	59
A K W A IBOM	16	11	21	13	331	113	331	113	331	113
ANAMBRA	-	-	-	-	215	84	215	84	215	84
BENUE	64	160	64	125	85	23	85	23	85	23
C R O S S RIVER	56	66	56	66	284	121	284	121	284	121
DELTA	102	2040	102	2054	75	37	75	37	75	37
EDO	-	-	-	-	62	42	62	42	62	42
ENUGU	23	400	23	408	116	40	116	40	116	40
IMO	-	-	-	-	537	122	537	122	537	122
KADUNA	6	25	6	25	-	-	-	-	-	-
KOGI	-	-	-	-	50	21	50	21	53	22
OGUN	-	-	-	-	125	34	125	34	125	34
ONDO	-	-	-	-	103	56	103	65	103	65
OSUN	-	-	-	-	411	23	411	23	411	23
OYO	-	-	-	-	202	58	202	58	202	58
RIVERS	125	23	125	23	176	93	176	93	176	93

Source: Federal Ministry of Agriculture, Nigeria.

2.4. WORLD PRODUCTION OF OIL PALM

Based on fossil, historical, and linguistic evidence, the origin of oil palm can be traced in Africa, although a Brasilia origin for commercial oil palm has also been suggested. Earlier accounts of palm groves and trade in palm oil and pre-Columbian description of the oil make it certain that the oil palm could not have been brought from America by the Portuguese as claimed by Cook (1942). Earlier herbal description indicate that oil palm was native to West Africa and indigenes to the Guinea Coast. Linguistic evidence also strongly supports a West Africa origin for the oil palm.

The World Production of Palm Oil increased substantially from 1983 thousand metric tons (MT) in 1969 to 1871 to 4049 thousand MT in 1978, 4549 thousand MT in 1979, and 5080 thousand MT in 1980 (Table 2.5). A similar progressive increase in the world production of palm kernel occurred in these years. The major producers of palm oil and palm kernel are Malaysia, Nigeria, Indonesia, China, Zaire, and Cameroon.

Table 2.5

MAJOR PRODUCER OF PALM OIL AND PALM KERNEL (1000MT)

Country	1969 B 1971	1978	1979	1980
		PALM OIL		
Malaysia	457.30	1778.00	2189.00	2575.00
Nigeria	528.33	670.00	650	675.00
INDONESIA	217.90	524.96	605.00	650.00
China	114.33	176.00	184.00	190.00
Zaire	232.43	170.90	170.00	179.50
I v o r y Coast	46.47	145.50	132.00	170.00
Cameroon	63.40	78.00	78.00	79.00
World	1983.03	4049.34	4549.68	5080.15
		PALM KERNEL		
Malaysia	98.99	367.50	475.00	550.00
Nigeria	287.10	239.03	335.00	345.00
INDONESIA	48.98	99.42	113.00	120.00
China	99.10	70.80	70.00	75.50
Zaire	68.65	66.00	70.00	70.00
I v o r y Coast	40.74	45.00	45.00	46.00
Cameroon	28.33	42.00	44.00	46.00
World	1178.65	1458.99	1703.38	1812.67

Source: F.A.O Production Yearbook, vol. 34, 1981.

2.5. USES OF PALM OIL

Moolayil (1979) reviewed world production, export, usage, and price of palm oil in relation to other fats and oils, its special characteristics, amount of palm oil that can be used in edible products, and factors affecting its use in minor oil products (e.g. margarine, shortenings, and cooking oils). Suggestions were made for increasing use by: ensuring that palm oil is consistently of good quality and finding ways and means to improve its quality. Still further, making suitable modification or refining, which in turn will result in low refining loss and avoid unwanted by-products; offering technical and marketing services to consumers; and creating palm oil with different fatty

acid compositions and glyceride structures having better demand.

USES OF OIL PALM PRODUCTS:

(a) Palm oil is edible oil.

(b) Palm kernel in refined to become edible vegetable oil.

(c) Palm kernel oil is used in confectionery.

(d) Palm oil in used in ice cream manufacture and in a patented cocoa butter substitute.

(e) Used for making margarine and compound cooking fats.

(f) Used in steel industries.

The derived fatty acids are utilized in the manufacture of crayons and candles.

Palm kernel cake is used as animal feed.

2.6. OBJECTIVES OF EDIBLE OIL PROCESSING INDUSTRIES

Oil palm processing industry is classified under food processing industries. Food processing industry as defined by Afful (1968) implies all the processes and facilities involved in the handling of the food stuffs from the farm to the time the food is served as meal on the dinning. This broad definition would embrace such specific processes as preservation, packaging and any other process that help to change the raw food from one form to another.

In the process of change, the food is made invariably, a little more attractive, easier to handle and perhaps quicker to prepare and serve. The addition of these extra services to the original food requires investment in expensive and sometimes very complicated machinery.

The following are some objectives of any food processing industry.

(a) Reducing the bulky produce to a convenient size for easy carriage by shoppers.

(b) Providing food of uniform quality on a large scale

(c) Improving the storage properties of the product and so avoiding waste.

(d) Increasing the monetary gains from the side of the particular product.

2.7. FACTORS TO BE CONSIDERED WHEN ESTABLISHING A MODERN EDIBLE OIL PROCESSING INDUSTRY

(A) Availability of raw materials

The proximity of raw material source to the industry is a very important factor in deciding its establishment in an area. That is the distance between the raw material source and the industry should be as short as possible.

(b) **Availability of Labour**

However, this factor is not very rigid as it can be brought from else where, if the one available fails to meet the requirement of the industry. Some industries employ the unskilled local labour and train them to acquire the necessary knowledge in the required fields.

(c) **Infrastructure Facilities**

The existence of good infrastructure facilities such as good roads, railways, air transport services etc. are also important factors that affect the establishment of such industries as these infrastructures provide a linkage between the industry and the potential markets for the products.

(d) **Adequate Water supply**

Adequate supply of a body of water for running the factory including waste disposal.

(e) **Adequate Power Supply**

Availability of adequate power for the running of the industry is also an important factor.

(f) **Adequate Land**

Land has to be abundantly available in order to support both the farm and the industry itself

(g) **Markets for the finished products**

The industry should be established in a place where there is readily available market for the finished products.

CHAPTER THREE

3.0. PLANNING FOR SANITATION IN THE INDUSTRY

3.1. INTRODUCTION

Food processing industries emphasize on mass production, and controls the quality of raw materials and finished products. Through research and development work in various research institutes, food-processing industry is continually improving its quality.

In any food processing industry. The hygiene of the production process and that of the environment is a very important factor, which can be achieved through proper planning for sanitation in the industry.

Food processing industry as defined by Afful (1968) "implies oil the processes and facilities involved in the handling of the food stuffs from the farm to the time the food is served as meal on the dinning table".

Food processing industries have special attention to certain requirements for effective and qualitative production. These include water supply and disposal of waste and sanitation, which should enable a hygienic system of production so that the finished productions are fit for human consumption.

Sanitation in a food processing industry can be defined as the control of environment in which raw foodstuff is processed to prevent contamination of the finished products. Thereby promoting the maintenance of good health.

An Architect is instrumental in creating such an environment. Apart from providing a suitable envelope for man and machinery to work in, the designer also plays a leading role in ensuring that an environment, which encourages the practice of good sanitation, is created and maintained. This is achieved by giving adequate consideration to sanitary and hygiene requirements with respect to factory design principles.

3.2. THE NEED FOR SANITATION IN OIL PALM INDUSTRIES

Sanitation is an important factor, which must be considered during the early stage of design. Poor sanitation conditions can lead to contamination, which may cause food spoilage. The success of any oil palm industry largely depends on the general sanitation it exhibits. This is because the processor is legally obliged to prevent the contamination of his products and raw materials. Where he fails and the contaminated products are sold to the consumer, severe legal penalties could be imposed. Such penalties can be

disastrous to the processor and they include, adverse publicity, seizures, prosecution, court convictions and injunctions, economic losses through difficult e.t.c All these adverse consequences make poor sanitation a total unnecessary luxury and a liability, proper sanitation creates a hygienic condition in the industry. It is then an important asset to the producer as well as the consumer.

3.3. AREAS OF SANITATION PROBLEMS AND ARCHITECTURAL REQUIREMENTS

Oil palm products like most food products could be contaminated either through microbial or non-microbial contaminants. As an Architect, emphasis will be primarily on the non-microbial contamination. The non-microbial contamination refers to the foreign bodies on the products, which include foreign odours, and flavours that are likely to have originated from the factory itself.

Foreign bodies found in the finished products could be as a result of faculties in any of the four basic components of a food processing industry, they are:

- Factory design, structure, fittings
- Equipment

- Personnel
- Handling of food stuffs from raw material to the finished product.

In trying to minimise the non-microbial contamination architecturally, the design, construction materials and maintenance of the industry must be put into consideration.

3.3.1. FACTORY DESIGN

A sanitary survey proved that a relationship exists between communicable disease and filth in the environment, and was said that safeguarding public health is the province of the engineer (designer) rather than the physician. The design of a factory needs the avoidance of certain pitfalls to minimise foreign body contamination. Such includes

(a) The location of amenities is very important. Amenities such as cafeteria and changing rooms are best located close to the production hall.

(b) Short and direct routes for waste removal are essential. It cannot be desirable to have waste trailed through open production rooms especially in view of the sanitary condition of most equipment used for waste collection.

(c) Lack of adequate space for the storage of raw materials and packing can result in these being

kept in production areas. Experience shows that a high proportion of foreign bodies comes with the raw materials, so the need for thorough raw material screening cannot be overemphasised.

(d) Cleaning and maintenance becomes difficult to achieve when there is congestion especially in areas of open production. Such exercise is advisable to take place after production time to reduce the contamination of food.

(e) Adequate spaces should be allocated for separate storage of finished products as lack of adequate space could result to turning other functions to serve as storage areas.

(f) Insufficient space for maintenance operations results to many problems. When storage space in not provided for temporary dis-used equipment they are often kept in the production areas. Such equipment=s are frequently infested and causes a psychological attitude of laziness in cleaners.

In planning of the industry, food zoning should be considered, and a proper segregation of dirty zones from cleans zones both within and outside the production area. The zoning should encourage easy removal of dirt=s and waste.

Despite the fact that most food industries of today are highly mechanized, they still require proper zoning, and arrangement of equipments and proper segregation of activities within the production area. It is best zoned into the following:

i. Dirty zone: raw materials reception
ii. Semi-clean zone. Processing area
iii. Clean zone: Finished product storage.

The production area should be open and free from congestion to prevent difficulty in cleaning and maintenance of the place.

3.3.2. OVERHEAD FITTINGS

Reduction of overhead equipment to the minimum is one certain way of reducing many foreign matters in production. It is common in conventional buildings to have ceilings covered in a network of ducting, pipe-work, lights heaters etc. The problems that arise are:

i. A lot of dirt=s setting on the wires and fittings, such dirt=s e.g. cobwebs could trap insects, which may later drop off and cause, direct contamination of products.
ii. Problems arising from sparrows are aggravated by overhead structures, which provide easy roosting. Droppings on equipment and raw materials are unpleasant.

These problems are reduced by the provision of underground channels for the necessary ducting. Overhead fittings should be selected with care. A single channel may then pass through the ceiling of the production area, and provide overhead service feed to us equipment. This arrangement also permits ceiling lighting, and air conditioning vents to be clear and free from pipe work, girders, and conduit, all of which may collect dust and pests. Principal services can be located with advantage in a separate overhead floor, which should be fully accessible for servicing and hygiene purposes.

3.3.4 FACTORY STRUCTURE

i. WALLS AND CEILINGS

Walls and ceilings easily retain dirt. Dust from same raw materials especially during dehulling or dehusking. Maintenance should be minimized as much as possible in food processing industries by selecting appropriate internal finishes.

Ceilings in the processing areas and warehouse should be washable with sealed joints. This helps prevent moisture condensation, which could be a nuisance and may even cause product contamination.

Tiled washable walls should be used in areas where equipment will be mounted. The walls in the warehouse should be smooth and light coloured painting must be controlled to avoid tainting of finished products, raw materials and packaging. Prefabricated sectional walls are preferred where possible of easy and speedy erection.

ii. **FLOORS**

Floor is a major consideration and a high initial investment. The disruption caused by defective floor may be very costly and a piece meal repair is difficult to achieve. Floors that are resistant to food acid and washing detergents should be used. The foundation and floors should also be able to withstand vibration from machines. They should provide sufficient slope and drains to reduce attack from spillage. Care must be taken to avoid uneven areas that will hold up liquids.

iii. **DRAINAGE**

Adequate provision must be made for floor drainage in the production hall, as it is important in the control of insect infestation problem by eliminating their breeding places. Covered channels present major cleaning problems when compared with appropriately sited gullies or open wall junction channel. Sufficient drainage reduces damage to floors from

spillage. Where drains are covered they should finish with floor to prevent pooling. Drains should be provided under equipment where spillage is likely or water is discharged.

iv. **PEST PROOFING**

Proofing against pest entry is a fundamental necessity in any food industry. Rats, being extremely nocturnal mammals, prefer small openings through which to enter a building. It is therefore important to guard the points of ingress and egress around pipes, unused stacks and flues, ventilators, and hatches.

Foundations must be continuous and extend not less than 450mm below the ground level and always flush with the under surface of the floor above.

Windows should be screened with wire mesh where necessary and lobbies should have electrical trapping device or an insecticide/rodenticide vapouriser.

v. **VENTILATION AND LIGHTING**

Adequate ventilation is important to prevent condensation of moisture and discomfort. Air intake and discharge may need filtration to bring in air free of microorganisms. Therefore optimum ventilation system is necessary in order to achieve a high standard of personnel and production hygiene.

To provide the best working condition it is necessary to control all the environmental factors that influences human performance and efficiency. Light is one of these important factors, it enables the workers to see quickly, accurately, comfortably and safely.

3.3.5. MACHINES/ EQUIPMENTS

There are some machines used in oil palm industries that are associated with dirt=s, they are:

(a) **Beater-arm bunch stripper**

During the stripping stage, the empty bunches are discharged at the end of the rotary drum onto the floor. This is to enable the worker to sort out the bunches that still have fruits on them and take them back into the machine. In the course of this, the bunches leave traces of oil on the floors which colonizes the floor and makes it slippery.

(b) **Rotary nut/fibre separator**

This machine discharges only fibres while the crude oil is extracted and passes through a different channel. The discharged fibres contain a percentage of oil, which also dirties its environment.

(c) **Rotary Screening Drum**

When this machine is in operation, dust particles escapes from it and settles on walls, floor, electrical switches, and on electric motor engines which sometimes help in spreading fire especially when there is a spark from the engines.

(d) **Bagging and Sealing Section**

The palm kernel cake has dusty particles being scattered all over. The storage section is also littered due to escape particles from the sealed sacks.

3.3.6. PRODUCTION FLOW

The area in which most food plants appear to have the most difficulty in maintaining proper sanitation and hygiene is the preparation department.

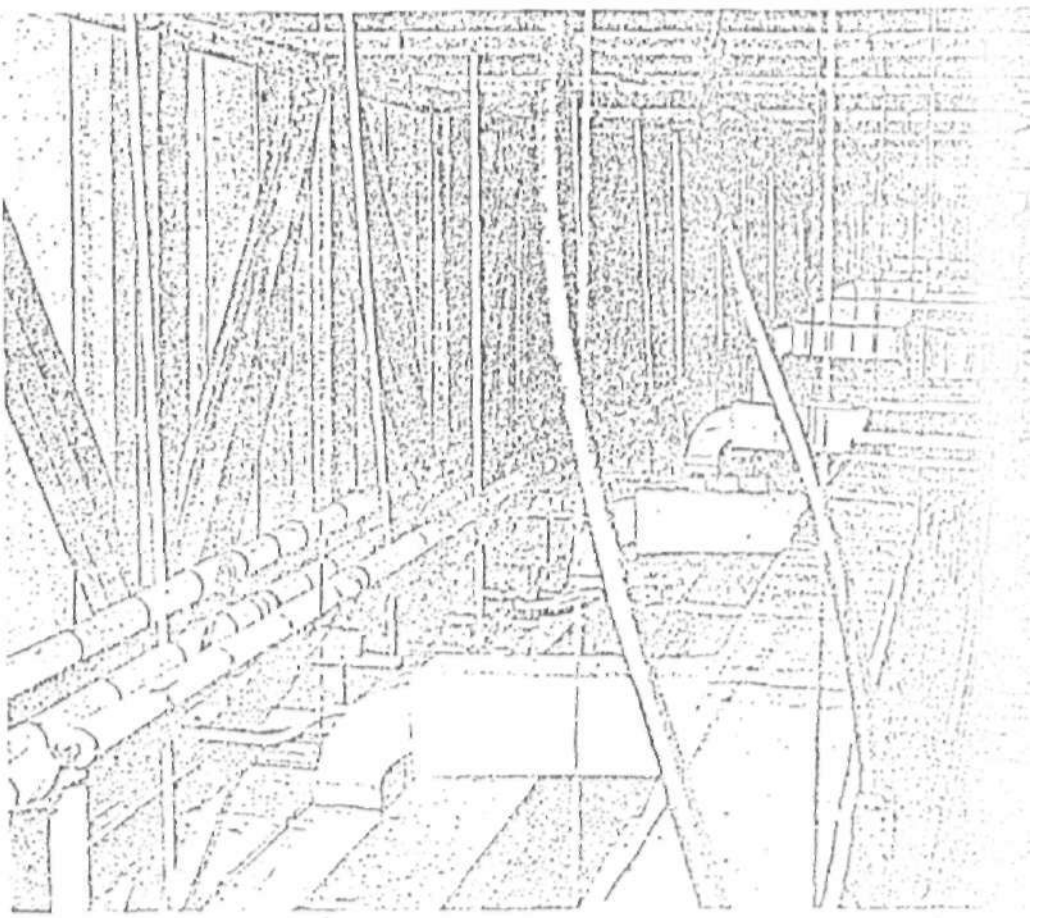
It is important to consider a proper production flow in the industry to reduce haphazard flow of products. The equipments must be placed next to each other in order of their functions. A straightforward flow eases sanitation problems. All spillage overflows and discarded portions of food will be easily spotted and evacuated.

There is need to have a quality control department with a well-equipped laboratory to monitor the intermediate stages of production. The laboratory is best located in the production hall to effectively serve its purpose.

3.3.7. WASTE DISPOSAL

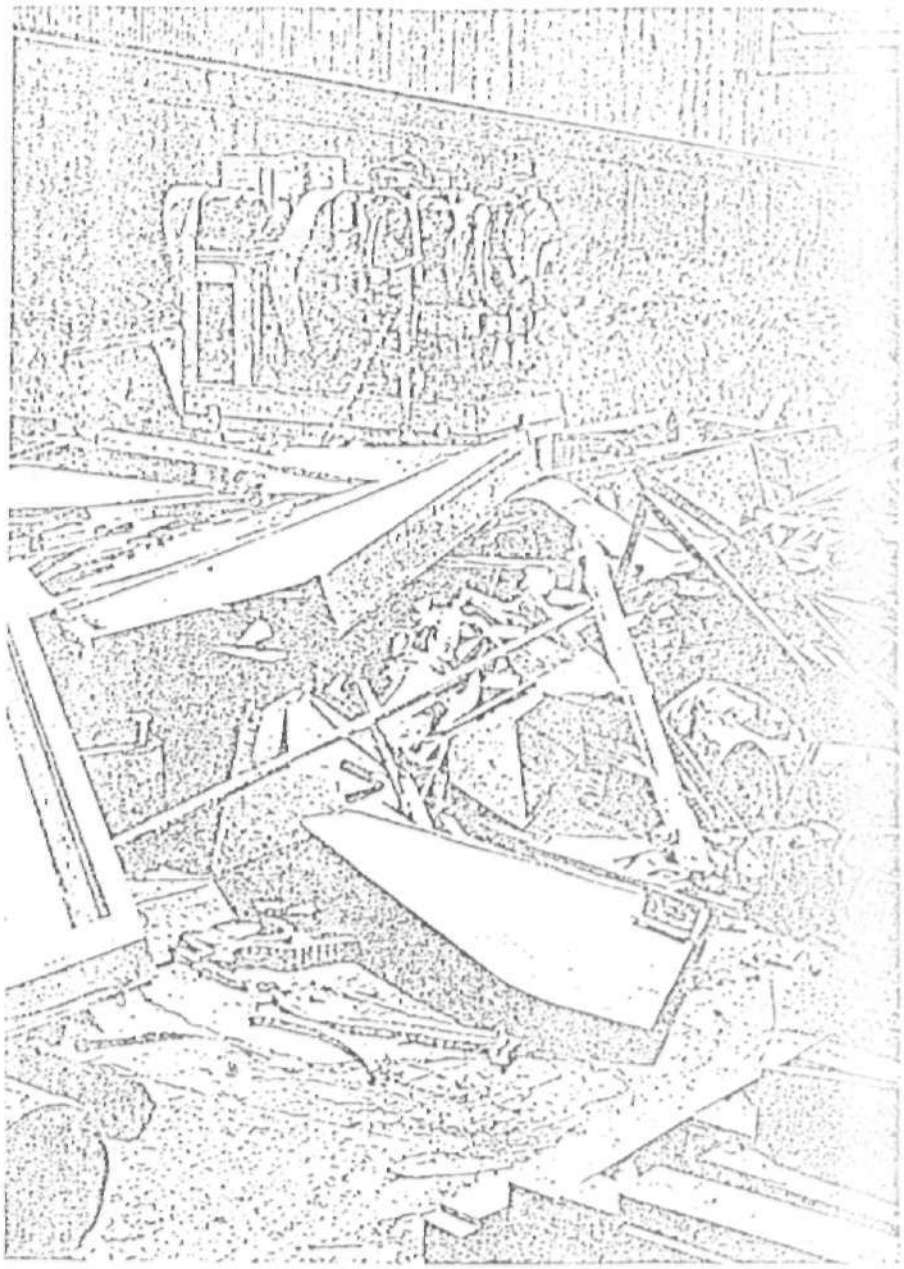
All materials, which enter the site and do not leave in form of finished products, must either leave as waste or effluent. Waste must not be allowed to

accumulate on site because of obvious hazards. Short and direct routes for waste disposal is essential. The waste handling facility should be properly located on site.



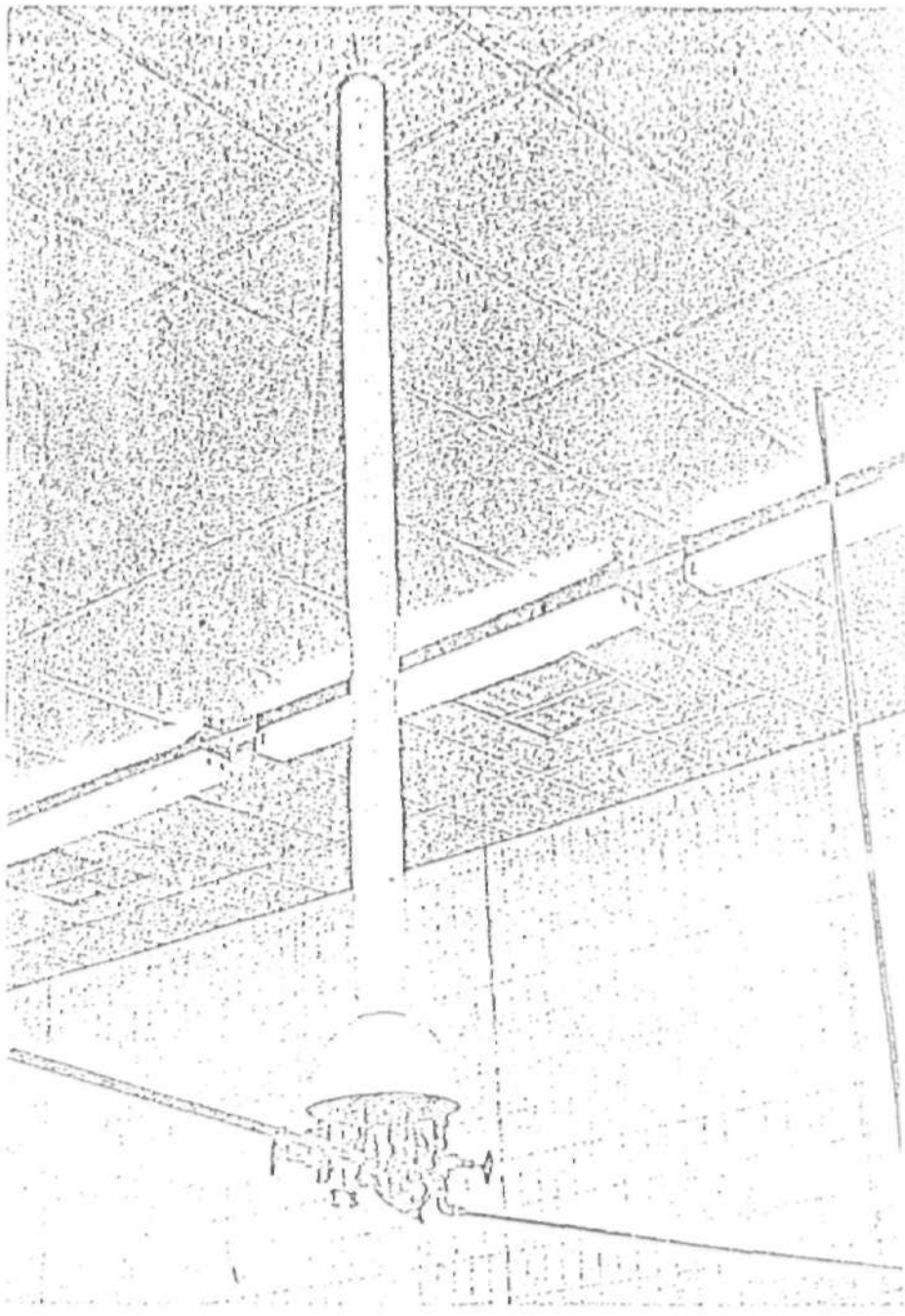
Principal services can be located with advantage in a
overhead floor, which should be fully accessible for servicing and hygiene

Fig 3.0 Overhead Service Fittings.



Surplus or useless equipment stored untidily on factory perimeter area. Often such equipment is not properly cleaned, and frequently harbours infestation.

Fig 3.1 Surplus Equipment in Production Hall.



A single channel then passes through the ceiling of the production area, and provides overhead service feed to the equipment. This arrangement also permits ceiling, lighting, and air conditioning vents to be clear and free from pipework, girders, and conduit, all of which may collect dust and pests.

Fig 3.2 Overhead Channel Fittings.

CHAPTER FOUR

4.0. CASE STUDIES

4.1. CASE STUDY 1: OM OIL MILL, OGBA IKEJA.

4.1.1 Introduction

OM Oil Mill is located in Ogba industrial layout Ikeja, Lagos State. It is a private owned industry. The industry is established to process oil palm seeds and has the capacity to produce 150 metric tons of edible oil daily. The products of the factory include palm kernel oil and palm kernel cake.

4.1.2 Facilities

The industry comprises of the following units,

- Administrative block
- Production hall
- Maintenance workshop
- Water treatment plant
- Boiler house
- Storage tanks/silos
- Generator

Architecture

Site Layout: The complex is made up of units that are closely related. It is a compact design. The production is oriented along the NE-SW axis for its longer axis. The zoning is fair enough

The Factory Buildings: All the units are made of sandcrete-blocks and steel portal frames. The production hall is cladded and roofed with aluminum sheets.

4.1.4 Observations

Merits

1. Access and circulation routes are well defined and effectively link up the units.
2. Placing of fire extinguishers at strategic points.
3. Production flow is functional.
4. The building structures are stable and safe.
5. Adequate clear over head height is provided in the buildings.

Demerits

1. It has a general store for both finished products and raw materials.
2. Planning is too compact.
3. Improper zoning, the noise from the off loading/loading bays affects the administrative block.

4. No landscaping.
5. Exposed overhead fittings collect dirt and create maintenance and cleaning problem.
6. The floor of the production hall is not provided with adequate finish as such it is susceptible to corrosion due to oil acid spillage and detergents.
7. Ventilation is inadequate in the production hall
8. Temporary disused equipment=s left in the production area creates sanitation problems.

4.1.5 Conclusion

Generally, the industry is quite compact and it is made of sandcrete blocks and steel frames. The production hall needs improvement to ease sanitation measures.

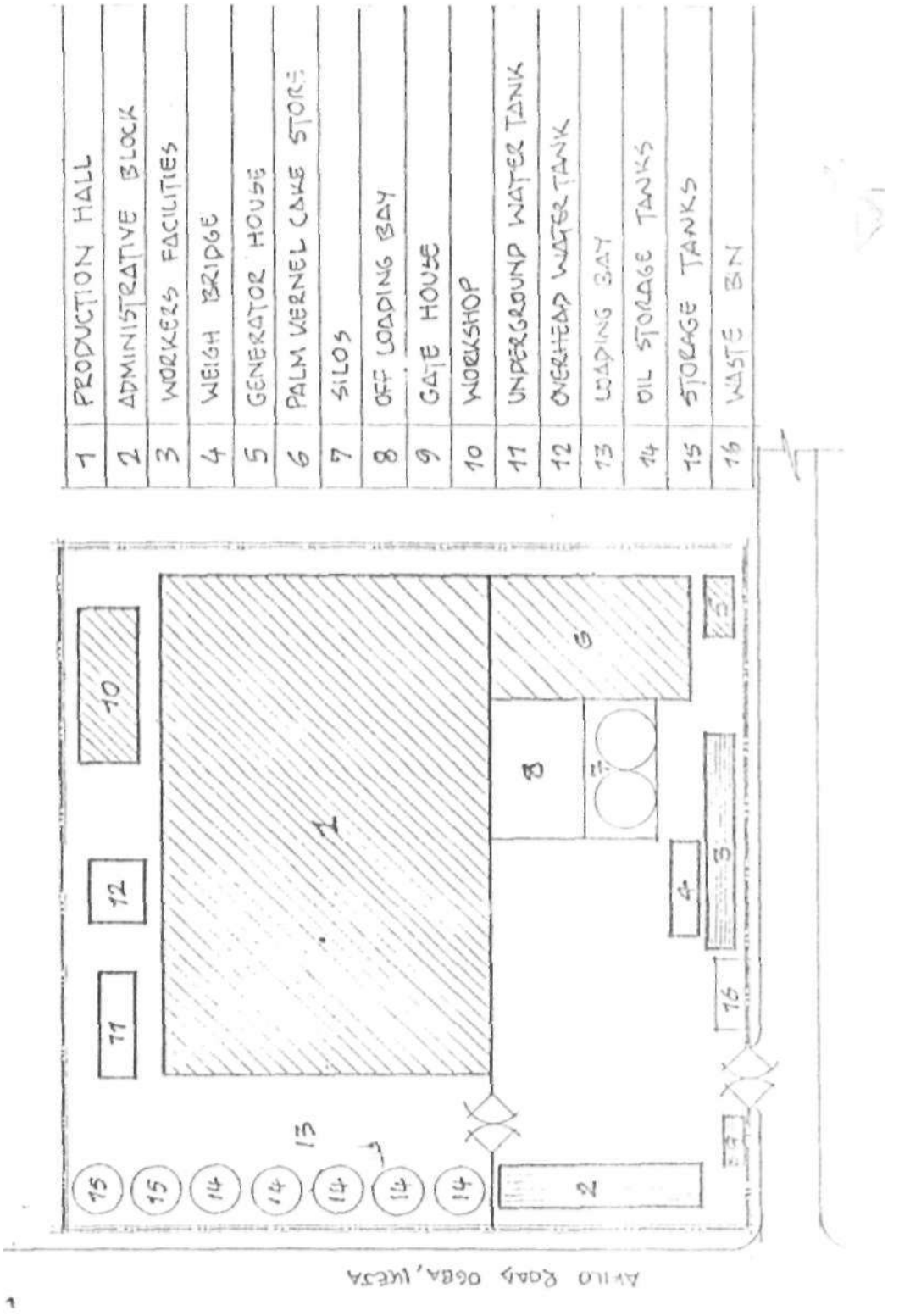


Fig 4.0 site layout of OM Oil mill.

4.2. CASE STUDY 2: PIONEER OIL INDUSTRY

4.2.1 Introduction:

Pioneer oil industry is located along Apapa-Oshodi Express Way, mile two, Lagos State. It is a private owned venture. The industry has been established to process both palm kernel seeds and palm oil into edible vegetable oil. It has the capacity of producing 120 metric tons of oil per day. It also produces palm kernel cake, which is used as animal feed.

4.2.2. Facilities:

The factory complex comprise of the following units

- The production hall
- Administrative block
- Workers facilities
- Storage tanks
- Gate house
- Car park.

4.2.3. Architecture:

Site Layout: The complex consists of separate close units that are not functionally related. The orientation of the building is North-South for the longer axis. Access into the site in through a single

gate. The administrative block is too close to the production hall while the workers facilities are not properly zoned.

The Factory Building: All units in the complex are built from sandcrete blocks. The production hall buttressed at intervals by steel portal frames and cladded with red aluminum roofing sheets.

4.2.4. Observations

Merits:

1. Adequate overhead space is provided for effective factory activities.
2. Adequate supply of water.
3. Raw materials are received under a cover in front of the production hall.
4. Movement can be easily regulated because of its one access
5. Well-landscaped site.

Demerits

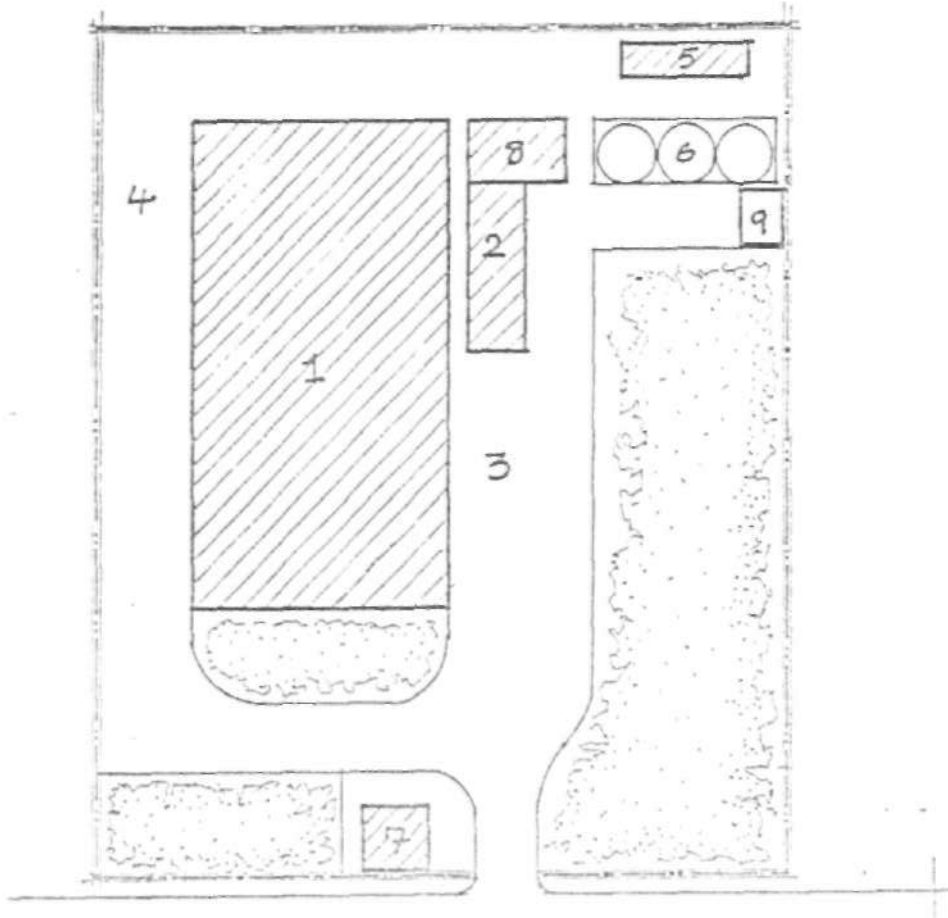
1. The noisy and quiet area are zoned together
2. Functional relationship of units is unsatisfactory. The workers facilities are far from the production hall.
3. Exposed overhead fittings collect dirt and are not easy to clean.
4. The heat transfer from the boiler room into the

production hall through the common wall they share makes it uncomfortable.

5. The drains are open and susceptible to infestation.
6. The orientation of the buildings are not favourable because it has its longer axis exposed to sun heat.

Conclusion:

The industry buildings are safe and stable. The choice of materials is quite favourable for human comfort. Sanitation is given fair considerations in the production hall.



1	PRODUCTION HALL
2	ADMINISTRATIVE BLOCK
3	OFFLOADING BAY
4	LOADING BAY
5	WORKERS FACILITIES
6	STORAGE TANKS
7	GATE HOUSE
8	WASTE STORAGE
9	WATER STORAGE TANK

Fig 4.1 Site Layout of Pioneer Oil Industry.

4.3. CASE STUDY 3: FUNTUA COTTONSEED CRUSHING COMPANY

4.3.1. Introduction:

Funtua cottonseed crushing company is located in the industrial estate of Funtua. It is an oil processing company that uses Soyabean, groundnut and cotton seed as raw material. However the processing of the different raw materials does not take place simultaneously. The same machinery is used in their processing, with a slight difference in that of Soyabean, which requires a dehuller along the production flow.

4.3.2. Observations

Merits

1. The location of the workshop close to the main production facilitates repairs of damaged machines.
2. Adequate space for the storage of raw materials.
3. Minimal use of partitions in production hall.
4. Adequate space provided for maintenance operations in production area.

Demerits

1. No provision for workers facilities such as clinic, cafeteria and changing rooms.
2. Lack of adequate lighting in production area, thereby causing problems to the psychological comfort of the workers.
3. Lack of adequate ventilation in production area
4. On-loading bay is not properly designed as crisis results when more than a truck is loading.
5. No provision is made to process/package the soap stock as it in allowed to run-off down a gutter.
6. Lack of properly designed foundations and floors to withstand vibrations from machines; this is evident in the sinking floor of the boiler house.

4.3.3. Facilities

- Administrative block
- Car park
- Production hall
- Refinery
- Generator

4.3.4. Architecture

Site Layout: The complex comprises of units that are functionally related. The orientation of the production hall is North south for the longer axis. Access is through a gate. The design is not compact.

The Factory Buildings: The production hall is constructed of steel portal frame at 6m off centers and a clear light of 14m in the hall. The wall is raised to 2m by sandcrete blocks and the remaining height is cladded by asbestos sheets.

4.3.5. Conclusion

Sanitation is not given fair consideration. Resulting to Oily black floors in the production area.

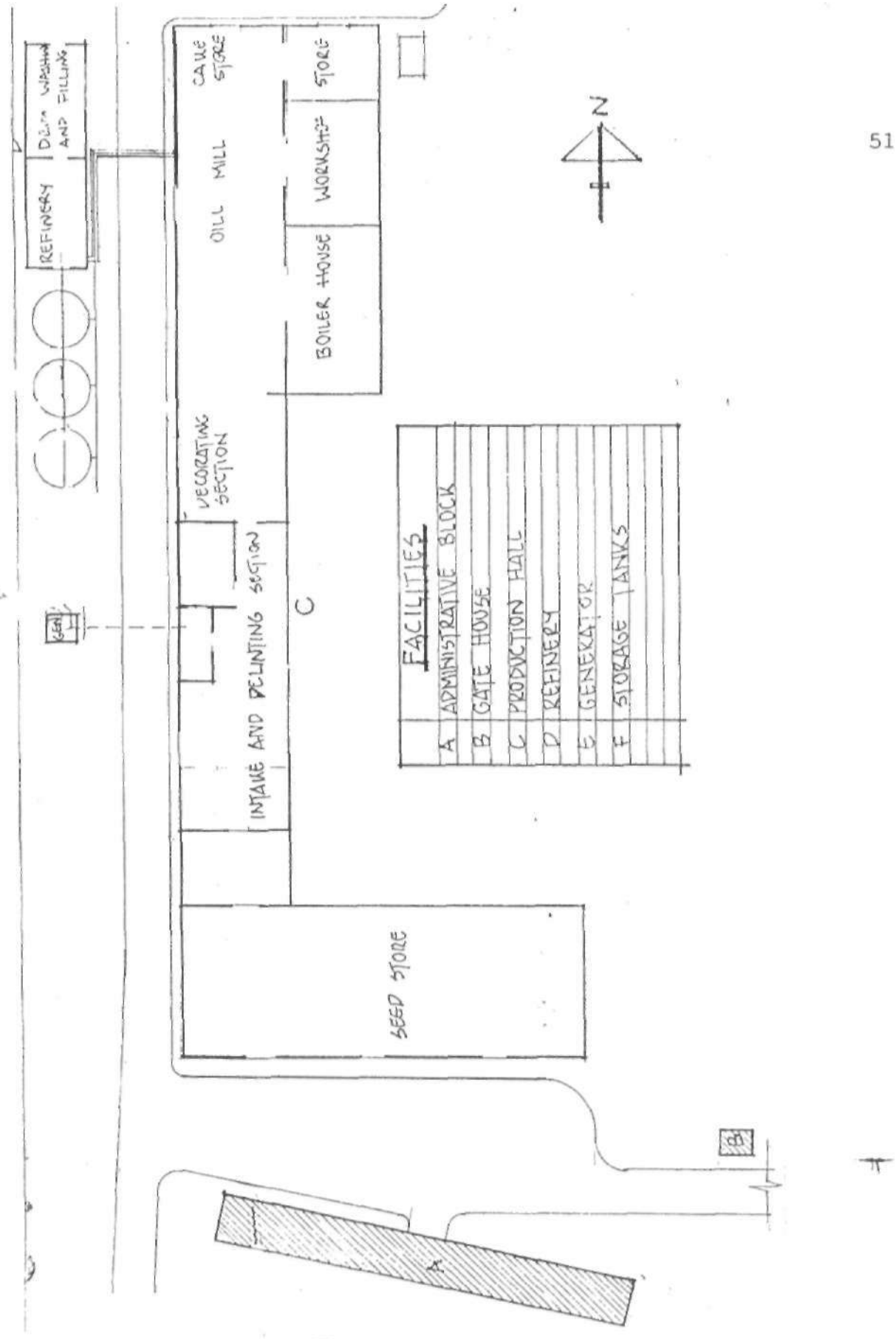


Fig 4.2 site layout of funtua cottonseed crushing company.

4.4. CASE STUDY 4: P.S-MANDRIDES Plc KANO.

4.4.1. Introduction

P.S. mandrides Plc is located on 111 Murtala Mohammed Way in Kano State. The industry produces edible oil. It has eight senior staff, seventy junior staff and forty casual staff. The industry crushes about 300 tons of groundnuts daily. Its main raw material is groundnut, which is crushed and extracted for edible oil.

4.4.2. Observations

Merits

1. The environment is clean.
2. There is an effluent treatment plant.
3. Site zoning is good.
4. Placement of fire extinguishers at strategic places.
5. Use of durable and strong materials for construction.

Demerits

1. Poor parking spaces.
2. Administration block looks more like a residential building.
3. Landscaping is sparse and inadequate.

Ventilation in the production hall is not adequate.

4.4.3. Facilities

- Administrative block
- Parking spaces
- Production hall
- Refinery
- Generator
- Storage tanks

4.4.4. Architecture

Site Layout: The complex comprises of administrative block workers facilities and production hall, which are functionally related. The parking space is not organised.

The Factory Building: The Administrative block is made of concrete columns and beams, and sandcrete blocks. The other buildings are made of steel stanchions embedded in concrete. They are all roofed with corrugated aluminum roofing sheets.

4.4.5. Conclusion

Hygiene is highly considered in the industry. Generally, the factory buildings are good and safe, even though they look old.



Fig 4.3 Site Layout of P.S. Mandrides Plc.

4.5 CASE STUDY 5: ANYIGBA PALM OIL MILL

4.5.1. Introduction:

Anyigba palm oil mill is located in Anyigba local government along Anyigba- Ankpa road. It is a small-scale industry with a combination of both traditional and modern methods of processing its raw material is fresh fruit bunches and it produces palm oil. The palm kernels are sold out to other industries.

4.5.2. Facilities:

The complex comprises of the following units,

- Administrative block
- Production hall
- Incinerator
- Drums shed
- Fresh fruit bunches storage

4.5.3. Architecture

Site Layout: The various units are scattered all over the site and there is no proper zoning. The incinerator is directly opposite the administrative block and the fresh fruit bunches are off-loaded right in the centre of the complex.

The Factory Buildings: The buildings (Administrative and Production Hall) are made of sandcrete blocks and steel frames. The drums shed is made of timber and aluminum roofing sheets.

4.5.4. Observations

Merits

1. Production flow is functional.
2. Adequate space for storage.
3. Minimal use of partition in production hall.
4. Building structures of administrative block and production hall are safe.

Demerits

1. The fresh fruit bunches are not properly stored and may cause increased fatty acids in the finished products.
2. The site is not well zoned.
3. Methods of storage is not quite hygienic.
4. Incinerator should not be located at the entrance.
5. Production hall is dark and dirty due to oil stains on the floors.
6. No provision for fire hydrants.

4.5.5. Conclusion:

The industry is generally not clean because of the method of zoning. The factory floor is susceptible to corrosion which can cause floor defect and resulting in accidents.

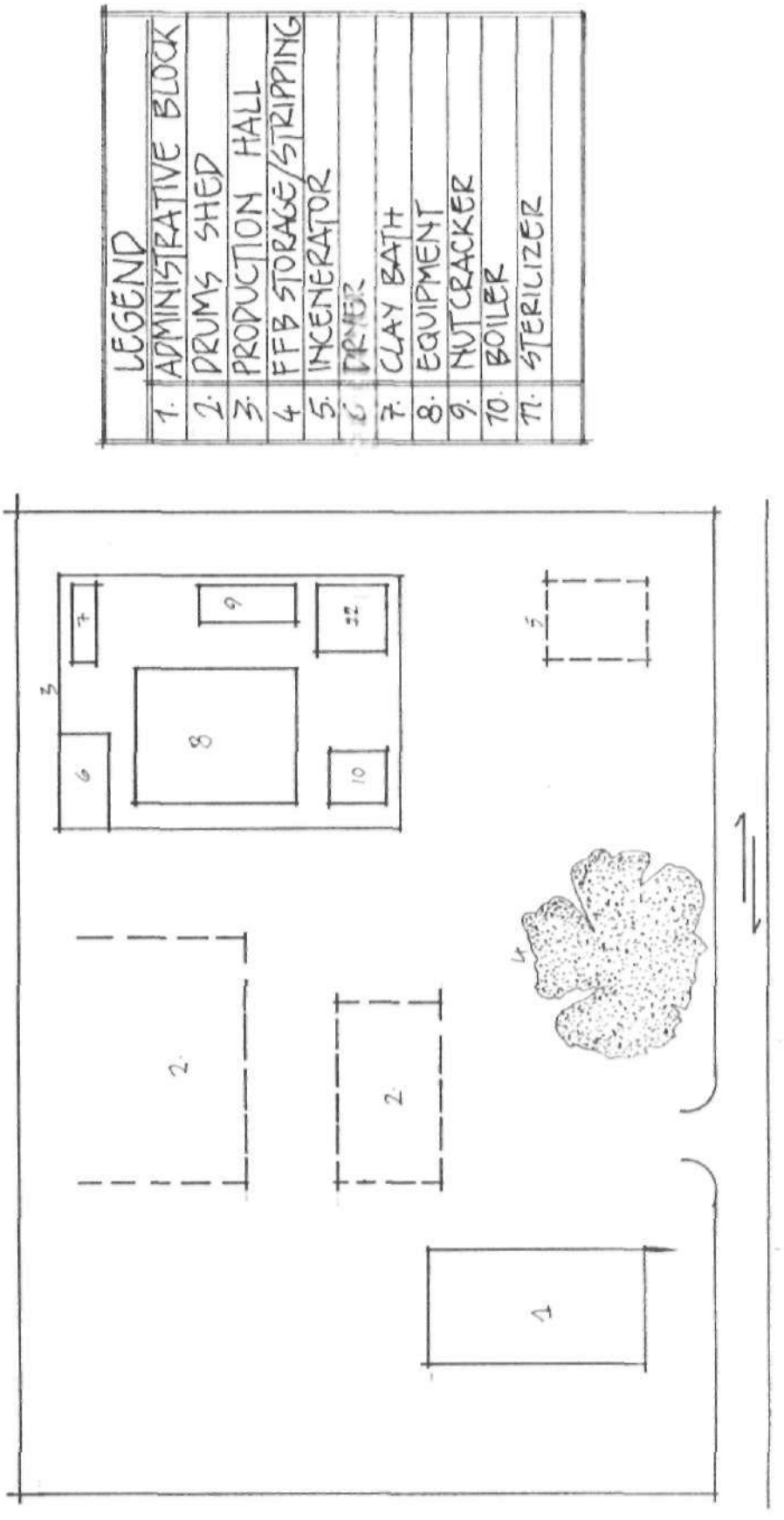


Fig 4.4 Site Layout of Anyigba Palm Oil Mill.

CHAPTER FIVE

5.0. THE SITE

5.1. LOCATION

The proposed industry has its site chosen around Ankpa in Ankpa local government, Kogi State. The site lies within the industrial zone of the current land use proposal of Ankpa town. Ankpa is located at a height of about 422m above mean sea level with latitude 8° latitude and longitude 7° 30' E.

5.2. SITE SELECTION CRITERIA

Oil palm processing industry is a raw material dependent industry, this is best-sited near the source of the raw materials. Ankpa is a suitable choice for the location of this industry as the main raw material is intensively cultivated in Ankpa and its surrounding villages. The following criteria are used for the selection of the site.

i. Availability of land: There should be enough land for the project so as to facilitates expansion and a flexible design.
ii. Market and availability of raw materials.
iii. Availability of labour.
iv. Conformity with the land use proposal of the Ankpa town.
v. Utilities and infrastructure.
vi. Cost of acquisition.

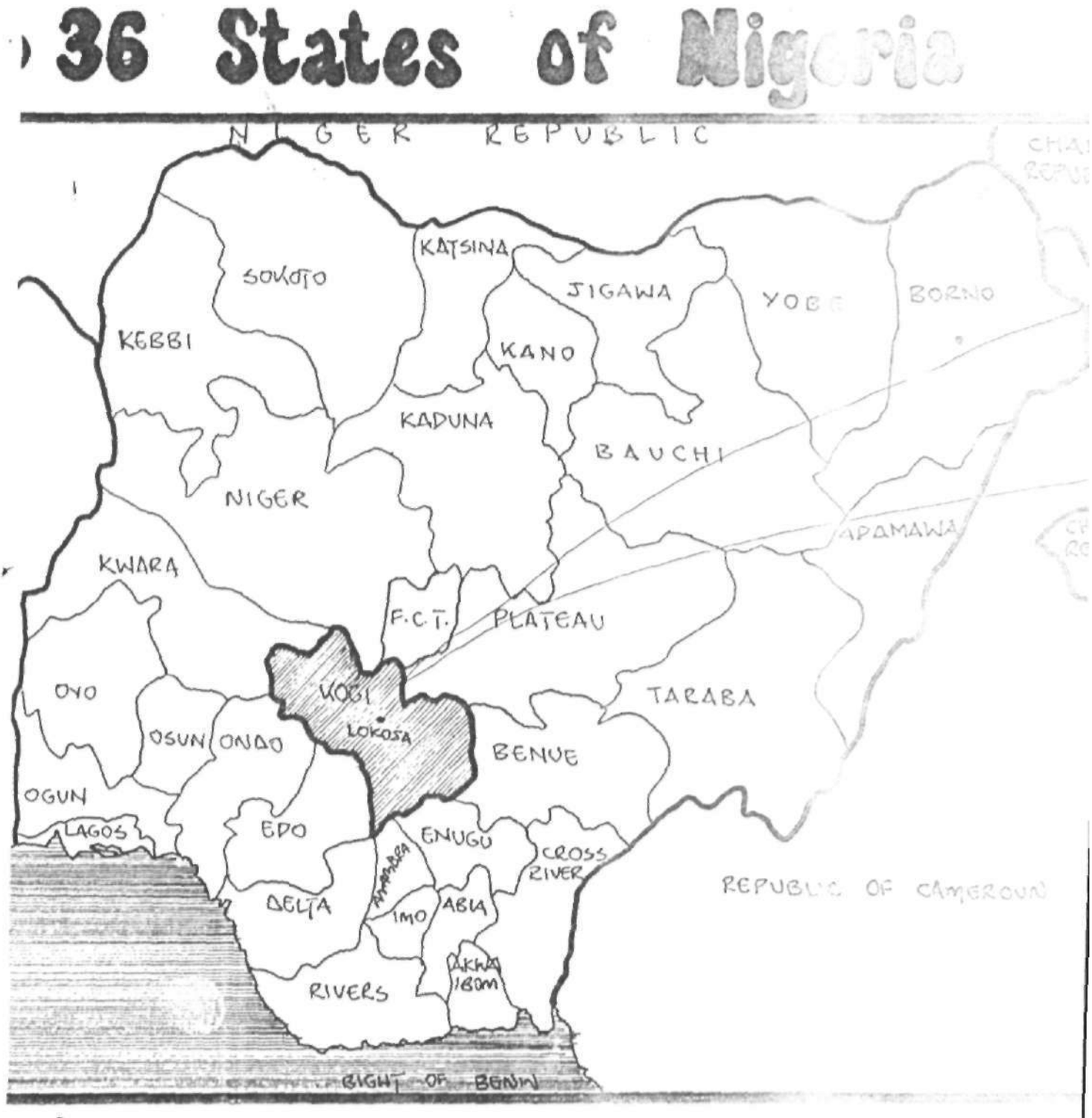


Fig 5.0 Map of Nigeria Showing Kogi State.

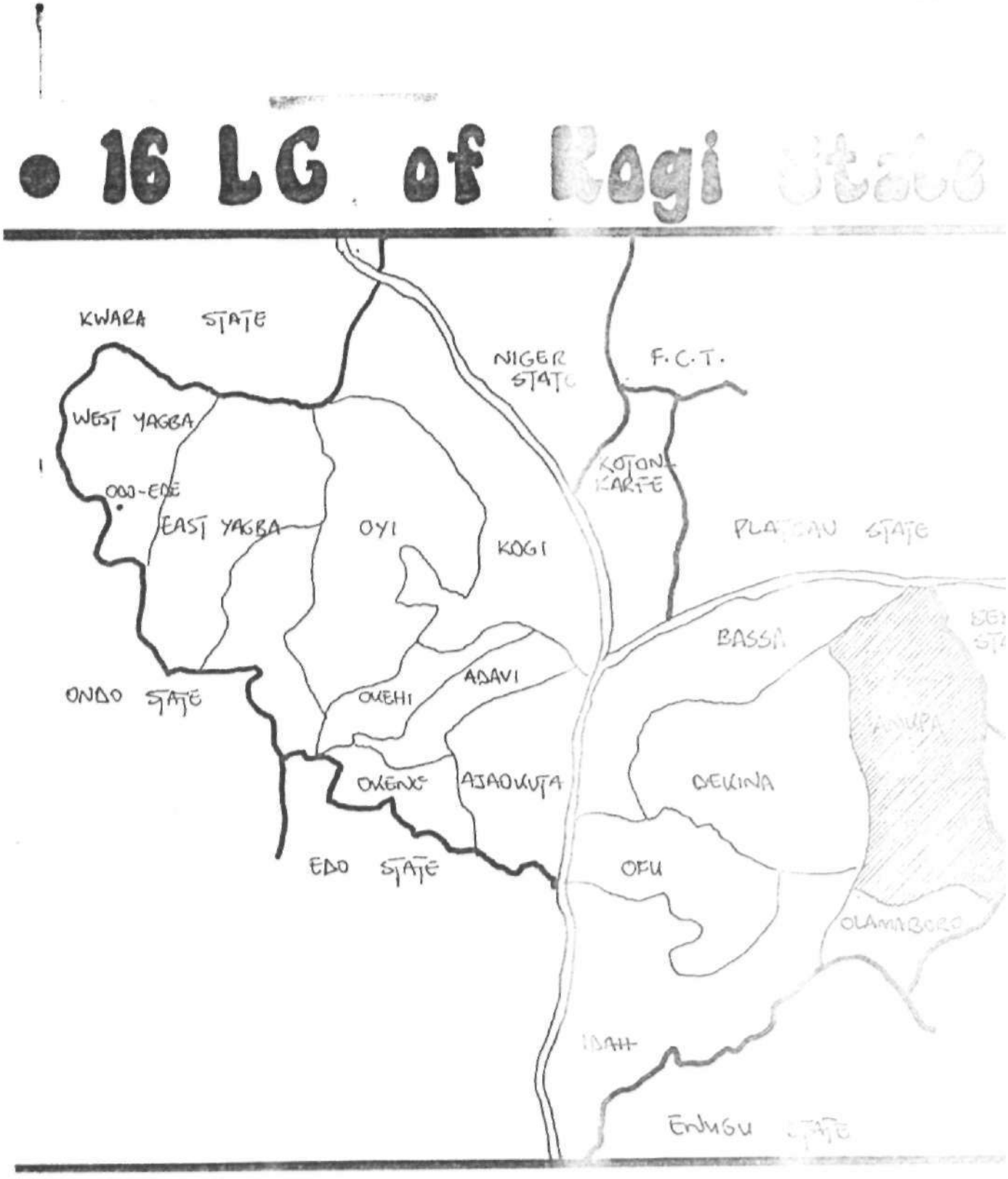


Fig 5.1 Map of Kogi State Showing Ankpa.

5.3. SITE SELECTION

The site selection is limited to areas allocated for industrial development only. The chosen site has already been marked out for on oil palm industry on the land use map.

The site was selected based on the following reasons:

- Very close to the source of raw materials, the Ankpa-Inye road leads to oil palm farms.
- Very good access.
- Undulating terrain.
- Proximity to already-present instrument which will allow for easy availability of infrastructure such as electricity, water and roads.

5.4. GEOGRAPHICAL ANALYSIS

5.4.1. CLIMATE

Ankpa town falls within the middle-belt and has two main seasons; the wet season from March to October, and the dry season from November to early March. A specific type of prevailing wind characterizes each season. The wet season brings with it south- westerly wind originating from equatorial rain belt and blowing from the high-pressure zones which occur over the attentive during their period. The dry season is

accomplished by harmattan, a dust-laden wind blowing from the Sahara Desert.

5.4.2. TEMPERATURE

The monthly means temperatures are 33.7° maximum and 22.7° minimum. The hottest months are between mid-February and mid-April with temperatures soaring as high as 38.3° minimum and 25.8° maximum. The temperature graph shows that there is thermal discomfort throughout the year with temperature variations of up to 10° on the average.

The area of influence on design will be on thermal comfort, cooling installations, effects on joints and panel movements, roofing types and openings.

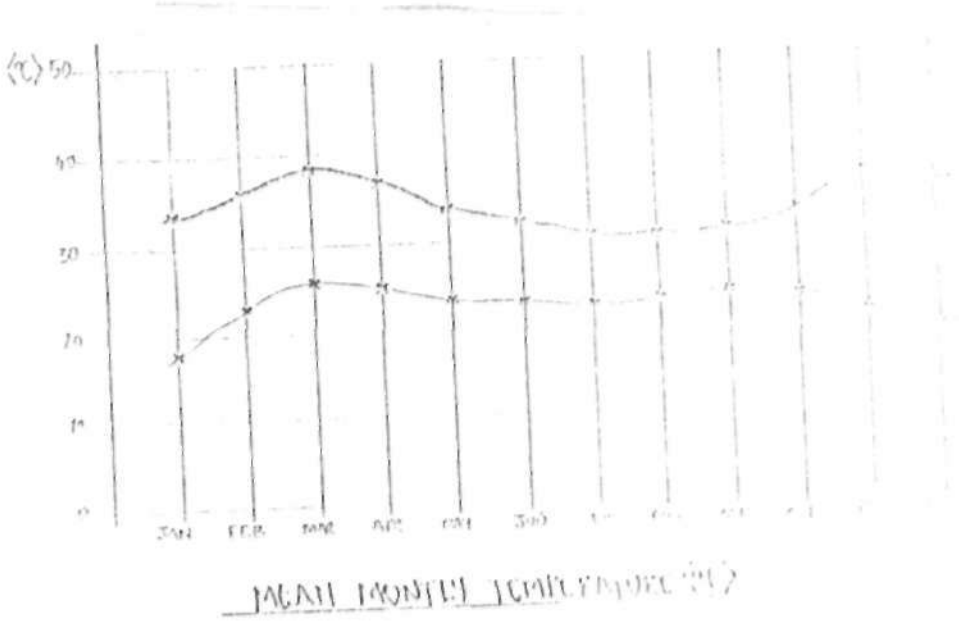


Fig 5.3 temperature chart.

5.4.3. RAINFALL

The table of rainfall indicates the pattern of rainfall; the annual mean rainfall is about 1279.85mm. The highest rainfall is recorded in June/August.

The area of influence on design will be on roof slope, efficient drainage of site and roof, problem of decay, corrosion, break down of finishes and joints.

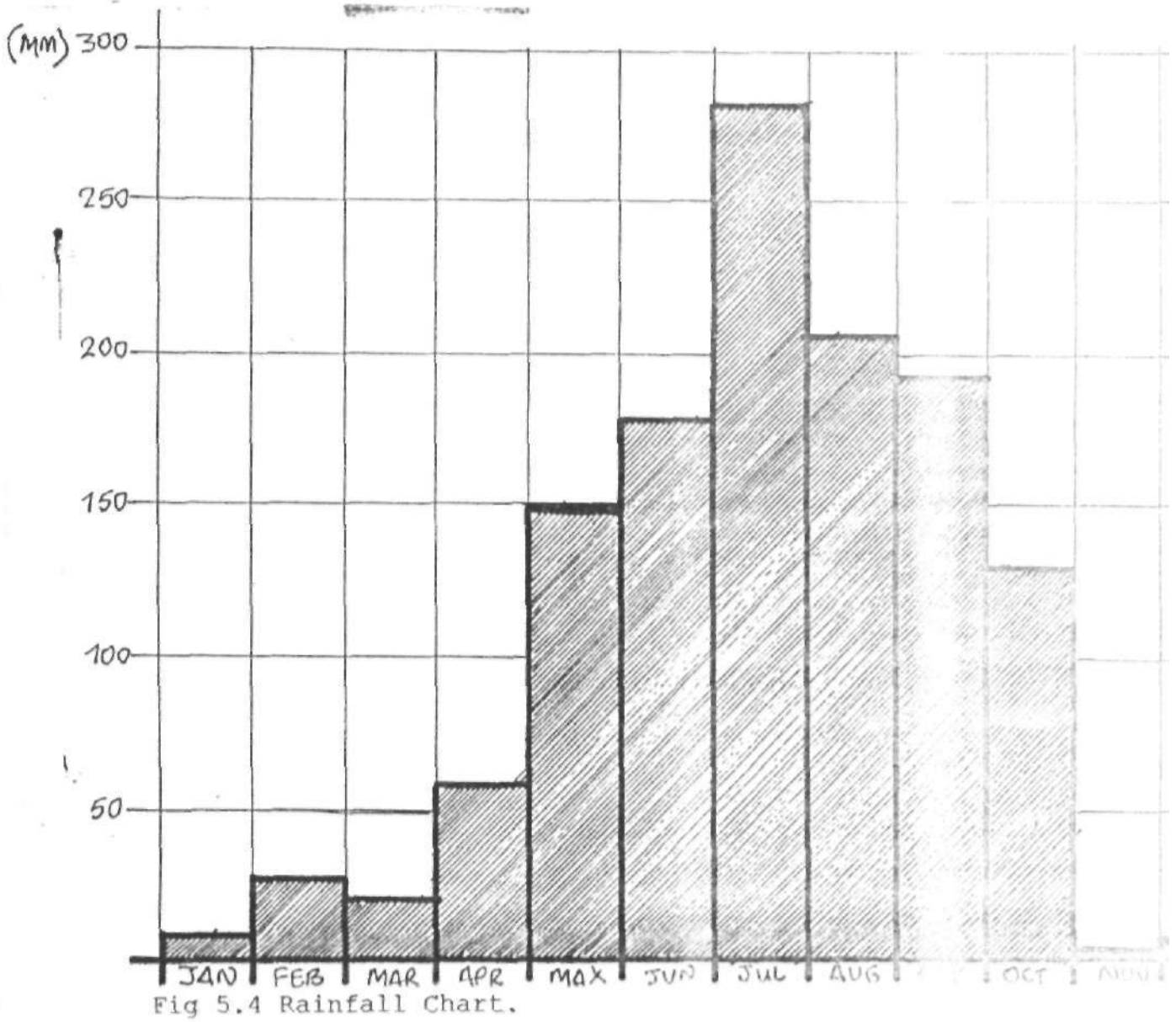


Fig 5.4 Rainfall Chart.

5.4.4. RELATIVE HUMDITY

The relative humidity of the area falls as low as 21% during the dry season and rise as high as 81% during the rainy season.

The interplay of temperature and humidity factors determines how comfortable or otherwise the person involved would be. Comfortable relative humidity (30%-70%) occurs on the months of April to June and October.

The possible influence of relative humidity on the design will be on the following areas.

- Ventilation
- Cooling plant design and building materials
- Thermal insulation
- Landscape Design

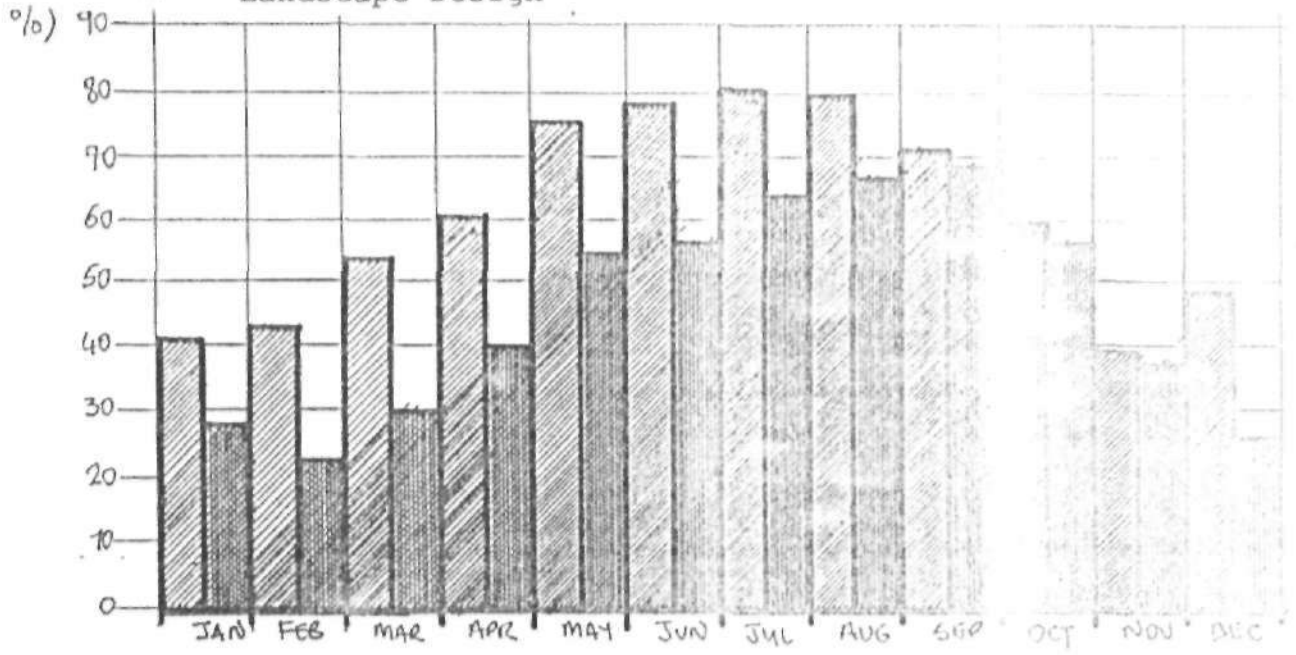


Fig 5.5 Relative Humidity.

5.4.5 WINDS

The wind flows are recorded from different directions, but the two most prevailing wind directions are; the North-east trade which brings the harmatten, a dry laden-wind blowing from the desert between the months of November and February while the south-west trade wind which is humid in nature brings the cool breeze from Atlantic Ocean between the months of March and October, the cool breeze brings about the rainfall.

5.4.6 SUNSHINE HOURS AND RADIATION

Ankpa town is on the tropic with a lot of sunshine. The hours of bright sunshine are greatest during the months of December, February and March but values decrease during the successive months. The average daily sunshine period is about 8 hours and the highest sunshine period is about 9 hours.

Solar radiation occurs more in the months of November, December, January, February and March while the lowest is on the months of May, September and October.

Glare effect is caused by radiation, from the aforementioned, the possible area of influence on the design are as follows:

- The wall finishes
- Roof and wall materials
- Thermal comfort

- Shading device and its depth
- Building orientation
- Landscape planning

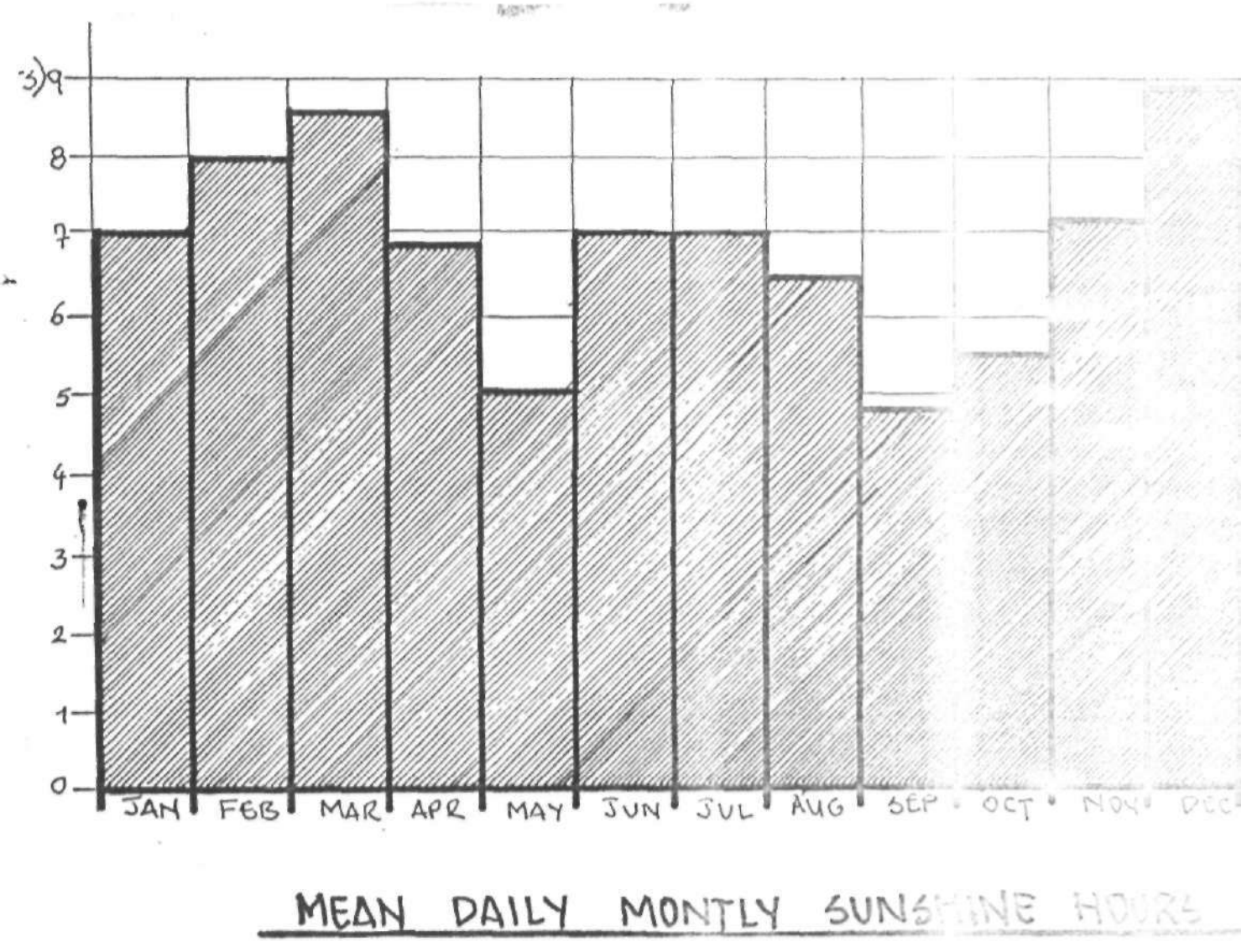


Fig 5.6 Sunshine Chart.

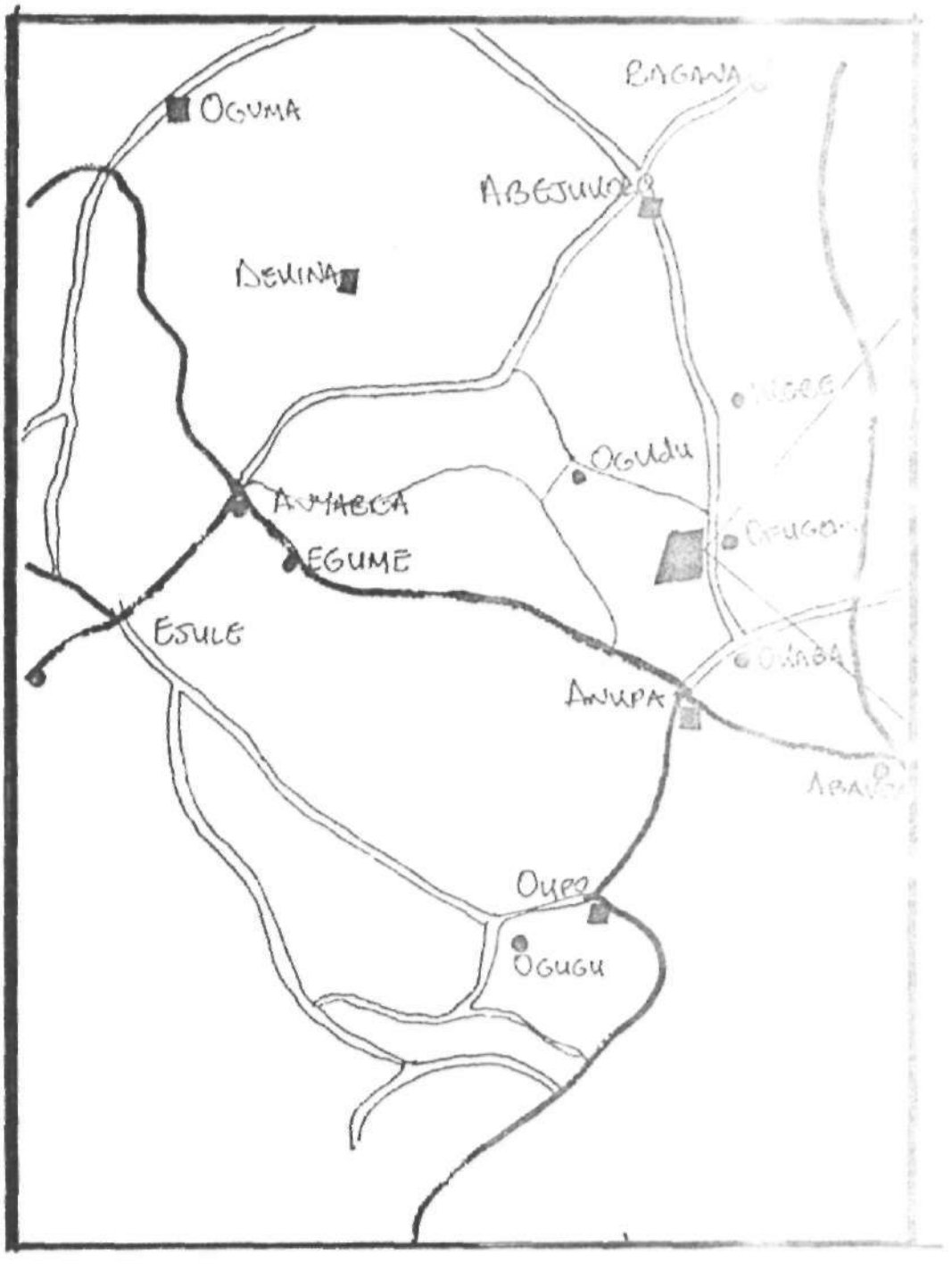


Fig 5.7 site location

5.5 SITE ANALYSIS

The site is covered with literate soil, reddish in colour. The site falls into the guinea Savannah vegetation it is covered with tall trees and grasses. It slopes gently towards the Northwest direction.

The Inye-Ankpa road borders the eastern and while the other sides is bordered by farmlands. 11KV NEPA line passed by the site from which power can be tapped and water supply is from the water board or from the Ankpa River.

The two major winds that affect the site are:

i. Southwest wind which is cool and moist wind that brings rain. Orientation of buildings shall facilitate maximum comfort and use of over hangs.

ii. Northeast wind which is cold, dry and dusty harmattan wind. Buffers shall be used as seem appropriate in design.

The sun rises about 6.00-6.30am and sets about 6.30p.m. The solar intensity is a bit favourable for human activities in the morning hours while it gets unfavourable for human activities towards evening. Shading devices shall be provided in appropriate places.

5.6 CLIENT

The client is the Ankpa agricultural development project in partnership with private entrepreneurs.

5.7 SOURCES AND EXENT OF RAW MATERIAL.

The raw material which are fresh fruit bunches(FFB) are from the oil palm groove that are wildly grown mostly in the south and south western part of the state.

The oil palm grooves in these areas are mainly of dura specie, which is charaterised with low yield of both palm oil and kernel. There are government owned plantations in the area where improved and high yielding tenera specie are planted and also there are private owned plantations.

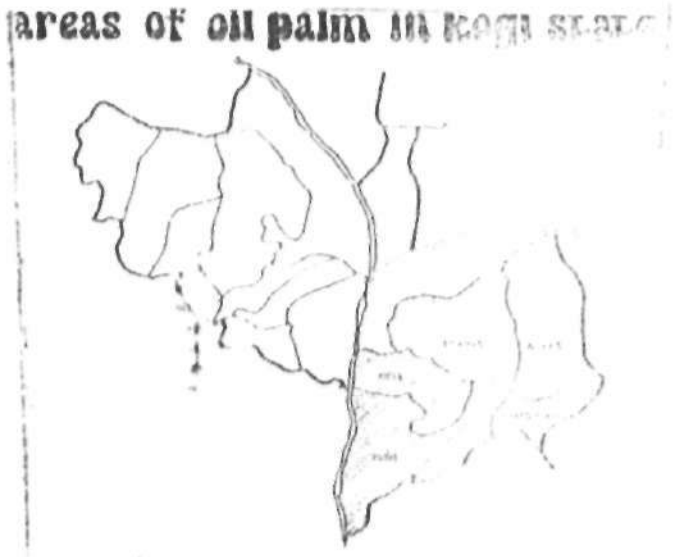


Fig 5.9 Sources and Extent of Materials

CHAPTER SIX

6.0. PROCESSING REQUIREMENTS AND METHODS

The basic raw materials to be processed in the industry are mainly fresh fruit bunches and palm kernels.

6.1. TRADITIONAL METHOD

The harvested fresh fruit bunches are left for some days so that the fruit can loosen up. The bunches are stripped and fruits are boiled until the pericarp softens. They are then turned into a mortar and trodden vigorously until the flesh begins to separate from the nuts. This is removed and strained to produce an emulsion, which together with the liquid in the mortar is then boiled and allowed to stand before the oil rises to the surface and is skimmed off. The remaining fibre is re-boiled and after further straining, it is picked over by hand to extract the nuts. The oil is then stored in containers made of copper, zinc, iron, aluminum or plastic.

The palm kernel are dried under the sun for some days and then cracked manually.

The whole process involves unhygienic methods and it gives the oil a low market grade value. A lot of sanitation problem is being faced using this method.

6.2. MODERN METHOD

6.2.1. PALM OIL

The fresh fruit bunches {FFB} are off-load from the trucks and dumped in the store. They are reloaded into sterilizer cages. The extraction of palm oil from fruit is in four stages.

i. STERILIZATION: The fresh fruit bunches are subjected to live steam under high pressure for 50-70 minutes. The purpose of sterilization is to deactivate the enzymes responsible for the breakdown of oil into free fatty acid and to loosen the fruit from the bunches so that the oil can be recovered later. Great care is taken during sterilization to exclude air, which interferes with the sterilization efficiency and may cause oxidation of the oil.

ii. STRIPPING: The sterilized bunches of fresh fruit are then continuously fed into a rotary drum whereby the threshing or stripping machine strips and separates fruit from the bunches. The fruit passes along channel bars running longitudinally along the drum, while the empty bunches are eventually discharged at the end of the drum.

iii. DIGESTION: The fruit are fed continuously into a digester after stripping. The digester converts the fruits into a homogeneous oil mash suitable for pressing.

iv. PRESSING: The digested mash is then fed into a presser for extraction of crude oil under pressure. Palm oil is extracted, refined and packaged. Palm kernel is discharged through a channel.

6.2.2 PALM KERNEL (VEGETABLE OIL)

The collected palm kernel is the raw material for this processing. They could be got from two ways

i. From the industry (palm oil section).

ii. From the local markets around.

The stages involved in the case of the industry processed palm kernel are:

i. Cracking- the palm kernel nuts are passed through a polishing drum. The nuts are cracked and the shells are separated from the kernel in a hydroclone

ii. Drying- the palm kernel nuts are dried to attain a minimum moisture level.

iii. Pressing- the palm kernel nuts are grinded into smaller fragments. The oil is squeezed out and sent into the settling tank. The cake is sent by Screw conveyor to the flaking roll.

iv. Filtration- the expelled oil is settled in a tank

and then filtered. It is they pumped to the crude oil storage.

v Flaking mills (Roll)- The conditioned meals or cake are squeezed, thus breaking down cellular wall structure and exposing more surface area for solvent extraction.

vi Solvent extraction- the meal flakes are sent to the percolation extractor where the oil is extracted by solvent action. The cake and the solvent are pumped into the desolventizer where the solvent is distilled off. The oil is pumped into the setting tank. From there the oil is filtered and pumped into the crude oil storage tanks.

vii Refining-There are three categories of refining the Oil,

Category	**Refining Process**
(a) Oil for export.	Physical(steam)refining.
(b) Oil for other industries.	Batch refining.
(c) Oil for domestic cooking.	Caustic refining.

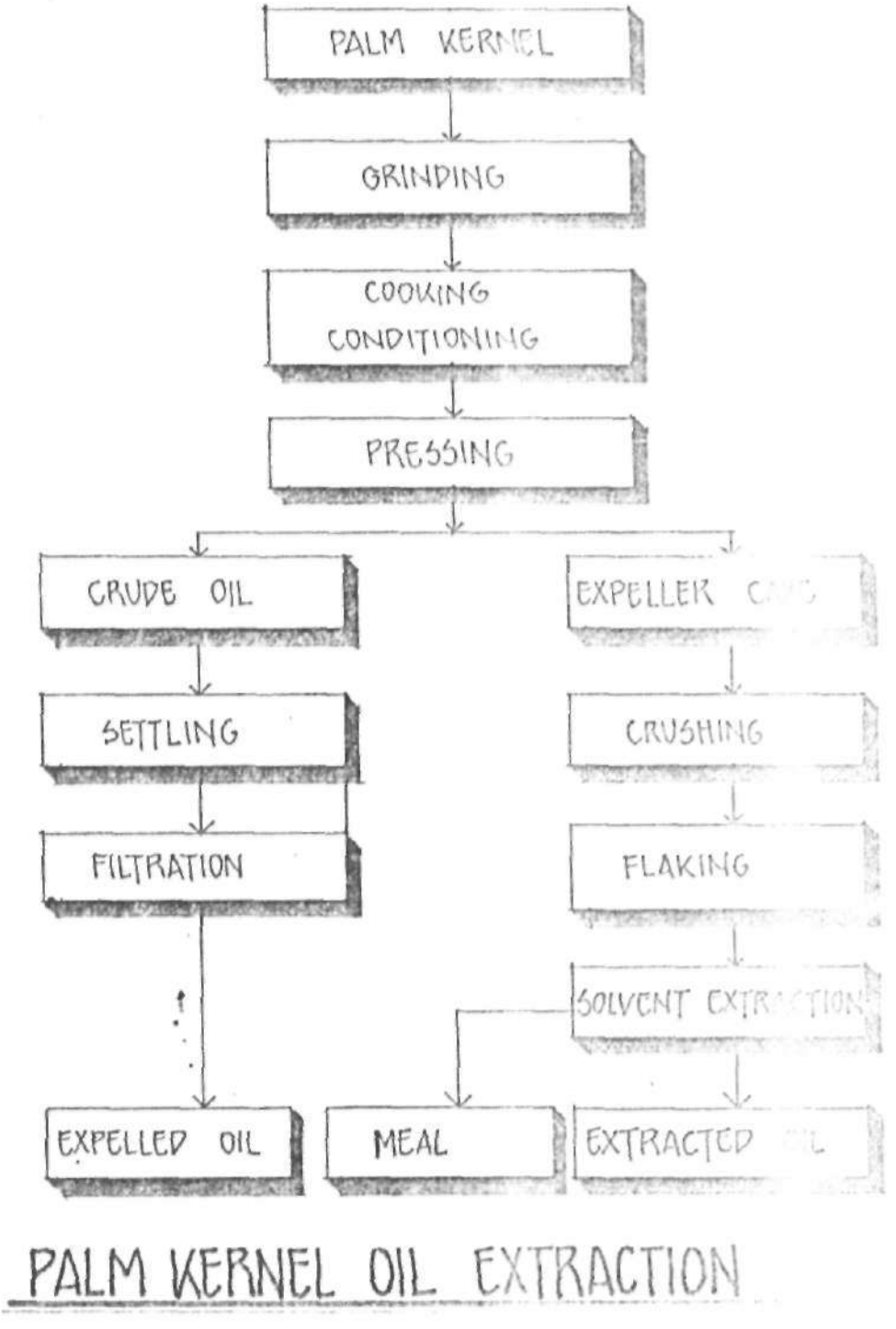


Fig 6.0 Palm Kernel Oil Extraction.

6.2.3. PALM KERNEL CAKE

This is the residue left after the extraction of oil from the palm kernel. It contains about 18-19% protein and is used in making livestock feeds.

6.3. OIL REFINING

6.3.1. PRE-TREAMENT (DEGUMMING) STAGE

Degumming is the removal of impurities present in oil to the extent that 0.03 to 3% in the form of a wide variety of complex molecules are removed. They may be in soluble, insoluble, or colloidal form in oil, and they may be of hydratable and/or non-hydratable types. These include, in varying amounts materials such as phospholipids and trace metals.

Most oils subjected to water and steam treatment during extraction are centrifuged to remove hydratable gums. The nonhydratable variety of oil in usually treated under vacuum with 0.05 to 0.5% concentrated phosphoric or citric acid. The reaction mixture in an alkali refining line is separated by centrifugation before the oil passes to the alkali neutralization step to give improved yield and oil quality.

6.3.2. PHYSICAL REFINING

Crude oil storage and the degumming stage are followed by physical refining of the oil which includes several steps such as neutralization, water washing, drying, bleaching, filtration, neutralized and bleached oil storage, deodorization, Polishing, cooling, and storage of edible oil.

In this process the pretreated oil is purified by three operations conducted under high vacuum at high temperature first, the free fatty acids are removed by multistage counter-current contact with steam. Then, the pigments are converted to a colourless form by retention of the hot oil for the required reaction time. Finally, the oil a deodorized by additional multistage counter-current contact with steam. An antioxidant is added to the developed oil and is thoroughly saturated with nitrogen to protect its quality.

(a) **Neutralization:**

Neutralizing it with caustic soda to produce a consistently high-quality product refines crude vegetable oil. Poorer-quality oil can be recovered by concurrent saponification of pigments with their removal via the soap stock. Both batch processes and semi-continuous / continuous refining lines are

employed. The yield or loss controls of continuous and semi-continuous refining plants of high capacity are of paramount importance in the oil processing technology.

(b) **Bleaching:**

The bleaching process removes soap, trace metals sulfurous compounds, and part of the more stable pigments and degraded pigment products resulting from the oxidation of raw materials. Bleaching earth is used for bleaching. Bleaching conditions require a vacuum, agitation of earth-mix, a residence time of a minimum of 20min, and a temperature of 90 to 100°c.

(c) **Deodorization:**

Oil is deodorized by steam distillation under vacuum. The residual free fatty acids, aldehydes, and ketones responsible for unacceptable oil odours and flavors are removed. The effectiveness of the deodorization process depends on the combination of the intimacy of mixing steam and oil and the vacuum and temperature employed.

(d) **Deacidification**

The distillation process deacidifies crude oil and eliminates the use of caustic soda refining. Acid oil factor (AOF) is used to measure the efficiency of the oil refining process.

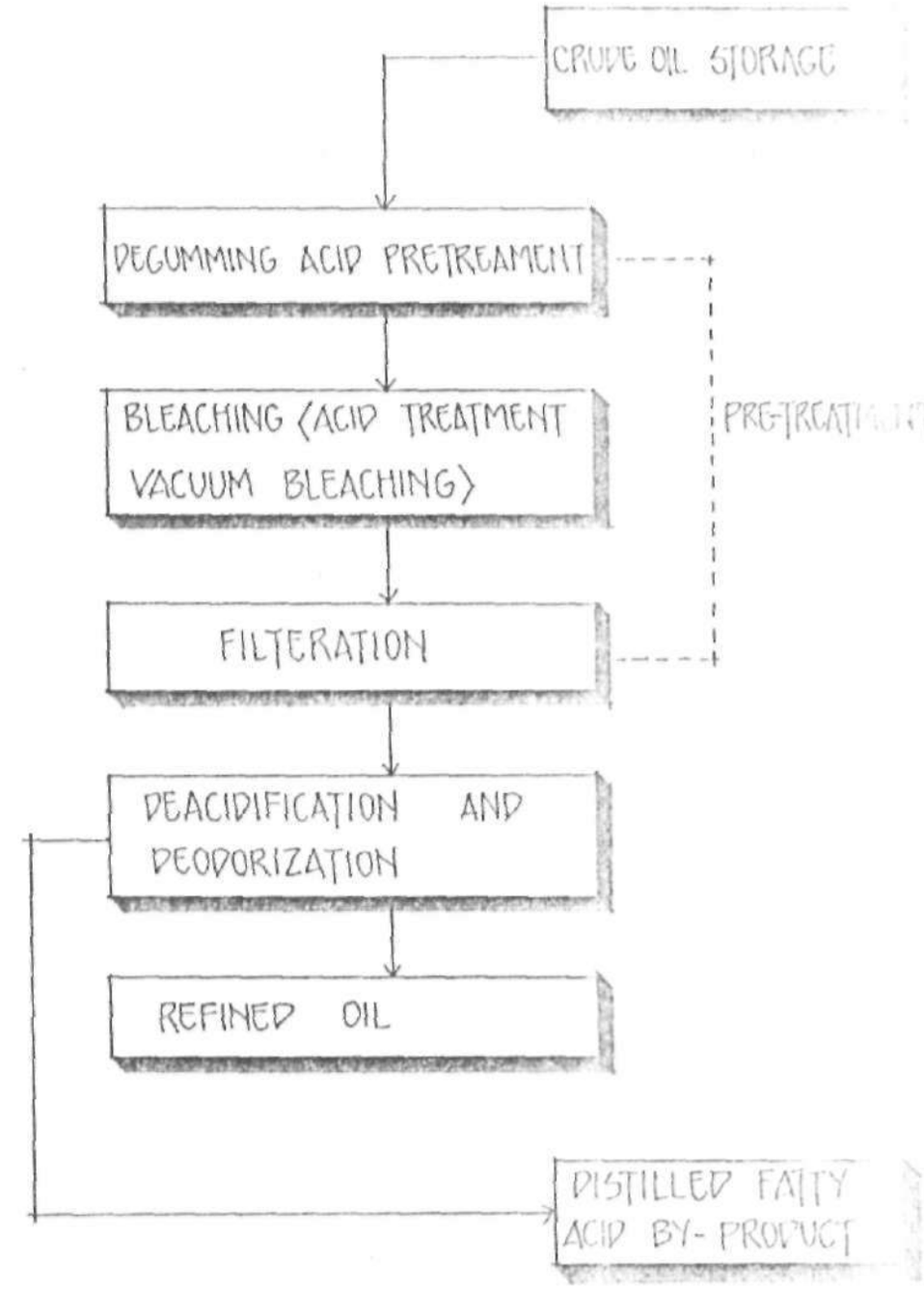


Fig 6.1 Physical Refining Flow-Chart.

6.3.3. BATCH (CHEMICAL) REFINING

The batch refining process consist of the following

(a) **Initial Refining:**

It involves degumming, bleaching and filtration. The neutralization, the free fatty acids, which are inherently undesirable and which would oxidize to cause rancidity are disposed off. This principle combines the free fatty acids with an alkali to form a soap solution, which can be separated from the oil by the centrifugal action. The separated oil in washed by wash centrifuge and dried under vacuum.

(b) **Modification**

i This is a process of adding hydrogen in the oil on the presence of a catalyst such as nicked or copper, to make the oil less liquid and more stable. Hydrogenated oil may have melting points between 40°c B60°c. The temperature of the operation is increased to 180°c by the addition of finely powdered catalyst. Afterwards, all traces of the catalyst are removed by filtration.

ii. **Fractionation**

All fats and mixtures of solid and liquid glycerides have a varied fatty acid composition

and have melting points ranging from-50 to 80°c. Fractionation is a means altering the proportion of solid to liquid.

iii. **Interestification**

This is a method of altering the melting point of fat or a mixture of fats by changing the positions of the fatty acids group in the glyceride molecules.

(c) **Final Refining:**

This stage involves the following, neutralization, bleaching, filtration and deodorizing.

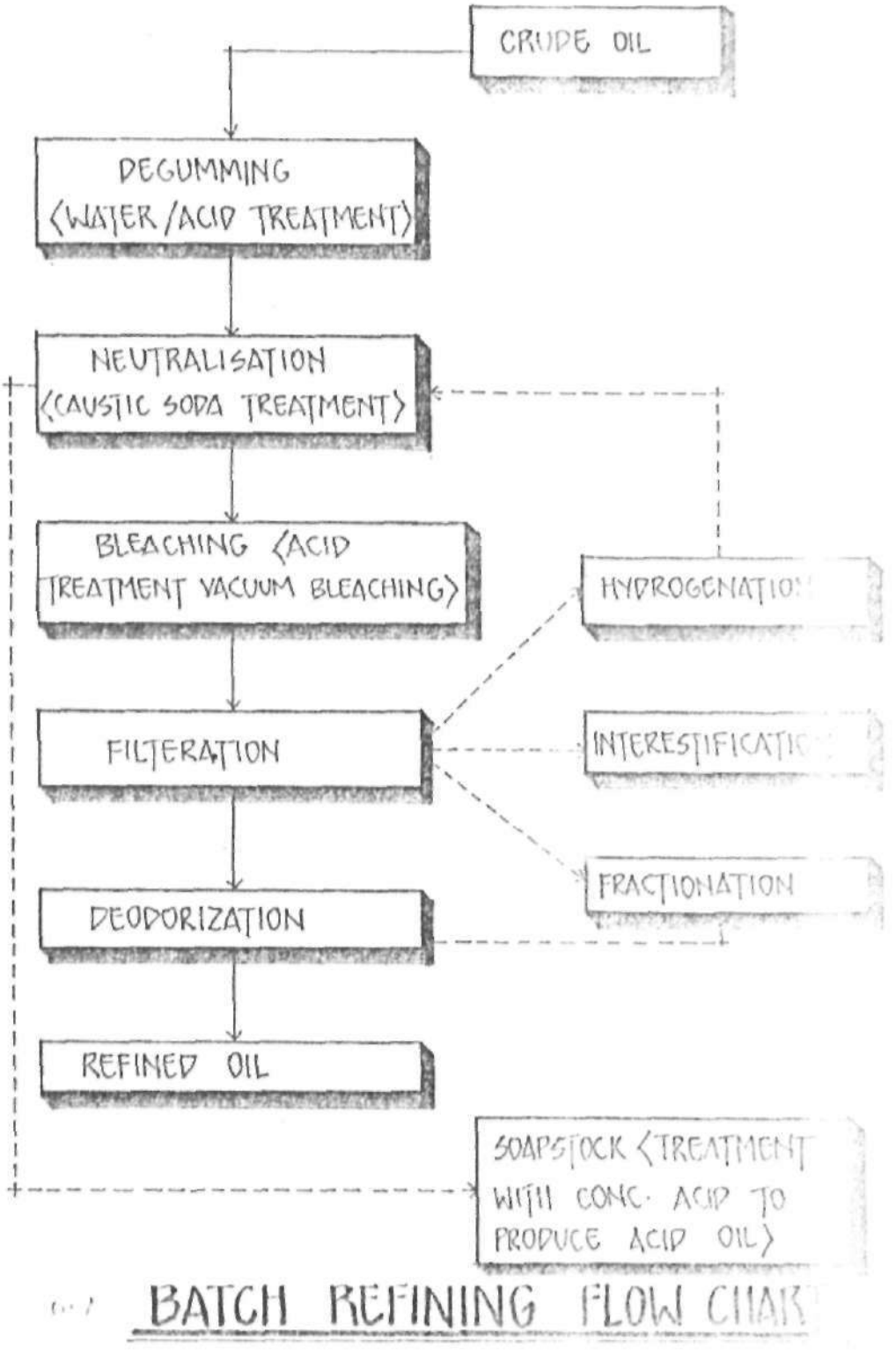


Fig 6.2. Batch Refining Flow Chart.

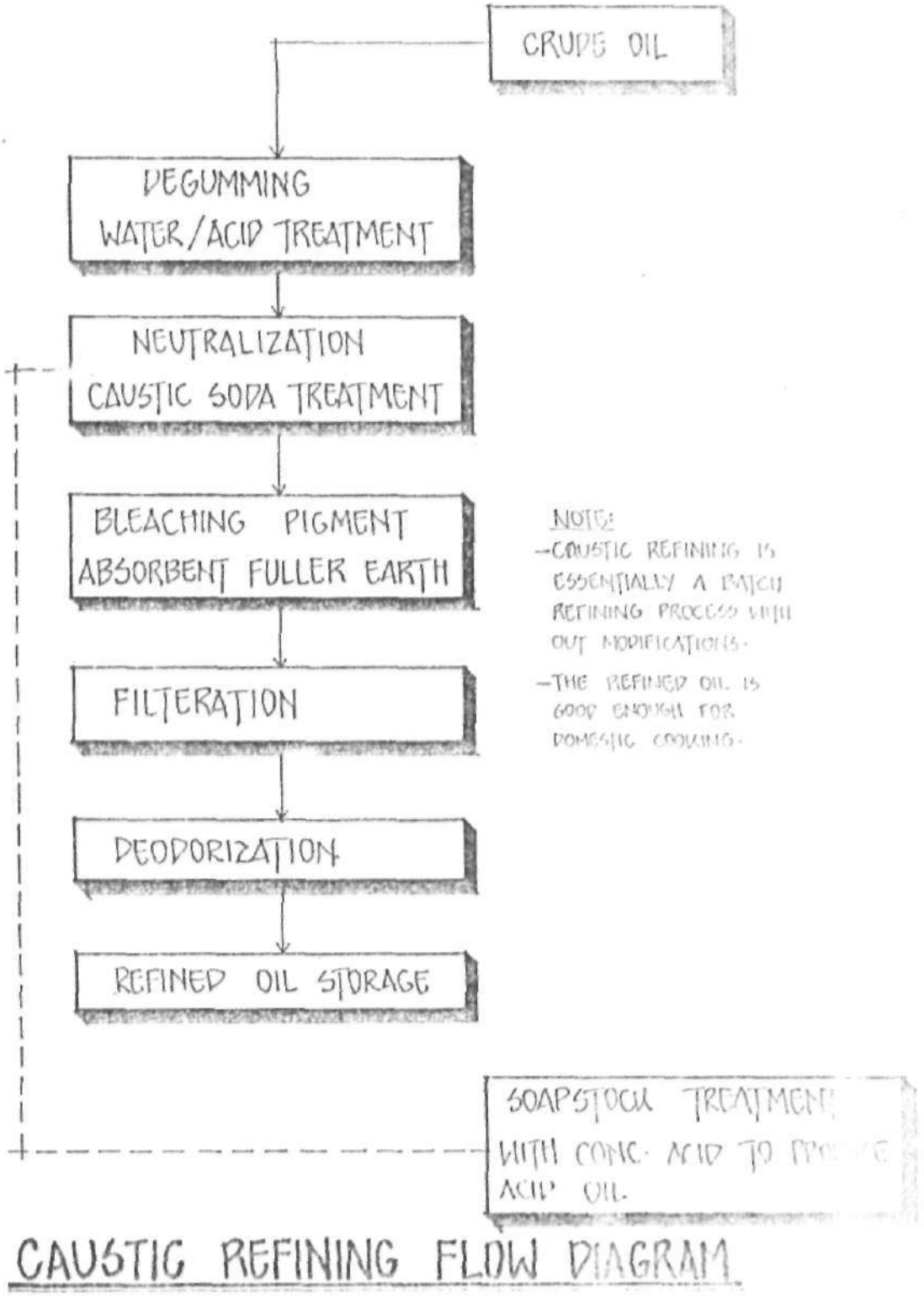


Fig 6.3 Caustic Refining Flow-Chart.

6.4. BY PRODUCTS

FATTY ACID AND GLYCERINE RECOVERY AND DISTILLATION

This process is designed to process fats, oils and refining by-product into fatty acids, glycerine and their derivatives. These plants sometimes enable materials of a low commercial value to be turned into high quality production suitable for special industrial application. The distilled fatty acids obtained which are of a high grade of purity can be used both in the soap industry and for the manufacture of synthetic resins and plants.

Glycerine is recovered from sweet water and spent lye=s. The vacuum distilled and bleached glycerin should be able to meet the requirements of the important pharmacopoeia.

Table 6.0 The Saturated And Unsaturated Fatty Acids Of Palm Oil.

Fatty Acids	Usual range	Mean range for Nigeria species
Saturated		
Myristic (C_{14})	0.6-5.9	2.3
Palmitic (C_{16})	32.3-45.1	41.2
Stearic (C_{18})	2.2-6.4	4.3
Unsaturated		
Hexadecenoic	0.8-1.4	-
Oleic	38.6 -52.4	42.5
Linoleic	5.0 -11.3	9.6

6.5. FINISHED PRODUCTS

(a) STORAGE

There are different storage facilities in the industry

- **Raw materials store**

This is used to store materials like the different acids used for refining

The raw material section for the fresh fruit bunch should be separate.

- **Silos**

Silos are used to store palm kernel seeds. The seeds are best stored in silos to prevent decay or infections.

- **Storage Tanks.**

Used for the storage of crude oil and refined oil. These tanks store palm oil and palm kernel oil

- **Finished Products**

Palm kernel cakes are stored in the finished product store in sacks.

Sealed domestic cooking oil is also stored here.

(b) **PACKAGING**

The finished products are packaged in container, which could be plastics, Aluminum drums or copper drums. Provision is made for customers to have their own containers filled in the factory.

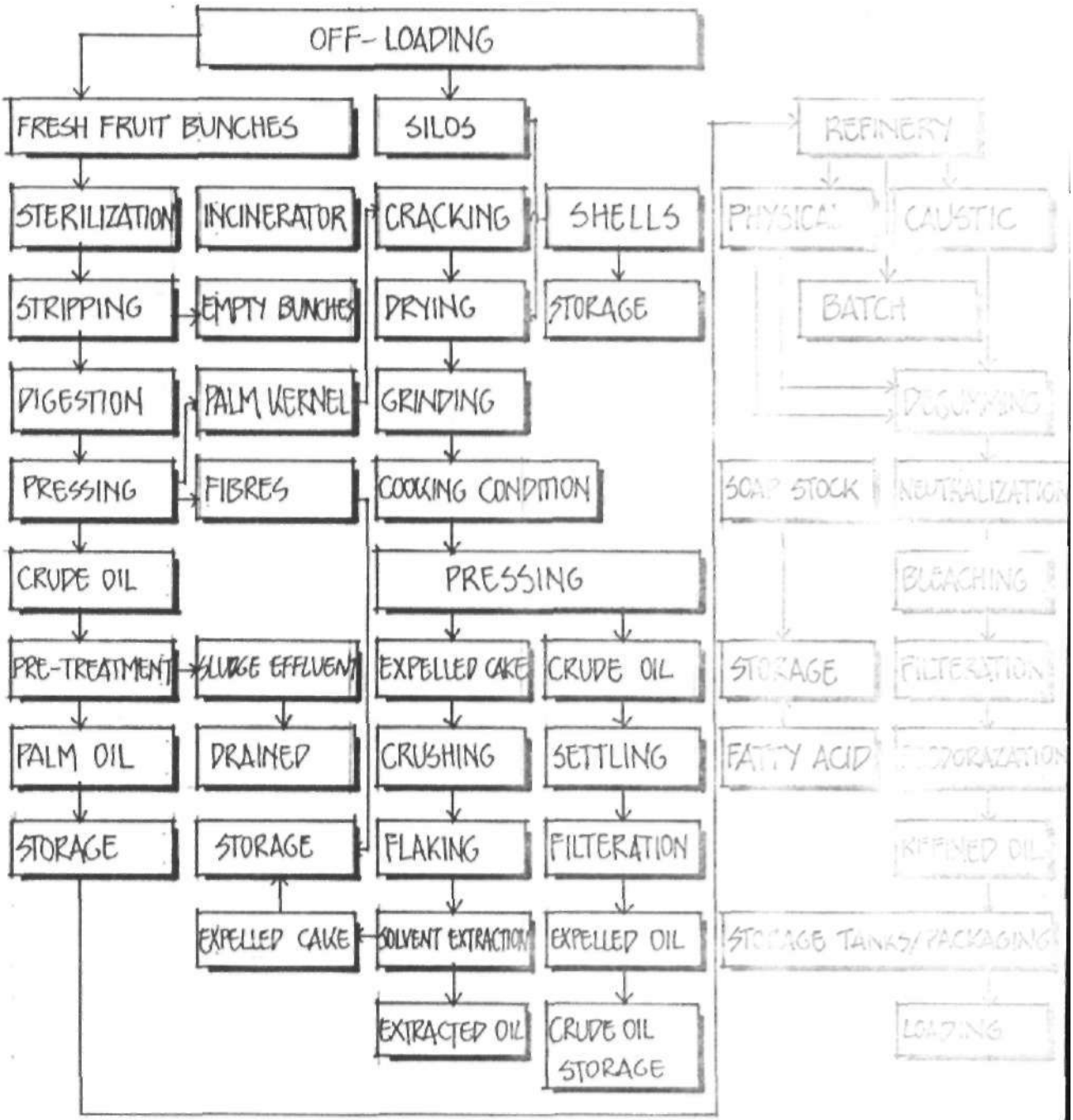


Fig 6.4 Production Flow.

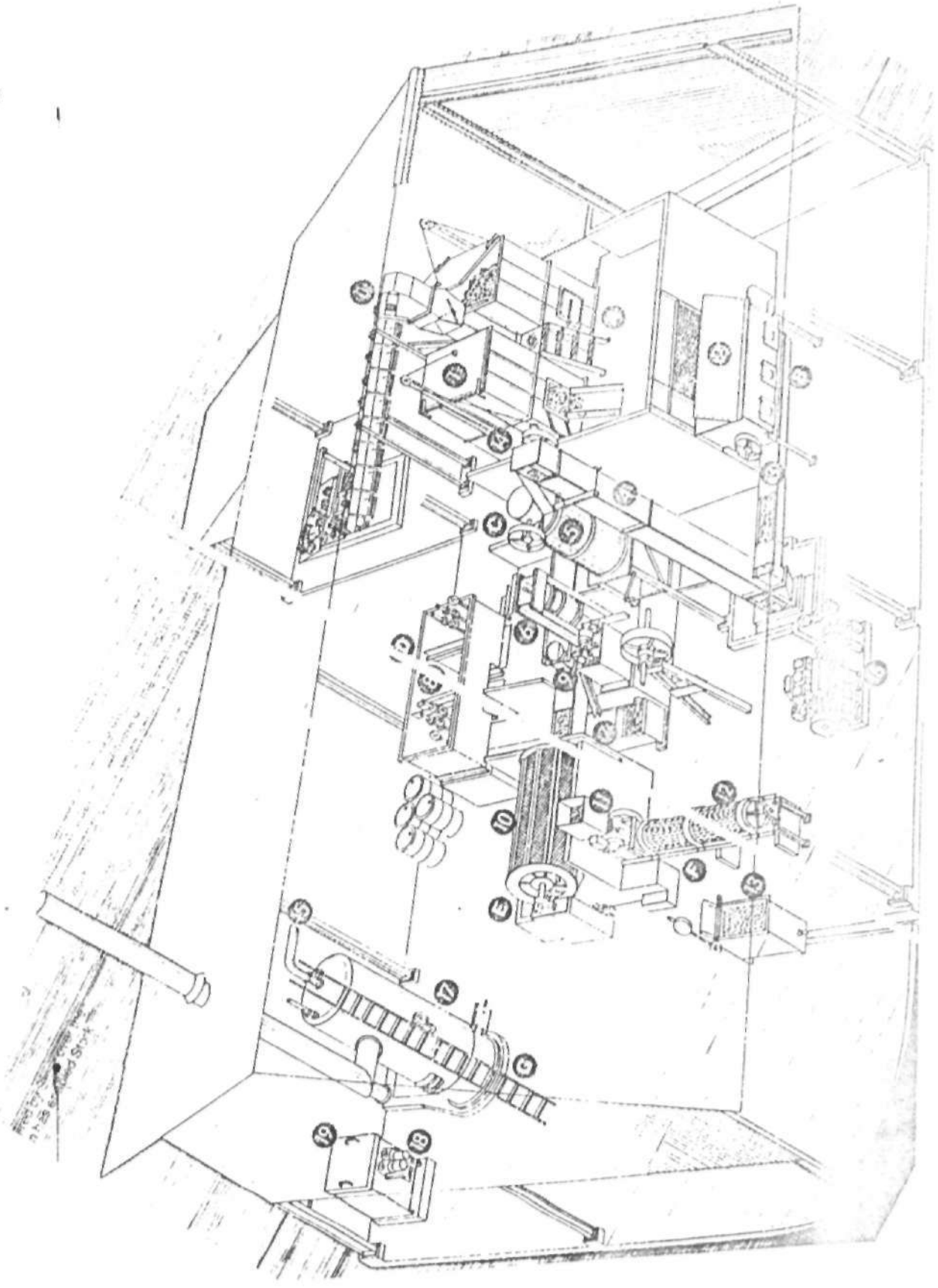


Fig 6.A Stock Standard Junior Palm Oil Mill

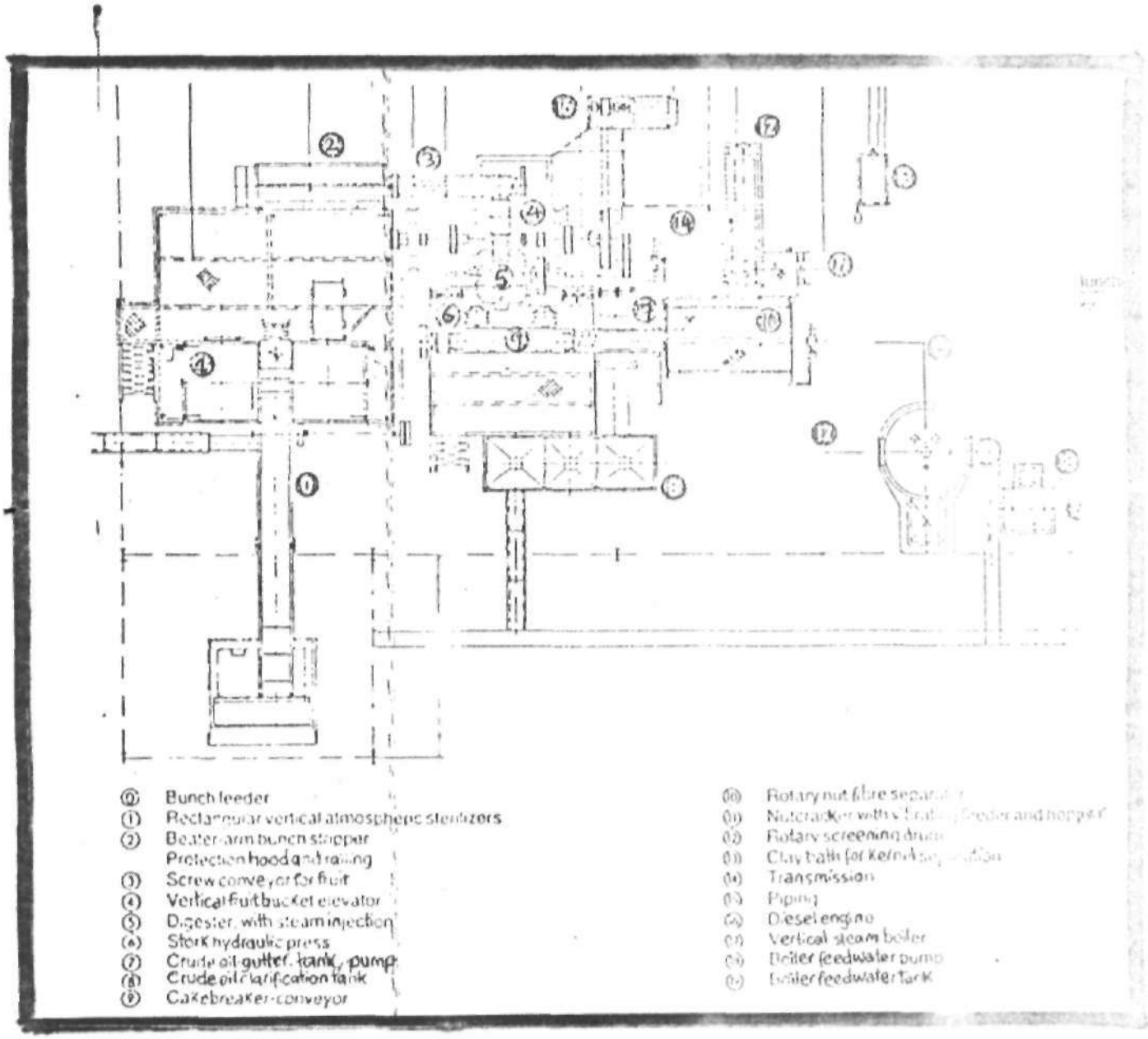


Fig 6.B How It Works (6.A).

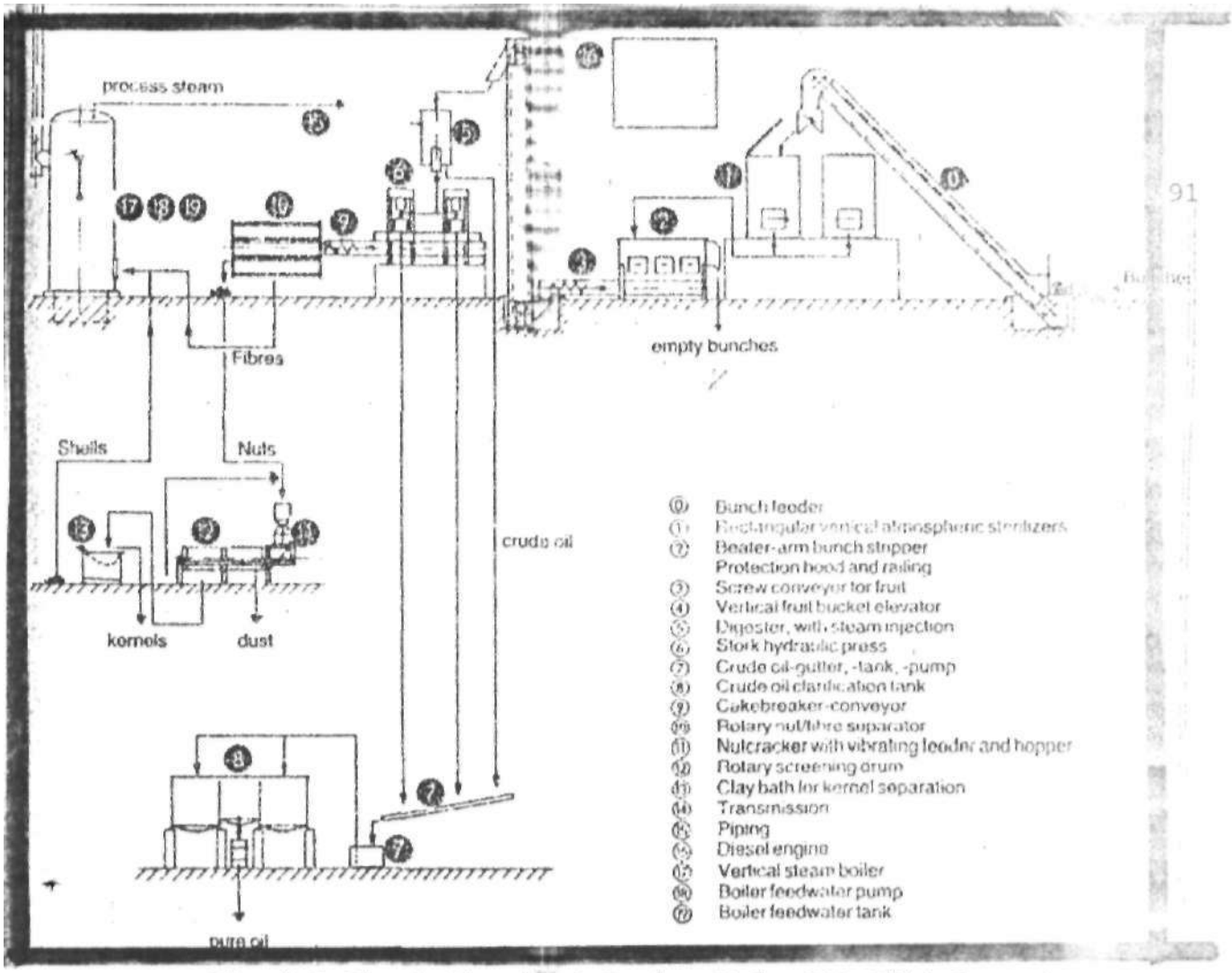


Fig 6.C Stock Standard Junior Palm Oil Mill Layout.

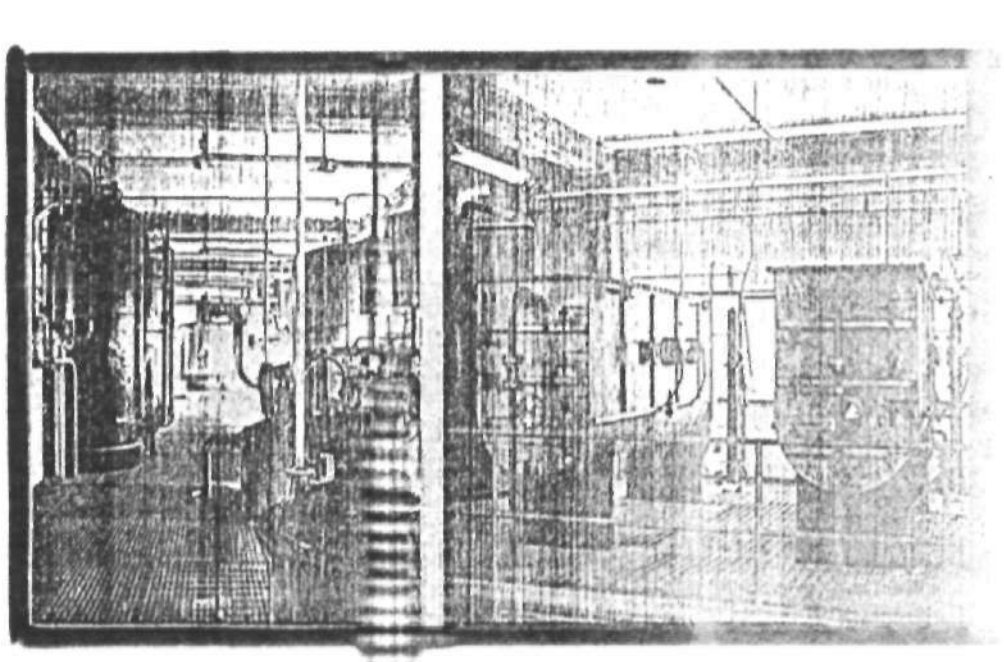


Fig 6.D Miscella refining.

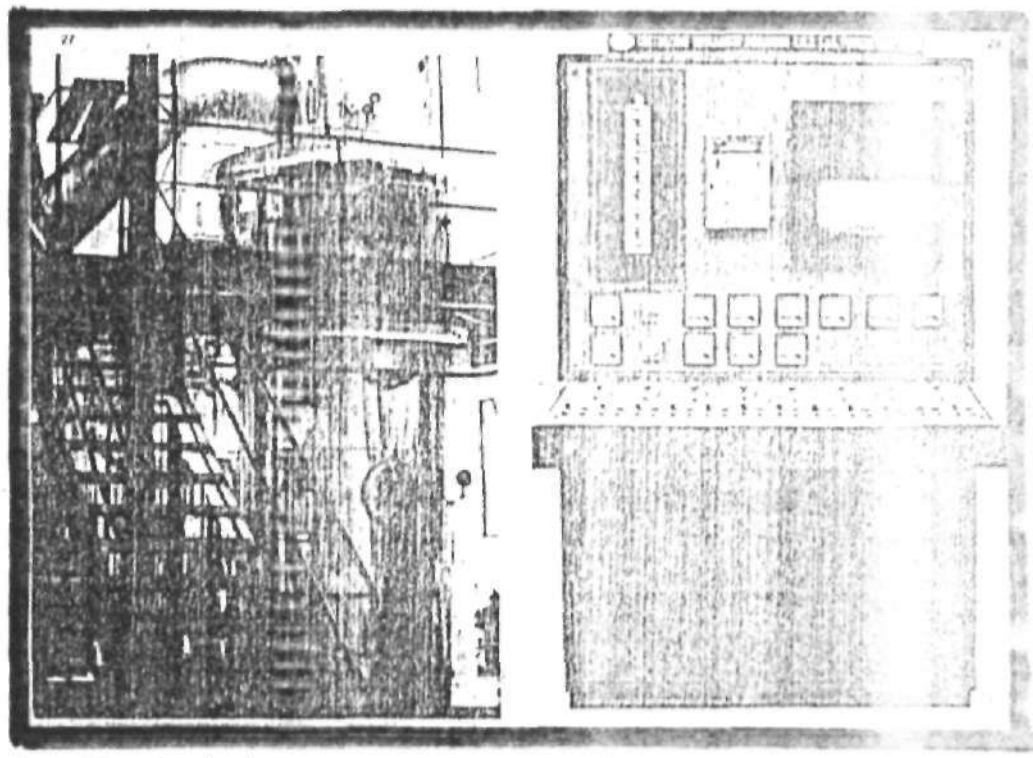


Fig 6.E Deodorising.

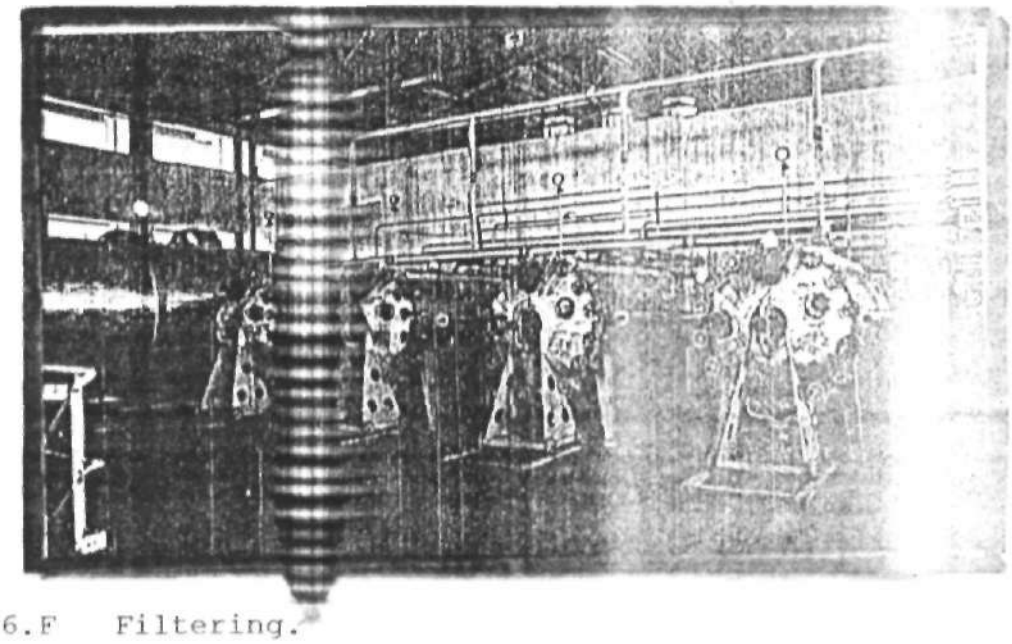


Fig 6.F Filtering.

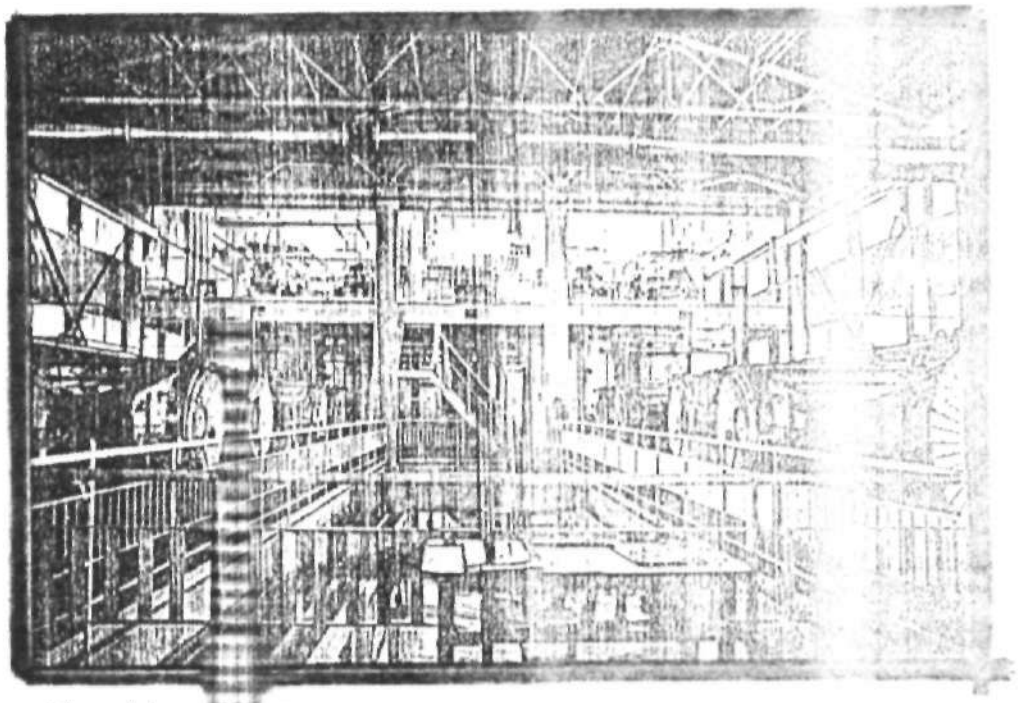


Fig 6.G Fractionation.

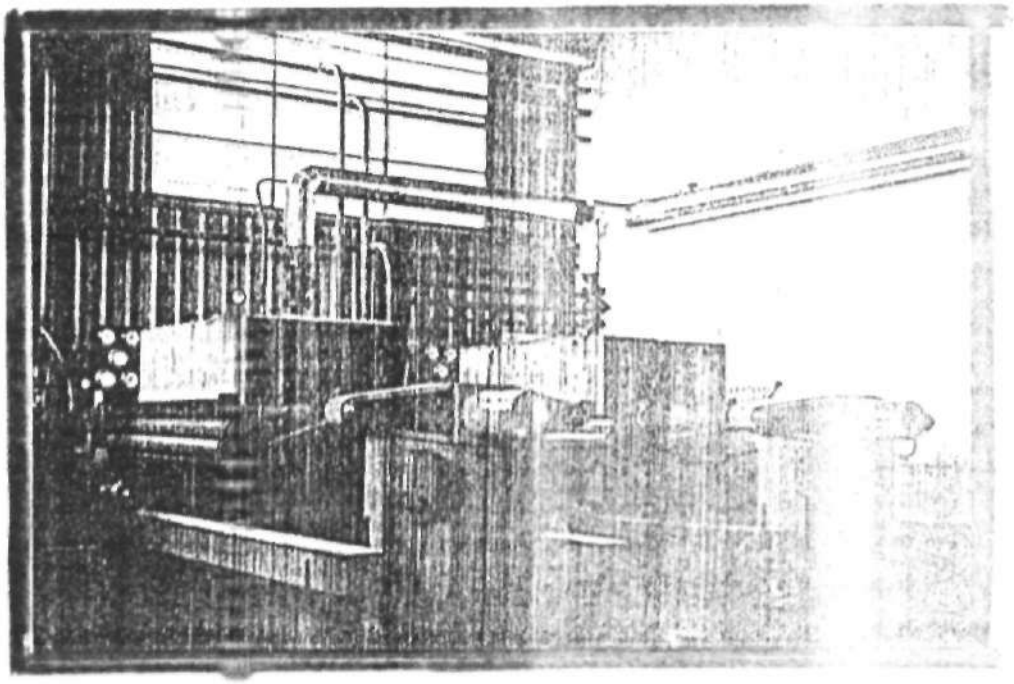
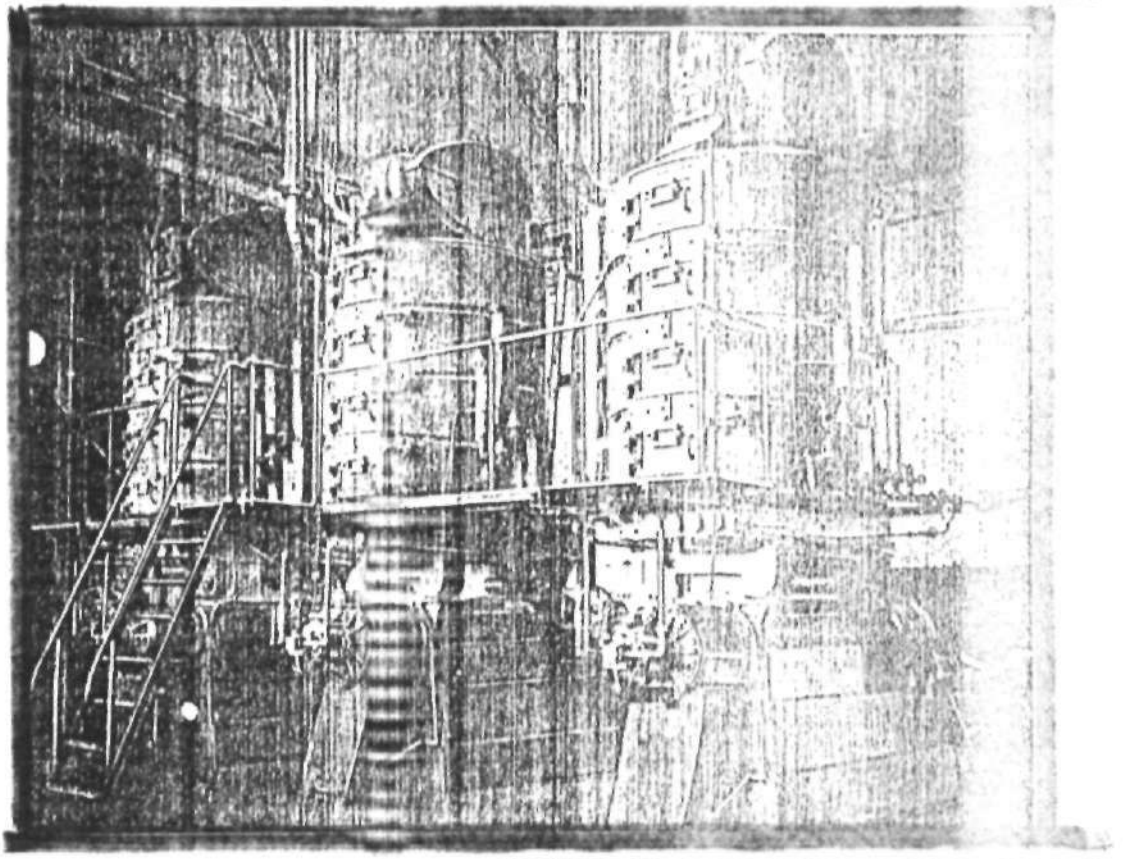


Fig 6.H Solvent Winterising.



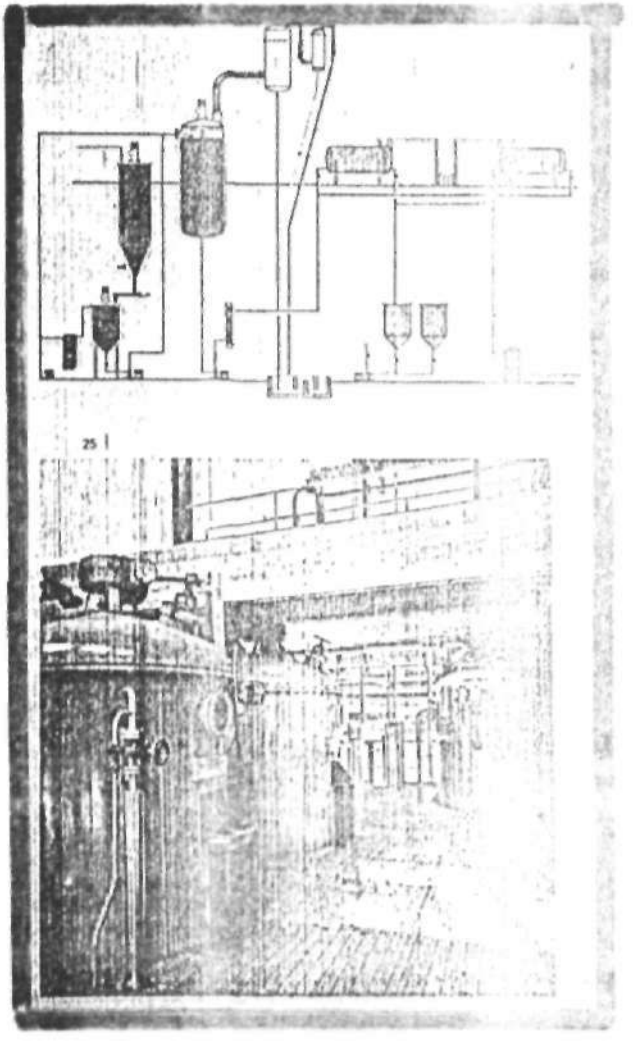


Fig 6.I Bleaching.

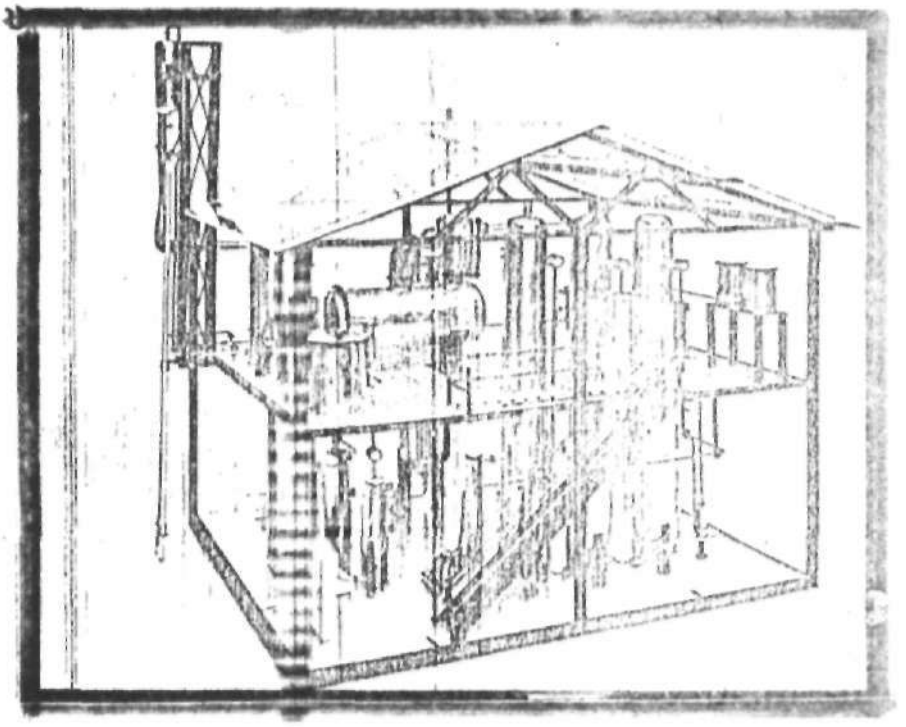


Fig 6.J Fatty Acids And Glycerine.

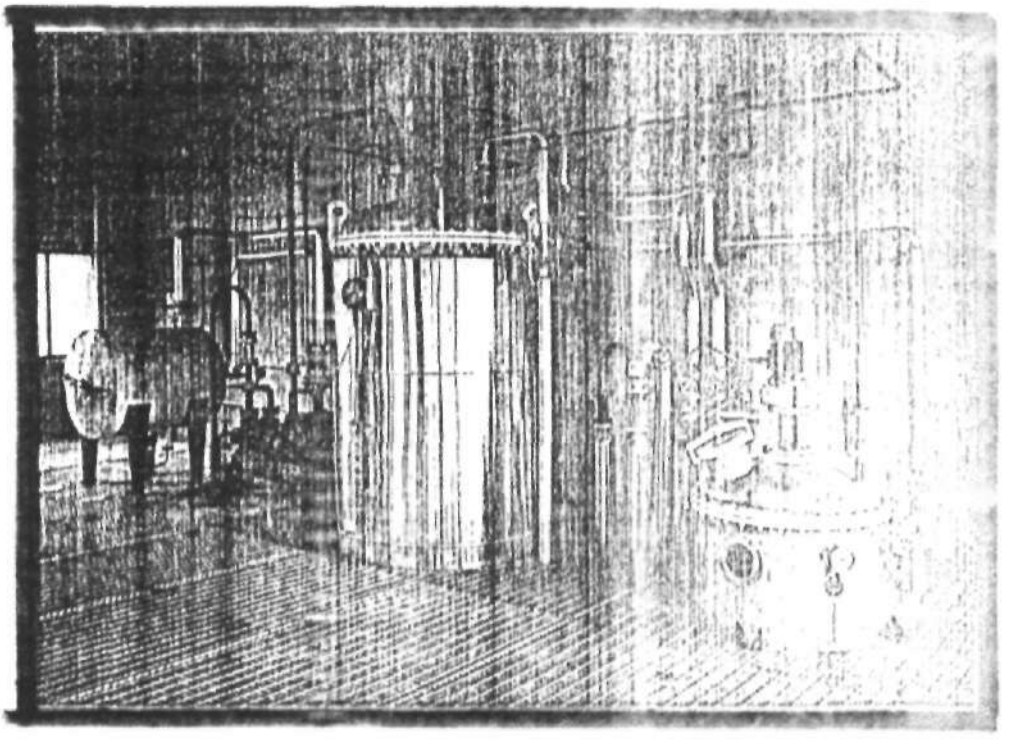


Fig 6.K Hydrogenation.

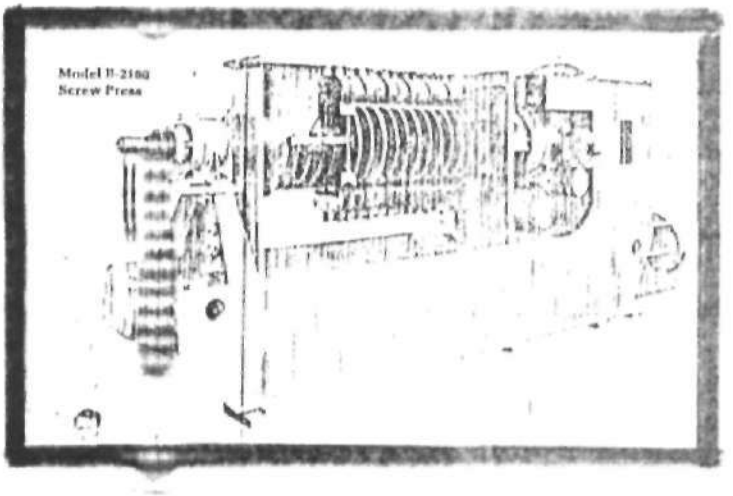


Fig 6.L Screw Press.

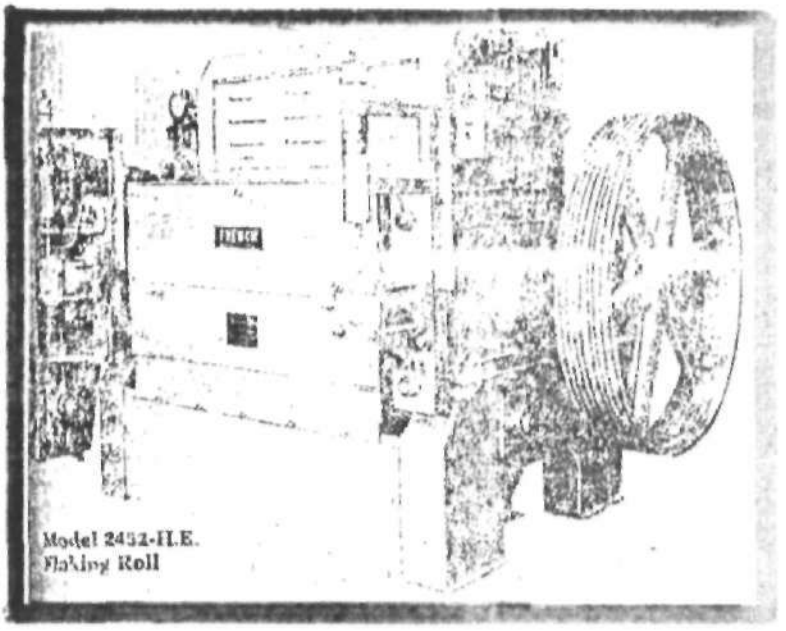


Fig 6.M Flaking Roll.

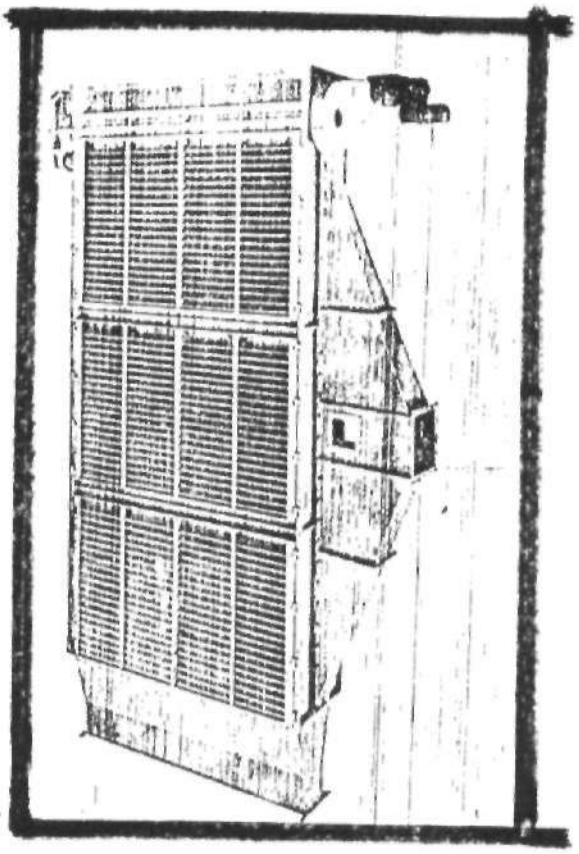


Fig 6.N Meal Cooler.

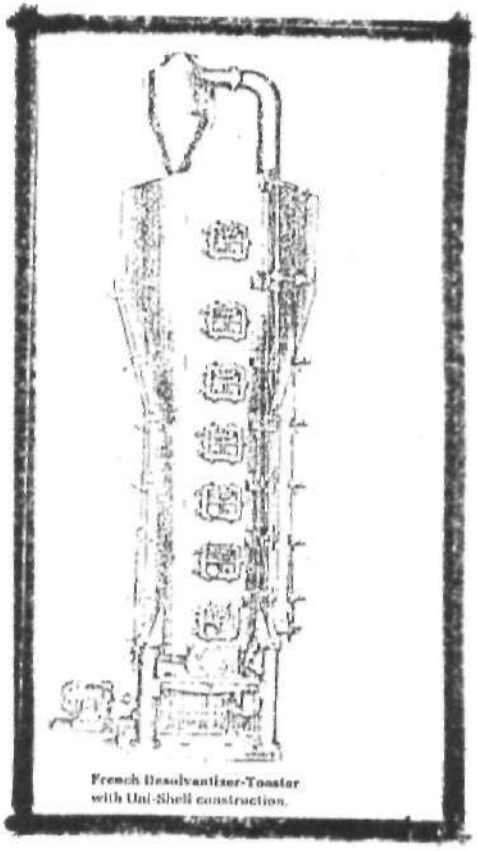
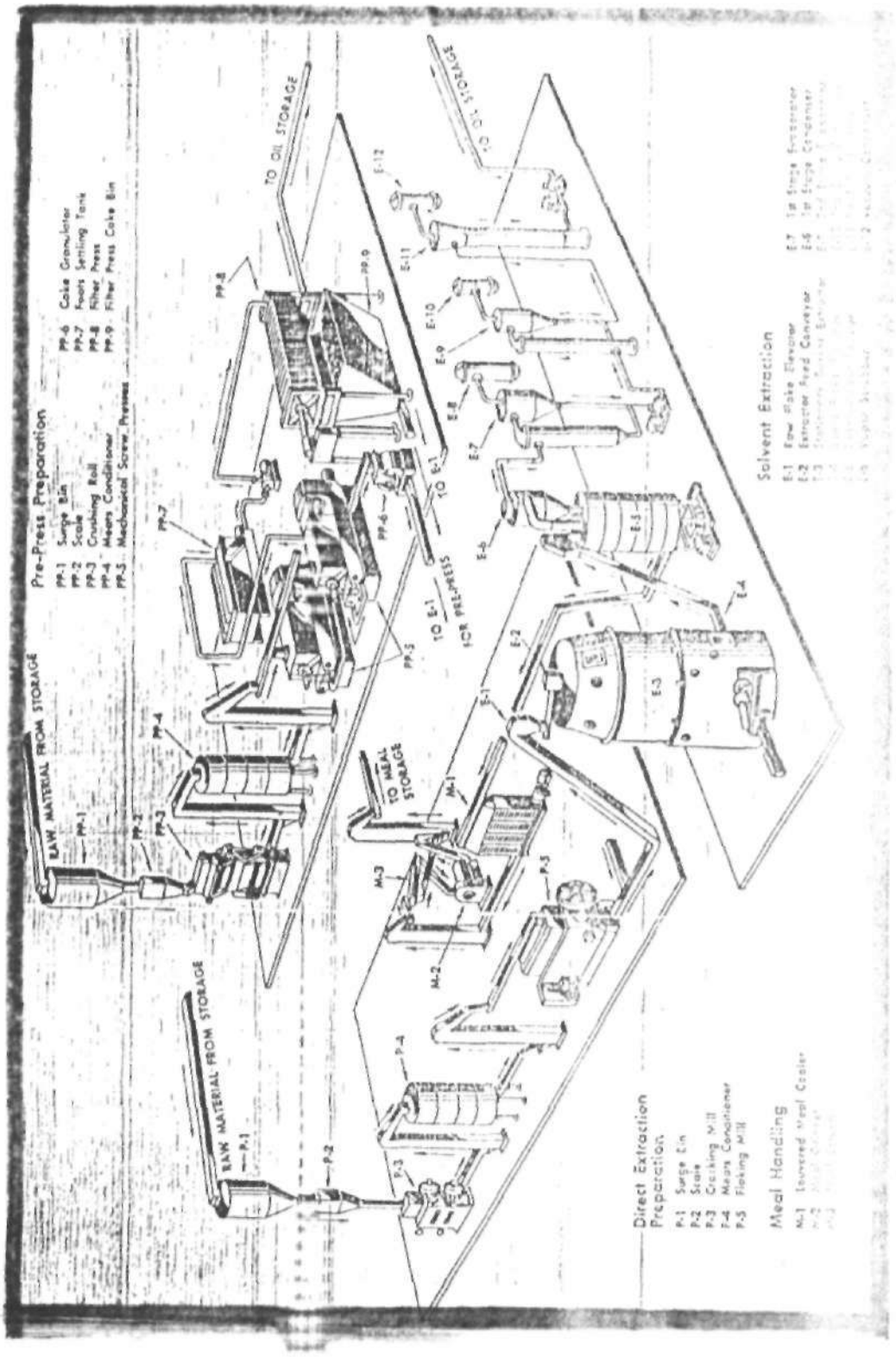


Fig 6.O Desolventizer B Toaster.



ig 6.P Neumeng Complete Vegetable Oil Mills.

Source: [illegible] equipment manufacturers' catalogs

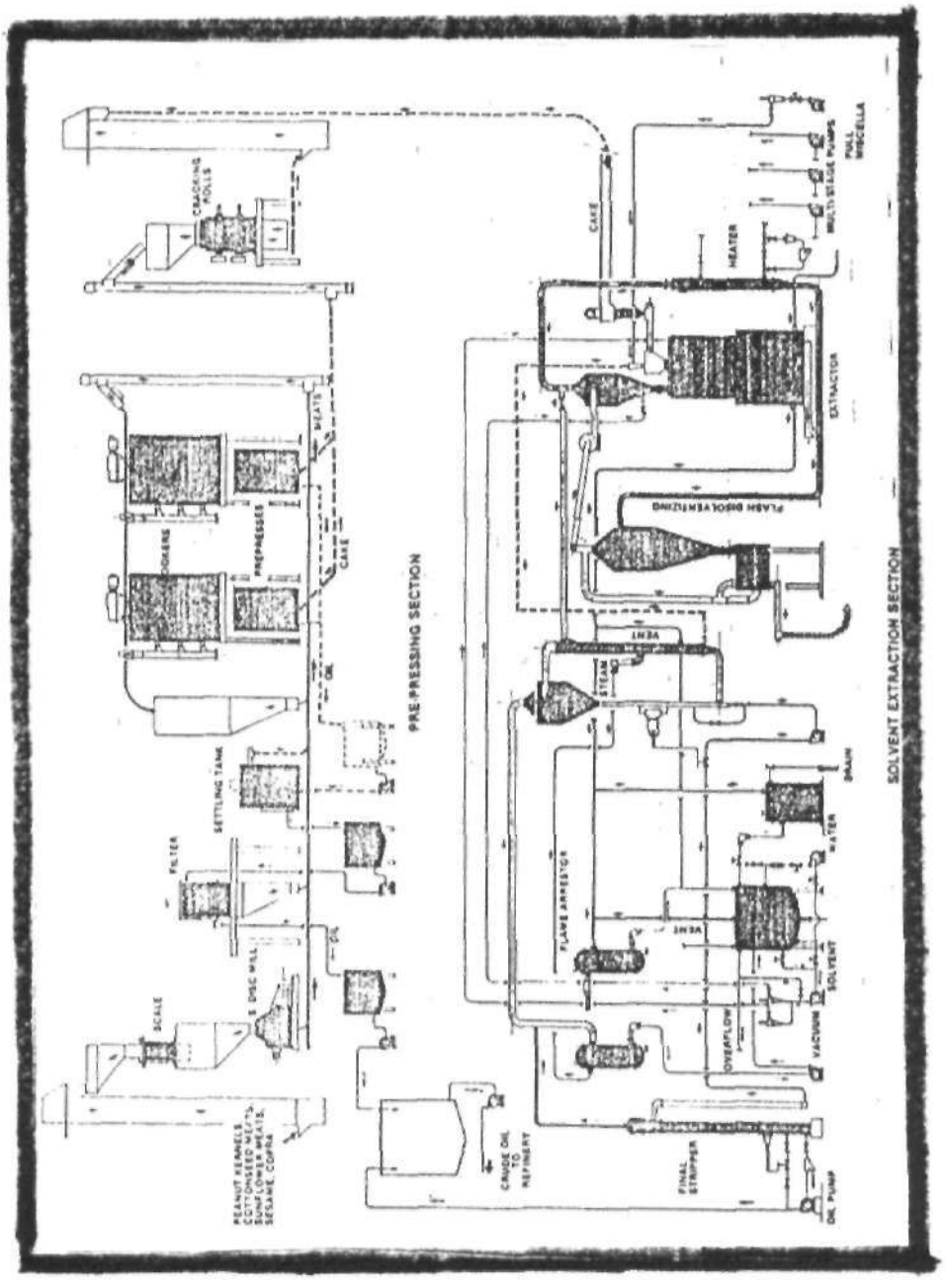


Fig 6.P1 Neumenz Complete Vegetable Oil Mills

CHAPTER SEVEN

7.0 DESIGN FORMULATION

7.1 PROBLEM DEFINITION

Sanitation in the edible oil industry can be defined as the control of environment in which raw foodstuff is processed to prevent the contamination of the finished product thereby promoting the maintenance of good health.

The thesis attempts to study various edible oil industries within the country and finding the problems being faced by them particularly those that are due to poor planning. The thesis also attempts to provide solutions to the identified problems through Architecture i.e. by planning effectively for sanitation and hygiene.

7.2 DESIGN BRIEF

The design brief needs to reflect a workable and economical functional dimension, which considers especially organs allowing for highly flexible and expansive growth of the industry. The brief must succeed in creating just an arrangement that eases the over-riding need for the factory to work as the sales and profit B making centre it is.

Facilities required basically in the industry for its effective functioning can be broadly grouped into the following sections.

ADMINISTRATION: The administrative unit which oversees the governing of the plant will also ensure the carrying out of operations and administer the internal work force.

WORKERS FACILITIES: For effective worker output the provisions of facilities such as changing rooms, canteen, first aid and others are essential. The size of these facilities must also reflect the anticipated workforce of the plant.

PRODUCTION HALL: The production hall should contain all the departments needed for an effective and efficient transition in the production process from raw material Reception to despatch of finished products.

There are two production lines:

i Palm oil: Extraction of red palm oil from the fruits after removing the fruit from the fresh fruit bunches. Extraction of palm kernel from the nut is also carried out.

ii Palm kernel extraction of oil from the palm kernel and compressing the cake into pallets for storage.

REFINERY: In the refinery, removing gum, odour, fatty acid, colour, metals and other impurities from the oil refines the crude oil. Pure fatty acid and glycerine are also recovered from the spent lye.

TECHNICAL ANXILLIARY FACILITIES: Provide support services for the industry; this includes provision of steam, hot water, cold water, water treatment and to supply electricity. Maintenance and repair services are also part of this department. It is situated off the production area to reduce traffic.

TRANSPORTATION: Major areas where vehicular accesses are required are the storage and administration zones for goods and personnel/visitors respectively.

FORKLIFTS: Are used to arrange goods.

PNEUMATIC AND SCREW CONVEYOR: Transport materials in granular form to storage silos and from storage to production halls into the daily production storage hoppers.

Within the production hall, overhead conveyors are used to distribute raw materials into machines and underground conveyors carry materials from one machine to another.

PIPES: Convey fluids and steam.

WEIGH BRIDGE READING ROOM: Goods entering and leaving the site are weighed and recorded.

STORAGE FACILITIES: Used for storage of raw materials and finished products; silos for the storage of palm kernel; oil tanks for storage of crude oil and refined oil. The warehouse for storage of selected domestic cooking oil.

7.3 STAFF STRENGTH

The total staff strength of the industry is determined based on an understanding of its planned work structure as the projected output. The proposed industry is expected to produce about 84,000 tonnes of refined oil annually. The industry will operate two shifts this will involve essentially the production staff. A comprehensive breakdown of the expected staff is as follows:

PRODUCTION AREA

SECTION	NO OF WORKERS
Raw material reception	16
Preparation	10
Processing	14
Refinery	20
Packaging	8
Ware house	6

74 x 2 (shift)

= 148

AUXILIARY

Generator room	1
Boiler room	2
Water treatment	4
Sludge treatment	2
Workshop	6
Scale Rm.	2
Security	3
	20 x 2 (shift)
	= 40

ADMINISTRATION

Reception/waiting	1
Sales Manager	1
Sales department	4
General office	4
Welfare officer	1
P.R.O	1
Admin officer	1
Janitor	2
Farm Manager	1
Maintenance officer	1
Managing Director	1
Sec. To M.D	1
Asst. M.D	1
Sec. To Assit. M.D	1

KASIIM [illegible]

Asst. M.D	1
Computerist	1
Accountant	1
Accounts office	4
Library	1
Duplicating room	1
Raw material officer	1
Company Secretary	1
Engineers	2
Officers	2
	35

WORKERS FACILITIES

Doctor	1
Nurse	2
Canteen Staff	5
Cloaking room	1
9 x 2 (Shifts)	
	= 18

Total Workers = 148 + 40 + 35 + 18

=241 workers.

7.4 SCHEDULE OF ACCOMODATION

7.4.1 ADMINISTRATION

ALLOTMENT	FLOOR AREA (Msq)
Reception/waiting	24
Display area	8
Sales Manager	16
Sales Department	24
General office	24
Welfare officer	24
P.R.O	12
Duplicating room	18
Janitor	8
Administrative officer	18
Farm Manager	12
Maintenance officer	12
General Store	16
Conference room	24
Managing Director	24
Sec. To M.D.	12
Deputy M.D	24
Sec. To Deputy M.D	12
Computer room	12
Accounts section	24
Accountant	16

Tea room	8
Library	24
Company Secretary	12
Engineer 1	12
Engineer 2	12
Officers	12
Toilets1.5 x 16	24

WORKERS FACILITIES

Canteen	196
Kitchen	36
Store	12
Servery	10
Lobby	36
Male Changing	81
Female Changing	54
First Aid room	42
Clocking	20

SERVICES

Effluent treatment	144
Boiler room	48
Scale room	6
Power room	36
Store	20

Water treatment	76
Equipment store	24
Workshop	144
Gate house	12
Control room	15
Security	6

PRODUCTION

Production hall	1980
Silos (3)	750T
Raw materials store	576
Waste Product store	216
Palm oil packaging/storage	576
Refinery	1152
Ware house	648
Crude oil tank (3)	280,000lit
Crude oil tank (2)	200,000lit
Refined oil tanks (8)	300,000lit

CHAPTER EIGHT

8.0 DESIGN REPORT AND CONCLUSION

8.1 DESIGN CONCEPTS.

8.1.1 PLANNING PRINCIPLES

Experience that the blending of good planning, efficient construction and pleasant appearance, when applied to industrial buildings does produce happier and healthier working environment for the workers, therefore, greater production and a higher standard workmanship have proved it.

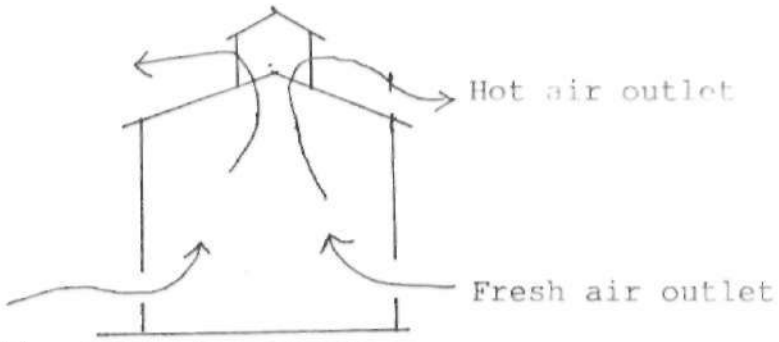
8.1.2 DESIGN CONSIDERATIONS

i VENTILATION/THERMAL COMFORT

Excessive heat is always a serious environmental hazard in industries.

Apart from the internal heat produced, heat is also generated from outside in the form of solar heat penetration through openings and through the building fabric. The factors that affect airflow through buildings include number and size of openings, position of opening and opening components.

To ventilate the production halls, it is best to make use of natural ventilation. A lot of heated hot air is generated and rises up, which can be gotten rid of through the use of stack effect ventilation to allow fresh air from below to replace the hot air. This helps in reducing mechanical means.



ii. **NOISE/VIBRATION**

Noise and vibrations of machines are the main sources of noise and in addition to this other sources are vehicular movements, boiler and generator rooms. Using neoprene pads will reduce the machine vibration.

All ducts and services passing through the walls will have flexible connections or be insulated with absorbent materials at the place of contact with the structure. Landscaping is also used to absorb sound.

iii. **EXPANSION**

Future expansion, additions and alterations due to changes in technology must be taken into consideration. The buildings should be able to be used for new production technology.

Hard surfaces should not exceed more than the built up area and should expand outwards within the site.

iv. ACCESS

Vehicular and pedestrian access should be well defined as well as minimum turning radius to be considered. Access into the site is from the existing secondary road.

V WORKFLOW

The production process must not be staggered but should be easy and functional and in a sequential order of a AU@ line or straight line.

For the proposed industry, it is best to have a AU@ production line to achieve a compact design and minimise the area of hard surfaces. It is also noted that the best way to achieve uncontaminated products is to segregate/isolate certain processes from each other.

vi. **PSYCHOLOGICAL IMPACT**

To provide the best working condition it is necessary to control all the environmental factors that influences human performance and efficiency. Important among these factors is light, which enables workers to see quickly, accurately, comfortably, and safe.

The feeling of safety, which the workers are exposed to directly, affects their productivity. When a humane internal working condition is provided, the workers tend to feel at ease thereby increasing their efficiency

Provision should be properly made for escape routes in time of emergency. Visual display signs, placards and controls should be fixed in places where the human eye see can danger signals fast.

8.1.3 SITE ZONING

The site for the industry is zoned based on the analysis using the following criteria:

i Noise

ii Privacy/Accessibility

iii Hygiene.

Noise is a strong factor of both safety and comfort, as such it forms a major criteria for site zoning. From the site analysis, the secondary road is

the major source of noise. The level of noise from the road is quite low and the use of trees, as a buffer will drastically reduce noise from entering the site.

From the site analysis, access into the site is proposed to be tapped from the secondary road. As regards to privacy therefore the site is zoned such that some areas are accessible to the customers (public areas) such as the administrative block and the warehouse. The production area and refinery are considered as a private zone.

The site is also zoned based on hygiene. Possible sources of contamination were identified and analysed and eventually the site is zoned into less hygiene, relatively hygienic and hygienic zones.

8.1.4 SITE CONCEPTS

The site concept is indeed the organisation and structural arrangement adopted within the site. The site concept is based on functionality and simplicity. The functional flow was given more consideration in developing the site concept. The final layout is as a result of a marriage between functionality and zoning concepts to arrive at a functional and economic design.

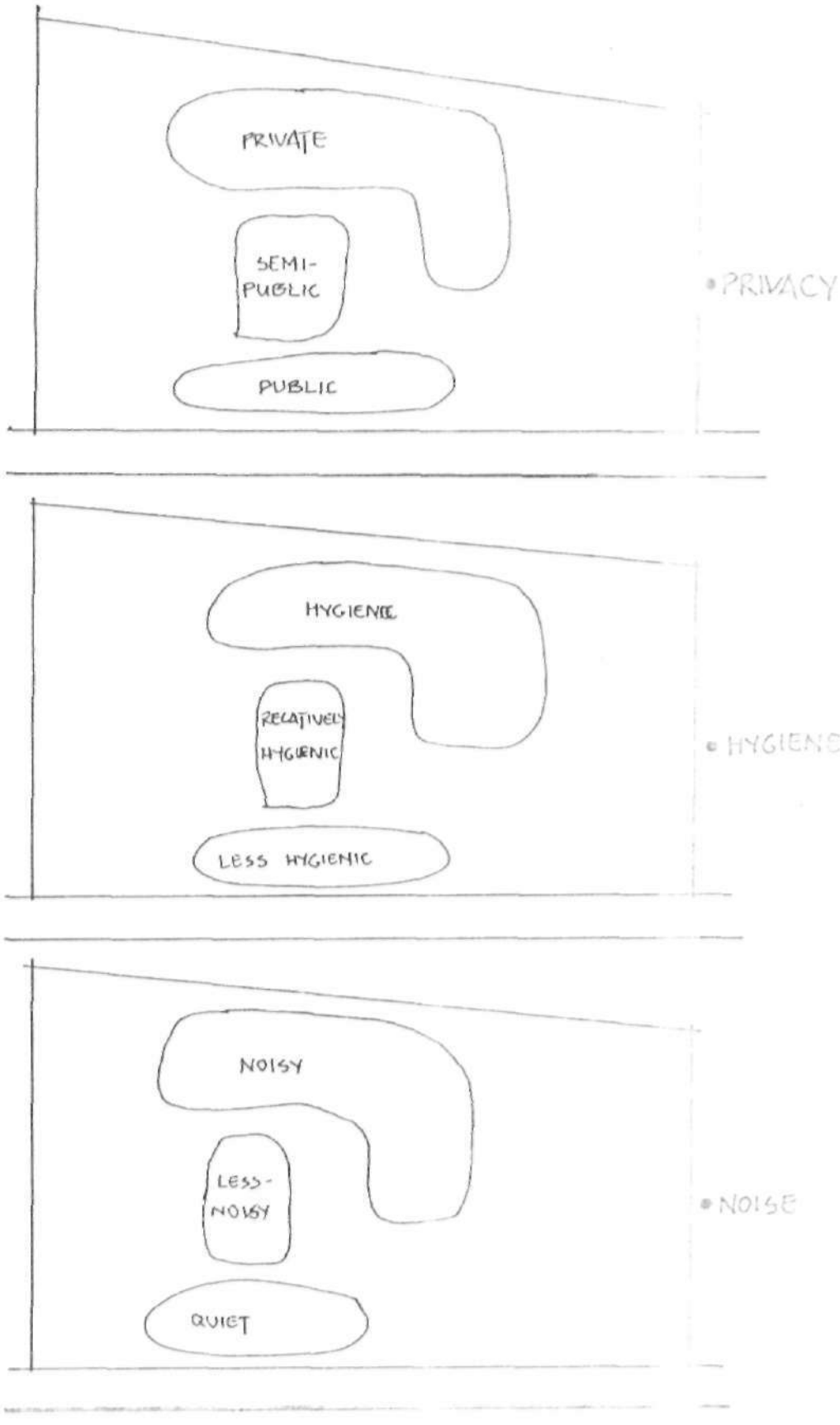


Fig 8.0 Site Zoning/ Concept.

8.2 DESIGN OVERVIEW

8.2.1 SITE PLAN

The site plan has a simple efficient and functional layout. The buildings are arranged to provide for short and direct paths of flow of production and to minimise the amount of piping and wiring.

Buildings on site are as much as possible well oriented for solar radiation and winds. Possibility of future expansion of production hall has been considered and also the storage tanks in case of increased production.

Access to the site in through a single gate for effective control and security. The weighbridge is placed almost near the loading and offloading bay to decongest traffic at the entrance. Bus taxi/customer drop off in provided at the gate outside the fence. There is sufficient parking in front of the administrative block to serve both the staff and customers. Bicycle/motorcycle shed for junior staff is provided near the workers facilities.

8.2.2 PLANNING

In planning the units, functional flexibility was strived to be achieved. That is by Planning such that the units are functionally related and spatially integrated.

In planning, the industry was grouped into three units, the administration, workers facilities and the production unit.

ADMINISTRATION:

The one storey administration unit has been planned with a courtyard and single banking to increase cross ventilation and illumination.

The planning keeps the customer comfort services on the ground floor and it is a noisy section. The upper floor accommodates the senior managerial personnel as well as the conference hall and library. Thus treated as a quieter zone. There are two staircases that serve for vertical communication.

WORKERS FACILITIES:

The workers facility is placed in between the administrative unit and the production hall. Facilities provided in the unit include changing rooms with showers and water closet for both males and females. The toilets are separated from the locker rooms for security and hygienic reasons. A canteen is

also provided and located in such a way that it serves both the administrative block and production staff. A first aid clinic with four-bed space is provided close to the production hall. Clocking room is the last of this unit from which one moves into the production hall. An ample shed for bicycles / motorcycles as well as delivery bay for the kitchen are provided.

PRODUCTION:

The production area is sited at the rear part of the site. It is made up of several units which include the production hall, refinery, treatment plants, maintenance unit, ware house, scale room and generator room.

The production hall has a portal frame structure. The portal frames span 30 meters and spaced at 6 meters interval (centre to centre). The floor is made from reinforced concrete with granolithic screed over which are set ceramic tiles with corrosion resistant resin fixative. The walls are built from sandcrete blocks and finished with white ceramic tiles up to a height of 1.2 meters at the interior face to sanitise them and for easy cleaning. Service pipes are carried in under floor channels while a drainage channel covered with steel grating passes through the processing hall. The drainage channels are laid in such a way that each

serves a processing line and is provided below the machine, so that all drippage will go directly into it without wetting other parts of the floor especially the circulation spaces.

The production hall is open and free from so many partitions. The dirty zone (Raw material section) is placed out of the processing hall. Refuse collection bins and drainage channels are provided for fast and effective removal of waste materials and water.

The palm crude oil is processed and packaged as palm oil. This crude oil can also be sent to the refinery, depending on the type of oil that is required. So there are 2 storage tanks for palm crude oil.

The kernel crude oil is transported to the refinery from the 3 storage tanks outside the production hall.

The refinery refines the oil using any of the three methods. The stairs attached to the machine give accesses to the machines above the first floor and they have steel landings/floors. The refined oil is sent into the eight storage tanks. If production increased there is enough space for additional installation of storage tanks.

The Warehouse packages and stores the refined oil. The oil is best stored in the tanks, they are only packages on demand. There is also provision for filling customers tanks by the use of hose. The warehouse and the raw materials receiving section are raised to 1.2 meters to ease loading and off loading.

The quality control laboratory is provided in the production hall.

The auxiliary services and maintenance section are placed together but close to the production area. The sketch design drawings are shown in the appendix.

8.3 CONCLUSION

In the design of an edible oil industry, the role of an architect cannot be over-emphasised. Although he plays the role of an adviser rather than a creator in the initial stage of design. It is extremely important that when architects design buildings for oil processing, they should consult a hygiene specialist, so that allowance would be made for proper hygiene in the estimated building costs.

In conclusion therefore, the industrial design solution for planning effectively for sanitation can be said to be a product of three factors.

The scope, kind and quality of finished products desired.

The economy, power and installation factors.

The architectural consideration necessities and possibilities with respect to hygiene and sanitary requirements.

More emphasis should be laid on zoning of activities both outside and within the production area. In this regard, three zones have been identified areas, which require less hygiene, moderate hygiene and high requirements. The design as much as possible tried to separate these zones.

Hygienic environment is an asset to production, an asset to employee moral, co-operation and interest. The production area is designed with drainages at appropriate places for fast removal of dirt.

It is hoped that the establishment of Ankpa Oil palm processing industry will eliminate the sanitation problems faced in edible oil industries.

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SOIL TYPE

THE SITE IS COVERED WITH LATERITE SOIL, REDDISH IN COLOUR.

SUNSET (WEST)

SOLAR INTENSITY IS HIGH AND COULD BE UNFAVOURABLE FOR HUMAN ACTIVITIES. SHADING DEVICES SHALL BE PROVIDED.

TOPOGRAPHY

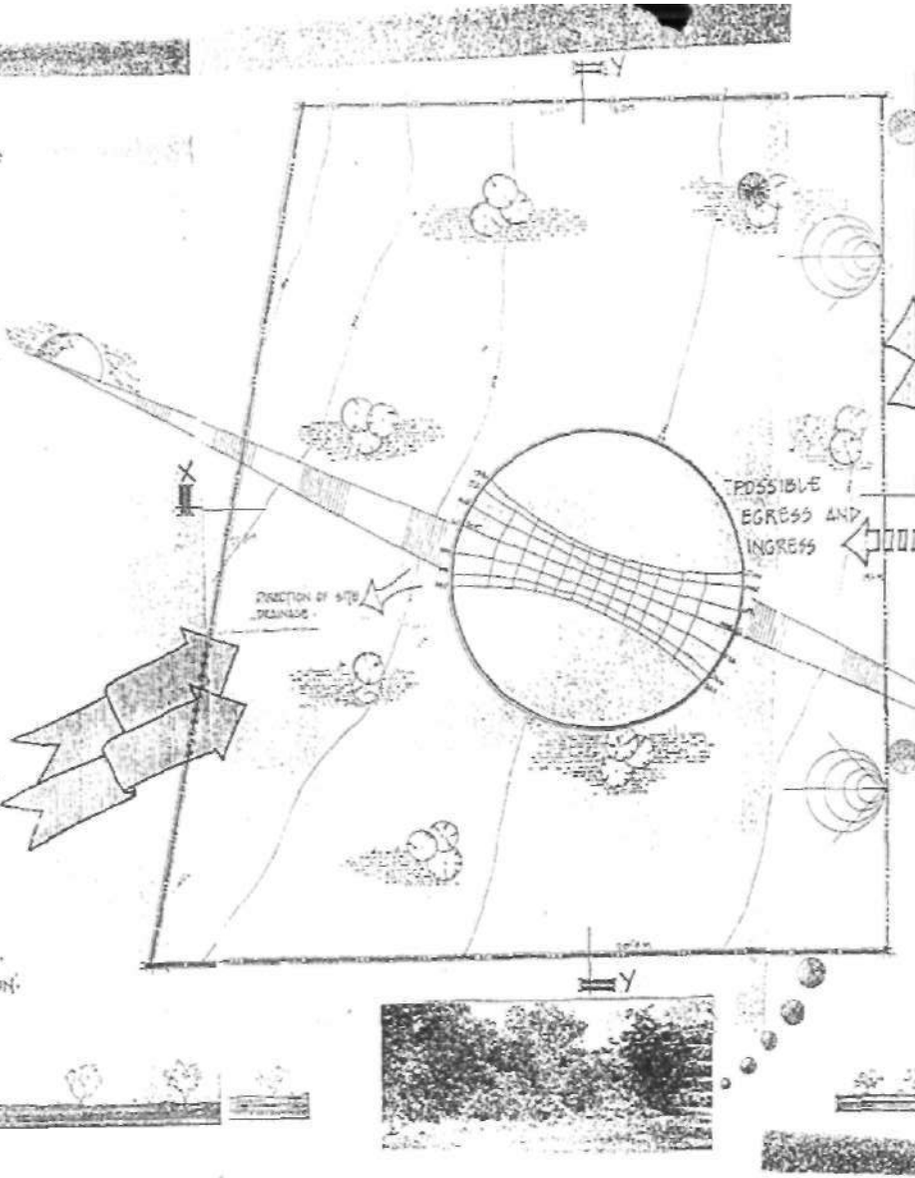
THE SITE IS RELATIVELY FLAT AND SLOPES TOWARDS NORTH-WEST DIRECTION.

SOUTH WEST WIND

COOL, MOIST WIND THAT BRINGS RAIN. ORIENTATION OF BUILDINGS SHALL FACILITATE MAXIMUM COMFORT AND USE OF OVER HANGS.

VEGETATION

THE SITE IS COVERED WITH TALL TREES AND GRASSES, CHARACTERISTICS OF GUINEA SAVANNAH REGION.



NORTH EAST WIND

COLD, DRY AND DUSTY HARMATTAN WIND. EFFORT SHALL BE MADE TO USE BUFFERS AS MAY SEEM APROPRIATE IN DESIGN.

NOISE

THE EXISTING ROAD IS THE SOURCE OF NOISE.

SUNRISE (EAST)

THE SUN RISES ABOUT 6:00 – 6:30 AM. SOLAR INTENSITY IS A BIT FAVOURABLE FOR HUMAN ACTIVITIES.



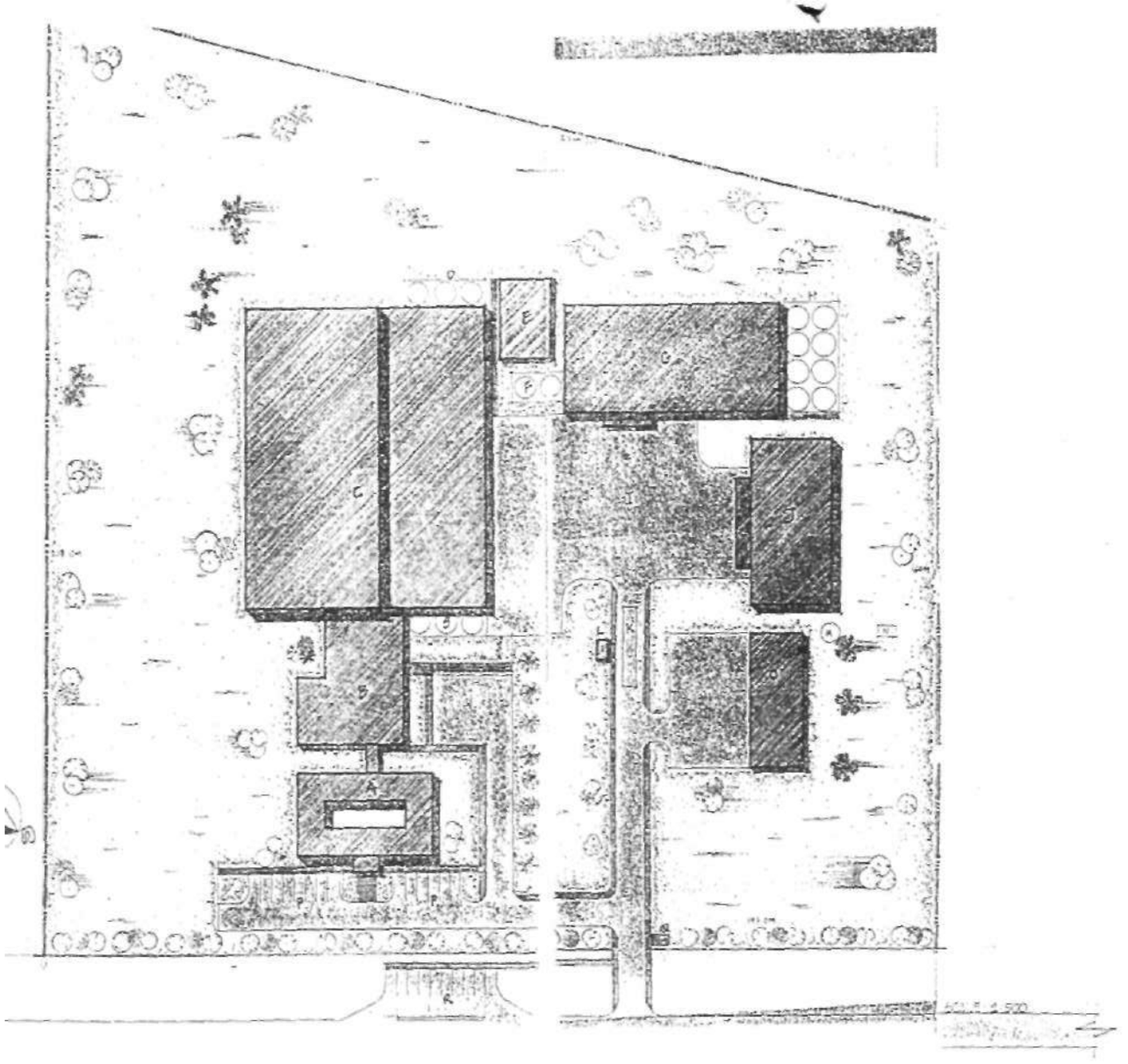
SECTION Y-Y



SECTION X-X

Name: OMATA MERCY
Reg No: M.Sc/Env.Des

SITE ANALYSIS

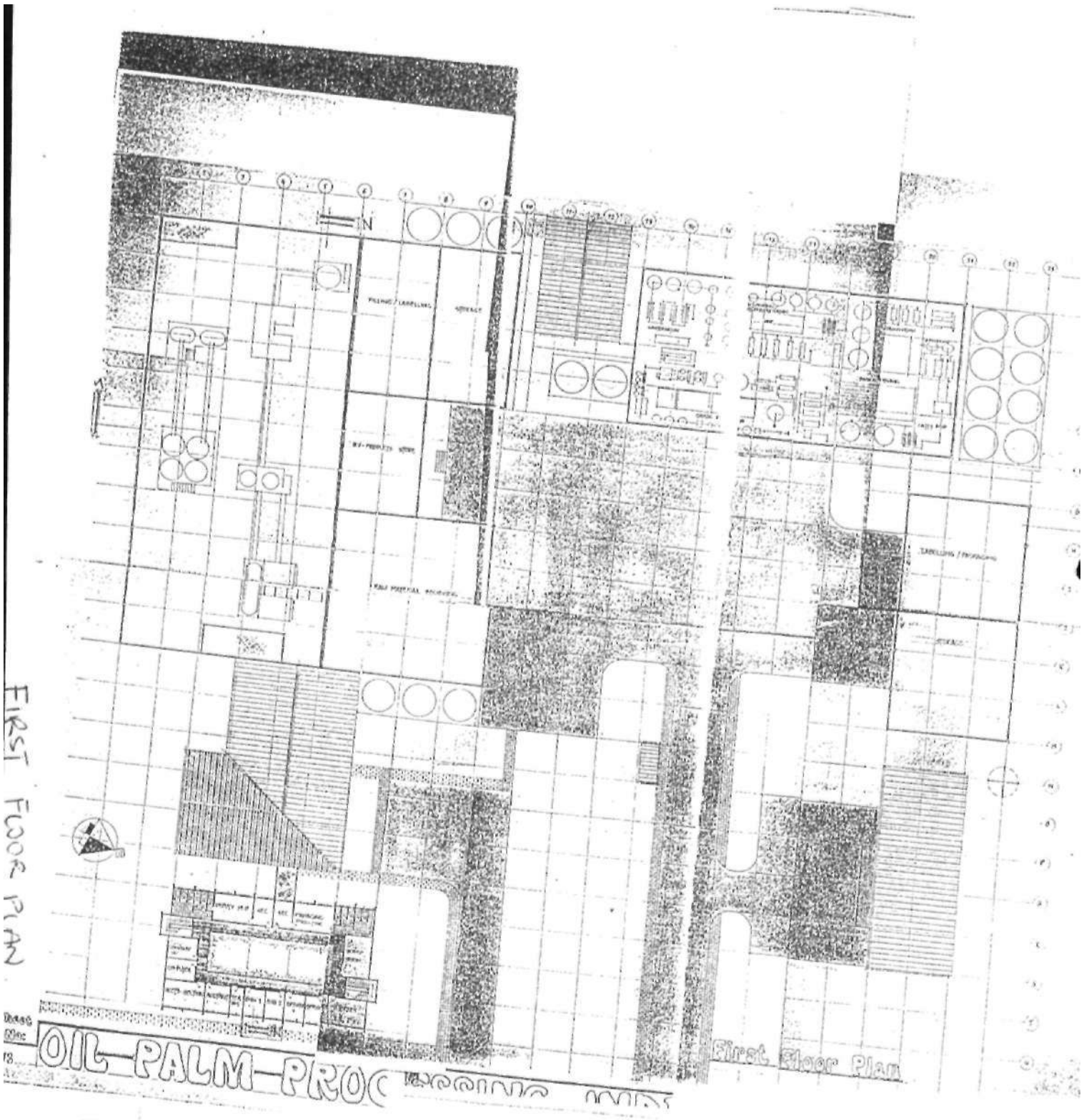


LEGEND	
A	ADMINISTRATIVE BLOCK
B	WORKERS FACILITIES
C	PRODUCTION HALL
D	CRUDE OIL STORAGE TANKS
E	BOILER ROOM / SLUDGE TREATMENT
F	CRUDE OIL STORAGE TANKS
G	REFINERY
H	REFINED OIL STORAGE TANKS
I	LOADING / OFF LOADING BAY
J	WARE HOUSE
K	WEIGH BRIDGE
L	SCALE BOOK / SECURITY
M	OVER HEAD TANK
N	BORE HOLE
O	SERVICES BUILDING
P	STAFF PARKING
Q	GATE HOUSE
R	VISITORS PARKING
S	STORAGE SILOS
	WALKWAY

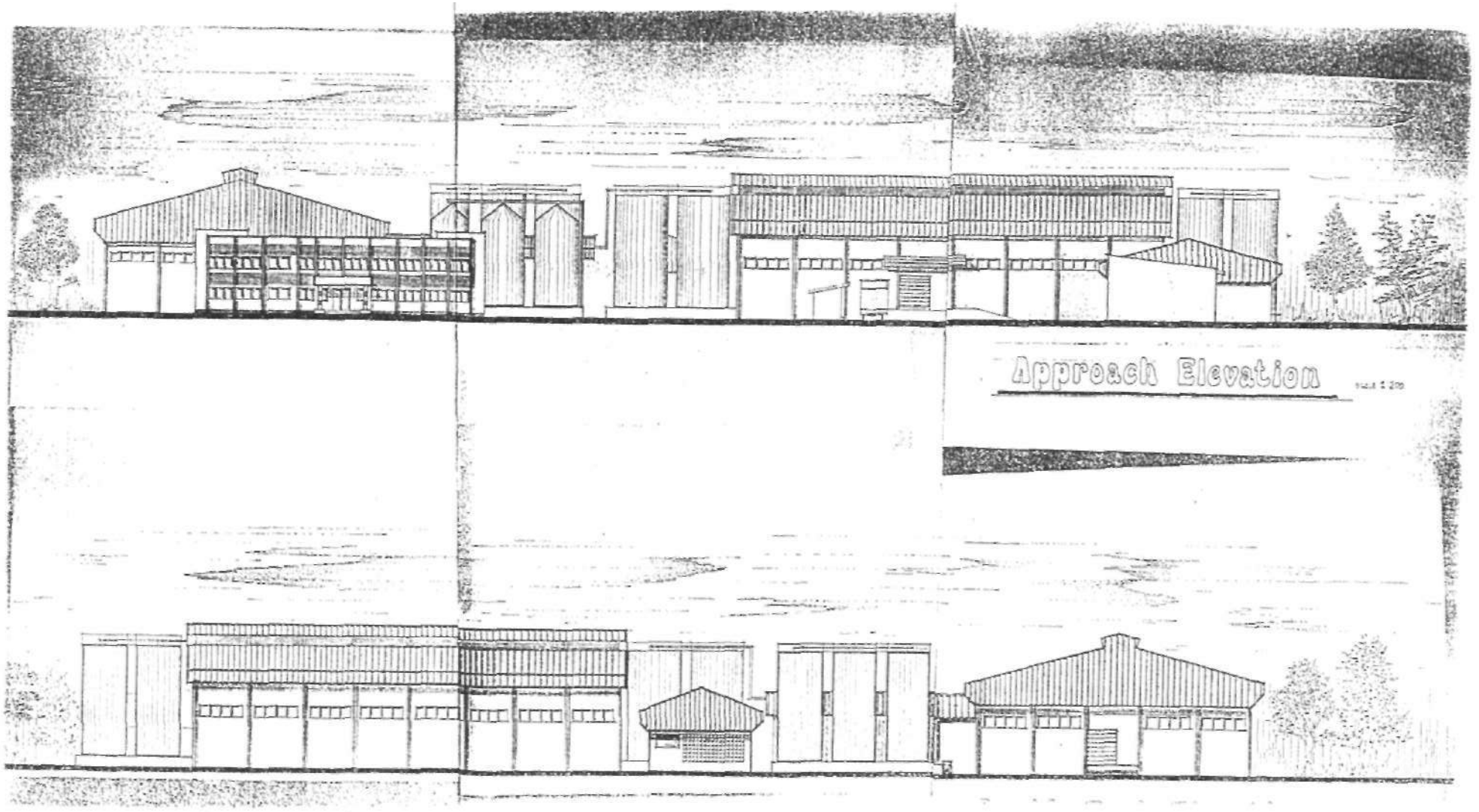
LAND USE ANALYSIS	
TOTAL AREA OF SITE	362.68 M²
BUILT-UP AREA	69.00 M²
UNBUILT AREA	293.68 M²
% OF BUILT-UP AREA	19%
% OF UNBUILT AREA	81%

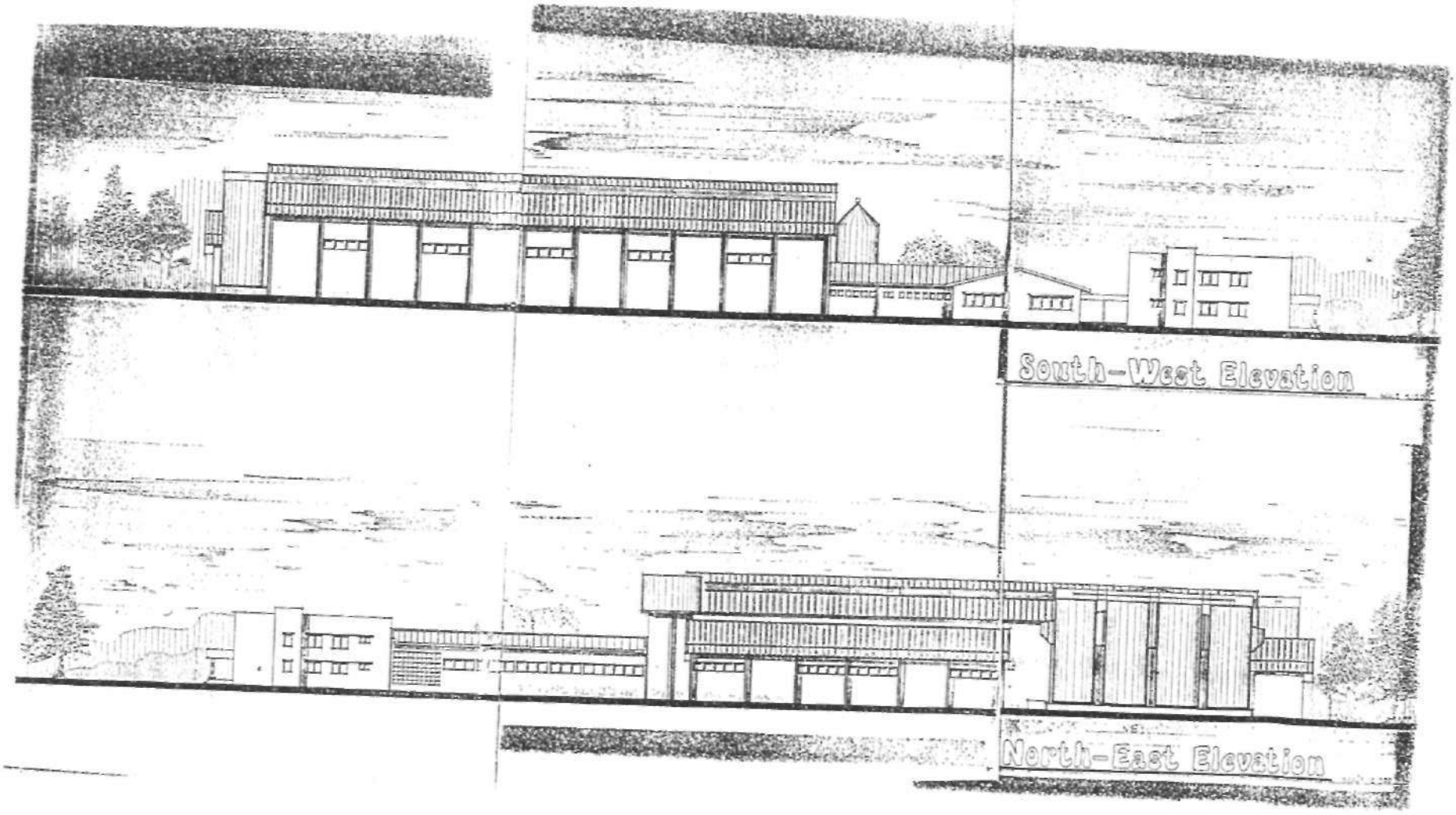
SITE PLAN

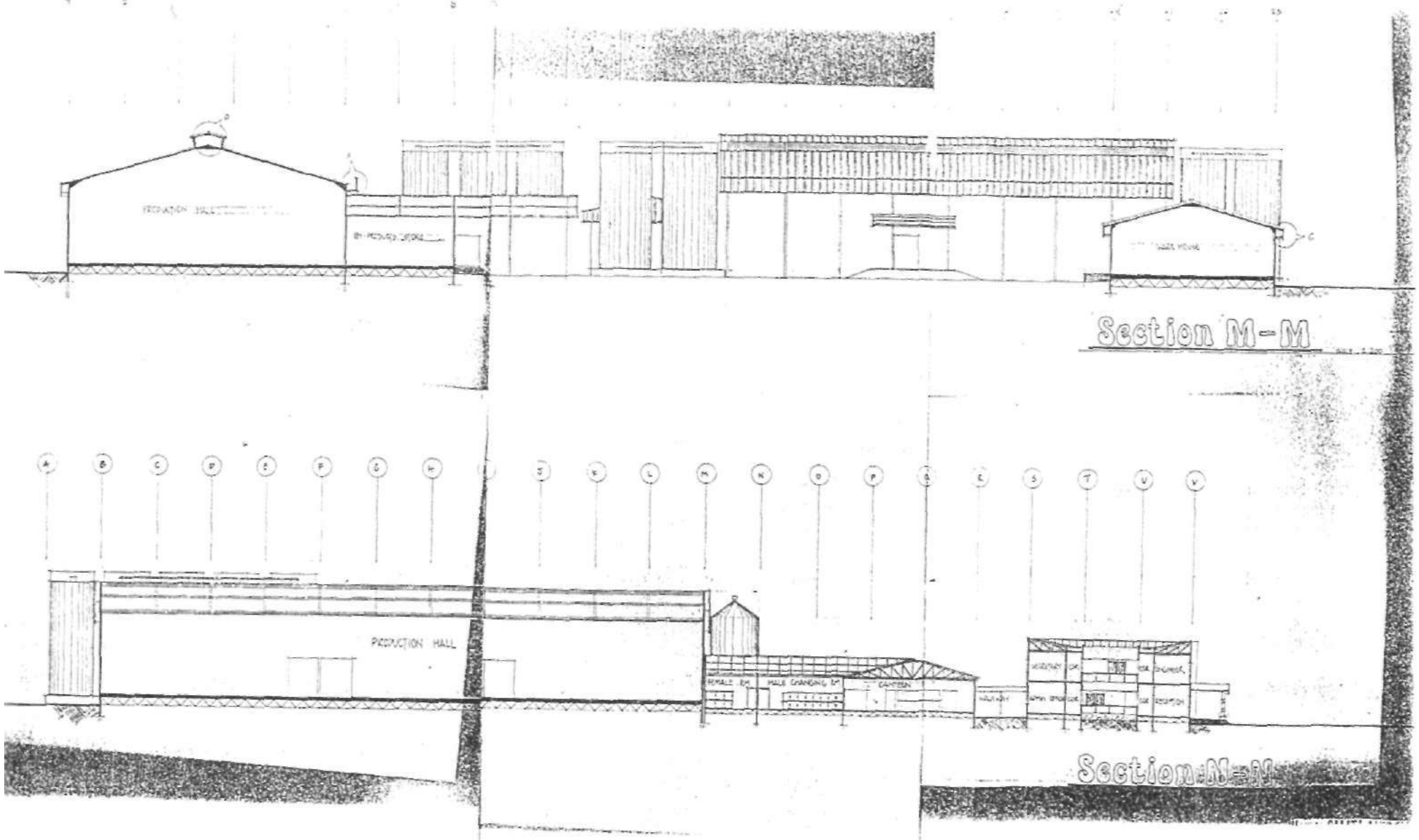
GROUND FLOOR PLAN



FIRST FLOOR PLAN


Approach Elevation


South-West Elevation
North-East Elevation


Section M-M
PRODUCTION HALL
Section N-N