GRAINS STORAGE AND DISTRIBUTION CENTRE - LOKOJA.

(EFFECT OF STORAGE ENVIRONMENT ON GRAINS LONGEVITY).

BY

OPALUWA HASSAN **OGWU**

B.Sc. (Hons) ARCHITECTURE, ZARIA,

A THESIS SUBMITTED TO THE POST-GRADUATE SCHOOL, AHMADU BELLO UNIVERSITY ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE MASTER OF SCIENCE (M.Sc.) DEGREE IN ARCHITECTURE.

DEPARTMENT OF ARCHITECTURE,
FACULTY OF ENVIRONMENTAL DESIGN,
AHMADU BELLO UNIVERSITY,
ZARIA., NIGERIA.

SEPTEMBER, 1997.

CERTIFICATION

This is to certify that this thesis entitled: GRAINS STORAGE AND DISTRIBUTION CENTRE; LOKOJA. "Effect of storage environment on grains longevity" by OPALUWA HASSAN OGWU meets the regulations governing the award of the degree of Master of science in Architecture of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

Chairman, Supervisory committee	22/11/98 Date
S. S. TULPULE Member, Supervisory committee	22011998 Date
Member, Supervisory committee	8/10/2001 Date
DEPT. OF ARCHITECTURAL Environmental Design M. H. MUHAMMAD Head of Department	10/10/01 Date
Dean, Post graduate School.	20/9/02 Date

DECLARATION

I, OPALUWA HASSAN OGWU do hereby declare that this thesis entitled: GRAINS STORAGE AND DISTRIBUTION CENTRE, LOKOJA. " Effect of storage environment on grains longevity"; has been composed by myself and is a record of my own research, and that it has not been accepted in any previous publication for a higher degree. All quotations and sources of information are duly acknowledged.

Signature

22011998
Date

DEDICATION

This thesis is dedicated to my wife, Mrs. Ruth Opaluwa; My sons, Abdul-Said and Sheriff for their love, patience and encouragement, and all Men and Women of good will.

ABSTRACT

Considerable amount of grains arc lost annually in the country. The losses are attributed to lack of or poor storage facilities. In most part of Nigeria, farmers store their grains in traditional storage structures. However, about 30% - 40% of grains stored in these structures are often lost to insects, rodents, birds, micro-organisms, five and theft.

Governments participation in grains storage has been declining in recent times compared to its policy on increasing food production. This action has led to the increased amount of grains lost annually.

Reduction of these huge losses is an acknowledged means of increasing the available food supply. On this premise., the thesis concentrated on the study of the causes of grains deterioration and losses during storage. Other factors that influence storage practices and grains handling were also looked into. The effect of the storage environment on grains longevity were also studied.

The design of the grains storage and distribution centre. Lokoja is aimed at reducing grams losses during storage and providing the conducive environment for long term storage of grains. The centre is provided with all the facilities that will enhance successful grains storage and distribution.

ACKNOWLEDGMENT

My first vote of thanks goes to Almighty God for His mercies and blessings.

My sincere thanks and gratitude goes to my supervisor Arc. Tulpule, S.S. whose intellectual guidance and encouragement has made the completion of this work possible.

I wish to acknowledge the contributions of the entire members of staff of the department for their teachings and guidance during my course of study.

I would like to thank the Director of produce, ministry of Agriculture. Lokoja Mr. Faruna Opaluwa; Mrs. Fatima Usman of Kogi Agricultural Development Project. Lokoja; Mr. Elaigwu Williams, Depot manager Fertilizers stores, Lokoja; The technical officer Mallam Nasir and the weighing clerk Mrs. Saratu Lolo of the grains processing centre, Zaria; For their various assistance in my data collection.

My sincere thanks and gratitude goes to my state Coordinator; Mr. R. Y. Awoniyi for his kindness and goodwill without which this course of study would have been impossible. My Thanks also go to my colleagues in the office for their co-operation and understanding during my absence from work.

I will like to thank Mr. Ayeh Jibrin for his assistance to my family in my absence. I want to thank all my brothers and sisters, Umaru, Adamu, Hassan senior, Musa, Abdullahi, my twin brother Hussaini and Ahmed for their various contributions. I wish to also thank Danladi and Ataguba.

My thanks goes to all my classmates particularly Sadauki, Jerry, Bashir, Suleiman and the class representative Jackson.

Finally but not the least Mall. Isah E. Saliu for sacrificing his leisure time in typing this project. And all those I could not mention their names, I say thank you all.

LIST OF TABLES

TABLE		Page
1.	Relationship between safe storage period, storage air temperature and moisture content of the grains	19
2.	Crop yield obtained in Kogi state 1993 - 96 (1,000) tons	59
3.	Schedule of accommodation	70 - 74

LIST OF FIGURES

FIGURES		Page
1.	Relationship between storage period, storage air temperature and moisture content of grains	18
2.	Traditional storage structures	27 - 30
3.	Strategic grains reserve Centre, Lokoja	32 - 34
4.	Farmers Supply Company grains stores (FASCOM)	36 - 38
5.	Grains Processing Centre, Zaria	40 - 41
6.	Conventional silos and others	46 - 49
7.	Map of Nigeria showing Kogi state	55
8.	Map of Kogi state showing Kogi local government area	56
9.	Map of Kogi Local government area showing Lokoja	57
10.	Production trend in Kogi state	61
11.	Production trend in Nigeria	62
12.	Site analysis	63
13.	Temperature and humidity chart	66
14.	Geology and Vegetation	67
15.	Rainfall and Sunshine charts	68

TABLE OF CONTENT.

		Page
Title		i
Certification		ii
Declaration		iii
Dedication		iv
Acknowledgement		v
Abstact		vi
List of Tables		vii
List of Figures		viii
List of Plates		ix
CHAPTER ONE :	INTRODUCTION.	
1.1	General Introduction	1
1.2	Research / Study	2
1.3	Aims and Objectives	2
1.4	Scope and limitations	3
1.5	Architectural Significance	3
1.6	Research Methodology	3
1.7	Literature Review	4
1.8	References.	6
CHAPTER TWO:	FACTORS INFLUENCING GRAINS STORAGE PRACTICES.	
2.1	Climate	7
2.2	Culture	8
2.3	Materials	8
2.4	Economy	9

2.0.5 Politics ---------- 9

2.0.6 References ---------- 10

CHAPTER THREE: CAUSES AND PREVENTION OF POST-HARVEST GRAINS LOSS.

3.0 Introduction ---------- 11

3.1. Grain Losses ---------- 11

3.1.1 Pre-storage Losses ---------- 11

3.1.2 Harvesting Losses ---------- 11

3.1.3 Losses during Threshing and Shelling ---------- 12

3.1.4 Losses during Drying ---------- 13

3.1.5 Losses during Processing ---------- 13

3.2 Losses during Storage ---------- 13

3.2.1 Losses due to insect ---------- 14

3.2.2 Losses due to Rodents and birds ---------- 15

3.2.3 Losses due to Micro-organisms ---------- 15

3.2.4 Losses due to storage environment ---------- 17

3.3 References ---------- 20

CHAPTER FOUR: GRAINS HANDLING AND STORAGE PRACTICES IN KOGI STATE.

4.0 Introduction ---------- 21

4.1 Grain Handling and Processing ---------- 21

4.1.1 Harvesting ---------- 21

4.1.2 Threshing and Shelling ---------- 22

4.1.3 Winowing and cleaning ---------- 22

4.1.4 Drying ---------- 23

4.1.5 Processing ---------- 23

4.2 Existing storage practices ---------- 23

4.2.1 Farm level storage ---------- 24

4.2.2 State level storage ---------- 25
4.3 References ---------- 25
CHAPTER FIVE: CASE STUDIES.
5.0 Introduction ---------- 26
5.0.1 Dried earth granaries ---------- 26
5.0.2 Plant Material store ---------- 26
5.0.3 The Crib ---------- 27
5.0.4 In-hut store ---------- 27
5.0.5 Raised platform store ---------- 27
5.0.6 Appraisal ---------- 27
5.1 Strategic grains reserve Store, Lokoja ---------- 31
5.1.1 Planning ---------- 31
5.1.2 Orientation ---------- 31
5.1.3 Construction and Materials ---------- 31
5.1.4 The storage environment ---------- 31
5.1.5 Appraisal ---------- 35
5.2 Farmers Supply Company grains stores (FASCOM), Kaduna ---------- 35
5.2.1 Planning ---------- 35
5.2.2 Orientation ---------- 35
5.2.3 Construction and Materials ---------- 35
5.2.4 The storage environment ---------- 39
5.2.5 Appraisal ---------- 39
5.3 Grains Processing Plant, Zaria ---------- 39
5.3.1 Planning ---------- 39
5.3.2 Orientation ---------- 42
5.3.3 Construction and Materials ---------- 42
5.3.4 The storage environment ---------- 42

5.3.5 Appraisal ---------- 42
5.4 Food security project, Senegal---------- 43
5.4.1 Planning ---------- 43
5.4.2 Construction and materials ---------- 43
5.4.3 The storage environment ---------- 43
5.4.4 Appraisal ---------- 44
5.5 Ctesiphon Stores, Cyprus. ---------- 44
5.5.1 Construction and materials ---------- 44
5.5.2 The storage environment ---------- 44
5.5.3 Appraisal ---------- 45
5.6 Conventional silos.---------- 45
5.6.1 Construction and materials ---------- 45
5.6.2 The storage environment ---------- 45
5.6.3 Appraisal ---------- 50
5.7 Conclusions.---------- 50
5.8 References.---------- 51

CHAPTER SIX: THE SITE AND ITS ENVIRONMENT.

6.0 Historical background.---------- 52
6.0.1 Economic base.---------- 53
6.0.2 Socio - Cultural Fabric.---------- 54
6.1 Site Location.---------- 58
6.2 Site Selection Criteria.---------- 58
6.3 Site analysis.---------- 64
6.3.1 Climate.---------- 64
6.3.2 Geology.---------- 69
6.3.3 Vegetation.---------- 69
6.3.4 Topography.---------- 69
6.3.5 Existing features and Utilities.---------- 70

CHAPTER SEVEN: DESIGN PROPOSAL AND REPORTS.

7.0 The brief.---------- 71

7.1 Space analysis.---------- 72

7.2 Schedule of accommodation.---------- 73

7.3 Functional Relationship.---------- 77

7.4 Design Report.---------- 78

7.4.1 Circulation.---------- 78

7.4.2 Climatic control.---------- 79

7.4.3 Maintenance of storage Environment.---------- 81

7.5 Architectural Design Variables in the Centre.---------- 81

7.5.1 Culture.---------- 81

7.5.2 Ventilatiion.---------- 82

7.5.3 Lighting.---------- 82

7.5.4 Materials and construction.---------- 82

7.5.5 Structural Stability.---------- 83

7.5.6 Traffic.---------- 83

7.5.7 Security.---------- 84

7.5.8 Economy.---------- 84

7.5.9 Rhythm.---------- 84

7.6.0 Maintenance.---------- 84

7.6.1 Building Regulation.---------- 85

7.6.2 Future Expansions.---------- 85

7.6.3 References.---------- 85

CHAPTER EIGHT: SUMMARY AND CONCLUSION.

8.0 Summary.---------- 86

8.1 Conclusion.---------- 87

KASHIM IBRAHIM LIBRARY

CHAPTER ONE

INTRODUCTION

1.1 GENERAL INTRODUCTION.

One of the most pressing needs of man is food. To satisfy this need, man since creation has been pre-occupied by providing food for himself and the family. Many nations have initiated and executed several policies and programmes aimed at boosting agricultural production in recognition of the importance of food in our lives. Nigeria since independence has initiated and executed several policies and programmes, such as Operation Feed the Nation (O.F.N.), Green Revolution, River Basin Development Authorities, National Directorate of Employment (N.D.E.), Directorate of Food, Roads and Rural Infrastructures (DFRRI), to mention a few. The thrust of these efforts is to achieve self-sufficiency in food production and a solid base for the agro-allied industries. However, no serious efforts have been made towards the processing and storage of the expected increased yield.

Grains are very important staple food in Nigeria. Grains provide most of the carbohydrates needed in the daily diet of many Nigerians. Grains in one form or the other, constitute part of the daily intake of both adults and babies. Their use in the large scale production of animal feeds is even more prominent. Although grains are consumed daily, they are seasonal crops harvested once or in some cases twice a year. It is therefore, necessary that grains should be stored from one harvest season to the other. This will ensure its availability all the year round.

In most parts of Nigeria, farmers store their grains and other crops in traditional storage facilities constructed from locally available materials. However, These existing on-farm traditional facilities are not adequate or satisfactory. Thirty to forty percent grain losses in such on-farm traditional facilities have been reported (Crop storage Unit, F.D.A., 1990).

Reduction in post-harvest grain loss has been acknowledged as a means of increasing available world's food supply. Post-harvest grain loss in developing countries has been estimated to be in the range of "Tens of millions of metric tons per year. A maximum of ten percent loss for cereal is cited and is valued at billions of dollars." (National Research Council, 1978).

Nigeria could be self-sufficient in food production without necessarily cultivating more land if adequate measures could be effectively taken to prevent or minimize post-harvest losses and thus conserve what is presently being produced. (NSPRI / NAERLS, 1983).

Grain losses in Lokoja and Kogi state as a whole is often connected with the tropical climatic conditions coupled with the dearth of functional and effective storage facilities. The architect's contribution in preventing or minimizing this huge post-harvest losses due to poor storage facilities and the unfavourable climatic conditions, is to delve into the study and design of grains storage structures.

1.2 RESEARCH / STUDY.

This research is motivated by the following :

1. The annual enormous post-harvest grain loss.
2. The increasing number of farming population, and
3. The considerable inter-seasonal price variation.

1.3 AIMS AND OBJECTIVES.

The research is aimed at understanding the causes of the huge post-harvest grain losses, and how to curtail it. The effects of the storage environment on grains longevity will also be studied to facilitate the design of a storage centre capable of minimizing post-harvest losses and storing grains for long duration.

The objectives will be to convert necessary available scientific data into favourable agro-industrial storage environment for grain protection and to ensure all year round availability of grains for consumption, thus stabilizing consumer prices.

1.4 SCOPE AND LIMITATION.

The centre will be located at Lokoja. It will cater for the central zone which comprises of seven Local Government areas. The local government areas are Kogi, Koton-Karfe, Adavi, Okehi, Okene, Ajaokuta and Ogori-Magogo.

The study will be limited to the appraisal of the post-harvest system, existing storage structures and the effects of storage environment on grains longevity. The emphasis will focus on the design of an articulated centre comprising of an administrative unit, workers facilities, laboratories for pre- and post-treatment testing of grains, processing and bagging unit, silos, cribs for drying of grains and warehouses for storage with facilities for loading and un-loading.

1.5 ARCHITECTURAL SIGNIFICANCE.

This research will enhance the design of storage facilities that can preserve the viability of grains over a long period based on the comprehensive study and the architectural analysis of the storage environment.

1.6 RESEARCH METHODOLOGY.

This research will rely on review of literature, studies of existing situations and the use of interviews and personal observations.

LITERATURE REVIEW.

Available literature has addressed problems of grains storage and post-harvest grain losses, however, very little has been done in the area of its processing, storage and distribution.

In September, 1975, an increasing awareness of the need to reduce post-harvest grains losses led to a resolution by the seventh special session of the United Nations General Assembly which stated. "the further reduction of post-harvest food losses in developing countries should be undertaken as a matter of priority with a view to reaching at least fifty percent reduction by 1985." (Bourne, 1977).

Out of about ten million tons of cereal grains and grains legumes produced annually in Nigeria, about one and a half to two million tons was lost during storage (FAO, 1975).

Most cereal grain are relatively easy to store. Their value as food for mankind rests largely on their performance in storage. The evolution of civilization and successful development of agriculture are possible due to the existence of these durable dry cereals (Oxley, 1948).

To store grains successfully, the atmosphere in and around the stored grains must be maintained under conditions which discourage or prevent the growth of micro-organisms that eventually cause spoilage (I.J. Ross, 1973).

Improving grain storage would mean less hunger, improved nutrition for the individual, higher standards of living and sounder economy for the Nation (Linbam, 1976).

In most developing countries seventy to eighty percent of all the staple produce never leaves the farm on which it was grown and many factors affect farm stored products. Of these, damage due to insects, rodents and fungi are probably the main cause of loss in quality and quantity of stored food (P. Golob, 1984).

It is absolutely necessary to match efforts in food production with equal if not greater efforts in preventing wastage. Appropriate technology and facilities must therefore be evolved to ensure availability of good wholesome food crops all the year round (M. B. Zaria, 1988).

There is increasing demand for good quality grain crops in Nigeria. The short supply of these grains in Nigeria is due mostly to losses associated with the attack by the pests, and the loss is put at about fifteen to twenty percent of production (A.O. Oyebanji, 1995).

Anderson (1974), noted that the causes of deterioration in stored grains are due to the presence of insects and grain rodents in and around storage facilities.

The vitality of seeds would be prolonged if stored under conditions to protect them from heat, moisture and oxygen (Oren, L. Justice et al, 1979).

For each one percent reduction in moisture content the storage life of grain or seed is doubled, and for each five degrees Celsius reduction of the storage temperature, the storage life is also doubled (Harrington, 1963).

The major factors which influence the longevity of seed grains in storage are temperature, moisture content and oxygen pressure (Owen, 1956).

Empirical investigations on the effects of temperature and moisture content on the longevity of seed grains in storage has indicated that the lower the temperature and moisture content, the longer the period of viability (Anon, 1997, Roberts, 1961).

All storage fungi are completely dominant below sixty two percent relative humidity (Semenvik, 1954) and very little activity below about seventy-five percent relative humidity (Milner and Geddes, 1954).

Below eight percent moisture content, there is no insect activity but if the grain is infected, increased activity may generally be expected up to about fifteen percent moisture content (Cotton, 1954).

Longevity of grains in storage can be attained if the moisture content of the stored grain is below thirteen percent, the grain temperature is below five degrees Celsius, and physical damage to the grain during harvesting and drying is low (Brooker, et al, 1981).

If the sum total of the percentage relative humidity and the temperature in degrees Fahrenheit is less or equal to one hundred, the storage conditions are considered favourable for grains longevity (James, 1961).

In arid areas many kinds of grains and seeds can be stored for five years or longer under ambient conditions if the temperature is not too high. The same kind of grains can only be stored for two to three years in a temperate region; Whereas they lose viability in a few months in the humid subtropical and tropical regions at ambient conditions (Oren, L. Justice and Louis N. Bass, 1979).

For very long-term storage, grains should be dried to five percent or lower moisture content, sealed in moisture-proof containers at minus seventeen and a half degrees Celsius. However, cereal grains stored at four degrees Celsius and fifty percent relative humidity can remain viable for ten years or longer (Oren, et al, 1979).

1.8 REFERENCES.

1. BROOKER, B.D; et al (1981). Drying Cereal grains. Avi Publishing Company Inc. West port, Conn.
2. OREN, L.J; AND BASS, N.L. (1979). Principles and practice of seed storage. Castle House Publications Ltd.; London.
3. OXLEY, T.A. (1948). Scientific principles of grain storage. The northern Publishing Company Ltd., Liverpool.
4. PEDERSON, R.J. (1981). The role of grain storage in quality Preservation. Recent advances in food science and technology vol.1, pp. 343 - 354.

CHAPTER TWO

FACTORS INFLUENCING GRAINS STORAGE PRACTICES.

2.1 INTRODUCTION.

Grains storage practices vary from one locality to the other. Each locality evolves its grains storing and handling system suitable to the level and type of crop production. The production and storage of food crops are often constrained by the resources available to the farmer, time or labour available on the farm or the locality. Generally, the most important factors are culture, climate, materials, economy and politics.

2.2 CLIMATE.

Climatic factors are the most important detriment of the form of storage practiced in a given locality. Considerable quantity of grains lose their quality due to the neglect of climatic criteria in design. The climatic conditions that most affect storage of grains are temperature and relative humidity. For maximum storage life to be achieved, these climatic conditions must be carefully controlled.

Wind and sunshine are other climatic elements employed for drying of grains. Grains need to be dried adequately before being stored. This is to prevent mold development and spoilage.

In drier areas and places where seasonal and diurnal temperature variations are prevalent, pit storage is the common practice. However, in the humid regions the use of cribs for drying and storage is the practice.

2.3 CULTURE.

Cultural attitudes and practices form the critical back drop of the farming techniques and the post-harvest operations practiced in a given society. The techniques of food conservation and storage are frequently dictated more by traditional beliefs than by immediate utility. The roles of male and female, or relationships among individuals and families are reflected in the particular ways of the handling and storage of grains and other food crops after harvest.

Storage structures in addition to storing of food, expresses the economic power and cultural believes of the people. The importance attached to the food store and the cultural practices of a given society often influences its spatial organization, size and type of openings and the location within the compound.

2.4 MATERIALS.

Like culture, the choice of materials for the construction of storage structures vary from one place to the other. The ability of the material to protect the grains from the harsh climatic conditions and its ready availability are the key factors considered in the selection of such materials. The available materials are worked into structural forms suitable to the particular storage structure desired. Where large expanse of land is available, they can afford to build pit storage structure; while areas with abundant plant materials are inclined to construct plant material storage structures. It should be noted that materials alone cannot be considered in isolation, when viewing the storage practices.

2.5 ECONOMY.

The economic resources at the disposal of an individual peasant farmer, group of farmers or corporate organization determines to a great extent the size and type of storage systems adopted. Another important economic consideration is the cost benefit derivable from the decision. For instance, a commercial farmer whose aim is to store his grains and later sell it when the profit margins are high, the size and type of storage he will adopt will be determined by this criterion. the number and sizes of the grains stored in any compound is an expression of the economic status of the family.

In developed countries, terminal elevators and sophisticated storage structures are used because of their economic buoyancy. However, in developing countries with poor economies the least sophisticated storage systems are in use.

2.6 POLITICS.

Government policies affects the attitudes of people to food storage practices. Government incentives like the provision of fertilizers, removal of restriction on the importation of agricultural machinery and the provision of infrastructures in the rural areas and farmer education through the various agricultural extension services unit have immensely affected not only the production technique but also the food storage practices.

Government involvement in food storage practices has a lot of political undertones in addition to its socio-economic goals. Political stability cannot be achieved if the citizenry are starving.

In government owned storage facilities, the decision on size, type of storage, and location are often dictated by political considerations. An elected government for instance would like to embark on this type of project in order to gain the confidence of the electorate.

Fixing prices and quota for grains to be purchased after harvest by government influences the size as well as the type of storage to be used. The uniformity of government storage structures all over the place without regards to the climatic differences of such areas cannot be completely divorced from political considerations.

2.7 REFERENCES.

1. GILES, P.H. (1965). The storage of cereals by farmers in Northern Nigeria. I.A.R. Samaru, Zaria. pp. 197.
2. SMITH, C.V. (1969). Metrology and grain storage. World Meterological Association, Geneva.
3. NATIONAL ACADEMY OF SCIENCE. (1978). Post Harvest Food losses in developing countries. Washington, D.C.

CHAPTER THREE

CAUSES AND PREVENTION OF POST-HARVEST GRAIN LOSS.

3.1. INTRODUCTION.

There are numerous causes of post-harvest grain loss. These causes can be classified into two categories reflecting the important activity stages of the post-harvest operations. The stages are:- 1). The pre-storage and 2). The storage period.

3.2. GRAIN LOSSES.

Grain losses are recorded within the pre-storage stages in varying degrees. However, the losses that occur during storage and its prevention or control is of paramount importance.

3.2.1. PRE - STORAGE LOSSES.

The pre-storage activities include harvesting, threshing and shelling, drying and processing. The losses of grain at each of these operations are highlighted below.

3.2.2. HARVESTING LOSSES.

The time at which harvesting is carried out is the most important factor that affects the storage quality of the grain. Harvesting losses usually occur if the grains are harvested too early or lately. The losses affects both the quality and quantity of the grains.

Grains harvested too early before they are fully ripened contained higher proportion of moisture which can lead to rapid deterioration. In addition, they are low in weight and starch content which invariably affects its market value.

On the other hand, delayed harvesting of grains lead to insect damage, rodents and birds attack, microbial attack, physical damage to the grains through repeated wetting and drying by the rain or dews, and the sun respectively, and even the shattering of the grains to the ground.

Another cause of grain loss is the method of harvesting employed and the skill of the harvesters. The method used depends on the mode of planting, crop height amongst others.

To control harvesting losses, grains must be harvested as soon as they have matured. also the harvesters should exercise utmost care during the harvesting exercise, in addition to the use of appropriate method peculiar to the crop.

3.2.3. LOSSES DURING THRESHING AND SHELLING.

Grains losses occur at this stage of post-harvest operation through incomplete threshing, physical damage to the grain, scattering and spillage.

The use of animals to trample on the sheaves or even the modern equivalent of using tractor wheels usually result in loss of grains through incomplete separation and some trodden into the ground. This method allows impurities to get into the grains.

Incorrect use of mechanical threshing and shelling devices result in excessive breakage of grains.

To control the losses due to scattering and spillage, screen should be provided around the threshing floor, while care should be exercised to minimize the physical damage.

3.2.4. LOSSES DURING DRYING.

In countries where natural means of drying is prevalent, losses can occur through pilfering by animals, scattering of the grains by fowls, contamination by foreign materials such as dust and sand particles. In arid regions, excessive exposure of the grains to the sun or heat causes cracking, scorching, bleaching and discolouration.

On the other hand, if grains are under-dried, losses due to fungi and bacteria infection will result.

The control of losses during drying is through the use of appropriate drying method suitable to the prevailing climatic conditions.

3.2.5. LOSSES DURING PROCESSING.

Quality and physical losses occur during processing in the post-harvest system. Quality loss occurdue to breakage caused by maladjusted machinery and poor pre-treatment of the grain (e.g. milling of rice). Physical loss through spillage is also common at this stage.

Generally, losses during processing are specific to particular crops due to their varying processing methods. Whichever processing method used (manual or mechanical) the key to loss reduction is carefulness.

3.3. STORAGE LOSSES.

The principal agents responsible for grain losses during storage are insects, rodents and birds, and micro-organisms. Storage environment is another important factor that determines the extent to which deterioration and loss occur in grain storage.

3.1. LOSSES DUE TO INSECTS

Insects are the major cause of post-harvest grain loss. Out of over one million insect species identified on the earth, only about seventy-five species have been shown to cause damage to grains. The maize weevil (sitophilis zeamais), rice weevil (s. oryzae (L)), the granary weevil (s. granarius (L)), the lesser grain borer (Rhyzopertha Dominica (F)), and the Angoumois grain moth (sitotroga Cereallella (oliv)) cause the greatest destruction to stored grains.

A few species of the bruchidae are associated with destruction of stored legumes. Some of these insects feed on the endosperm of the grain especially the flour beetle (tribolium spp) and the grain moths (cadra spp). Others bore holes into the kernel. The larvae of the lesser grain borer (Rhyzopertha Dominica (F.)) develops inside the grain kernel. These insects have high rate of reproduction given a favourable condition. For instance the rice weevil (s. oryzae (L.)) can increase from one pair to six hundred and seventy-five million adults within six months.

Insect infestation of grains often begins on the field and continues into storage. The resultant effects of this infestation are reduction in weight and quality, loss of germinability, contamination with excrement and webbing, and heating with consequent condensation and mold development.

Insect infestation can be controlled or limited by a number of management practices (storage hygiene and regular inspection), the use of insecticides, and fumigants. There are many varieties of insecticides in the form of dusts, powders, and emulsion. Some have long residual action (e.g. B H C) while others like Malathion have little residual action. Grains for human consumption are always treated with the later type of insecticides.

Another important way of controlling insect infestation is to ensure that grains are stored at lower moisture content below fourteen percent. At moisture content of below ten percent, insects activity becomes impossible.

3.3.2. LOSSES DUE TO RODENTS AND BIRDS.

Rodents and birds can cause severe losses in stored grains. Losses due to rodents affects the quality and quantity of the grains. They feed on the grains, contaminate the grains with their excrement and dead bodies and broken parts. They also carry fungi and other micro-organisms into the grain.
They damage storage containers and bags by gnawing holes that result in leakage and wastage of grain. Grains stored in bags are more prone to damage by rodents than those stored in bulk in a silo.

There are three main species of rodents associated with grain damage and losses. They are the Norway rat (Rattus norvegicus), the roof or black rat (Rattus rattus), and the house mouse (mus musculus).

However, losses associated with birds are greater in the field than in stored grains. They, in addition to feeding on the grains, also contaminate them.

Rodents can be controlled through the use of rodenteides, fumigation with phosphine or other gases, poison baiting, improved sanitation and careful storage design and construction.

3.3.3. LOSSES DUE TO MICRO - ORGANISM.

Like insects, micro-organisms especially fungi and bacteria attack grains at various stages. They commence their attack on grains right from the production stages through processing and storage.

The most damaging micro-organisms to stored grains are a dozen species of the genus Aspergillus, several species of the genus penicillium, and one specie of the genus sporedonema. They are abundant around farms and grain storage structures. The condition of the grain, its moisture content and temperature, the amount of foreign materials and extraneous organisms present in it affect the development of mold in stored grains. The molds of fungi are capable of growth and causing grain deterioration at relatively low moisture level of thirteen and one-fifth to fifteen percent, and an optimum temperature of between seventy-seven and eighty-six degrees Fahrenheit.

The relative humidity favourable for mold germination is between sixty-five and ninety-three percent. Thus, preventing mold growth on grains at any temperature, the relative humidity within the grain mass must be kept below sixty-five percent.

The major losses caused by micro-organisms in grains are, decrease in germinability, seed discolouration, heating and mustiness, biochemical changes, production of toxins and reduction in weight.

The control of micro-organisms involves the control of physical, structural and biological factors that affect the moisture content of grain. The safe moisture content for grains are those in equilibrium with a relative humidity of sixty percent at twenty-seven degrees Celsius.

3.3.4. LOSSES DUE TO STORAGE ENVIRONMENT.

Grains deterioration is often connected with the storage environment and its condition. Prominent among these environmental conditions are temperature and humidity. High temperature and humidity encourages mold formation and rapid growth of insect population. Grains deterioration is very minimal in a cool and dry storage environment, it is however, high in a cool and damp condition, and very high in hot and damp environment.

Moisture translocation and migration in grains are due to seasonal and diurnal temperature variations. This leads to condensation of moisture on grains thereby providing favourable condition for mold development.

Climatic conditions affect the residual activity of some pesticides and even the effective life of storage containers and structures. Structural materials have their own chemical properties which invariably alters the effectiveness of some insecticides.

The choice of storage method and the over all management of the system has an over-riding effect on the extent of deterioration. For instance, cobs of maize stored in open sided cribs, take up moisture more rapidly in rainy season than shelled maize stored in mud-walled cribs. On the other hand, properly designed open-sided cribs allow relatively rapid drying of unhusked ears of maize thereby reducing the incidence of mold development.

Physical cleanliness of both the internal and external surroundings of the grain storage structure enhances a healthy storage environment.

Relationship between safe storage period, storage air temperature and moisture content of the grains [MAIZE].

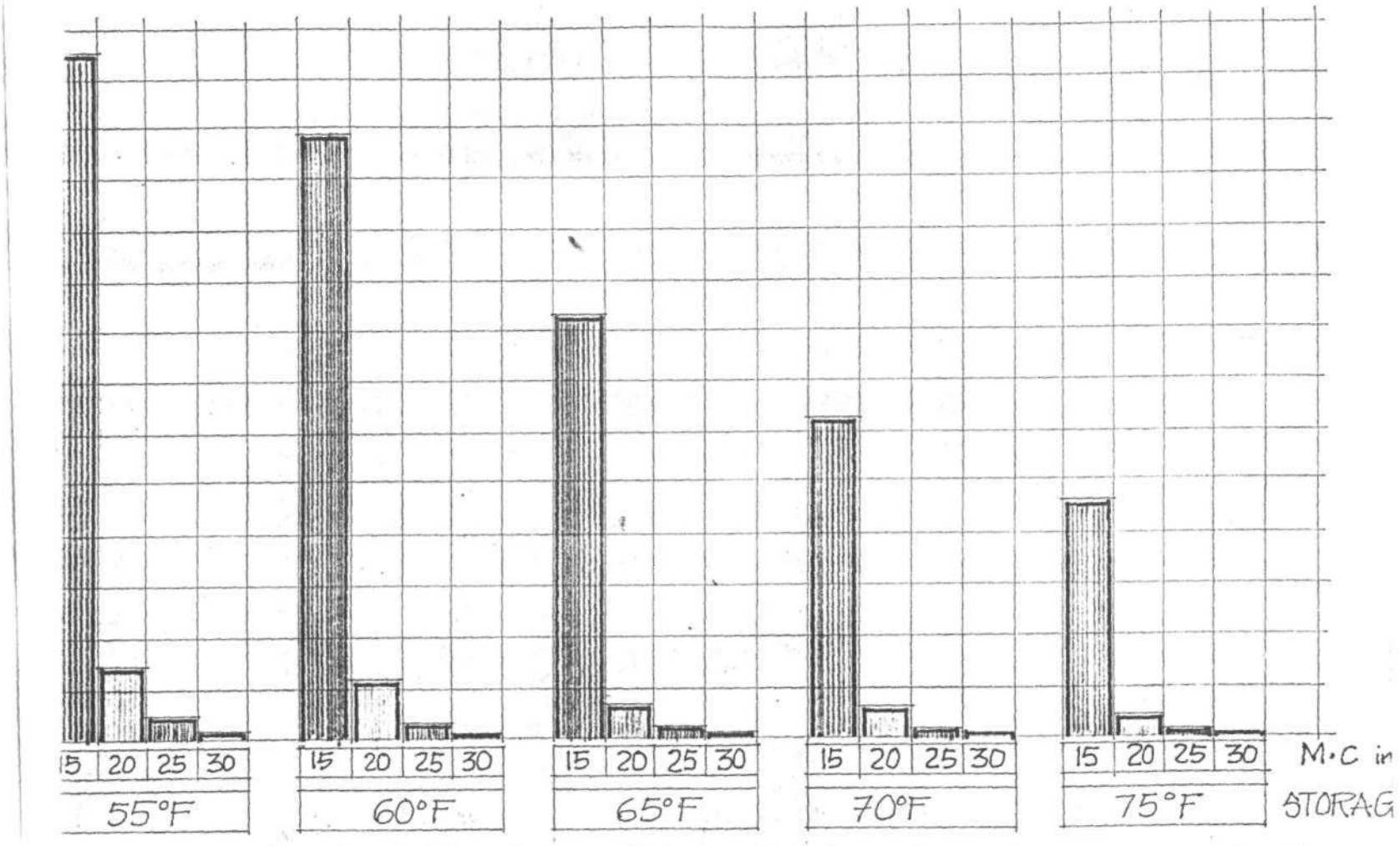
- Table 1.

STORAGE AIR TEMP.(^{0} F)	MOISTURE CONTENT (% W.B).			
	15%	20%	25%	30%
75	116 days	12 days	4 days	2 days
70	155	16	5	3
65	207	21	7	4
60	259	27	9	5
55	337	35	12	7
50	466	48	17	10
45	726	75	27	16
40	906	94	34	20
35	1140	118	42	25

From the table, safe storage periods for the maize grain increased markedly as the temperature and moisture content decreased.

Source: USDA (1968).

Table 1.



RELATIONSHIP BETWEEN STORAGE PERIOD, TEMPERATURE AND MOISTURE CONTENT OF GRAINS.

3.3. REFERENCES.

1. AERLS and NSPRI. (1988). Workshop proceedings on post-harvest losses. AERLS, A.B.U. Zaria.
2. DONALD B. BROOKNER, et al, (1981). Drying Cereal grains. Avi Publishing Company, Inc. West port, Conn. pp. 54-58.
3. NATIONAL ACADEMY OF SCIENCE, (1978). Post-harvest food losses in developing countries. Washington, D.C.
4. OREN, L. JUSTICE, AND LOIUS, N. Bass; (1979). Principles and practice of seed storage. Castle house Publications Ltd., London.
5. OYEBANJi, A.O. (1995). Storage and storage pests control in grains. Paper presented at Kogi State A.D.P. Lokoja. 15-17th October (Type written).
6. PEDERSON R. JOHN; (1981). The role of grain storage in quality preservation. Recent advances in food science and technology journal, vol. I: 343-354.
7. TROPICAL DEVELOPMENT RESEARCH INSTITUTE. (1986). A critical review of the methodology for assessing farm-level grain losses after harvest.

CHAPTER FOUR

GRAINS HANDLING AND STORAGE PRACTICES IN KOGI STATE.

4.0. INTRODUCTION.

As earlier mentioned, grains handling and storage practices vary from one locality to the other. Some of the factors that influence this variation have been discussed in detail in chapter two.

4.1. GRAINS HANDLING AND PROCESSING.

Handling of grains during and after harvest is very important in the grain production system. It ensures that what is produced gets to the users in wholesome conditions.

The most common handling and processing operations practiced in Kogi state are harvesting, threshing and shelling, winnowing and cleaning, drying, milling and storage.

4.1.1. HARVESTING.

This involves the removal or separation of the food portion of a crop from the producing plant. This exercise is normally carried out when the crop has reached maturity. The duration between planting and maturity varies from one crop type to the other and the variety (early maturing or late maturing). Harvesting can be accomplished by manual or mechanical means. Majority of the peasant farmers utilize the manual system to harvest their crops while commercial farmers and government resort to the use of both manual and mechanical means.

The manual means involves the use of hand to remove maize cobs from the husk while on the plant, and cutting of the stem of sorghum, millet and rice using the sickle or knife.

Other implements used in manual harvesting are hoes and cutlasses used for digging yam tubers, cassava and sweet potatoes. Crops like groundnut and babara nuts are pulled from the ground while beans are picked by hand from the plant.

4.1.2. THRESHING AND SHELLING.

Threshing and shelling are the separation of the grains from the stalks or panicles on which they grew. Like harvesting, it could be accomplished by manual or mechanical means. manual threshing and shelling is the most common practice in Kogi state. It can be done either in the field or at home. Manual threshing is usually done using sticks or flails to beat the grain heads spread on the threshing floor, and in some cases mortar is used for the pounding of the panicle to separate the grains. Maize shelling is usually carried out by women and children.

Large scale farmers and government usually make use of the mechanical Sheller and huller for grains threshing and shelling.

4.1.3. WINNOWING AND CLEANING.

Winnowing and cleaning of grains is done after the threshing. This helps to remove impurities and chaffs from the grains. This is usually done by blowing with mouth and using air movement. Woven mat trays or the modern metal trays or calabashes are used for the cleaning and winnowing exercise. Both the grains and impurities are dropped from a height in a thin stream through the air unto a clean basin or surface. In the process the chaff and impurities which are often lighter than the grains are blown away by the breeze.

KASHIM IBRAHIM LIBRARY

4.1.4. DRYING.

The essence of drying grains is to reduce its moisture content to an acceptable level at which it can be safely stored.

Drying can be done using the natural sun and air or artificial drying methods. In developed countries, artificial dryers are used in drying grains. These dryers are of two types, namely the batch system dryers, and the continuos flow system dryers. These types are not in use in Kogi state. Farmers utilizes the abundant sunshine and air

movement in drying their grains in this area. The grains are spread in the yards, road sides or raised platforms, or the roofs and in the field.

4.1.5. PROCESSING.

Grains processing involves dehusking, milling and grinding. Both the traditional and mechanical methods are used in the state. The traditional method relies on manual removal of the husk by hand, pounding of the grains in a mortar to a very fine powder before sieving. Others use the grinding stone to grind grains. The introduction of the grinding machine has now taken over this labourious traditional method. It has enhanced greater output within a short time.

4.2. EXISTING STORAGE PRACTICES.

Grains storage practices in the state can be classified into two categories. These are farm and state levels storage.

4.2.1. FARM LEVEL STORAGE.

The small scale and large scale farmers are the people involved in storage practices. the small scale farmer employs the traditional storage methods in preserving their grains. They store their grains in cribs, dried earth granary, plant material store, raised platform and pots, calabashes and other in-hut stores.

The large scale farmers use stores and warehouses for the storage of their grains. The sizes of these stores and warehouses depend on the financial capacity of the farmer.

4.2.2. STORAGE AT STATE LEVEL.

Government involvement in grain storage dates back to the third National Development plan 1975 - 1980. State governments were given allocation of funds to embark on grains procurement and storage. This resulted in the construction of warehouses and silos in many states of the federation.

The present warehouses and silos in Kogi state are the product of that exercise. There are six of these warehouses located at Lokoja, Okene, Kabba, Idah, Dekina and Ankpa local government areas.

The state government procures surplus grains from farmers through the produce department of the ministry of Agriculture. The grains thus procured are then stored in the various warehouses. The grains are packaged in the one hundred kilograms bag and stacked on each other. They are later sold to the public and civil servants when prices of grains begin to rise astronomically.

The main objectives of governments' involvement in grains storage are:

1. To achieve price stabilization.

2. To have reserve stock to meet emergency situations caused by draught, crop failure and other forms of disaster.
3. To provide regional food security to meet food grain shortages in neighbouring countries.
4. To transfer essential storage technology and guarantee the quality of food grains

4.3. REFERENCES.

1. AERLS/NSPRI (1988). Workshop Proceedings on post-harvest losses. AERLS, A.B.U, Zaria.
2. GILES P.H , (1965). The storage of cereals by farmers in Northern Nigeria. I.A.R. Samaru, Zaria. pp. 197.
3. NATIONAL ACADEMY OF SCIENCES. (1978). Post harvest food losses in developing countries. Washington, D.C.

CHAPTER FIVE

CASE STUDIES.

5.0. INTRODUCTION.

Before the advent of modern storage structures, the following traditional structures were used for food storage particularly grains:

1. The dried earth granaries
2. Plant material stores
3. The crib
4. In - hut stores
5. Raised platform
6. Underground or pit stores.

A. DRIED EARTH GRANARY.

This is one of the most popular grains storage structures. The bulk of the food grains are stored in this structure. It is a circular bin resting on stones or poles of bifurcated tree branches. The walls are constructed of mixture of earth and grasses or plant materials. It has an apical opening through which the grains are un-loaded or loaded. This opening is usually covered with thatch roof. Few people use conrugated zinc sheet for the roofing.

B. PLANT MATERIAL STORE.

These type of storage structures are constructed from plant materials such as grass matting, corn or guinea corn stalks and sticks. It is usually cylindrical in shape and covered with thatch roof. The store is raised above the ground in similar manner to the dried earth granary. They are mostly in use where grasses and plant materials abound.

KASHIM IB[illegible] LIBRARY

C. **THE CRIB.**

The crib is usually used for both drying and storage of maize grains simultaneously. They are constructed from either plant materials or timber board. The structure allows free entry of air into the stored grains thereby enhancing its drying. It is also raised above the ground and rodents guard mounted on the legs. The cribs are used in the humid regions most.

D. **RAISED PLATFORM STORE.**

This type of store is constructed as an upper floor within either the animal shed or living room. The space between the platform and the roof serves as the store. The space below it can be used as animal shed or living room. The thatch roof and the wooden platform are supported by bifurcated tree branched or trunks fixed firmly to the ground. An opening is often left at the center of the platform to allow for access into the store.

E. **INDOOR STORE.**

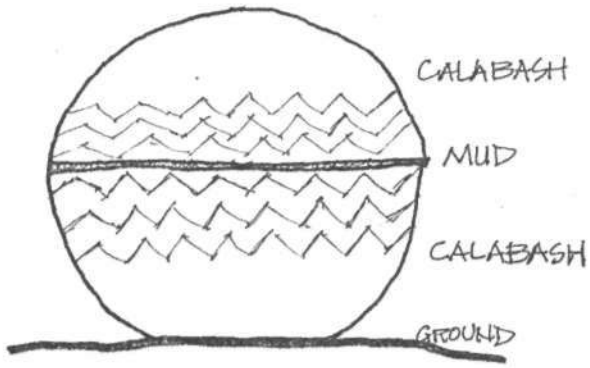
The indoor store is comprised of pot, calabash, bag, plastic containers and drums. Pots and calabashes are used to store seed grains for the next planting season. The jute bags, plastic containers and drums are used for storing food grains for immediate consumption. They have limited capacity.

F. **APPRAISAL.**

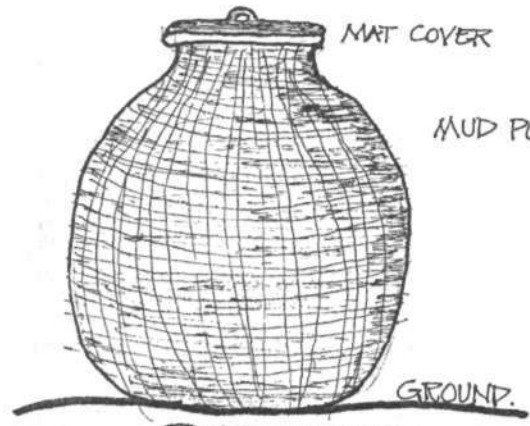
The traditional storage structures lack the required conditions for effective grains storage. The storage environment is easily accessible to rodents, insects and even moisture. These agents are responsible for grains deterioration in storage.

In addition, the traditioinal structures are limited in capacity and high annual maintenance cost. They are prone to theft and fire attack. Long term storage is impossible with traditional structures.

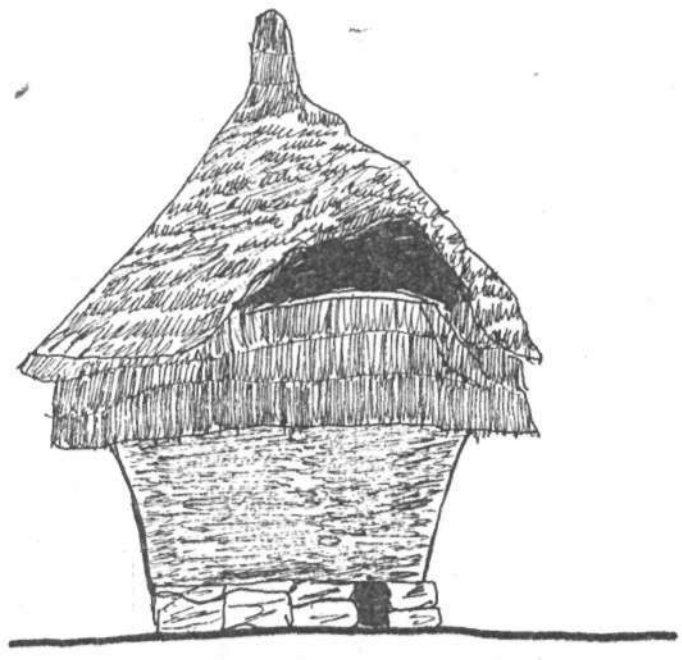
IN-HOUSE STORE



CALABASH STORE

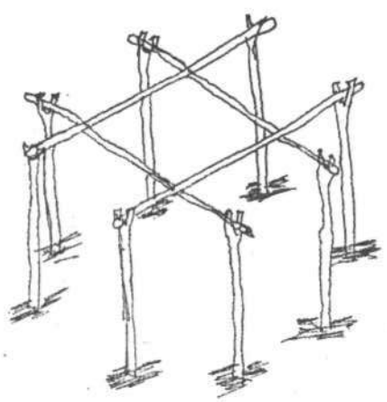


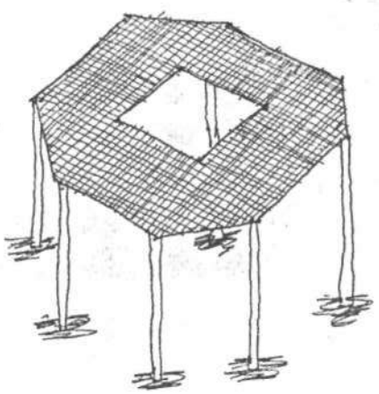
POT STORE



DRIED EARTH GRANARY.

KASHIM IBRAHIM LIBRARY

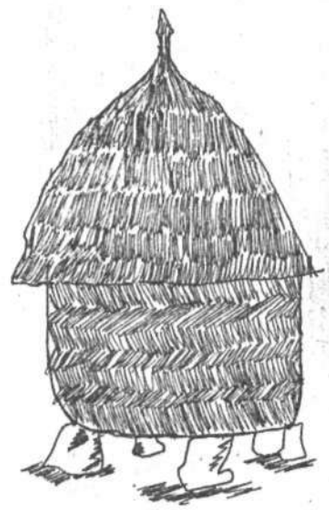






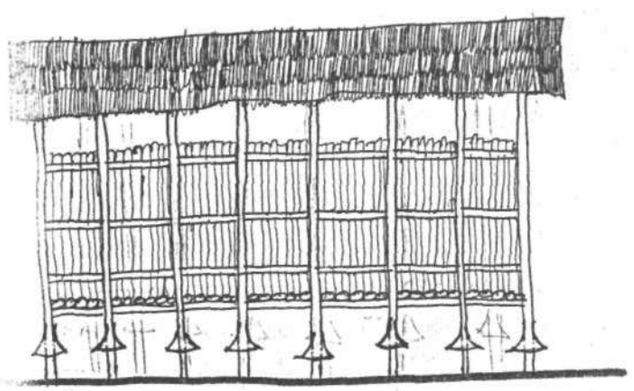
● RAISED PLATFORM STORE.

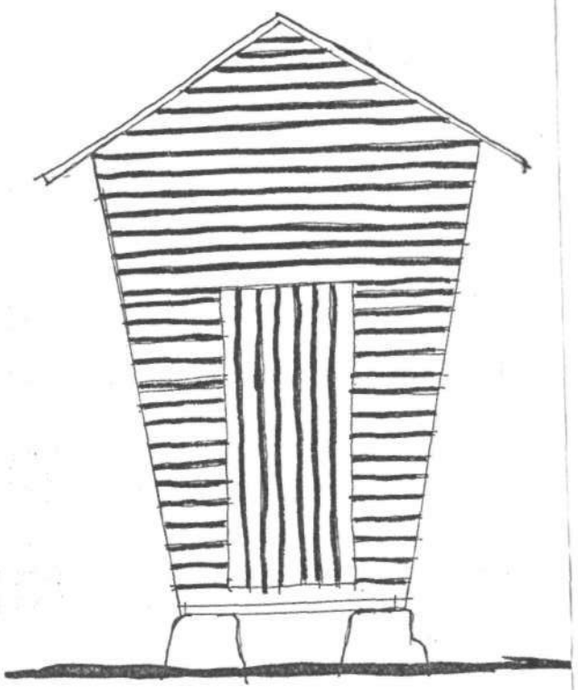




● PLANT MATERIAL STORE.

THE CRIB.





5.1. STRATEGIC GRAINS RESERVE STORE, LOKOJA.

The grains store is located in Lokoja town off Ibrahim Babangida Road by Chris Alli street. The storage Complex consist of silos and warehouses. The Complex was built sometime between 1975 and 1980 by the Federal government in pursuance of the grains reserve policy. The stores and silos have a capacity of 2,000 tons.

5.1.1. PLANNING.

The two blocks of warehouse are arranged in a linear row with the silos on the opposite. There is no defined planning for vehicular and pedestrian circulation within the complex.

5.1.2. ORIENTATION.

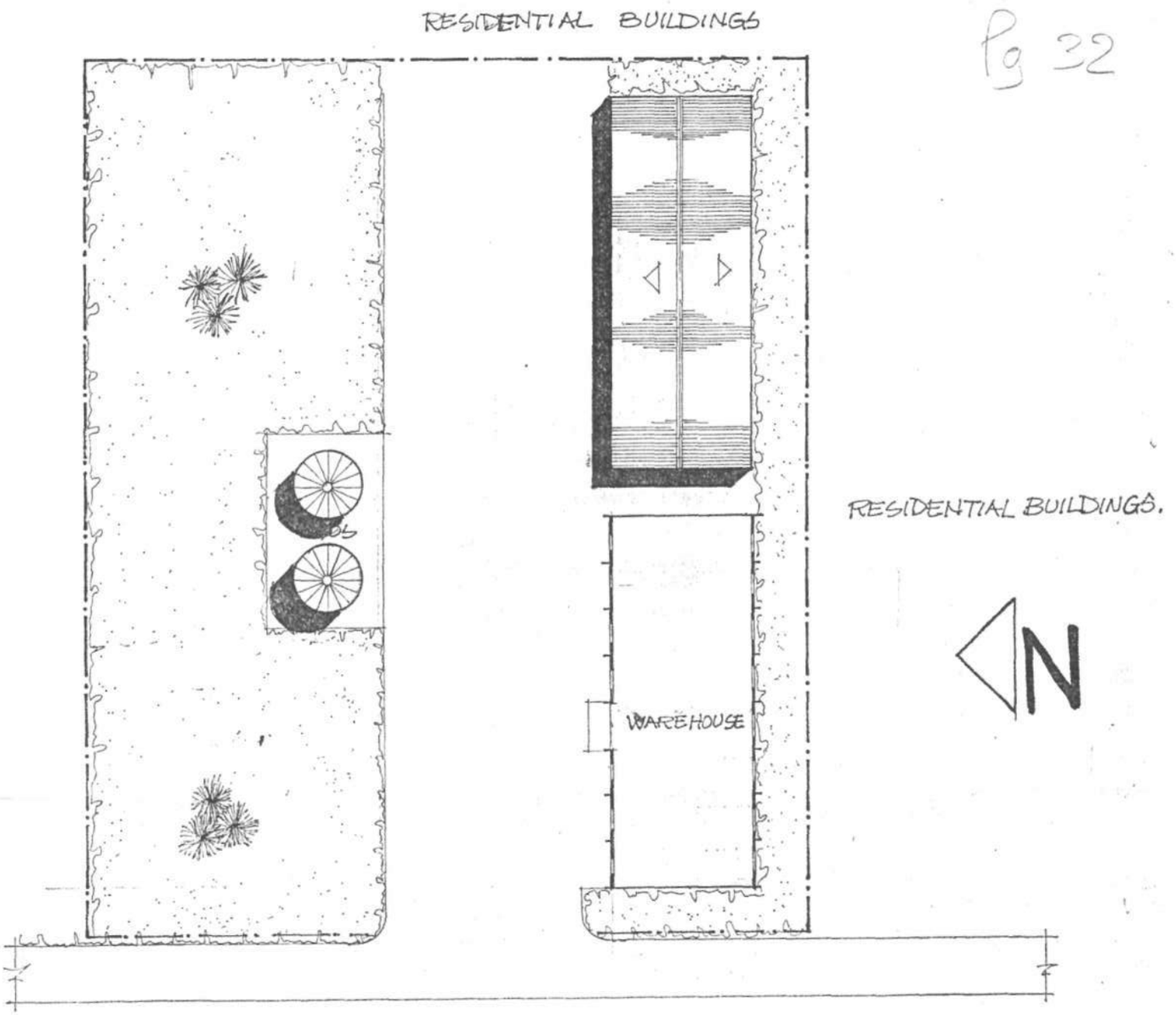
The warehouses have the longer sides orientated along the north-south axis. This reduces the solar heat penetrating the building.

5.1.3. CONSTRUCTION AND MATERIALS.

The silos are constructed with steel. They have circular form. The warehouses are rectangular in shape and constructed with sandcrete block walls. The roof is pitched using steel trusses covered with conrugated zinc sheets. The walls are finished in white paints on plaster.

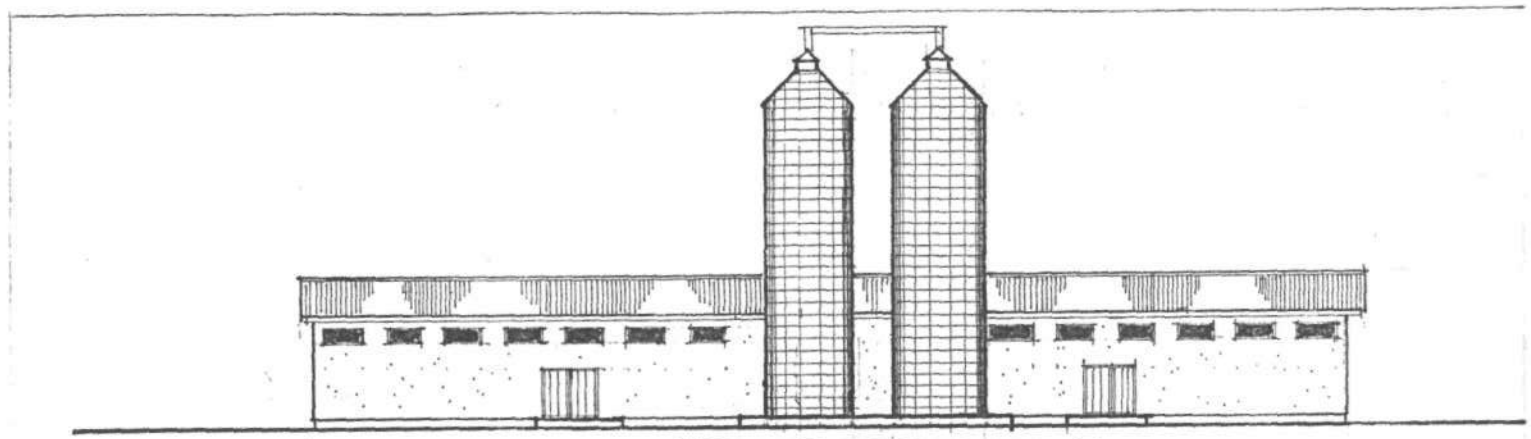
5.1.4. THE STORAGE ENVIRONMENT.

The complex is situated in an area that is prone to flooding. The surrounding areas are water logged. The rivers Niger and Benue are very close to the site. There is no provision for draining surface water.

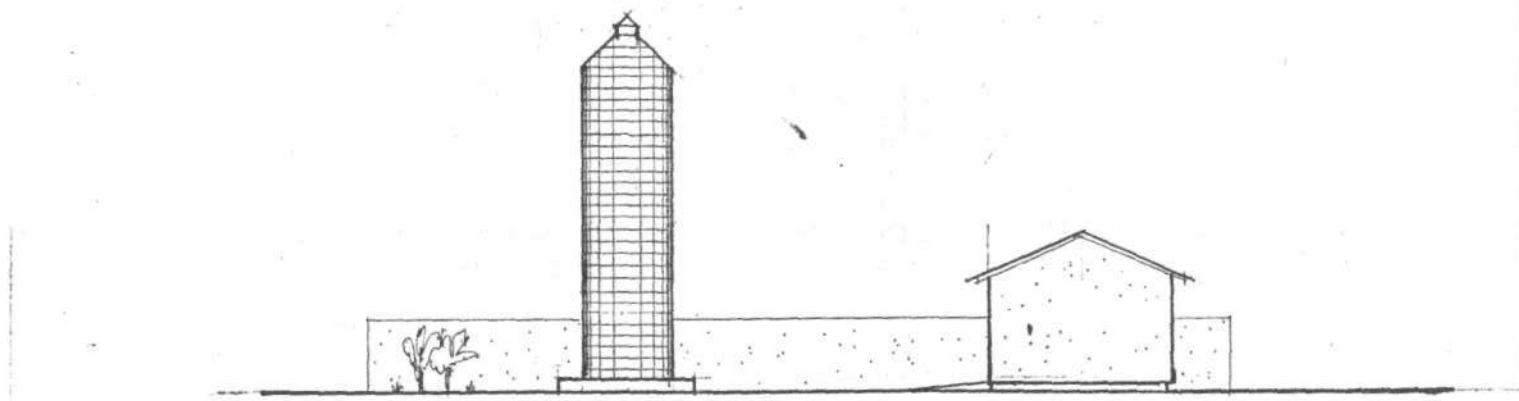

RESIDENTIAL BUILDINGS
WAREHOUSE
RESIDENTIAL BUILDINGS.
N

Pg 32

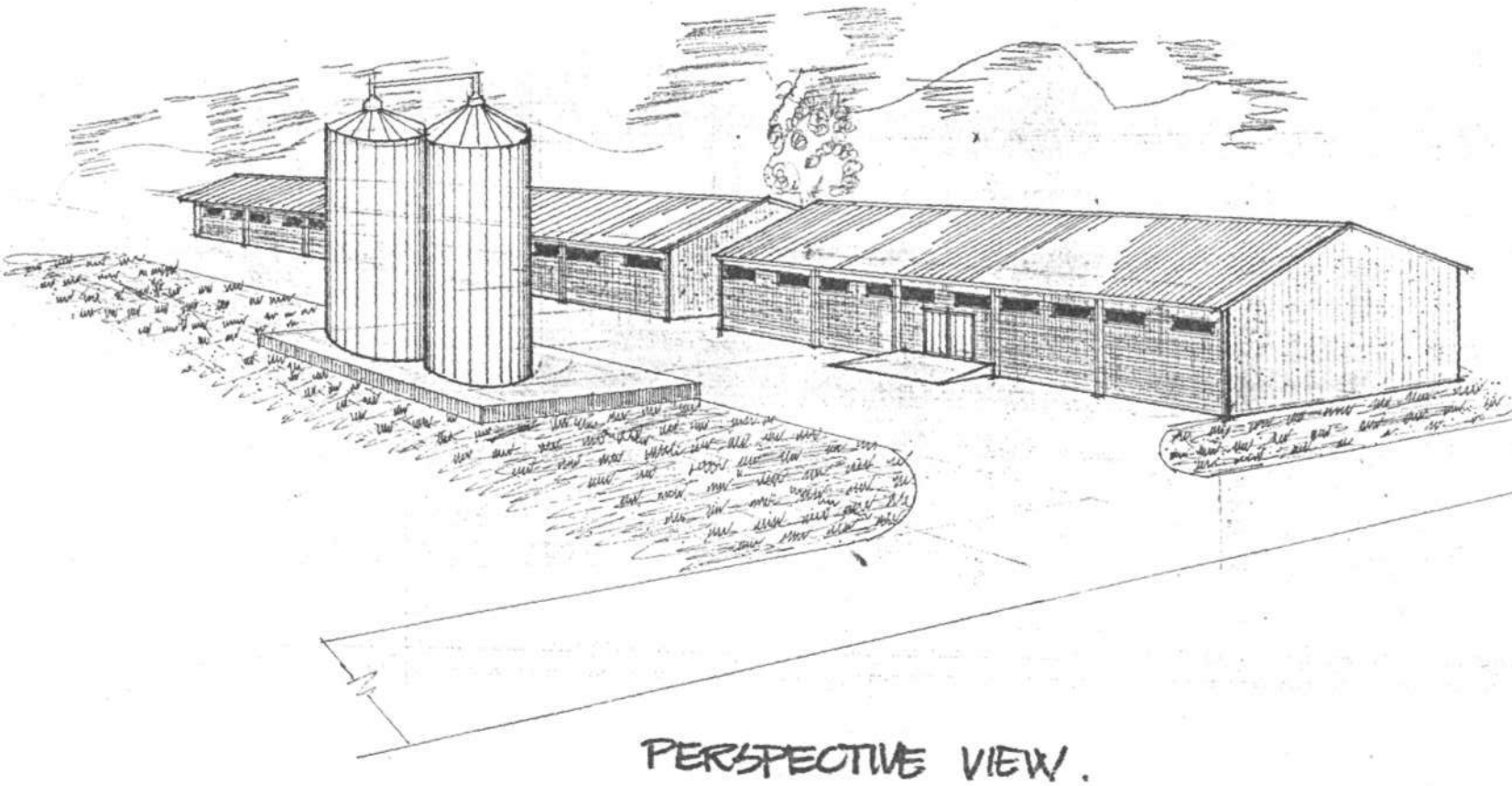
32.



NORTH ELEVATION



WEST ELEVATION



PERSPECTIVE VIEW.

5.1.5. APPRAISAL.

The complex is not properly situated. Its proximity to the rivers and water logged surroundings makes it unsuitable for grains storage. The cost of maintaining the complex is high. There is no allowance for expansion as the complex is completely surrounded by residential buildings. There is no administrative facility.

5.2. FARMERS SUPPLY COMPANY GRAINS STORES (FASCOM), KADUNA.

The Farmers Supply Company grains stores are located about 10km to Kaduna along the Kaduna - Zaria express way. The stores are jointly owned by the Farmers and the State government. The center is managed by the Farmers supply company.

5.2.1. PLANNING.

The complex consists of several warehouses arranged in rows. The administrative unit is not within the complex. the road network within the complex is not properly planned. Vehicular and pedestrian circulation are not well defined.

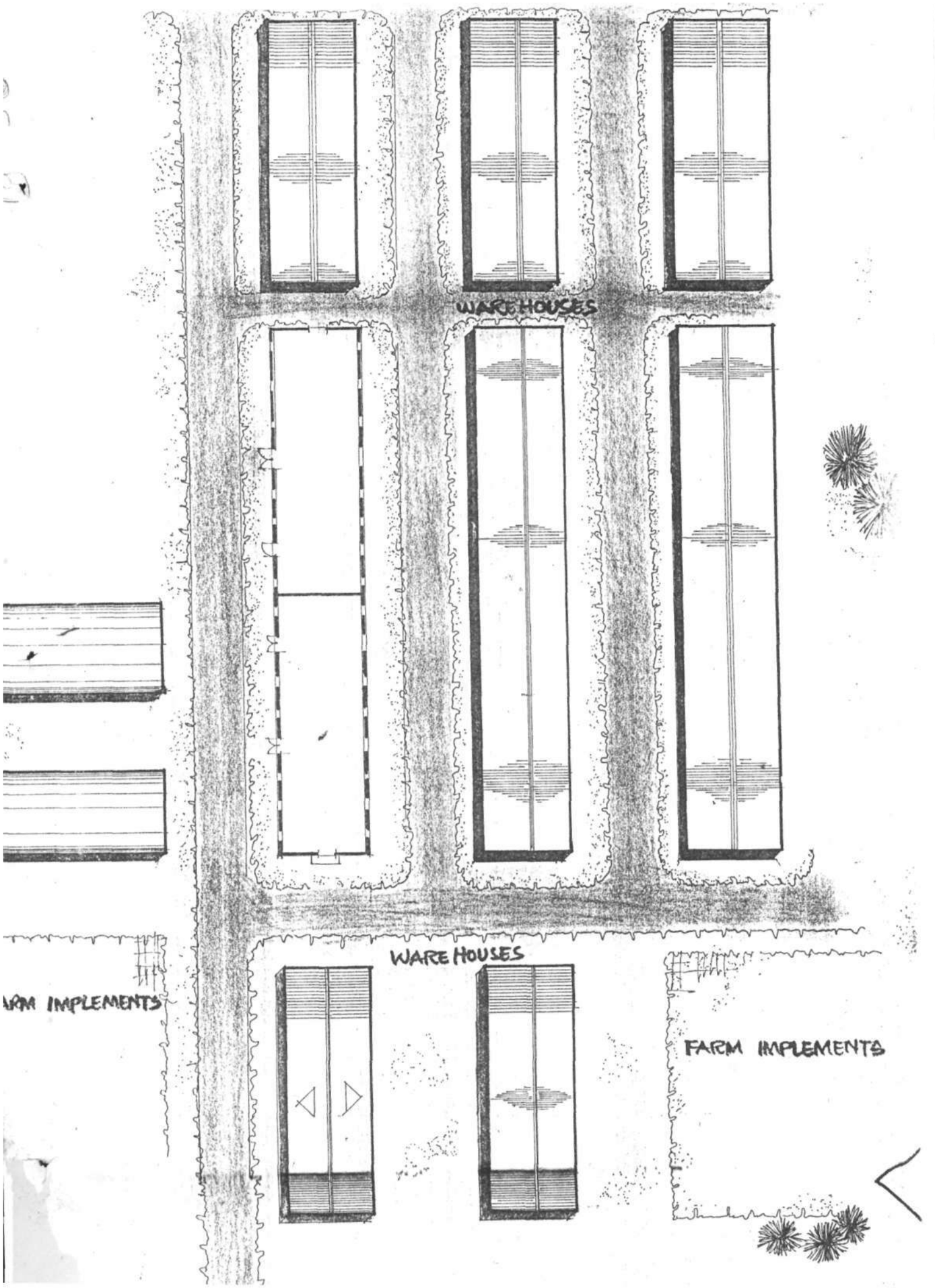
5.2.2. ORIENTATION.

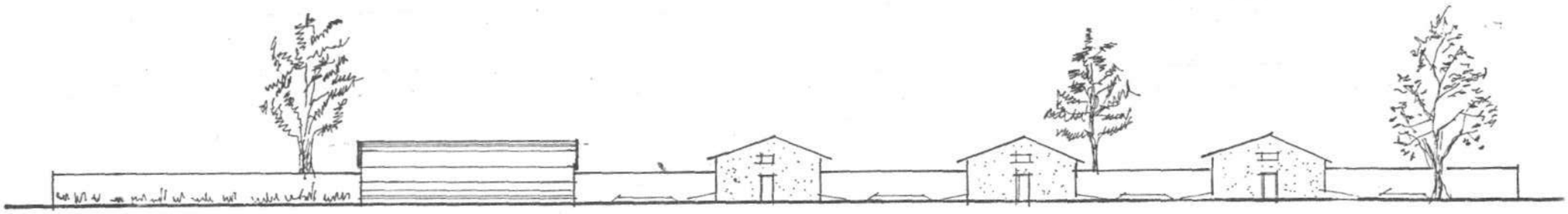
The longer axis of the stores are orientated towards the north - south direction. However, the barrel vaulted stores has its longer axis facing the east-west direction.

5.2.3. CONSTRUCTION AND MATERIAL.

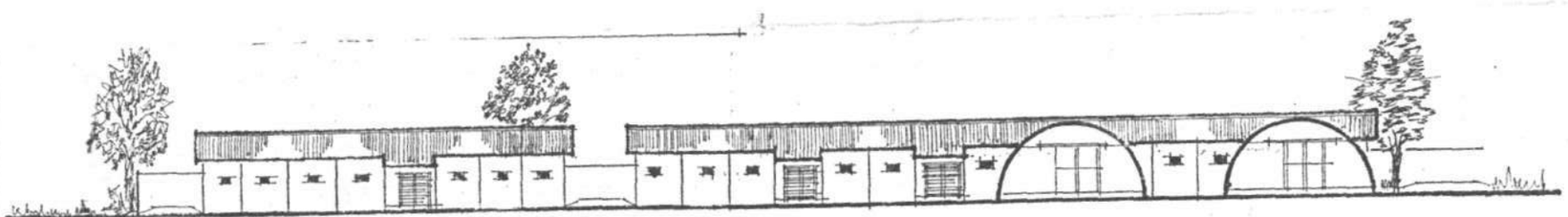
The warehouses are built with sandcrete block walls and pitched roof with short over hanging eaves. The floors are about 300mm above the ground. Small openings covered with wire mesh are provided at the eaves. The walls are finished in white lime paint. Two blocks of the warehouses are roofed using barrel vaults.

KASH

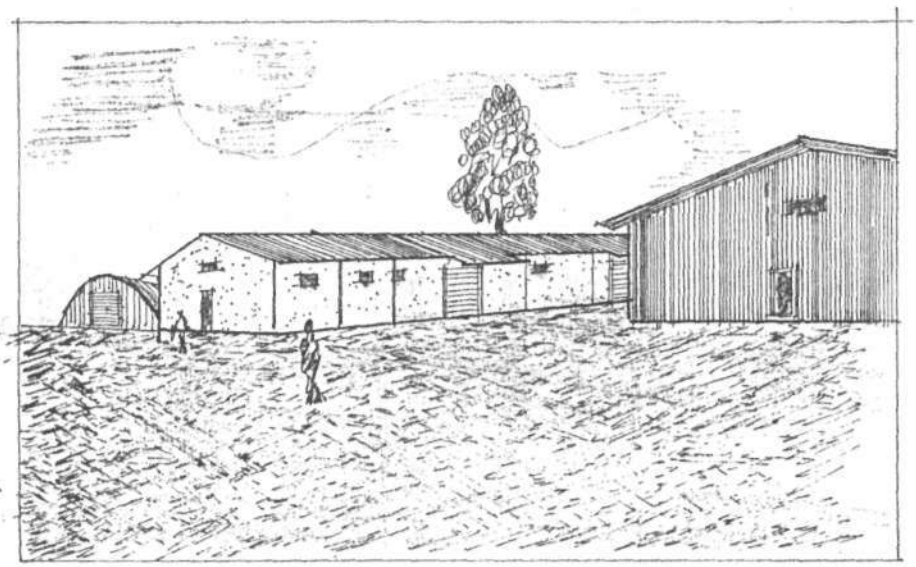

WARE HOUSES
WARE HOUSES
FARM IMPLEMENTS
FARM IMPLEMENTS



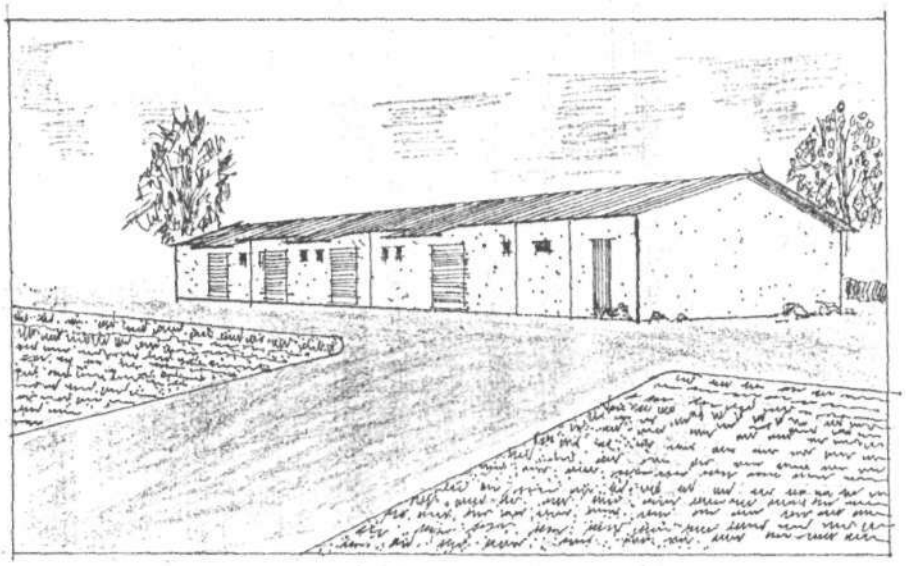
APPROACH ELEVATION



SOUTH ELEVATION.



PERSPECTIVE OF WAREHOUSE



PERSPECTIVE VIEW

5.2.4. THE STORAGE ENVIRONMENT.

Adequate drainage of surface water is lacking around the warehouses. The stores surrounding are not properly maintained.

5.2.5. APPRAISAL.

There are no provisions for the administrative and workers facilities, and laboratory for pre and post storage testing of grains. The short over hanging eaves cannot throw roof water clear off the building. There is no waste disposal facility.

5.3. GRAINS PROCESSING CENTRE, ZARIA.

The grains processing centre is located at Chikaji Industrial Zone, Zaria. The centre is manned by a team of grains specialists. The centre is owned by both the Federal and Kaduna state governments. The centre comprises of the administrative block, silos and the processing hall. The centre stores and processes grains for the beverages and food industries. The capacity of the silos put together is 5,000 tons.

5.3.1. PLANNING.

There is no conscious planning of the centre. The administrative block is not properly related to the processing hall and silos. There are two gates, one serves the administrative block and the second for workers entry and grains delivery or dispatch. The silos are free standing and are arranged in two rows.

There are six silos altogether, two of them have 500 tons capacity each while four have 1,000 tons capacity each. The unloading bay has a roof covering and an inlet pit. The grains are fed into the silos by an elevator. There is a mechanical grains drying machine.

KASHIM IBRAHIM LIBRARY



PLATE 1 : GRAINS PROCESSING CENTRE, ZARIA

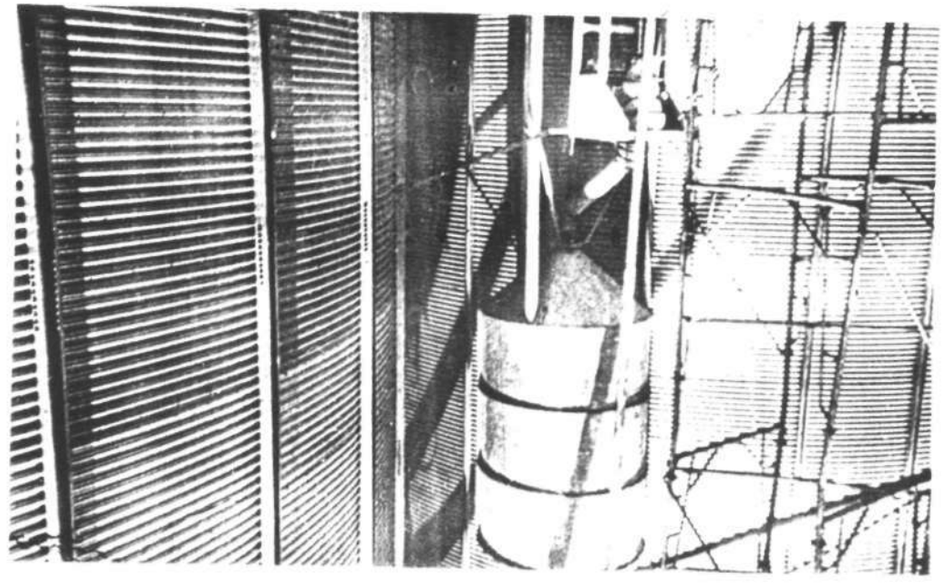


PLATE 2 : SHOWING BASE OF SILOS

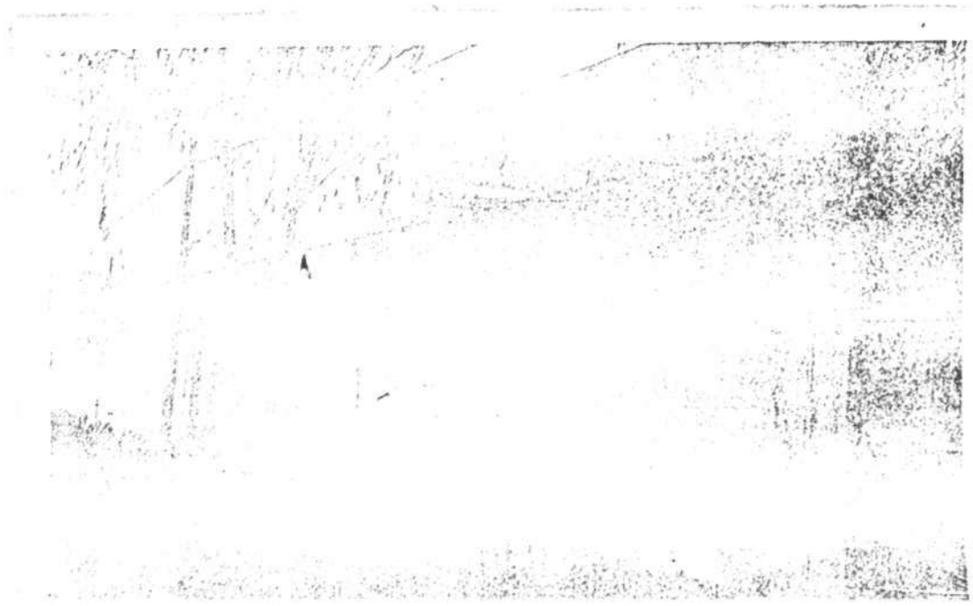


PLATE 3. SHOWING THE TRACKSHIFTING HALL



PLATE 4. [illegible]

5.3.2. ORIENTATION.

The processing hall has its longer axis facing the North-South direction.

5.3.3. CONSTRUCTION AND MATERIALS.

The administrative block is constructed of sandcrete block walls with pitched roof. The roof is hidden behind concrete parapet wall with sprouts at intervals for drainage.

The silos are circular in shape and are made of galvanized steel sheets with reflective coating. The silos are raised on a concrete platform about 600mm above the ground.

The processing hall has steel "I" sections as columns with conrugated zinc sheet as wall cladding and roofing sheets. The floor of the processing hall is laid with reinforced concrete floor joists of 150mm x 75mm spaced at 25mm centres. This serves as a raised platform for stacking of the bagged grains.

5.3.4. THE STORAGE ENVIRONMENT.

The silos and processing hall area is provided with drainage gutters. The surroundings are well kept and landscaped. The silos have devices for cooling the grains, this provides the needed favourable storage environment.

5.3.5. APPRAISAL.

The centre lacks parking spaces, the weighing bridge is located outside the complex. There is no convenient loading bay. The vehicular and pedestrian circulation is not differentiated. Waste disposal facility is not available.

5.4. FOOD SECURITY PROJECT, SENEGAL.

The Sahelian drought of 1972-1974 led to the financing of the food security projects in 1975. The government of the Federal Republic of Germany under the acgis of the F.A.O established these food security projects in many cities within the sahelian region. The projects were aimed at providing reserve food stock particularly grains.

The countries that benefited from this food project are: Niger - 70,000 tons, Upper Volta - 20,000 tons, Mali - 70,000 tons, Mauritania - 30,000 tons and Senegal - 80,000 tons.

5.4.1. PLANNING.

The centre comprises of administrative unit, several blocks of warehouses for both grains and chemicals and equipment. The dimensions of the storage units are 10m span x 15m length x 4.4m height. The normal capacity of each storage unit is 500 tons.

5.4.2. CONSTRUCTION AND MATERIALS.

The stores are constructed of sandcrete block walls with aluminium curtain walls as cladding steel portal frames are also used. The eaves over hang is about 0.62m, this ensures that rain water is thrown clear off the building. Other measures against rain water getting into the warehouses are the sloping of the sills of the air vents towards the exterior of the building, placing the air vents very close to the roof and providing an overlapping metal flange above the warehouse door.

5.4.3. THE STORAGE ENVIRONMENT.

The environment is well maintained and properly drained. Sealing of the warehouse from the influence of the external environment keeps the grains under controlled conditions.

5.4.4. APPRAISAL.

The Food security projects, Senegal is a great improvement over previous attempts at food storage. Sealing the warehouses for the period of storage prevents rodents, insects and mites attack. Provision for draining the warehouses surrounding is adequate.

5.5. CTESIPHON STORES, CYPRUS.

The ctesiphon stores has a spherical dome above a conical underground store. It has proved successful in areas where water seepage and high relative humidity are prevalent. They are also known to be effective where there is diurnal temperature variation.

The grains are loaded and unloaded from the store through pipes laid inside the walls of the structure using gravity and sucking effects respectively.

5.5.1. CONSTRUCTION AND MATERIALS.

The structure is constructed using reinforced concrete laid on precast ribs connected to a ring beam set about 9m above the ground. Damp proof membrane is applied to both the internal and external surfaces of the structure. The structure is rendered smooth in 3 coats of 2" - 3" thick cement; Sand mortar of 1:3 ratio.

5.5.2. THE STORAGE ENVIRONMENT.

The internal environment is completely under controlled conditions. It is not influenced by external environmental conditions.

5.5.3. APPRAISAL.

The major short coming of the structure is the frequent cracking of the fabric at the top of the ribs. This weakens the arch and could result in rain leaking into the store.

5.6. CONVENTIONAL SILOS.

The use of silos has gained prominence amongst commercial farmers and public enterprises in the topics. Silos can be rectangular square, hexagonal or circular. Its capacity depends on the stored products. The diameter varies from 5-12 metres while the height ranges from 15-30 metres. It can sometimes reach as high as 100 metres.

Silos are used for bulk storage of grains. The silos properly adopted is very effective in the tropics as in the temperate and cold regions.

5.6.1. CONSTRUCTION AND MATERIALS.

Silos can be constructed using bolted or welded steel, timber or concrete. The most widely used of these is steel. The silos are always erected on a concrete floor slab raised above the ground level.

5.6.2. THE STORAGE ENVIRONMENT.

The silos provide the necessary environment for grains protection against insect, rodents and external environmental influence. The internal storage conditions can be controlled using cooling devices.

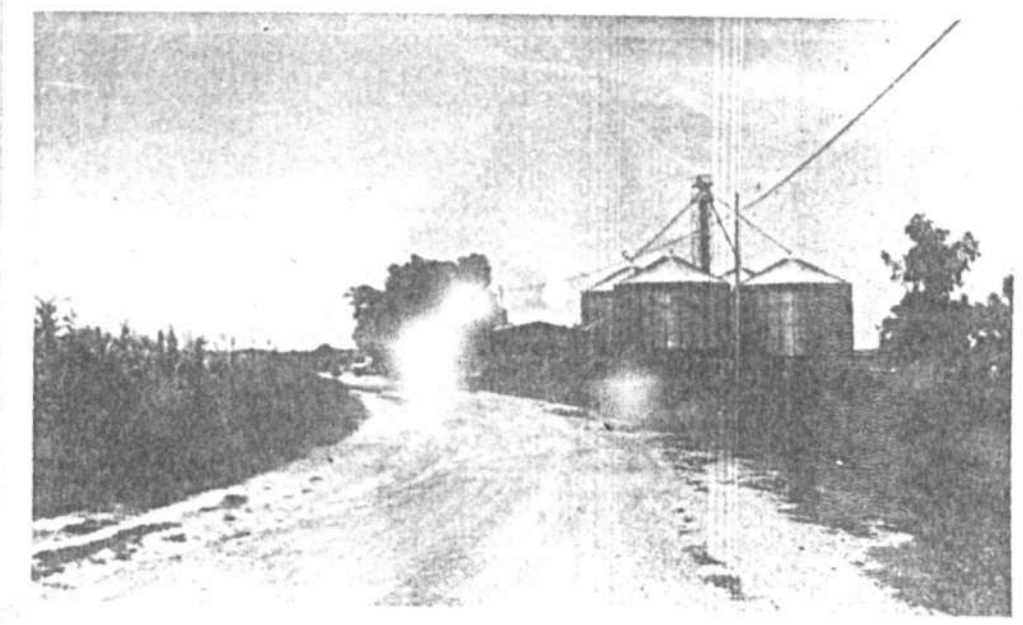


Plate 5: CONVENTIONAL SILOS

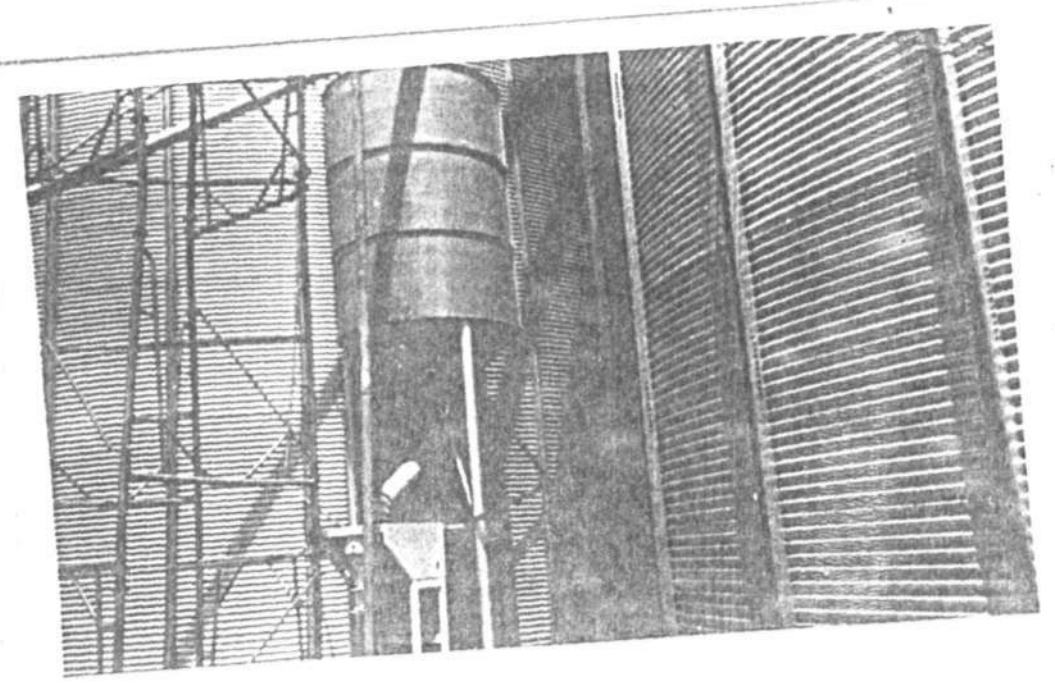


PLATE 6: CONVENTIONAL SILOS.



Plate 7 : CTSIPHON STORES, CYPRUS.

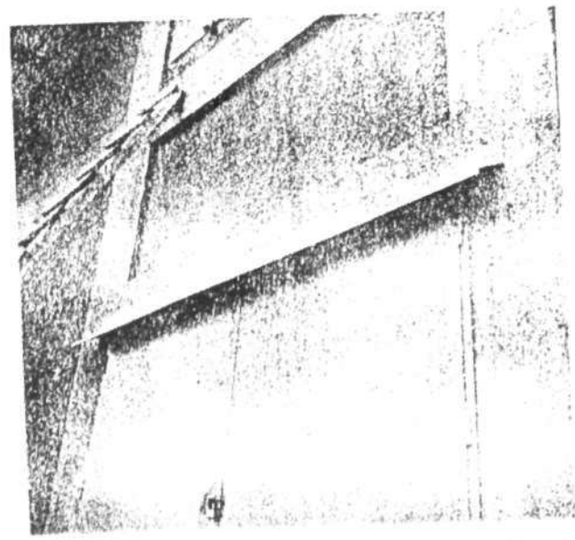


Plate 8: METAL RAIN-SHIELD OVER DOOR.

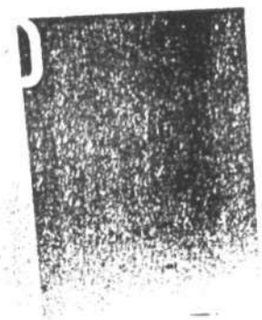


Plate 9: DETAIL OF STEEL FRAMED DOOR SHOWING OVERLAP AT THE BASE

FOOD SECURITY PROJECT, SENEGAL

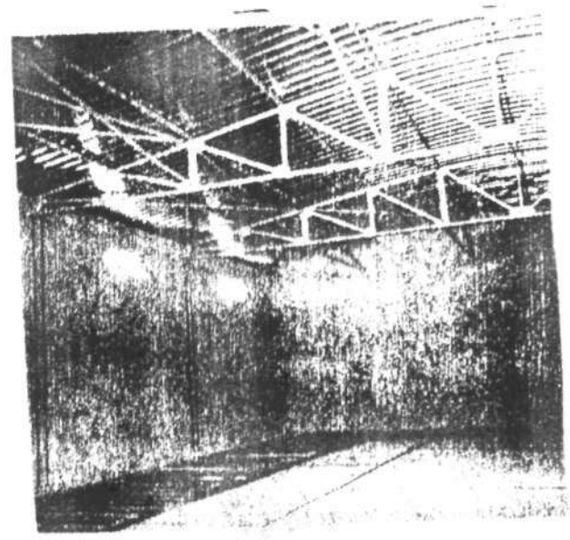


PLATE 10 : INTERIOR OF STORE

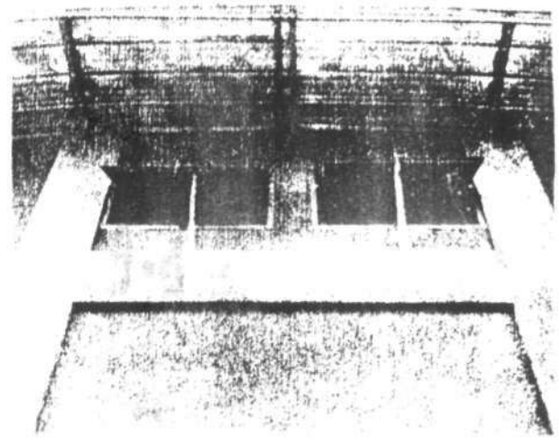


PLATE 11 : METAL FRAMED FLANGED COVER ON MESH SCREENED VENTILATORS

KAT ... LIBRARY

5.6.3. APPRAISAL.

The silos enables increased capacity of storage with minimum human labour. It completely eliminate rodents and insects. And it can keep grains dry and in good condition for a longer time.

5.7 CONCLUSIONS.

(1). Organizational layout: Linear layout allows for smooth flow of grains and people. This allows for un-interrupted activity and maximization of time. The grains should arrive at one end and leave at the other. Enough space for circulation should be provided with a clear segregation of the vehicular and pedestrian traffic.

2). Storage environment : The storage environment should be dry and cool always to ensure favourable storage conditions. Open spaces and courtyards should be effectively integrated into the design to keep the storage environment airy and dry. adequate provision for roof and surface drainage should be ensured. Landscape elements should be used to reduce solar heat absorption and radiation.

3). Protection from water : Stored grains should be protected from rain and ground water and moisture migration. Floors of grains store should be raised above the ground in addition to the use of damp proof course or membrane. All bolts and screws in the roof should have rubber washers.

4). Protection from rodents and insects : The stores should be rodents and insects proof. Raising the stores above the ground and covering the vents with wire mesh serves to restrict their entry. The use of steel or concrete for the storage structures provide good protection against rodent.

5). Protection from fire: Grains store should be protected from fire hazards. The use of steel or concrete is advisable due to their high fire resisting quality. All electrical outlets and switches should be equipped with dust and spark proof.

5.8. REFERENCES.

1. AGBOOLA, D.S. (1985). Effective post-harvest loss prevention and self reliance in food. I.A.R, A.B.U, Zaria.
2. BUNGUDU, L.M. (1984). Storage of farm products by farmers in my village. I.A.R; A.B.U; Zaria.
3. GNIADZIK, J.S. (1984). Structural Systems in Architecture . A.B.U. Department of Architecture, Zaria.
4. JARMUL,S. (1980). The Architects guide to energy conservation, Kingsport Press, USA.
5. MAMMAN, I.D. (1985). Zaria Cereals Collection and distribution centre, toward effective staple grains storage system. Unpublished M.sc. Thesis, A.B.U; Zaria.
6. RANSOM, W.H. (1960). Buildings for the storage of crops in warm climates. Tropical Building studies, No. 2.
7. TUNAU, F.A. (1991). Sokoto Grains Centre, Architectural consideration of the traditional grain storage system. Unpublished M.sc. Thesis, A.B.U; Zaria.

CHAPTER SIX

THE SITE AND ITS ENVIRONMENT.

6.0. HISTORICAL BACKGROUND.

Kogi state was created by the Babangida administration on the 27th August, 1991. The state is made up of three major ethnic groups and several smaller groups. The major ethnic groups are the Igalas, Igbiras and the Okuns. The state covers a land area of about 28,500 square kilometers.

The Igalas occupy about half of the land area of the state. The area which forms the Igala land is bordered on the north by the river Benue, while on the south by Nsukka and Onitsha in Anambra state. On its eastern flank is the Idoma land in Benue State, and on the Western flank is the river Niger. The Igalas have a population of about 1,066389 (Census 1991). Other ethnic settlers in Igala land are the Idomas, Igbiras, Yorubas, Hausas, Igbos and Nupes.

The second largest ethnic group are the Igbiras. They occupy the area situated between the Igalas and the Okuns. Flanking Igbira land on the North is Kogi local government area and the south by Ondo and Edo states. On the eastern side is the river Niger and on the west by Okun land. Their population is about 752,456. Other ethnic groups also settle amongst the Igbiras.

The Okuns constitute the third major ethnic group in the state. They occupy the western parts of the state. The Okun land is flanked on the north by Niger state and on the south by both Ondo and Oyo states. On the eastern side is Igbira land and on the western side is Kwara state. Their population is about 311,903. There is evidence of other ethnic settlers among the Okuns.

6.0.1. ECONOMIC BASE.

Agriculture constitute over eighty percent of the economic base of the state, while industries and government constitute the formal economy. The state is richly endowed with a lot of minerals deposit like Gold, Feldspar, iron-ore, diamond, quartz and limestone. The state has vast fertile land for agricultural purposes.

The rural population is predominantly involved in subsistence farming, handicrafts and few other occupations. Agricultural land is held on the family and community basis. Each adult member of the family is given a farm plot on which to cultivate. The typical family unit is composed of the family head (The eldest and most respected male member), his wife or wives and their children. Adult male children in addition to cultivating their own farm plots also assist their father on his own farms. Traditional system of cultivation is the most practiced method. They employ the use of hoes for ridging and cutlasses for land clearing.

The farmers often organize themselves into groups of five or more working on rotational basis on each of the members farm. This system allows for speedy completion of work on large farm lands. The member on whose farm the group works is responsible for the provision of food and drinks for that day while they are on the farm. However, some wealthy farmers employ farm labour or tractor to cultivate their farms.

The state government has been assisting the farmers in the areas of provision of fertilizers, improved seedlings and herbicides at subsidized rates. Government also acquired several hectares of farm land within each local government areas. These lands are cleared and divided into several holdings and given to civil servants interested in farm. The civil servants are provided seedlings, fertilizers and herbicides at subsidized rates.

To further enhance large scale farming in the state, government established the Tractor hiring Agency to provide tractor services to farmers. The rates of the tractor services are also subsidized.

The major crops that thrive well in the state are maize, sorghum, millet, cowpea, melon, beniseed, groundnut, locust bean, vegetables, yams, cassava, cocoa, coffee, oranges, mangoes, cashew, guava and rice.

The rivers and numerous streams in this area provide opportunities for fish farming, while the thick forests in the state provide the grounds for animal hunting.

6.0.2. SOCIO - CULTURAL FABRIC.

There is similarity in the socio-cultural ways of living among the three major ethnic groups. These similarities are due to the continuos interactions of the various cultures. There is similarity in activities like marriage ceremonies, funerals, coronations, feasts (New yam festival), oracles and masquerade dancing e.t.c.

Major festivals take place after the harvesting season. This is very significant in the sense that apart from the abundant availability of food and drinks, the people have enough time to attend such functions. On such occasions, the gods of the land are often appeased for granting the community bumper harvests and prosperity for that season.

Most households live in compound type clusters. The food stores are located in prominent position within the compound. In some localities, the stores are located in the middle of the compound while in some others they are located close to the compound entrance. The number and sizes of these stores depend on the household size.

MAP OF NIGERIA SHOWING KOGI STATE

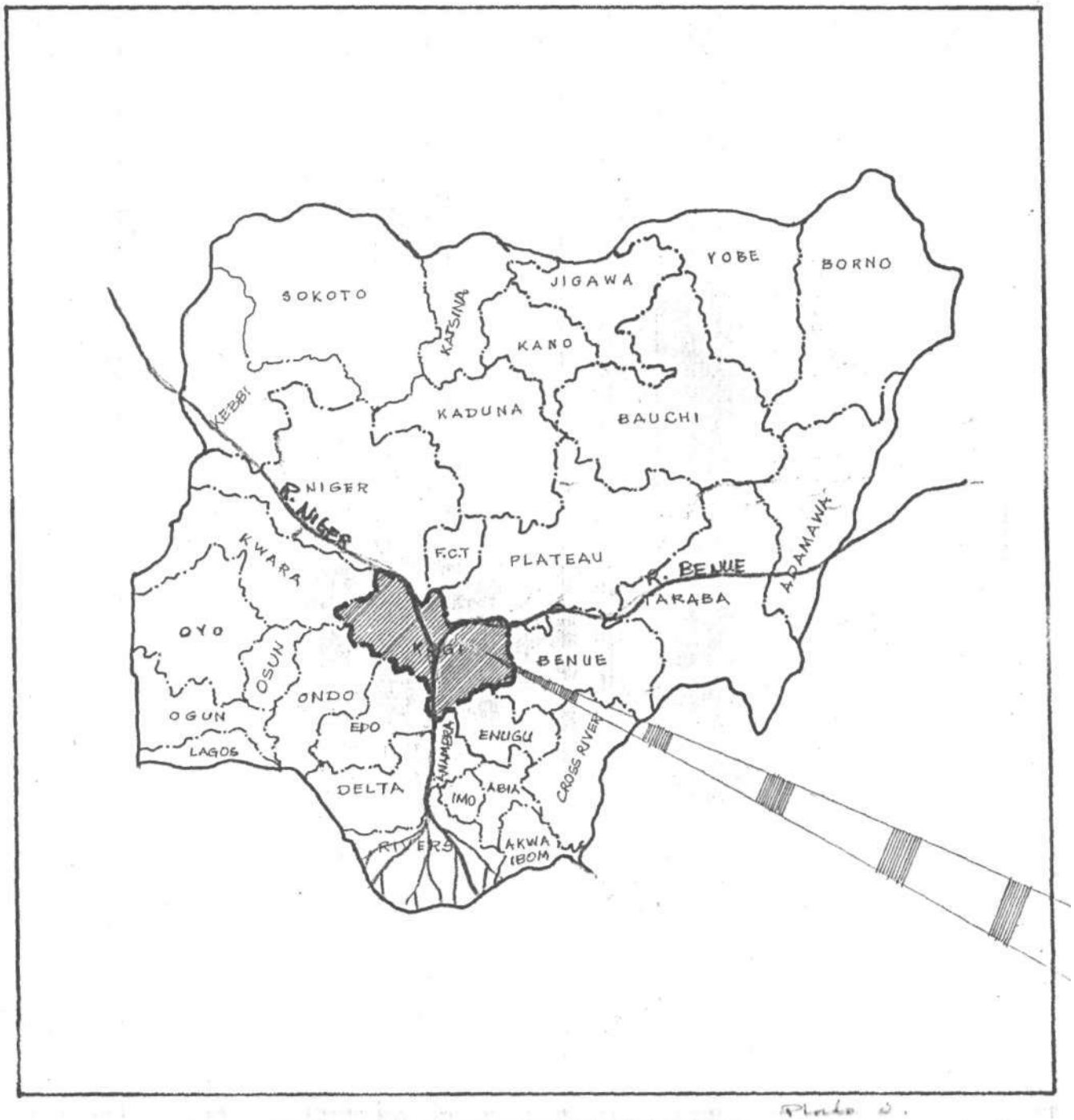


Plate 2.

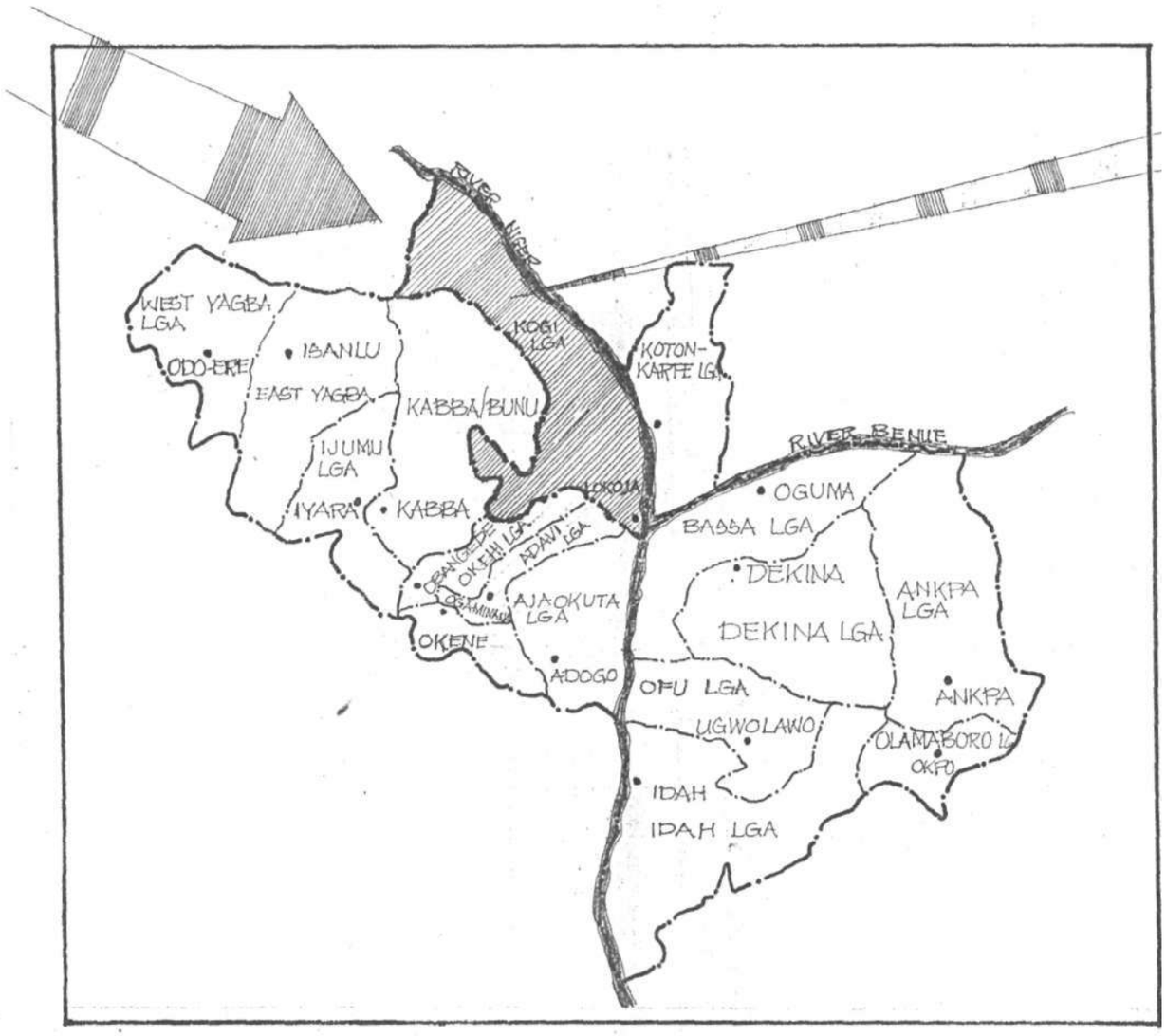
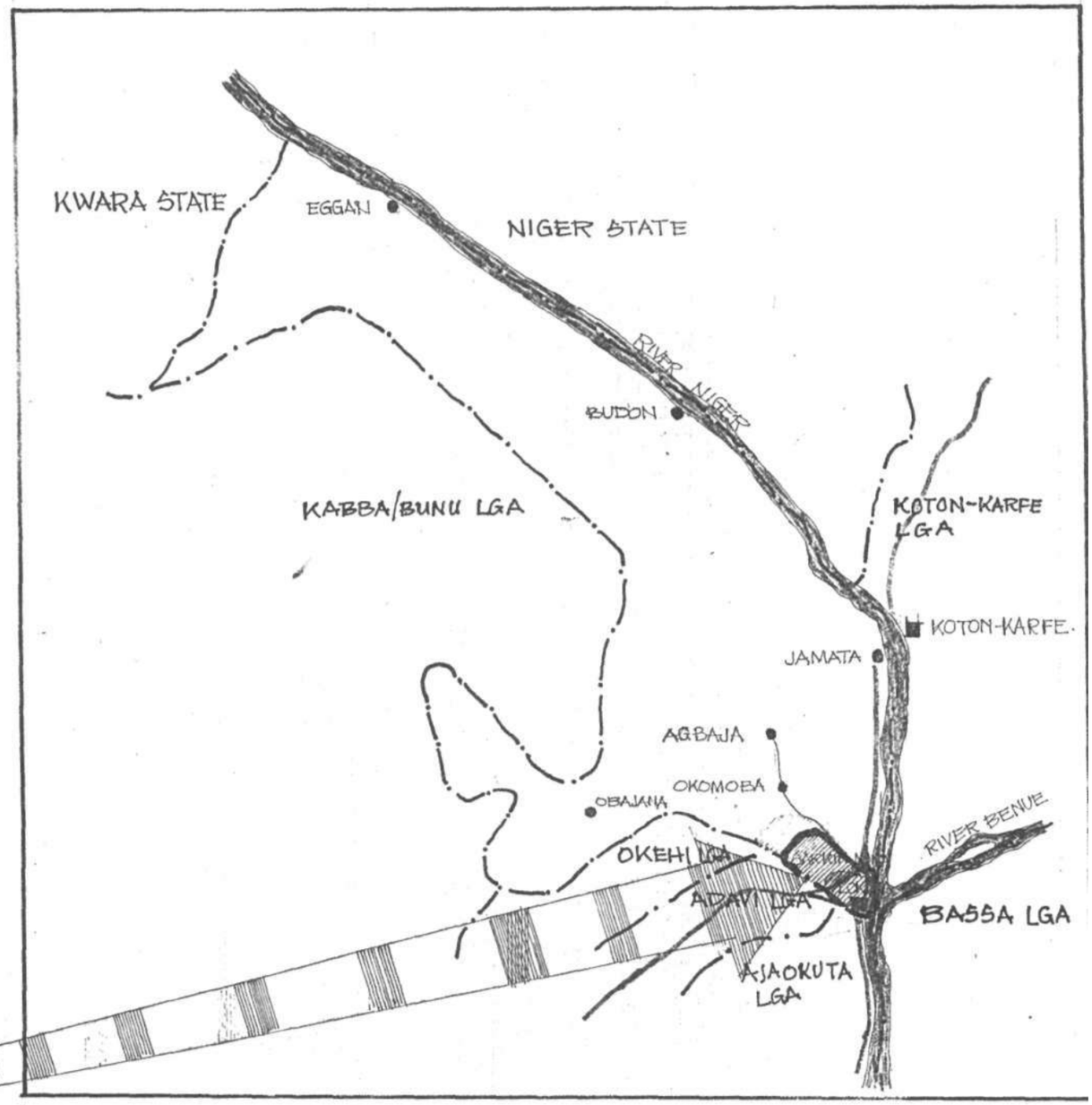


Plate 3;

● MAP OF KOGI STATE SHOWING KOGI LGA.

MAP OF KOGI LGA SHOWING LOKOJA.



6.1. SITE LOCATION.

The site chosen for the grains storage and distribution centre is in Lokoja. It is on the outskirts of the town along the Koton-Karfe to Okene highway. The town lies on latitude 7^0 48N and longitude 6^0 44E.

6.2. SITE SELECTION CRITERIA.

Several factors were considered in the selection of this site. The most prominent criteria are:-

a) Grains production area.
b) Market
c) Land availability.
d) Labour
e) Transportation
f) Public utility
g) Technology
h) Zoning regulation.

A). **Grains Production Area:-** The Kogi state agricultural development Project (KGADP) is comprised of four zones. The zones are: i) The central zone comprising of Kogi, Okehi, Adavi, Ajaokuta, Koto-Karfe and Ogori-magogo local government areas, ii) The western zone comprising of Kabba-Bunu, Ijumu, East-Yagba, Yagba-west and Mopa-Amuro local government areas, iii) The northern zone comprising of Ankpa, Olamaboro, Omala and Bassa local government areas, and iv) The south-eastern zone comprising of Idah, Dekina, Ofu, Ibaji and Igalamela-Odoru local government areas.

In the central zone, Kogi local government area is the highest grain producer followed by Koton-Karfe local government area. It has a vast arable land suitable for grains cultivation. Over eighty-five percent of the people are active farmers.

Table 2

CROP YIELD OBTAINED IN KOGI STATE 1993 - 1996 (1,000) TONS

CROP	1993	1994	1995	1996
Maize	73.16	123.58	184.74	222.19
Rice	2.91	89.18	93.92	99.59
Millet	7.20	3.63	0.82	15.11
Sorghum	34.80	131.13	53.36	77.23
Groundnut	9.43	6.66	34.50	33.42
Cocoa/Coffee	2.91	3.63	1.82	5.33
Beniseed	19.75	29.45	37.12	33.09
Melon	60.40	70.80	40.10	76.24
Beans	40.20	69.60	47.65	38.17

*Source : **Kogi state Agricultural Development Project (KGADP) report 1996.***

Of the total cereal grains produced in Kogi state, the central zone accounts for thirty-five percent. Majority of the farming households own at least one storage granary. Others use the in-house storage. The average capacity of these storage granaries is in the range of five hundreds to one thousand kilograms.

B). **Market:-** The availability of market for the procurement and sale of grains is of paramount importance. There are more a dozen village markets within the Lokoja market catchment area. Majority of these farmers sell their grains and other farm produce in these markets.

The sales and distribution outlets for this grain centre are the ministries and parastatals, Kogi people consumer shops and the flour mill under construction.

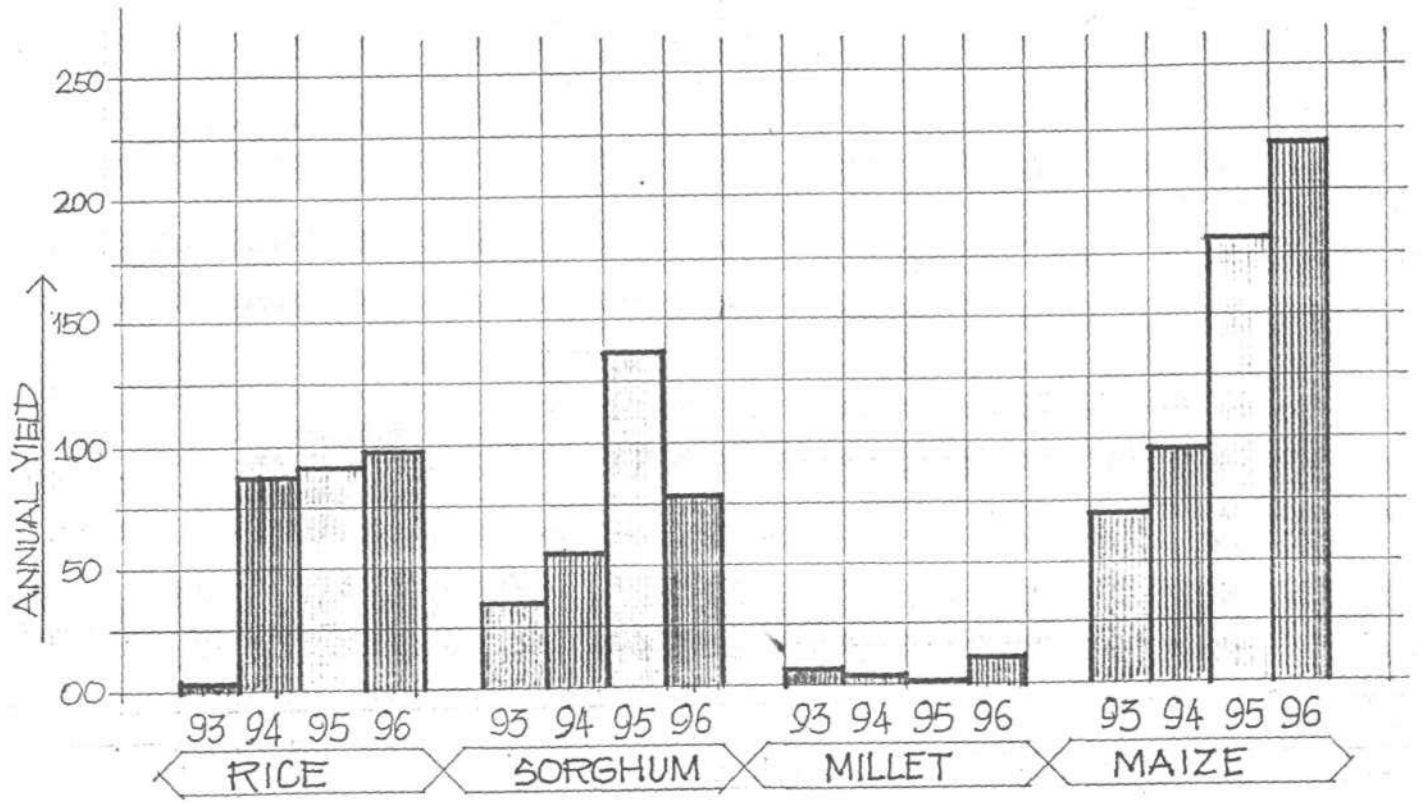
C). **Land availability:-** The site for this project has a land area of seventy-five thousand square metres. This allows for future expansion without constraints. The site is free of lakes and ponds of water which can increase its relative humidity.

D). **Labour:-** There is abundant skilled and unskilled manpower available in Lokoja town. Similarly, manpower can be sourced from the neighbouring settlements to supplement the labour force.

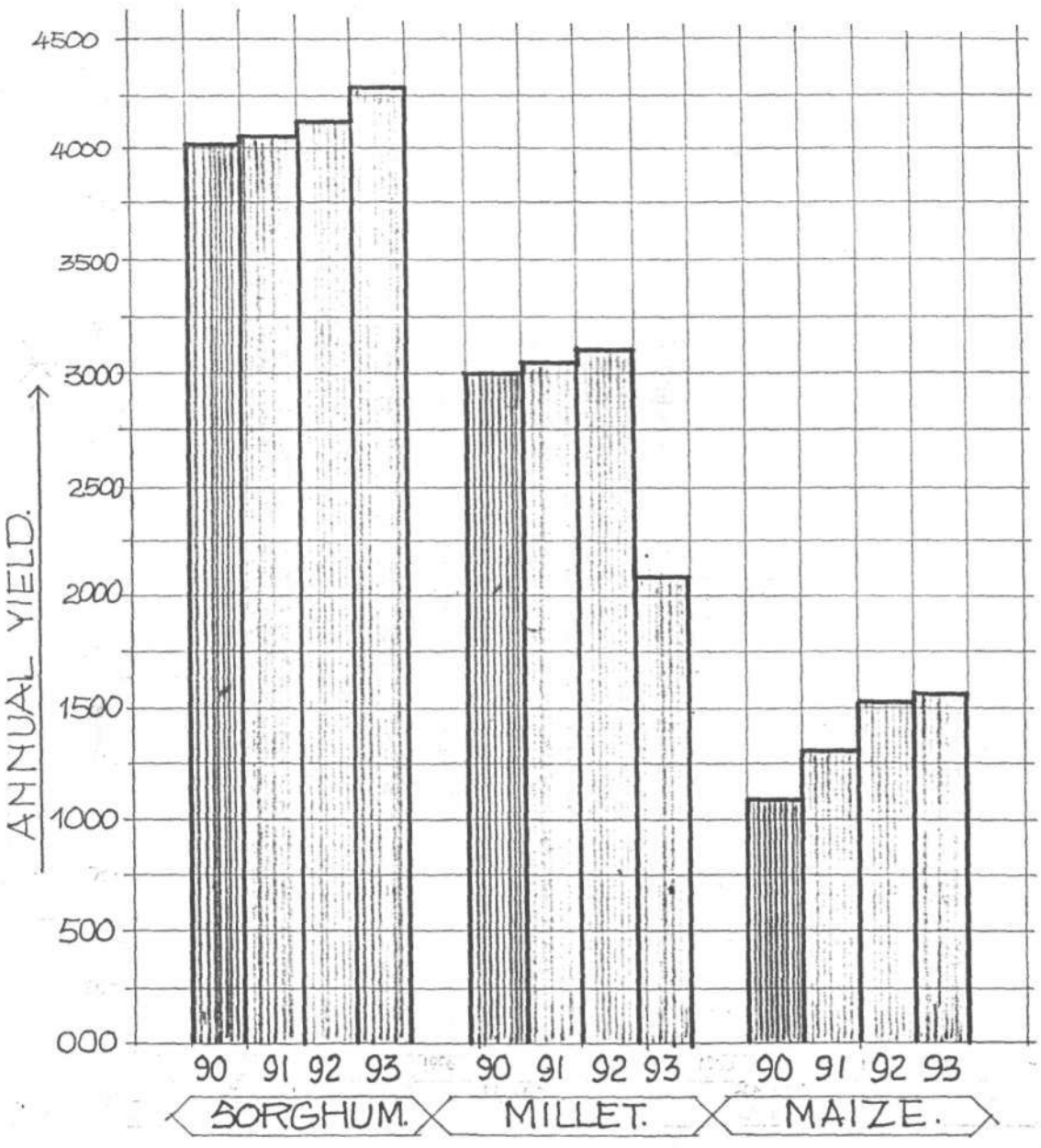
E). **Transportation:-** Lokoja enjoys a good network of roads. In addition to roads, water system of transportation is also used in this area. The two systems compliment each other perfectly in linking several towns and villages. However, the site chosen will only enjoy road transportation system to avoid the influence of the river on the relative humidity. The Koton-Karfe to Okene and Kabba highway which bye-passes the main town provides the access to the site.

F). **Public Utility:-** Electricity, water and telephone services will be tapped from the near by house of Assembly building.

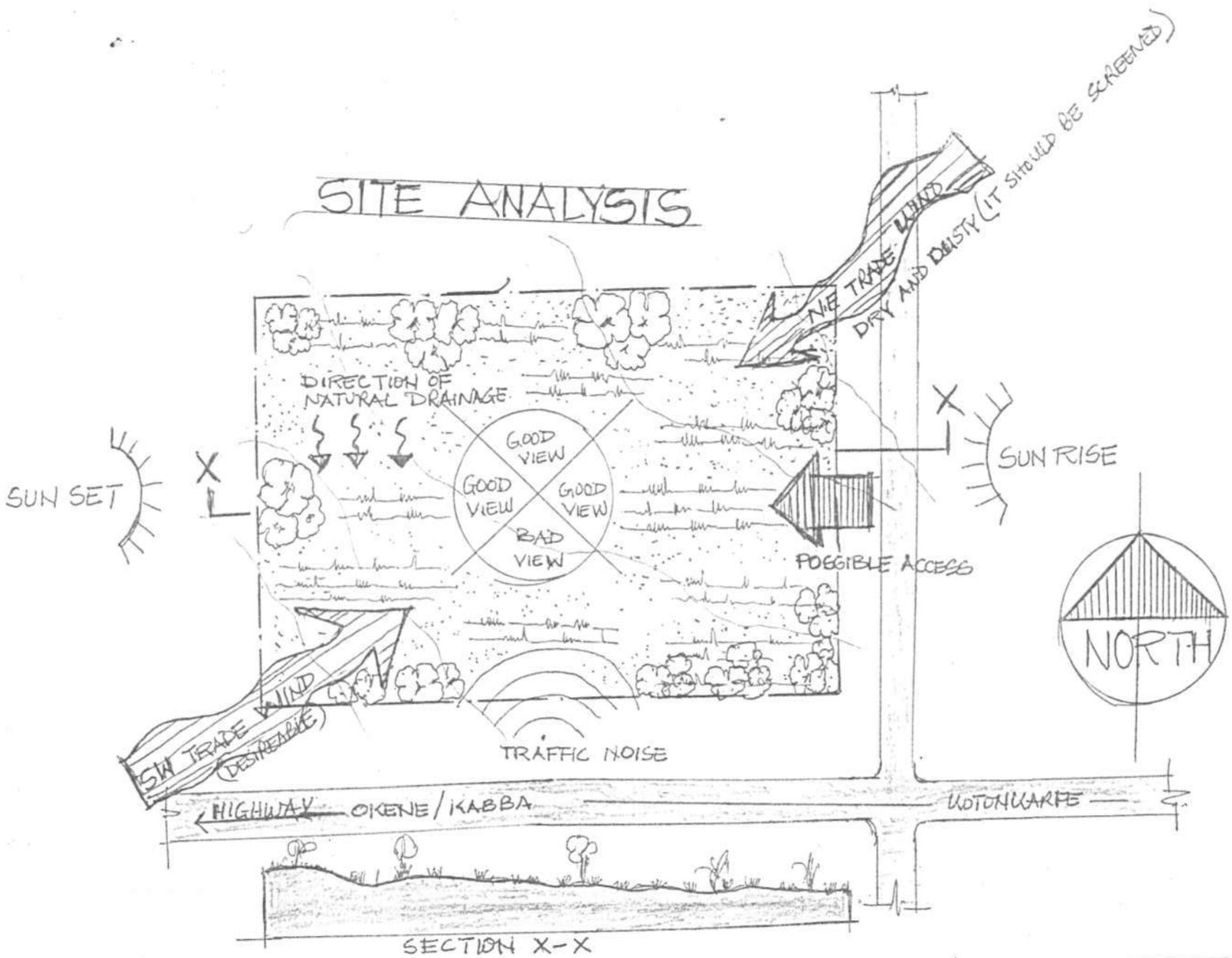
G). **Technology:-** Technical know-how and expert advice are within reach. The Kogi Agricultural Development Projects Lokoja and the Crop storage unit of the Federal Department of Agriculture, Abuja will provide the needed technical assistance. The engineering department of the Ajaokuta steel company can assist in the fabrications and maintenance of spare parts and machines respectively.



GRAINS PRODUCTION TREND IN KOGI STATE.



GRAINS PRODUCTION TREND IN NIGERIA.


SITE ANALYSIS
NE TRADE WIND
DRY AND DUSTY (IT SHOULD BE SCREENED)
DIRECTION OF NATURAL DRAINAGE
GOOD VIEW
GOOD VIEW
GOOD VIEW
BAD VIEW
SUN SET
SUN RISE
POSSIBLE ACCESS
NORTH
SW TRADE WIND (DESIRABLE)
TRAFFIC NOISE
HIGHWAY OKENE / KABBA
UDONGARFE
SECTION X-X

H). **Zoning**:- The project is located on the fringe of the industrial zone in the Lokoja land use map.

6.3. SITE ANALYSIS.

To achieve an articulated storage design, the inventory of all the forces, pressures and situations on and around the site is very necessary. The issues addressed are climate, geology, vegetation, topography, existing features and utilities, views from and of the site, surrounding traffic, zoning and setbacks.

6.3.1. CLIMATE.

Lokoja town lies within the middle belt region of the country. It is located in the southern part of Kogi local government area at the confluence of Benue and Niger rivers.

It has two main seasons. These are the rainy season from March to October, and the dry season from November to early part of March. Each season is characterised by a specific prevailing winds. The rainy season brings with it south westerly winds originating from the equatorial rain belt. It blows from the high pressure zones which occur over the Atlantic during this period. On the other hand, the dry season is usually accompanied by the harmattan. This is a dust-laden wind blowing from the North-East direction.

A). **TEMPERATURE.**

The town lies in the tropical climatic region. The maximum monthly mean temperature is 33.7^0c while the minimum monthly mean temperature is 22.7^0c. The hottest period is mid-February to mid-April. This period records a maximum temperature of 38.3^0c and a minimum of 25.8^0c.

B). RAINFALL.

Rainfall usually commences between the months of March and April. It signifies the commencement of farming activities. Though rainfall at this early stage is usually light and well spaced out. The highest rainfall is often recorded in the months of June to August. The mean annual rainfall is about 1280mm.

C). RELATIVE HUMIDITY.

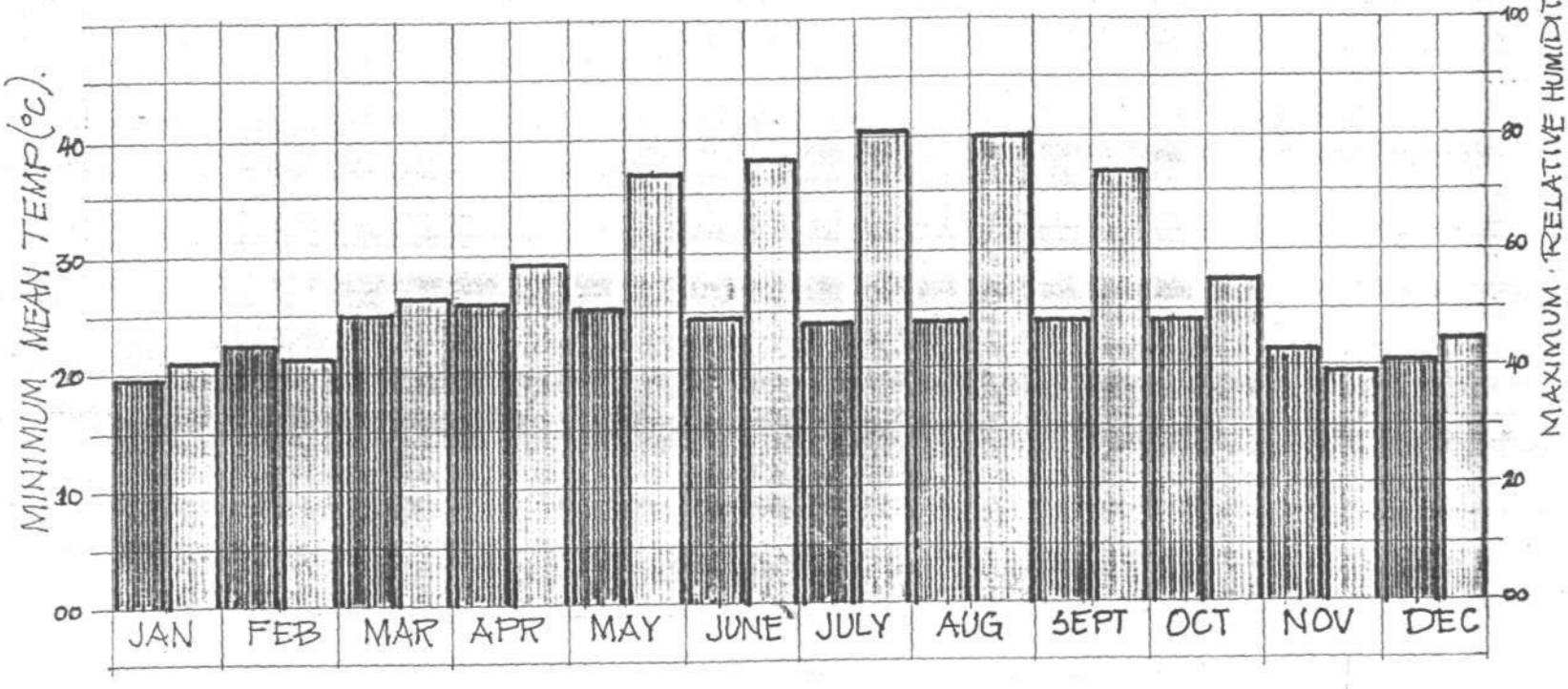
The relative humidity of the town during the dry season is about twenty-one percent. However, during the raining season it can rise as high as eighty-one percent.

The interplay of temperature and relative humidity determines the confortability of workers and users of the centre. In addition and more importantly is their influence on the longevity of the stored grains. The safest relative humidity for stored grains is below sixty-two percent, while that for human confort falls between thirty to seventy percent.

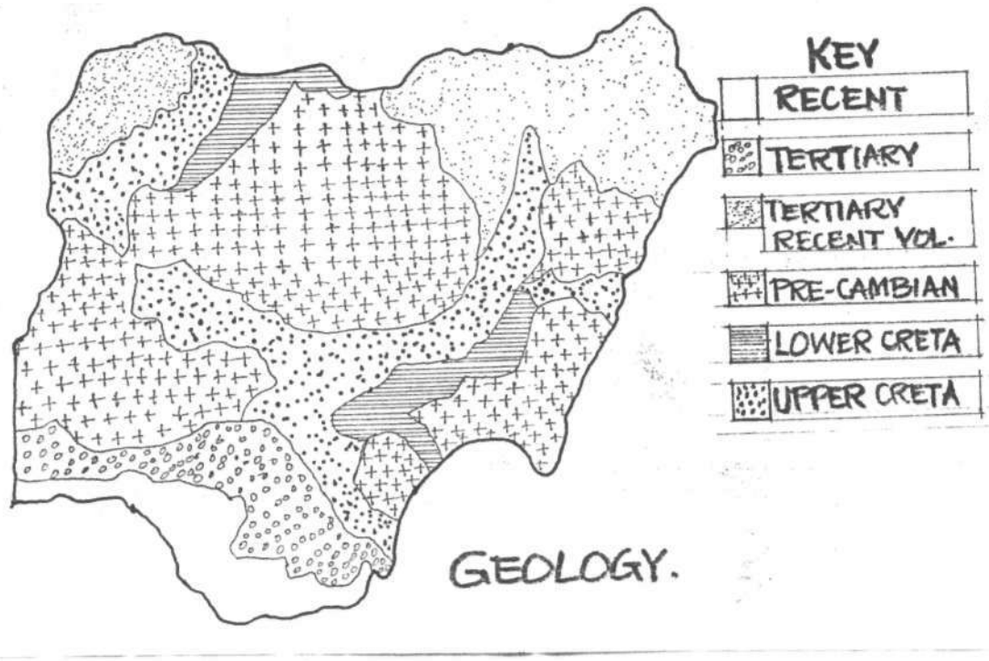
D). SUNSHINE AND RADIATION.

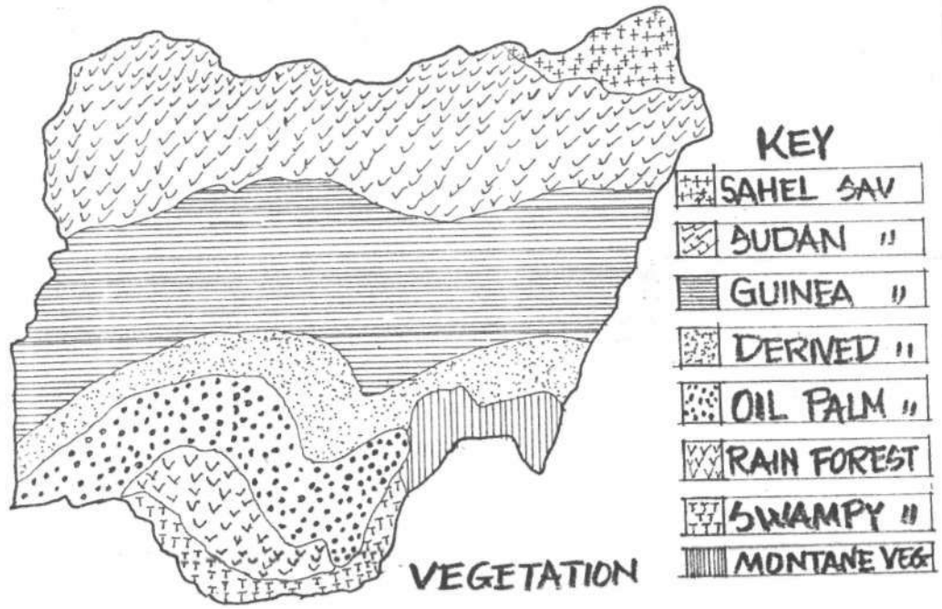
Lokoja town is in the tropics with a lot of sunshine. The sunshine hours are greatest during the months of December to march. The months of April to November witnesses less sunshine hours. The average daily sunshine period is eight hours, while the highest is nine hours.

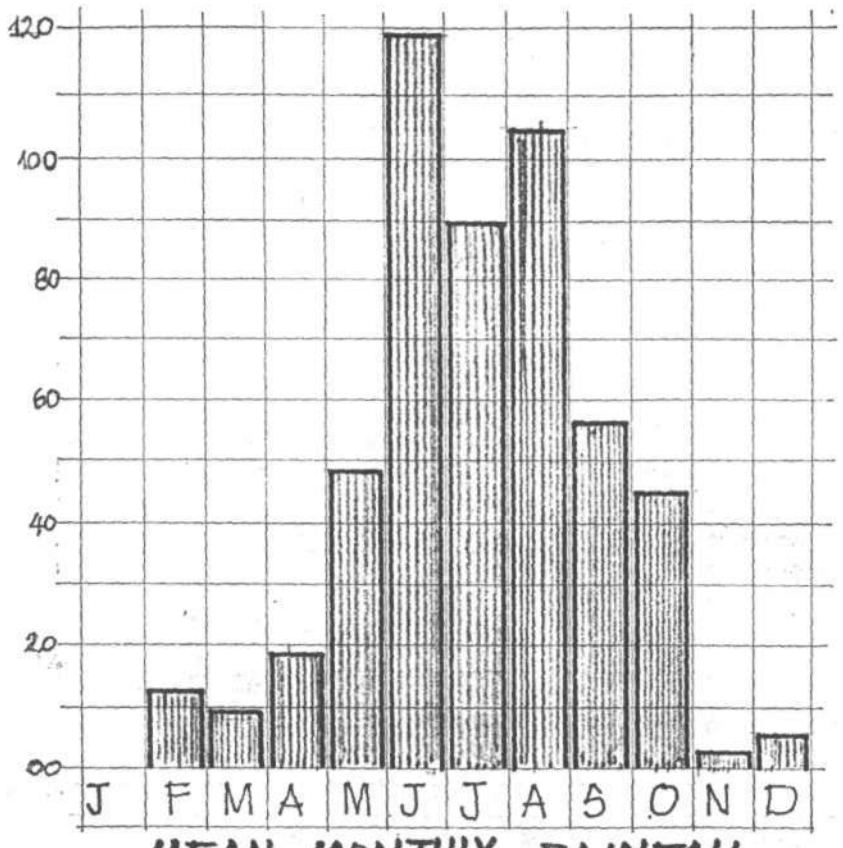
The heat generated by the sun's ray on the earth surface is higher in the months of November to March while the lowest heat radiation is recorded between the months of May to October.



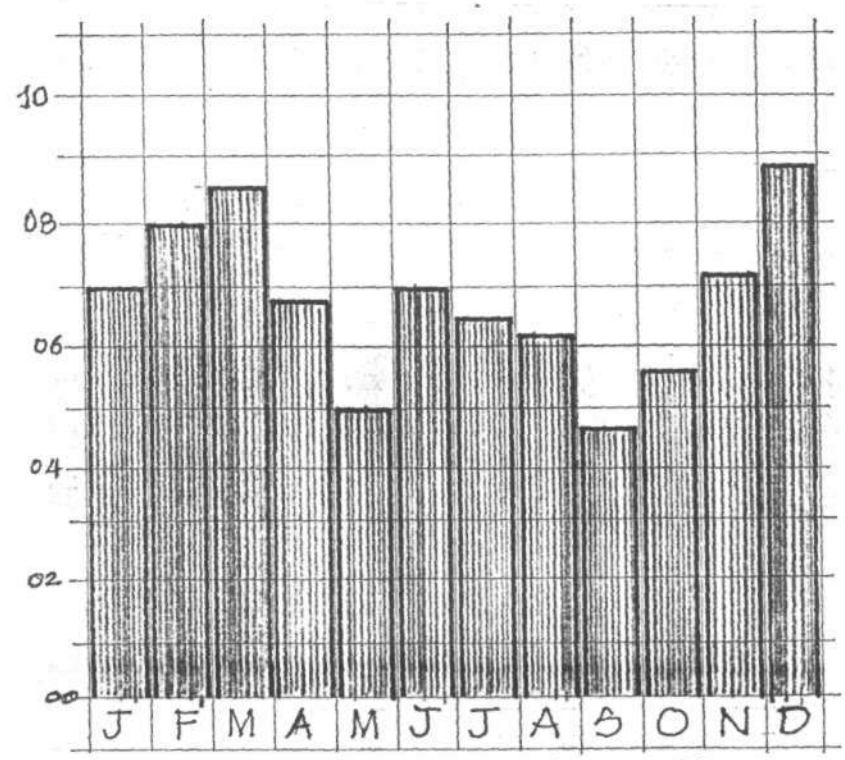
TEMPERATURE AND HUMIDITY (0900 HRS).


KEY
RECENT
TERTIARY
TERTIARY RECENT VOL.
PRE-CAMBIAN
LOWER CRETA
UPPER CRETA
GEOLOGY.


KEY
SAHEL SAV
SUDAN "
GUINEA "
DERIVED "
OIL PALM "
RAIN FOREST
SWAMPY "
MONTANE VEG
VEGETATION



MEAN MONTHLY RAINFALL



MEAN MONTHLY SUNSHINE HOURS.

6.3.2. GEOLOGY.

Lokoja and its surrounding areas are under lain by igneous and metamorphic rocks. This basement complex is composed mainly of granites, micas chists and meta sediments. It features a rough terrain with a mountainous landscape and high lying flat areas, forest and valleys.

6.3.3. VEGETATION.

The town is situated within the savanna wood land belt. It has a modified vegetation of thin soil cover. The vegetation is characterised by short grasses, trees of medium size up to four metres high or more. Most of the plains are exploited for cultivation. Frequent bush burning has reduced most of the vegetation to sparse acacia shrub.

6.3.4. TOPOGRAPHY.

The town is situated at the confluence of Rivers Niger and Benue. It lies on the west bank of the river Niger at an altitude of one hundred and twenty-five metres above sea level.

A high plateau dominates the north-west of the town. This plateau called Mount Patti reaches an altitude of four hundred metres above sea level. The town is penetrated by several streams which join either Mimi or river Niger. Most part of the town is characterised by an undulating land.

6.3.5. EXISTING FEATURES AND UTILITIES.

Presently the site and its environs is used for farming. Across the highway from the site are the House of Assembly building and the Judiciary. Also several metres away is the Kogi state Agricultural Development Projects headquarters. The Koton-Karfe to Okene highway passes close to the site. The northern, western and eastern sides of the site presents a scenic view of a horizon dotted with hills and valleys excitingly interwoven. There are few scattered trees on the site.

6.4. REFERENCES.

1. DAR AL-HANDASAH Consultants, Shair and Partners (1974). Lokoja Master plan. Nigeria.
2. Federal Surveys Dept. (19630. Lokoja Surveys maps, Lagos.
3. MAMMAH, I.D. (1985). Zaria Cereals Collection Centre - towards effective grains storage. Unpublished M.sc Thesis, Zaria.
4. TUNAU, F.A. (1991), Sokoto Grains centre - Architectural considerations of the traditional grain storage systems. Unpublished M.sc. Thesis, Zaria.

CHAPTER SEVEN

DESIGN PROPOSAL AND REPORTS

7.0. THE BRIEF.

The grains centre will be a joint venture between the Kogi state government and the seven local governments constituting the agricultural zone.

The centre will be responsible for the purchasing of grains from the farmers, storing and distribution of the stored grains when necessary. The beneficiaries of this scheme includes the civil servants, the general public and victims of disasters.

The distribution outlets will be through the ministries, parastatals, local governments and the people's consumer shops.

The centre will have the following facilities :-

1. **Gate house and truck weighing bridge:** The gate house is to control entry and exit from the centre. A bridge for weighing all in-coming and out-going trucks is also provided at the gate.

2. **Grains reception and grading:**- This unit consists of laboratory for pre storage tests, sorting / grading of grains, and in-take pit. Grains samples are tested in the laboratory before storage to determine its moisture content, The sorted or graded grains are sent into the temporary storage silos before the commencement of cleaning or into the drying hall.

3. **Processing Hall**:- This consists of the processing area, quality control laboratory, and stores for laboratory equipment and insecticides and waste materials.

4. **The storage facilities**:- These includes the silos, warehouses and the drying crib. The bagging unit is within the Warehouse area.

The cribs are raised on plinths with openings at the base. The floor is ducted to allow natural air pass from the base into the grains. The drying operation is quickened by the additional use of fan. The grain is warmed by the drying air during the day time fan operation while the heated grain serves as heat source for the cooler air during the night operation. The warmer air rises up and is removed through the vent.

The warehouses will only be used for short term storage. When demand for grains are received, they are called from the silos and bagged into 50kgs an 100kgs units. The bagged grains are then stored in the warehouse for immediate despatch.

The silos will serve the purpose of long term storage. The bulk of the grains are stored in the silos.

5). Administrative Unit: This unit will accommodate the administrative functions of the centre. The key departments in this unit are the Central administration, accounts, marketing and personnel.

6). Workers facilities : This unit will accommodate the changing rooms, toilets and shower, common room, first aid and the canteen.

7). Auxiliary facilities: This includes the generator room, spare parts stores, machinery stores, maintenance workshop and incinerator.

7.1. SPACE ANALYSIS AND REQUIREMENTS.

The calculation of the various spaces required is based on the analysis of each of them. The space sizes are determined by the nature of function it performs. Using the brief, the various spaces are allocated as shown below in the schedule of accommodation.

7.2. SCHEDULE OF ACCOMMODATION.

The average annual grains produced in the state stands at 303,107.5 metric tons. This figure is based on the production trend for the past four years (1993-1996).

The central zone produces about thirty-five percent of the state figure. This amounts to about 106.097 metric tons.

i.e. $\frac{35}{100} \times 303{,}107.5 = 106.097$ tons

It is projected that government through the centre will purchase about five percent of the grains produced in this zone.

i.e. $\frac{5}{100} \times 106{,}097 = 5{,}304.9$ tons

Based on the above, the storage capacity of the centre will be estimated at 6,000 tons. The breakdown of the grains to be stored in the centre are:

1. Maize = 3,000 tons
2. Sorghum = 2,000 tons
3. Rice = 1,000 tons

Total = 6,000 tons

ACCOMMODATION	USAGE/DESCRIPTION STORAGE	No. RQD.	AREA (M^2)
Silos	For long term storage of grains, a silo of capacity 500 tons is adopted	12 Nos.	Floor area/silo = 38.5m^2 : 12x38.5 = 462.0m^2
Cribs	For drying of grains to the safe moisture content level before storage	2 Nos.	120.0m^2/crib : 2x120 = 240.0m^2

Warehouses	For storage of bagged grains awaiting despatch. A warehouse of size 15mx21m can store 500 tons.	3 Nos.	Area/warehouse = 315m^2 : 3 warehouses = 3x315 = 945.0m^2
Loading and unloading bays	For loading of grains for despatch and unloading of grains respectively	1 each	Allow 20% of gross floor area of storage spaces. = 945.0 + 240.0 + 462.0 = 1647.0 $\frac{20 \times 1647.0}{100}$ = 329.4m^2 Total = 1976.4m^2
PROCESSING HALL			
Grains reception sorting and grading	Grains are sorted and graded	1 No.	360m^2
Processing Hall	Cleaning of grains and separation of good from bad grains. 3 processing limes. Alvan Blanch machines require about 9.0m^2 of space. The machine has a cleaning capacity of 10 tons/hr 2 operators/machine require 2.0m^2 of space. Housing the elevator that takes grains from the intake pit	3 Nos. 6 pers. 1 No.	Area/machine 9.0 x 3 27.0m^2 6x2.0 = 12.0m^2 36.0m^2
Bagging and weighing machines	Cleaned grains are bagged and weighed simultaneously. Each bagging unit requires about 15.0m^2 and 4 labour hands and 1 operator @ 2.0m^2 / pers.	3 Nos. 15 persons	machine area = 3 x 15 = 45.0m^2 Area = 15 x 2 = 30.0m^2
Laboratories and Quality control	Pre-storage and post-storage test to determine grains quality and conditions are done in the laboratories	2 Nos.	Area/lab = 7.0m^2 : 2 Labs = 2 x 27.0 = 54.0m^2

Control Panel room	Panel controlling all the silos, machines and conveyor systems are located here	1 No.	13.5m^2
Stores	For storage of pesticides and Laboratory equipment and waste materials.	2 Nos.	Allow for 54.0m^2 per store : 2 stores = 2x54.0 = 108.0m^2
Grains conditioning and treatment	Grains intended for long term storage are treated with chemicals here and sent into the silos or stored grains ready for consumption are conditioned here before being sent to the bagging unit. Each unit requires 15.0m^2	3 Nos.	Area required = 3x 15 =45.0m^2 Total = 730.5m^2
ADMINISTRATIVE UNIT			
Gate house and Scale room	The security men control entry and exit into and from the centre respectively. The scale room is used for weighing of trucks in coming or out-going.	1 No.	12.5m^2
Entrance / reception and waiting.	The main entrance and reception area Visitors to the centre also wait in this place	1No.	40.5m^2
General office.	Provide accommodation for 2 typists, 2 clerks and 2 messengers	1 No. Office	27.0m^2
Personnel Officer	Provide space for 1 Officer in charge of personnel matters.	1 No. office	13.5m^2
Public Relations officer	Provide for 1 officer	1 No.	13.5m^2
Purchasing officer	Provide for 1 Officer	1 No.	13.5m^2
Purchasing clerks	Provide for 2 clerks	1 No.	13.5m^2

Sales officer	Provide for I Officer	1 No.	13.5m^2
Sales clerks	Provide for 2 clerks	1 No.	13.5m^2
Research/Statistics Officer	Provide for 1 Officer	1 No.	13.5m^2
Auditor	Provide for 1 Officer	1 No.	13.5m^2
Inspectorate	Provide for 1 Officer	1 No.	13.5m^2
Accountant	Provide for 1 Officer safe and Cabinet	1 No.	33.75m^2
Accounts Clerks	Provide for 2 clerks	1 No.	13.5m^2
General Manager	Provide for settee for visitors. Cabinet, desk and chairs.	1 No.	27.0m^2
Secretary	Provide for chairs, File cabinet. and waiting.	1 No.	27.0m^2
General Store	Provide for storage of stationeries and office materials.	1 No.	20.25m^2
Toilets and cleaners	Provide 2 toilets each for male and female workers and store for cleaners kits.	1 No.	21.0m^2
		Total =	344.00m^2
WORKERS FACILITIES.			
Changing rooms	Provide lockers for workers changing into work clothes for 45 labourers at 1.0m^2/per.	1No.	45.0m^2
Shower, WC and Wash hand.	Provide 1 WC, Shower and wash hand for 10 pers.	5 No.	27.0m^2
Common room	For relaxation and games during break time	1 No.	63.0m^2
Canteen	To serve 40 persons at a time	1 No.	63.0m^2

KAS ... RY

Kitchen / Store	For cooking and storage of food items	1 No.	56.25m²
First Aid	For consultation with Nurse or visiting Doctor. Receiving injection/treatment.	2 No.	27.0m²
		Total = 281.25m²	
	AUXILIARY UNIT.		
Workshop	For servicing and repairs of vehicles, machines and equipment.	1 No.	70.0m²
Store	For machinery and spare parts.	1 No.	45.0m²
Generator room	For standby generating plant	1 No.	20.25m²
Incinerator	For waste disposal	1 No.	13.5m²
Parking for cars, trucks and bicycles / motor cycles.	Parking spaces for staff and visitors.	3 Nos.	233.0m²
		TOTAL = 381. 75m²	

Allow for 50% internal circulation = 1846.83 + 3,693.65 = 5,540.48

Provide 50% for expansion = 2770.24 + 5540.48 = 8,310.72

Provide for 20% for external circulation = 1, 662.14 + 8, 310.72 = 9972.86

7.3. FUNCTIONAL RELATIONSHIP.

Grains are brought to the centre by trucks or trailers. The trucks are weighed at the gate, and samples of the grains are collected and inspected. The grains that meet the required standard are then received at the reception area. The grains are then discharged into the intake pit. A conveyor system takes them into sorting and grading machines. Test for quality and moisture content level of the grains are done simultaneously. The sorted grains are then weighed and sent into the silos or crib.

The grains are later sent into the processing hall for cleaning and conditioning. The conditioned and treated grains are sent into the silos for long term storage while bad grains and waste materials are bagged and sent into the waste materials store.

The stored grains are returned to the processing hall, re-conditioned and bagged whenever they are needed for consumption. The bagged grains are then moved into the warehouses for despatch.

The workers facilities and the administrative unit are arranged side by side with courtyards separating them. A walkway and the common room provide the linkage between the two. The clinic and the changing rooms are very close to the processing hall and are easily accessible to the workers parking area. There is a direct access from the entrance hall to the processing and loading or un-loading areas.

The Auxiliary facilities are accessible to all the other units, it is separated from them by the circulation area for delivery and dispatch of grains.

7.4. DESIGN REPORT.

7.4.1. CIRCULATION.

A). **Grains:** Grains arrive in trucks through the gate to the reception and sorting area. Quality control officers check the sample and certify grains condition. The certified grains are then received and poured into the inlet pits. A system of bucket type elevator takes the grains into the sorting and grading machines. Impurities and extraneous materials are removed. The grains are graded into big and small sizes. The graded grains are then moved into the crib for drying or silos for temporary storage by both conveyor and elevator.

The grains move from the crib or temporary storage by the conveyor to the processing hall where they are let into a pit. The elevator is used in taking up the grains into the cleaning machines and the conditioning machines. From cleaning and conditioning, it is sent into the silo for long term storage or bagging machines. The bagged grains are removed by people and loaded on a fork lift which takes them to the warehouses. From the warehouses the grains are loaded unto trucks for despatch by people. The bagging machine has a weighing device attached to it.

B). **Staff and clients:** The staff and clients come through the gate either on foot, machines or bicycles, or cars. Those on foot move along the paved walkway to either the reception and the administrative unit or the workers facilities. Those that come in cars or machines get to the parking and walk on the paved walkway to either the administrative unit through the reception or direct to the workers facilities.

7.4.2. CLIMATIC CONTROL.

A). **Temperature control:-** As mentioned earlier, temperature is one of the most important variables in designing a grains storage centre. To achieve temperature control, the following measures were taken:

i). **Building orientation:** The longer axis of the structures of the complex are orientated along the N.E-S.W direction. Window openings along this axis ensures a better average indoor air velocity and distribution.

ii). **Shading** : Shading reduces the amount of solar heat absorption by the structures. This is achieved by the use of trees, canopies, shading devices, extension of roof over hangs and louvered shutters.

iii). Planning: The integration of open spaces and courtyards in the complex enhances free flow of air. This enhances good ventilation of the entire complex.

iv). Materials: Sandcrete hollow blocks are used for the walling of the structures on the complex. Burnt bricks are used as facing on the external surface to improve its heat insulating capacity.

Amiantus asbestos roofing sheets are also used as wall cladding on the eastern and western sides of the warehouse and processing hall.

The silos are constructed with galvanised steel welded together. The external surfaces are painted with aluminium paints.

The roofs are painted with aluminium paints to reduce the heat absorption.

vi). Mechanical devices: Fans and or air conditioners are also used in the administrative unit. Fans are also used in the silos and drying cribs to control temperature.

vii). Building shape: The shape of building influences the amount of solar heat it can absorb. Circular or round and square buildings have less surface areas exposed tc the sun than rectangular buildings.

b). Humidity control: Humidity is the other most important factor in storage design. Humidity control is achieved by the use of the following measures.

i). Plinths: The floors of the warehouse, silos, processing hall and the drying crib are raised about 1.0m above the ground level. This reduces the possibility of surface water entering the structure.

ii). Damp proof membrane: Damp proof materials are laid between the floor slabs and hard core, to prevent moisture migration from the ground into the stores and structures. Rubber washers are used to cover all bolts and screws in the roof. Similarly all the expansion joints are filled with bitumen felt.

iii). **Chemical dehumidifiers**: Chemical dehumidifiers are used to absorb moisture from the enclosure. They are in the form of powder or granules. They save cost and energy consumption.

iv). **Drainage**: Proper drainage gutters for surface run-off water and roof water enhances the speedy evacuation of water from the site and building surroundings. The immediate surrounding of the structures are paved and slanted away from the footing.

7.4.3. MAINTENANCE OF STORAGE ENVIRONMENT:

The maintenance of both the external and internal environment of the storage facilities is very important. A clean warehouse and premises presents a better company image to visitors and clients. This will further prevent insect and rodents encroachment into the storage premises. The open spaces should be planted with lawns and trees. The lawns should be properly maintained. Also waste disposal facility is provided to rid the premises of waste materials.

The silos and warehouse should be cleaned and fumigated before and after a storage session, this will enhance favourable environment for grains storage.

7.5. ARCHITECTURAL DESIGN VARIABLES IN THE CENTRE.

7.5.1. CULTURE:

The traditional system of raising the storage structures and cribs on stone or wooden stands has been translated into the design. The drying crib is raised on concrete piles spaced at 3.0m interval with void between the piles. The void allows natural air to get into the grains through the perforated false floor of the crib. It rises up and gets expelled by the exhaust fan at the openings close to the roof. The crib uses the principle of stack effect to dry the grains.

7.5.2. VENTILATION:

Emphasis is placed on natural ventilation in most of the structures of this complex except the silos that are air tight. Louvred glass windows are used to enhance maximum air entry into the room spaces. Roof vents are provided in the warehouses, processing hall and the drying crib in addition to the fan. Walkways and corridors are wide enough to allow for adequate air circulation.

7.5.3. LIGHTING:

All the buildings on the complex are lighted using natural light. However, the drying crib is provided with both artificial and natural lighting. Roof lighting are provided at the processing hall, the drying crib and the warehouses.

7.5.4. MATERIALS AND CONSTRUCTION.

a). Reinforced concrete: This is used for the floor slab and pavement for the walkways and roof covering for the corridors; The loading bay canopy is also made of concrete. All the structural columns, beams and lintels are of concrete, Parapet walls, gutters and shading devices are constructed with concrete.

b). Burnt bricks: This is used as facing elements on the buildings except the incinerator that is built of burnt brick entirely.

c). Sandcrete hollow blocks: All the block walls of the buildings are constructed with sandcrete hollow blocks, with exception of the incinerator and the silos.

d). Glass : Glass is used for the windows and the main entrance door.

e). Steel : The silos warehouse doors, gates and workers entrance doors are made of steel. The horizontal shading devices are made of steel. Steel portal frames are used in the crib, processing hall, warehouses and auxiliary units.

f). Butyl Rubber and bituminous felt : These are used as damp proof membranes.

g). Timber : The crib's false floor is constructed using treated timber boards.

h). Amianthus roofing sheet : Used as cladding on the east and West walls of the warehouse and processing hall.

I). Mortar and plaster : The walls are rendered smooth with cement-lime-sand mortar in the ratio of 1:2:9 or 1:1:6. The internal rendering should be very smooth for ease of cleaning.

j). Paint : White lime and aluminium paint are used because of their reflective qualities. Light coloured and reflective surfaces absorb lesser solar radiation.

The absorption coefficient for light surfaces is about 0.5, for medium surfaces it is about 0.8; with dark surfaces it is as high as 0.9.

7.5.5. STRUCTURAL STABILITY.

The processing hall has the longest span of 30m. Solid web steel portal frame encased in concrete is used as the structural element in the processing hall, warehouses, drying crib and grains reception area. The concrete roof slab of the walkways are supported by a network of columns and beams. Silos sizes are based on the structural specifications of tower silos limited.

7.5.6. TRAFFIC.

Pedestrian, light vehicles and heavy vehicles traffic are effectively segregated and defined. Parking facilities are provided for cars, motor cycles and bicycles, and trucks that bring in and carry out grains. All traffic come through a single gate.

7.5.7. SECURITY.

The site boundary is fenced round to check unwanted entry by people and animals. One entry point which is the gate is provided with security post. They control and check both entry and exit of people.

7.5.8. ECONOMY.

Economy is achieved in the articulated use of spaces. The choice of steel over concrete for the silos construction is dictated by economy. In view of the increasing labour unrest and demand for wage increases, the use of conveyors and elevators and machinery in performing most of the activities is justified.

7.5.9. RHYTHM.

The use of vertical and horizontal elements in composing the elevations present a harmonious entity. The spacing of columns and openings all have a rhythmic pattern.

7.6.0. MAINTENANCE.

Maintenance of the machines, equipment and the entire complex is very necessary for the continued functioning of the complex.

The machines, conveyor systems and equipment must be serviced routinely. This could be done during the lull period of activity.

The warehouse premises should be cleaned and fumigated before and after grains storage to kill all insects that might be available and remove any debris of the old grains. Rodent and insect guards should be provided.

The silos are cleaned using the suction fan to draw out any debris left behind after evacuating the grains. Cleaning and fumigation should be carried out before and after any storage period.

7.6.1. BUILDING REGULATIONS.

The right of ways for access roads of 20m and 30m for major roads are maintained in this design. There is provision for waste disposal and fire hydrants.

7.6.2. FUTURE EXPANSION.

Future expansion of the storage facilities is towards the northern side of the site.

7.6.3. REFERENCES.

1. RANSOM, W.H. (1960); Buildings for the storage of Crops in warm climates. Tropical Building Studies, No. 2.
2. R. BARRY; (1984); The Construction of Buildings. Richard Clay (The Chaucer press) Ltd; Bungay, Suffolk. Vol.3.
4. WELLEN JOHN. B. (1965); Farm buildings : Techniques and materials. Vol.II.

CHAPTER EIGHT: SUMMARY AND CONCLUSION.

8.0. SUMMARY.

In most parts of Nigeria, farmers store their grains and other crops in traditional storage facilities constructed from locally available materials. However, these existing on-farm storage facilities are not adequate and their performance is not satisfactory. About 30% of grains stored in these structures are often lost to insects, rodents and birds, and micro-organisms, fire and theft.

Reduction of these huge loses is an acknowledged means of increasing the available food supply. On this premise, the research sought to understand the causes and means of curtailing the losses.

Grains storage practices are influenced by several factors. The predominant factors are culture of the people, the climatic conditions, available construction materials, the economy of the people or family and the political discretion of government. These over riding factors have greatly influenced the type, size and location of storage structures.

Post-harvest grains losses are caused by several agents and actions. Losses occur right from the pre-storage through the storage periods in the post-harvest operations.

The pre-storage grains losses occur during harvesting, shelling and threshing, drying and processing. The extent of loss depends on the method employed in carrying out these activities.

However, grains losses during storage are caused by insects, rodents and birds, micro-organisms and mites. the activities of these agents have caused severe losses and deterioration of stored grains. The storage environment also affects the stored grains. It determines the extent to which grains can be successfully stored.

Handling of grains during and after harvest is an important operation in the grains production system. It is a major determinant of the quality of grains available for storage or consumption.

The main objective of grain storage whether in the traditional structures or modern one is to protect grains from agents of destruction and ensuring its availability in times of need. It is very pertinent that an efficient storage structure should be able to protect stored grains from water, contamination, rodents, insects, micro-organisms and fire.

8.1. CONCLUSION.

Grains production and demand in the country has undergone changes in the last few decades. The increased food production in recent times has strained the performance of the existing methods of handling, storing and processing. The resultant effect is increased food losses. There is no doubt of the importance of reduction of grains loss to governments as a means of increasing food availability in view of the rising costs of fertilizers and pesticides.

Lokoja grains storage centre is aimed at reducing grains losses during storage and providing conducive storage environment for long term storage. This will cushion the impact of governments recent policy on removal of subsidy on fertilizer. The center has a defined distribution channel through the ministries, parastatals and the peoples consumer shops.

The centre comprises of the administrative, workers facilities, processing and storage units well articulated to provide a favourable environment for grains storage and workers.

Available scientific data on climates, storage structures and materials, socio-economic and agricultural trends were studied and converted into useful design parameters. Temperature and humidity which play a significant role in grain storage was given a prominent consideration in the design.

Temperature is controlled using tree planting and lawns to reduce heat absorption and emission. Courtyards and open spaces were effectively integrated to enhance good ventilation. The storage facilities like the warehouse and the crib have roof vents and fan for cooling the storage environment. The silos are installed with exhaust fan for maintaining the cool environment required by the grains.
The design of the crib with its perforated floor allows the use of natural air to cool and dry the grains.

To control humidity, around the storage areas, open spaces were effectively integrated into the design. This allows free flow of air thus dissipating any moisture accumulation within the surrounding. The natural slope of the site was utilised to achieve surface water drainage, and gutters are provided around the buildings. The storage structures are raised above the ground by about 1.0m.

To achieve long term storage, the grains are dried to a moisture content below 10% using the dryer and stored in silos under controlled temperature and humidity.

The silos and warehouses can be expanded to meet future needs without constraints.

It is recommended that the centre be constructed in two phases; The phase one development should include the construction of the administrative, workers facilities, processing hall, warehouses and three each of the pre and post-processing storage silos. The Phase two will include the completion of the remaining silos and the cribs.

The implementation of this design will not only ensure reduction in post-harvest grain losses but will make the availability of grains constant thus achieving consumer price stability.

BIBLIOGRAPHY.

BOOKS.

1. AGBOOLA, S.D; (1985). Effective Post-harvest losss preventio as a major contributory factor to Nigerian self reliance in food. I.A.R; A.B.U; Zaria.
2. ANON. (1978). Priorities for action in grain post-harvest loss reduction. GASGA, London.
3. ASIEDU, J.J. (1989). Processing Tropical Crops. Macmillan Education Ltd., Hampshire.
4. ANDERSON, J.A. and ALCOCK, A.W. (editors) 1954. Storage of Cereal grains and their Products. St. Paul, Minnesota, America.
5. AYERTEY, J.N. (1980). Towards a reduction of Post-harvest grain losses in Northern Nigeria. I.A.R; A.B.U; Zaria.
6. BAILEY, C.H. (1940). Respiration of cereal grains and flaxseed. Plant Physiol. 15:257 - 274.
7. BARTON, L.V. and GARMAN, H.R. (1946). Effect of age and storage condition of seeds on the yields of certain plants. Boyce Thompson Inst. Contrib. 14: 243-255.
8. BARTONY, N. and CHERNOV, I. (1989). Architectural Engineering. M.R. Publishers, moscow, pp.250-306.
9. BOURNE, M.C. (1977). Post-harvest food loss - the neglected dimension in increasing the world food supply. Cornell International Agriculture Mimeograph, 53.
10. BROWN, C.W; and MYERS, A. (1960). Long term Cereal storage. Agr. Gaz. N.S. Wales 71: 348-355.
11. BROOKER, B.DONALD. (1981). Drying Cereal Grains. The AVI publishing company, Inc.. Westport, Connecticut.

12. CHRISTENSEN, C.M. (1974). Storage of Cereal Grains and their Products; 2nd edition; St. Paul, Minnesota.

13. GNIADZIK, J.S. (1984). Structural Systems in Architecture. A.B.U; Zaria.

14. JARMUL, S. (1980). The archtects guide to energy Conservation - Realistic energy planning for buildings. The Kings-port press, USA.

15. MAMMAN, I.D. (1985). Zaria Cereal Collection and distribution Centre - towards effective staple grains storage system. Unpublished M.sc. Thesis, A.B.U; Zaria.

16. NATIONAL ACADEMY OF SCIENCES. (1978). Post-harvest food losses in Developing Countries. Washington, D.C.

17. NEUFERT, E. (1970). Architects Data. William Clowes Ltd; London.

18. OREN, L.J. and BASS, N.L. (1979). Principles and practices of seed storage. Castle house Publications Ltd; London.

19. OWEN, B.E. (1957). The Storage of seeds for Maintenance of ciability. Commonwealth Agricultural Bureaux; England.

20. OXLEY,T.A. (1948). Scientific Principles of grains Storage. The northern publishing company Ltd; Liverpool.

21. ROBERTS, H.E. (Editor) (1972). Viability of seeds. Fletcher and son Ltd. Great Britain.

22. ROSS, I.J. and WHITE, G.M. (1973). Principles of storage. Macmillan publishers, pp. 8-13.

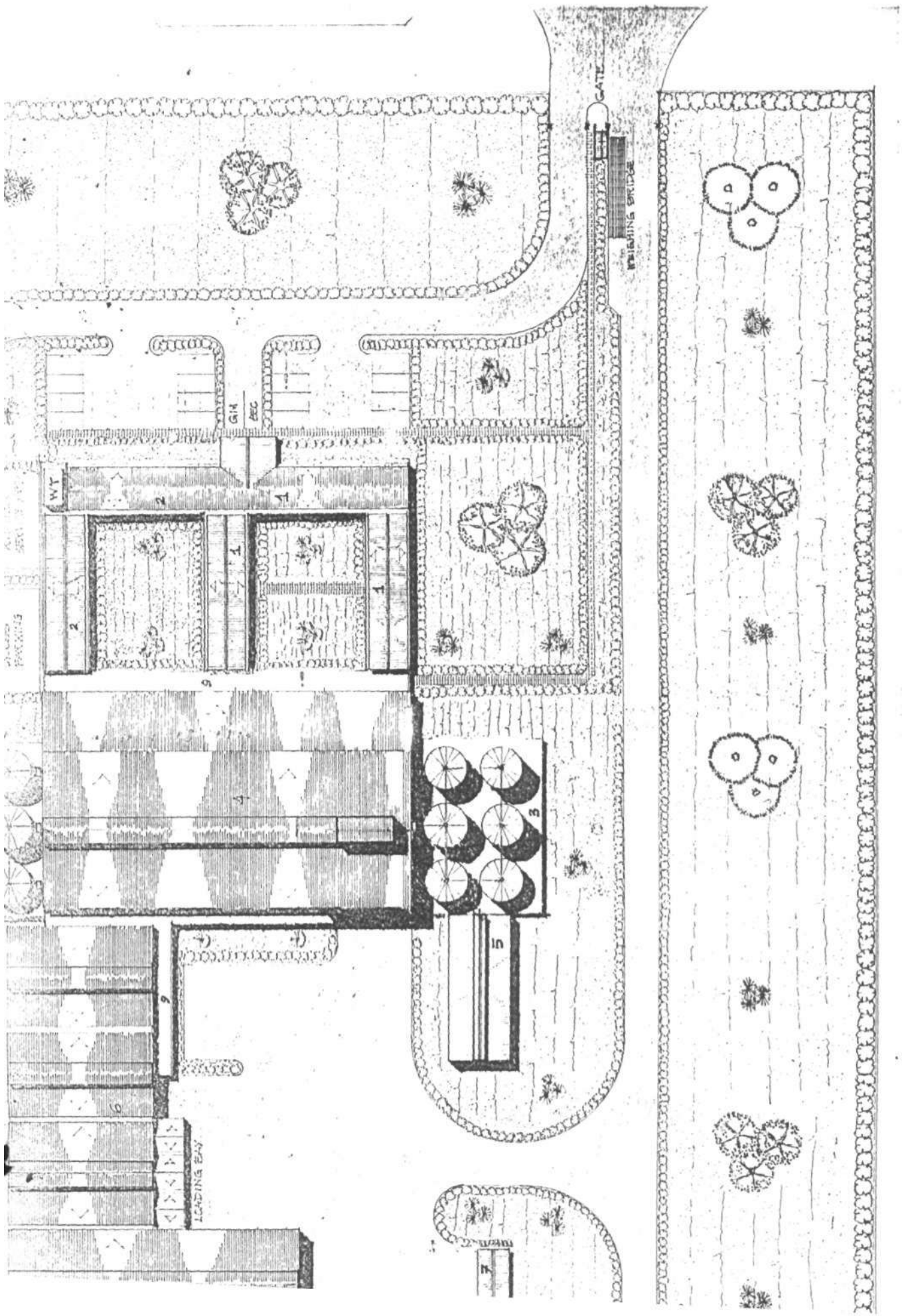
23. SMITH, C.V. (1969). Meterology and grain storage. World Meteological Association, Geneva.

24. TUNAU, F.A. (1991). Sokoto grains Centre - architectural considerations of the traditional grains storage system. Unpublished M.sc. Thesis, A.B.U. Zaria.

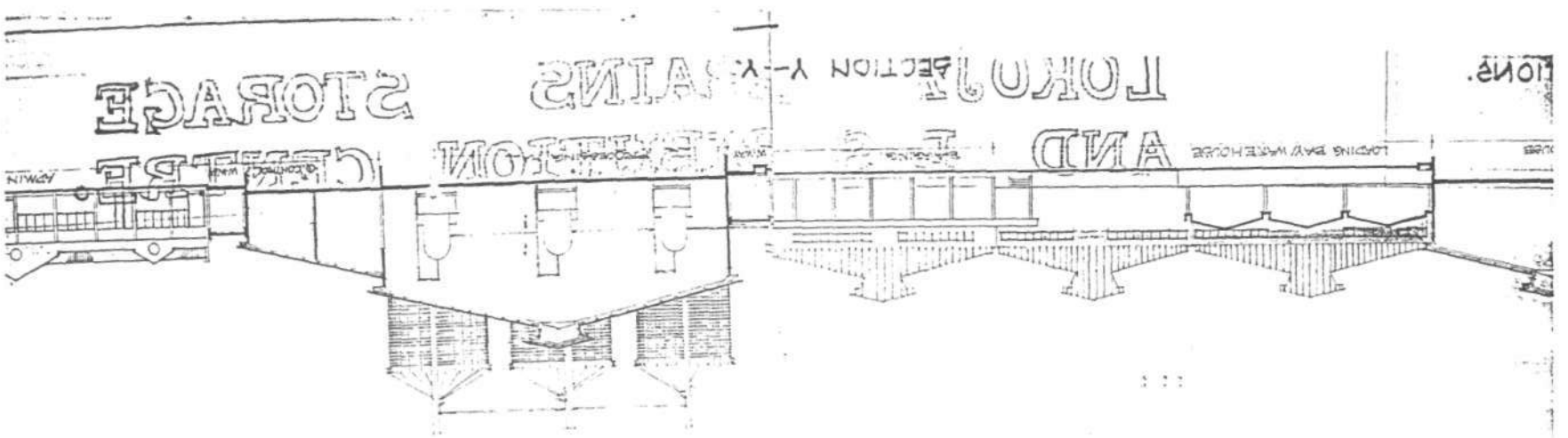
25. UDOSEN, N.S. (1979). Grains storage and distribution Centre. Unpublished M.sc. Thesis, A.B.U; Zaria.

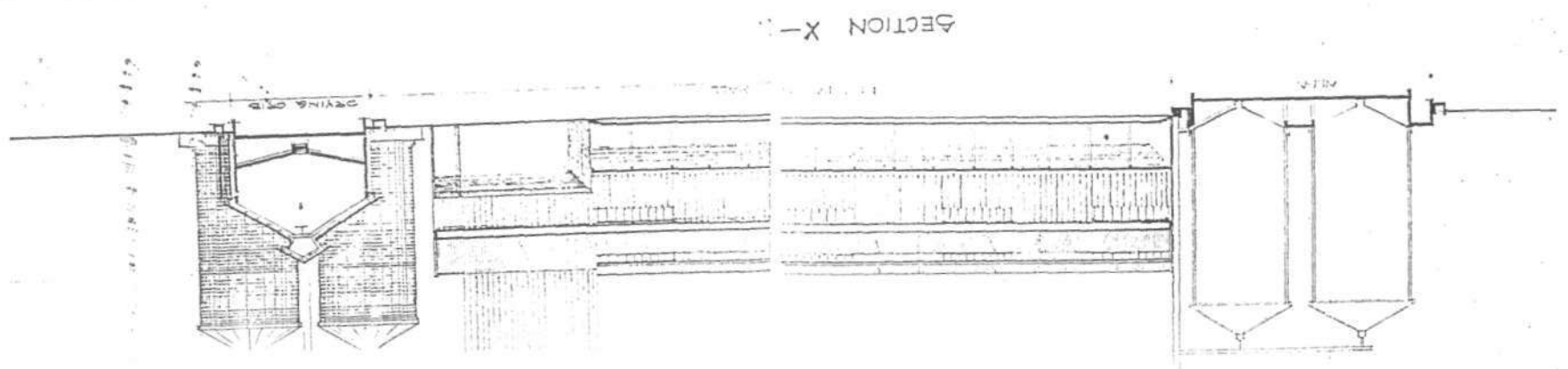
JOURNALS AND PAPERS.

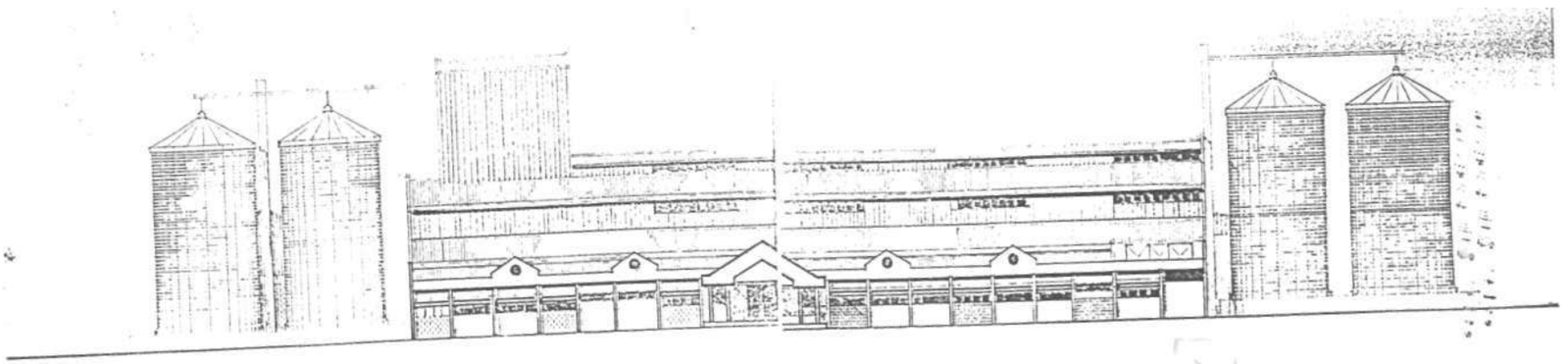
1. AERLS / NSPRI (1988). Workshop proceedings on post-harvest losses. A.B.U; Zaria.
2. AGRODOK 31. (1990). The storage of tropical agricultural products. Netherlands.
3. BUNGUDU, L.M. (1984). Storage of farm products by farmers in my village. I.A.R. Agric seminar paper.
4. CASH WELL, G.H. (1975). Grain storage problems in Nigeria. Samaru Agricultural Newsletter, Vol.17, No.1.
5. GILES, P.H. (1965). The storage of cereals by farmers in Northern Nigeria; I.A.R; Samaru, Newsletter, S.R.B. No.42, pg. 197.
6. OYEBANJI, A.O. (1995). Storage and storage pests control in grains. Paper presented at Kogi state A.D.P. Lokoja.
7. PEDERSON, R.J. (1981). The role of grain storage in quality preservation. Recent advances in Food science and Technology. Vol.1, pg. 343-354.
8. TROPICAL DEVELOPMENT AND RESEACH INSTITUTE (1986). A Critical review of the methodology for assessing farm level grain losses after harvest. G.191, pg. 22-49.
9. TROPICAL STORED PRODUCTS INSTITUTE. Food storage journals. No.40/1981; No. 49/1984, No.50/1984.
10. CROP STORAGE UNIT, FDA. Improved indoor Metal bins for on-farm grain storage.
11. CROP STORAGE UNIT, FDA. Improved indoor and outdoor non-metallic storage structures for on-farm grain storage.


GATE
GIH
DEC
WT
LOADING BAY

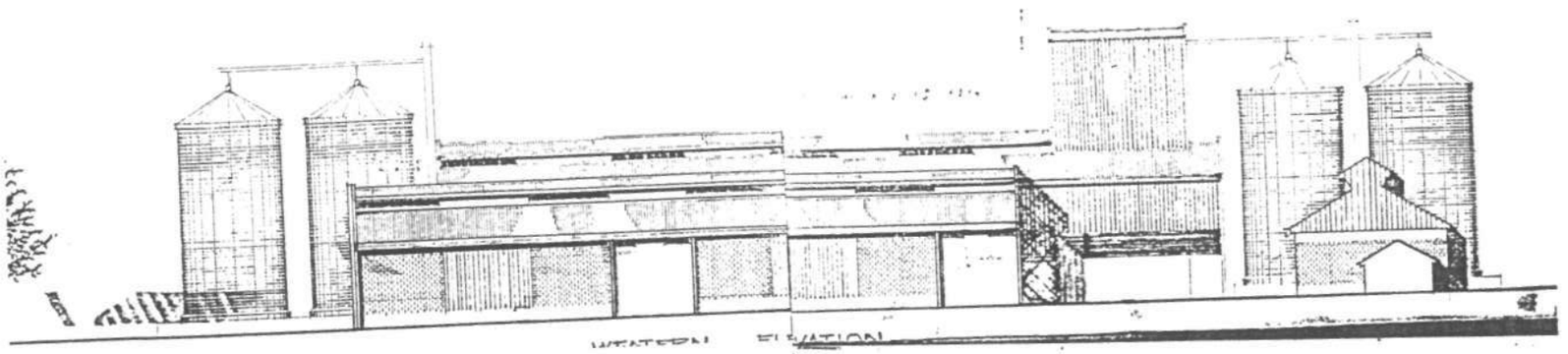
IM IBRAHIM LIBRARY

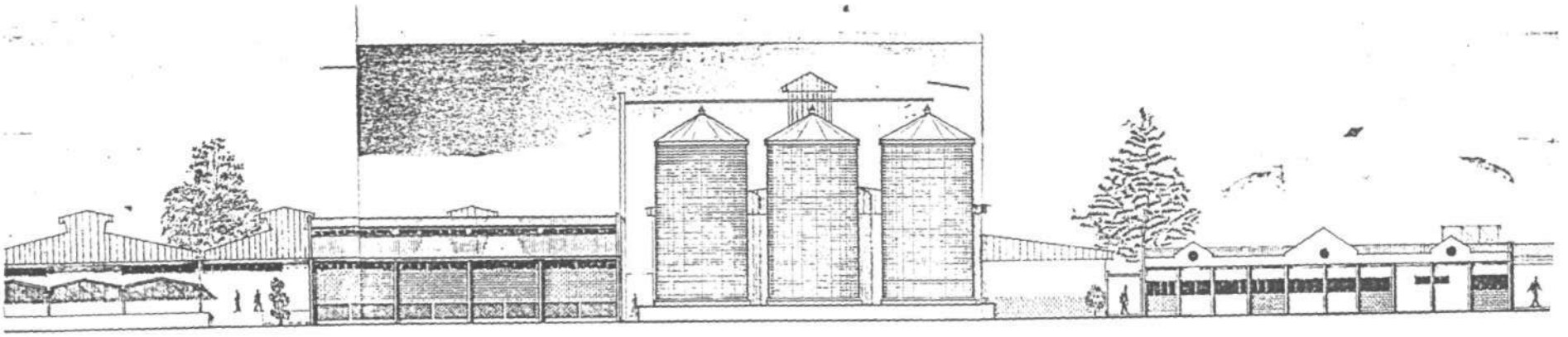




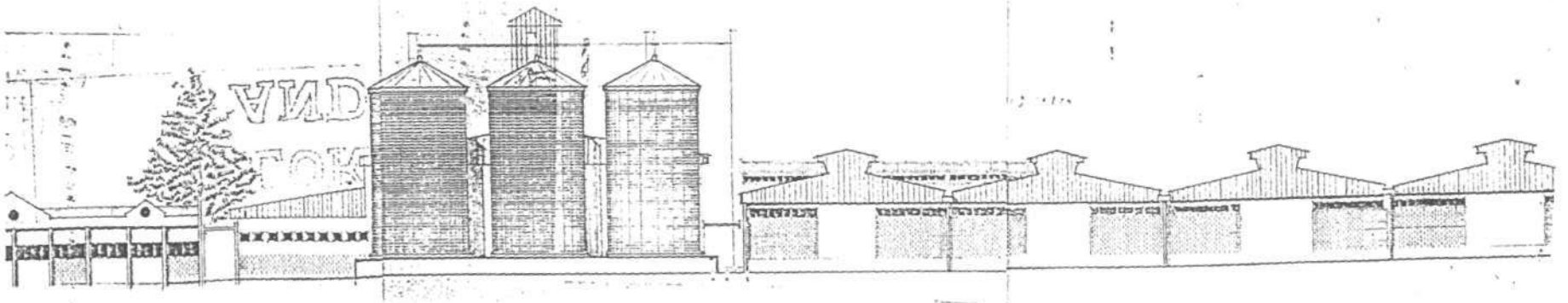


EASTERN ELEVATION.





SOUTH ELEVATION.



NORTH ELEVATION.

