TEMPERATURE AND MOISTURE CHANGES DURING STORAGE OF MAIZE (Zea mays) IN A WOODEN SILO

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CERTIFICATION

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DEDICATION

To God Almighty who sustained me throughout this programme.

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ABSTRACT

The temperature and moisture contents of the grain in the wooden silo were determined with the Humidimeter TR 400Ps meter by weighing the grains to 400g. The Relative Humidity was determined with a digital psychrometer. Temperature and Relative Humidity within the silo and the ambient temperature were taken in the morning, afternoon and evening. The moisture content was also determined once in a week. In figure 2, it was observed that the dry bulb temperature decreases in the first week of August, which also rises in the first week of September. Compared to the centre temperature of the grains in the silo, that maintains a temperature of 24^0 C to 28^0C from the month of June to September while in Figure 1, there is an increase on the Top in the first week of June and the dry bulb temperature decreases in first of August which also increases towards the end of the month of August. In figure 4, the top, bottom and centre were compared and a very low temperature of 16^0C in the bottom was observed in the first week of July. Why there is an increase in the top grains in the wooden silo due to weather conditions. But the centre of the grains in the wooden silo maintains a temperature of 25^0C to 28^0C from June to September. From the test carried out, it was observed that the problem of moisture condensation which is predominant with storage structures made of steel was not experienced using the wooden silo. The results from the test confirms the uniform variation in temperature, which is as a result of low thermal conductivity of the wooden structure. The issue of storing grains within short period of four months can not give an accurate result of the grains storage. It is necessary that the wooden silo be subjected to the environmental conditions for a much longer duration, this is to enable the test, cover all the season in the year for better result of the grains storage. The application of phostoxine and coopex (dust chemical) are the best chemical used during the storage period which seriously attacked termite in the grains.

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CHAPTER ONE

INTRODUCTION

Maize is the principal food crop for the people of Northern Nigeria. Its cultivation extends to the North of the country where it constitutes the second cash crop after cotton. Maize is an important commodity traded commercially within the country and with neighboring countries.

Grain silo is a storage tower structure designed to store agricultural grains such as millet, threshed rice, guinea corn and shelled maize. This is done so that there will be assurance of food supply at all seasons of the year. After harvest, many products of Agriculture goes to the market directly, some will be stored on the farm while some will go into commercial storage.

In Nigeria grains form a major part of the food consumed by man and livestock and so it plays a vital role in the life of the people. The demand for it is all year round, but it can only be produced within a certain period of time during the year and as there is need to store some of the grains so that there will be continues supply for the people.

Crop storage is a critical part of farming operation. It involves a mean where food is preserved in order for it to be available throughout the year and also to monitor the quality harvested in the year.

Farmers all over the world loses much of their grains after it has been harvested through attacks by insects, rats, birds, some micro-organism such as fungi virus and bacterial action.

Lack of good storage facilities makes it difficult for small scale producer to hold stock and key are therefore forced to dispose there product during harvest, increased productivity cannot be translated into a proportionate increased in the level of income when the storage is inefficient because the farmer losses motivation and interest to grow more due to inadequate storage facility for his products.

Most of the large-scale producers required large storage facilities for their products. There is the need to design a farm grain storage structure that will be suitable for storing grains produced in large quantity the choice of materials also depends on the environment and the technology needed to install the silo, hence, the need for the design and construction of the wooden silo arose using locally available material such as plywood to meet the need to the local farmers.

1.1 STATEMENT OF PROBLEM

In her effort toward ensuring available of grains year round, the Federal Government of Nigeria embarked on 250,000 tons Capacity Strategic Grain Reserve using metallic silo in every state of the country.

These metals silo, under the Nigeria climate, have been associated with caking of grains, development of hot spots, grain dampness and hence mould growth, and are associated with high cost of importation, technical and management problem.

1.2 JUSTIFICATION

There are silos constructed of other materials like Alummium or steel which can be good for storage purpose. The use of wooden silo in the storage of grains has been constructed due to its advantage over the metallic type of silo due to its low thermal expansion and poor heat transfer characteristic.

1.3 AIMS AND OBJECTIVES

(1) To determine the effect of temperature and moisture content variation on the grains in a wooden silo.

(2) To determine the effect of environmental factors on the wooden structure.

CHAPTER TWO

LITERATURE REVIEW

2.1 TEMPERATURE AND MOISTURE VARIATIONS

A time lag was observed between the seasonal ambient Temperature and the grains bulb centre Temperature. Large diameter bins maintained Warner centre Temperatures than small diameter bins. The influence of heat transfer from or to the top and bottom of the grain bulks. A small diameter, tall grain bulk maintained lower grain Temperatures than a large diameter short grain bulk. Jayas, et al, (1994)

A stored grain bulk is a man made ecological system in which deterioration of the stored product results from interactions among physical, chemical and biological factors. Temperature and moisture movement in stored grains result from internal and external sources of heat. The production of heat and moisture by respiration of grains, insects, mites, fungi and bacteria and thermal (Specific heat and thermal conductivity) and physical (bulk density and porosity) properties of the bulk and the main internal factors that affect the movement of heat and moisture in stored grains. External heat comes largely from the atmospheric environment around the stored bin. Knowledge of temperature distribution in stored grains not only helps in identifying active deterioration but also gives an indication of the potential for deterioration. Collecting the temperature data at various points in grains storage bins of different sizes over a period of time is one way of finding the temperature distribution. But this is an inefficient method requiring a lot of time cost and labour. Mathematical models based on physical principles can potentially predict with accuracy the temperature distribution in a grain storage bin. Further, the effects of bin size wall materials, location, etc, on the temperature distribution can be studied using the mathematical models.

Many attempt (converse et. al, 1973; Lo et. al, 1975; Yaciuk et. al, 1980; Metzger and Muir, 1983; Bala et. al, 1989; Alagusandaran et. al, 1990; et. al, 1993; Jayas et. al, 1994; Basunia et. al, 1996 and Abe and Basunia, 1996) were made in developing mathematical models to predict the temperature distribution in grains storage bins. Theses models have been solved for one dimensional (Converse et. al, 1973; Muir et. al, 1980; Bala et. al, 1989 and Basunia et. al, 1996), two dimensional (Muir et. al, 1980 and Metzger and Muir, 1983) and three dimensional (Alagusandaram et. al, 1990) configurations. The models have also been solved using analytical (Converse et. al, 1973), finite difference (muir et. al, 1980 and Bala et. al, 1989) and finite elements (Alagusandaram et. al, 1990 and Basunia et. al, 1996) methods. Many research workers also reported experimental data of wheat, barley, rice and rapeseeds used for validation of their models. No data of temperature and moisture content, throughout a storage period, of maize have been so far reported for heat transfer and moisture content models validation.

Simulated temperatures in stored grains change slowly except for the layers next to the bin wall and at or near, the surface. The lag between the wall and centre simulated temperatures is large, which is consistent with measured temperature values found in the reports of many investigators. It can be seen that even with a considerable change in the outside temperature, change inside the bin are relatively small and the amplitude of seasonable temperature changes gradually decrease toward the centre. From a uniform start at the time of storage, the temperature at centre remains higher than that near the walls from mid October until late March. The reverse of this process occurs throughout the spring and summer. In other words, the grains temperature at the centre is higher than that near the walls during fall and winter and is lower during spring and summer.

Moisture migration, or movement, within the bin is a direct consequence of temperature variation. During the fall and winter, the grains near the walls cools faster than that at the centre of the bin. The temperature gradient thus created gives rise to "convection currents", causing cool "air" to downward near the outside walls, than across toward the centre of the bin where the "air" is warmed and rises toward the surface as has been discussed by Holman and Carter. The higher temperature at the centre causes moisture transfer from the grains to the warmer "air", and the moisture is carried by the "convection air currents" to the cooler area near the surface where moisture is lost by the "air" and is absorbed by the grains. Consequently, the moisture content increases at or near the surface during the fall and winter and decreases during the spring and summer. Moisture movement during the summer is not as pronounced as in winter, so surface moisture content is not reduced to the original condition.

2.2 LOW-CAPACITY SILOS FOR FARM STORAGE.

On foam storage is the basic form of rural storage in of grain mostly for human consumption.

There are several types of traditional storage structure, each adapted to the climate of the country, their common features is the use of locally available materials. Some examples are enclosed earthen granaries of the dry zones and the ventilated granaries made of plant fibre and wood that are used in humid zones.

In dry zones, the risk of stock degradation come mainly from insects and rodents, and they are generally lower than the risk in humid zones, where stocks are attached not only by these pest but also by moulds.

There are two possible approaches to lowering losses from rest attacks improvements to traditional storage structures, and new structures built from non-traditional material.

The first approach has produced improvement in the construction of Earthen granaries (mixing small quantities of cement with the earth or careful finishing or smoothing of the silo walls) the second approach has introduced new storage that generally required nontraditional materials and construction techniques examples are silos made of concrete, reinforced concrete or metal.

No matter what type of structure is used for storage, curtain foundational rules must be observed.

(a) Store grain only when it is really dry and rid of impurities

(b) Before and during storage, check the condition of conservation of the grain and the degree of insect infestation and if necessary, treat with insecticide

2.2.1 HIGH-CAPACITY SILOS

High-capacity silos are complex structures intended for the commercial storage of large quantities (several) thousand tonnes)

Specialized builders offer various types of silos, two, in particular.

(a) Vertical silos

(b) Horizontal silos

Vertical silos are made up of several sheet metal or reinforced concrete storage bins stacked vertically. This category includes silos composed of round bin made of flat or corrugated galvanized sheet metal,. Polygonal bins made of painted or galvanized metal panels; round bins made of reinforced concrete.

Horizontal silos are made of sheet metal or concrete and are composed of juxtaposed square or rectangular bins laid horizontally.

In order to avoid the disadvantages of potential rise in temperature, and to guarantee good storage, storage bins are often equipped with ventilation system backed up by temperature controls.

In term of storage, these ventilation system can have the following effects.

(i) To lower the temperature of the grain in order to slow down biochemical degradation processes (cooling ventilation)

(ii) To keep the grain at a constant temperature, by systematically evacuating the heat produced by the grain mass itself (maintenance ventilation)

(iii) To day the grain slowly (drying ventilation) In addition, again in order to guarantee good conservation of grain, in order to guarantee good conservation of grain, special airtight silos store the products in the absence of oxygen, in a confined or controlled atmosphere.

In the first case, the oxygen inside the silo is consumed by the natural "breathing of the grain and the insect and microorganism, and is simultaneously replaced by the carbon dioxide produced by this breathing.

In the second case, once the air tight silo has been closed, the internal atmosphere is replaced by the injection of inert gasses (nitrogen, carbon-dioxide) Despite the obvious advantages of these storage system , airtight silos still have limited distribution because of their technological complexity explicitly for the high capacity bins.

2.2.2 COMMERCIAL LEVEL GRAIN STORAGE

Grain storage in this level is carried out by large scale grades, exporters, agro-based and allied companies, government agencies and some of the few existing large scale farmers.

The structure of this storage method are long lasting and permanent and they are mainly silos or warehouse.

2.3 SILO

Silos are storage structure in which grains can be stored loosely in bulk without putting them in bags or sacks. In either case, the producer has to store the sacks of grains for some time before they are sold. During this period, precautions have to be taken to ensure the safety of the grain and maintain its quality.

At the very least, the bagged grain must be kept off the ground to prevent spoilage by translocating water and/or termites. Low platforms, tarpaulins or plastic sheeting may serve this purpose, but if there is a risk of rain during the temporary storage period the bags should be covered with water proof sheeting (but not all the time if the grain has a moisture content much in excess of 12%)

Alternatively, the sacks of grain should be stacked on dunnage or waterproof sheeting, away from walls, in a rodent proofed barn. The need for chemical methods of pest control should not arise, if the storage period is short.

Where sacks are used for domestic grain storage, similar conservation measures should be adopted. However it will be necessary to employ some of insect pest control, second hand sacks must be thoroughly cleaned and disinfected before use.

2.3.1 BACKGROUND OF THE INVENTION AND UNDERLYING PROBLEM.

Silos for cereal grain and the like are evacuated by means of allowing the grain to flow out through an outlet in the bottom of the silo. In order to be able to utilize the volume of the silo to the greatest possible extent, the silo bottom in conveniently arranged in a horizontal direction, resulting in the formation of a remaining residue of bulk good, corresponding to the angle of repose of the material in question, which has its largest height at the silo walls and slopes to wards the outlet or the outlets.

Thereby, it is desired that this remaining material in evacuated by means of an evacuation conveyor, which consist of a perforations jets of pressurized directed along the floor pass, and being the bulk goods into movement towards an outlet opening or the like SE218067C and SE459575B are examples of previously known devices of this types.

A disadvantages with these previously known devices in that the pressurized are locates passages in which the lowest resistance prevail i.e where the layer of bulk goods in the thinnest, thereby leaving the thicker portions more or less unaffected. In the position where been able to transport away the goods, empty or sparsely coated floor areas are created, and a considerable portion of the pressurized air flows our from the silo without having been effective in the displacement of the cereal grain

2.3.2 TYPES OF SILOS

(i) The "Pusa" bin

(ii) The "Burkino" silo

(iii) The "Usaid" silo

(iv) Concrete/Cement silos

(v) Metal silos

(vi) Synthetic silos

2.3.2.1 THE "PUSA" BIN

Developed by the Indian Agricultural Research institute (I.A.R.I), these silos are made of earth or sun-dried bricks; they are rectangular in shape and have capacity of 1 to 3 tonnes.

A typical "Pusa" bin has a foundation of bricks, compacted earth, or stabilized earth. A polyethylene sheet is laid on this, followed by a concrete slab floor 10cm thick. An internal wall of the desired height (usually 1.5 to 2 metres) is constructed of bricks or compacted earth, with a sheet of polyethylene wrapped around it. This sheet is heat sealed to the basal sheet, and the external wall is then erected. During the construction of the wall on outlet pipe is built into its base.

The Pusa bin has been widely adopted in India, and has been demonstrated in some African countries. It given good result when loaded with well dried grain.

2.3.2.2 THE "BURKINO" SILO

Based on a traditional dome shaped type of bin, this silo is constructed with stabilized earth bricks various models and capacities are available.

The base is made of stabilized earth resting on the ground or on concrete pillars. The demeshaped roof is also made of stabilized earth bricks, using special wooden formers.

The techniques of making a dome-shaped roof is not easy to master, and usually has to be done by skilled masons. A variants has been developed with the roof resting upon a wooden frame which can be erected by unskilled farmers.

2.3.2.3 THE "USAID" SILO.

This silo is based on the "Burkino" silo and example have been erected in Nigeria, holding one tones of maize grain, the silo rests on stone or concrete pillars supporting a rein forced concrete slab 1.5 metres in diameter. The wall are made of stabilized earth bricks and are plastered inside and out with cement reinforced with chicken were mesh. The top is dome shaped with a central round opening, and covered with a cone-shaped earthen cap. This is plastered with cement, and rest on bamboo's or on a metallic drum base. an outlet door, consisting of a 15x30cm plate 1.5mm thick which is smeared with grease for easy sliding, is let into the base concrete slabe.

2.3.2.4 CONCRETE/CEMENT SILOS

Such silos are cement rich, and often include other materials which normally have to be imported into developing countries. Therefore they are potentially (and usually) expensive structures, which can be seriously considered only when improvements to traditional storage bins cannot be practically applied. Their redeeming features, given that they are properly constructed and used, is that they are robust and should give many years of satisfactory service.

The ferocement bin ("Ferrumbu"). Developed in Cameroon (Qstergard, 1977), and tested in a number of African Countries, this bin is similar to the "Burkino" bin in shape but consists mainly of chicken wire plastered inside and out with cement mortar. Details of its constructed may be found in Bodholt and Diop (1987)

The wall varies in thickness from 3.5cm for a bin of $0.9m^3$ capacity to 6cm for one of $14.4m^3$ capacity.

2.3.2.5 METAL SILOS

Economically valid for storing large quantities cover 25 tonnes), metal silos are often regarded as too costly for small scale storage. Nevertheless, certain projects have been successful in introducing small metal silos of o. 4 to 10 tones capacity, at farm \ village level in developing countries Swaziland {walker, 1975}, Bolivia (Anon, 1982). India (Anon, no date), to mention just a few. Metal silos are reported to have been used on farms and in village in Guatemala for over 50years (Brett, 1976) and in swizaland, on a small scale, for possibly longer.

2.3.2.6 SYNTHETIC SILOS

Various attempts have been made to develop small scale storage bins, using synthetic material such as bytyl rubber (0'Dowd, 1971) and high density polyethylene (CFTRI, 1975) However, such bins proved to be either too expensive

2.3.2.7 WOODEN SILO

Wood products have not been considered for grain silos construction in Nigeria because of the numerous problems which are believe to be associated with timber. But wood has been successfully used in silo construction in Washington, United State as for back as 1948. Wood product have been excessively used in the construction of grain silo which competed favourably well with those of steel Aluminum and concrete (Aldrich 1948, Warner 1956; Warner 1962) Plywood bores have been successfully used for the storage of grains.

Wood has been used primarily in Nigeria for the construction of cribs. A major problem is that farm storage have been installed on very short notice owning to excessive large yield on overfilled commercial storage. This installation has increased the advantage to the pre-fabricated bin market.

2.4.0 QUALITY CHARACTERISTICS OF GRAINS

The criteria of grain qualities established in any grading standard are those that are of most importance for the end-use. Generally these criteria, according FAO (1994), are the intrinsic varietal qualities and those that are environment – or process – induced. The intrinsic qualities assigned to grains include colour, composition, bulk density, odour and aroma as well as size and shape; Induced qualities are age, broken grain, chalky or immature grain, foreign matter, infested and infected grain mixed varieties and moisture content. On the other hand, Henderson and Perry (1980) classified the quality criteria, which they termed as grade factors, under three broad headings of physical, chemical and biological characteristics. According to their classification, physical characteristics include moisture content, unit size and weight, texture, colour, foreign matter and shape; composition, odour and flavour of grain are grouped under chemical characteristics while biological characteristics include such factors as germinability, type and amount of insect damage, and amount of mould damage. It is clear that the difference in only academic as it does not affect the final quality classification of any particular grain. All of these characteristics and how they influence grain quality are described in the following sections.

2.4.1.0 COLOUR

Cereal grains are pigmented and range through the colour spectrum form very light tan or almost white, to black. Where extractive milling is required, highly pigmented varieties may give low yield of white flour (FAO, 1994). Maize for instance, comes as either yellow or white maize and the white type yields better white flour (Codex Alimentarius Commssion).

2.4.2.0 BULK DENSITY

This has been defined by FAO (1994) as the weight per standard volume, measured in a standard manner. Cruz and Diop (1989) defined it as the weight of 100 liters (i.e. one hectoliter) of grain. Bulk density is also known as 'test weight', 'specific weight' or bushel weight and the value is expressed as kilogram per hectoliter (kg/hl). Investigations have shown that insect infestation, excessive foreign matter and high percentage moisture content are factors which affect bulk density. Consequently a product's bulk density is sometimes used for an overall evaluation of the grain moisture content, cleanliness and maturity.

Each type or variety of grain when in optimum health, fully mature etc., has a characteristic bulk density. Products with high values of bulk density are generally regarded as being of higher quality than the same type or variety of that product that has low bulk density. Experience with certain products, such as wheat and maize, have shown that the bulk density is a reasonable indicator of milling yielding. Nevertheless shown that the bulk density can give a precise indication of grain quality. Its practical value lies in its use in determining the storage volume required to store a certain amount of dry matter. According to Brooker et al (1978) a decrease in the value of bulk density of maize from 72 to 62 kg/hl will necessitate an increase of 10% in the storage volume in order to store the same quantity of dry matter.

2.4.2.1 INDUCED QUALITIES OF GRAINS

BROKEN GRAINS

Grain that is broken is normally considered to be of inferior quality to unbroken whole grain. Grain breakage may occur from stress-cracks that develop as a result of mechanical impacts on the grain during threshing and also from fissures that result from excessive drying/weather conditions in the field. There are several reasons why the amount of broken kernels in a grain mass influences the overall grain quality. One of these reasons is that broken grains reduce acceptability of the grain. Other reasons are that broken kernels increase the deterioration rate during storage, (especially infestation) and then because they are normally passed as dockage materials.

2.4.2.2 CHALKY OR IMMATURE GRAINS

Some grains are found to be empty, that is without the starchy endosperm, at harvest. This condition is caused by sterility and field infections and insect attack. Immature grain content influenced by time of harvest, a high content being the result of too early harvest. FAO (1994) gave the cause for grain chalkiness as incomplete filling of the starchy endosperm. This condition, it was observed, lower the mechanical strength of the grain and causes it to break easily during handling. Of course, the broken portion is more easily invaded by certain storage pests.

2.4.2.3 INFESTED AND INFECTED GRAINS

Grain that is infested or that has been damaged by micro-organisms is clearly considered to be of inferior quality. Insect damage to grain has been grouped into four categories (Grey, 1966) viz; (i) bored holes and the disappearance of a large portion of the inside of the kernels; (ii) injury to the germs; (iii) heating and consequent condensation and moulding of the grain mass and (iv) contamination with excrements and webbing. The first category of damage results in loss of weight and food yield. Injury to the germs reduces the grain ability to germinate. Contamination has a direct implication on food hygiene.

On the other hand the presence of micro organisms may result in spoilage and in certain instances when toxins produced are ingested health problems do occur.

2.4.2.4 GRAIN QUALITY STANDARDS

A standard is a precise and authoritative statement of the criteria/specification necessary to ensure that a material, product or procedure is fir for the purpose for which it is intended. It therefore helps to define products and lay down quality assurance procedures for ensuring that the quality is in harmony with the generally established standards (SON, 1989). Standards are established for a very wide variety of materials, products and services. Quality standards are established for grains in order to provide an unambiguous description of their quality, to protect consumer rights and to provide a clear indication of quality requirements to both producer and end-user: Quality standards for grains are also known as grading standards because grading itself means sorting the grain into its various quality fractions under a standard classification on the basis of commercial value or usage. The establishment of these grading standards will therefore set the guidelines and rules for sale and purchase of grains. However in Nigeria, these standards are rarely employed in grain marketing. One of the reasons for this is that grain trade involves direct choice and price negotiation by the buyer, in front of the commodity. In such a situation the quality of the grain will be assessed visually and it will be influenced by the end-use. The price will also be determined by local factors. Another reason for non-compliance with standards is that most buying and selling of grain take place in rural areas and marketers where it is difficult to monitor compliance with established national standards. Grain standards are, nevertheless, established and implemented in flour mills and government storage depots.

Grain quality standards are of three types viz; standard specification, standard test method and grading standards. Standard specifications basically define and specify the grain. They provide criteria for characterizing the nature of the grain, usually on a pass or fail basis. A sample of grain is judged against the standard and may be accepted if it passes all the criteria listed.

Standard test method sets down the procedures for testing the specifications of grain samples. All samples must be tested in accordance with the standard methods before the results can be accepted as truly representing the quality of grain being considered. Grading standards are used to group (grade) grain into one of several classes based on inherent quality and projected market value.

Grading standards are usually established by Governments, associations, institutions and sometimes a group of producers. Most countries have a national standards institutions which formulate these standards and ensure compliance. In Nigeria, the Standards Organisation of Nigeria (SON) is entrusted with the formulation of standards and monitoring compliance. In the United States of America, the U.S. Department Agriculture controls the "Official grain' standards" (USDA, 1964). Apart from governments some important organizations like the Strategic Grain Reserve Department and International Organizations like the International Organisation for standardization (ISO), Codex Alimentarius Commission (Codex), International Association of Cereal Science and Technology (ICC) have also developed standards for grains that are specific to their needs or globally acceptable.

2.4.2.5 ASSESSMENT OF MAIZE QUALITY

Maize, like all other grain types, had certain properties which contributes to it overall quality. When these properties are put together, it becomes easier to grade and value the grain.

NIS 253-1989 specifies standard methods for testing maize specifications. The same standard gives a comprehensive description to guide anyone in making judgments as to what quality of grain can officially be referred to as maize.

In assessing the quality of a consignment of maize, the principle of representative sampling is normally employed. ISO 950-1980 gives the standard procedure for sampling cereal grains. The recommendations were adopted by SON for the maize standards.

Test weight assessment is generally done in accordance with recommendations contained in ISO 7971. All standards available point out the need to remove foreign matter from a sample by sieving before the assessment of the test weight.

Foreign matter content is normally determined by screening in sieves of various diameters. The method used is the globally acceptable ISO standards i.e. ISO 2591 – 1973. This specifies the nominal sizes of the screen openings and other factors such as the recommended volume of grain to be loaded into the sieves.

Moisture content determination in a sample of grains is normally done in accordance with ISO 712 which is a globally accepted standard test method. This standard recommends that testing of MC be done by mass loss in a hot-air oven. Experience had however shown that this method is time consuming. Organizations, particularly the Association of Official Analytical Chemists (AOAC), the American Society of Agricultural Engineers (ASAE) and the American Association of Cereal Chemists (AACC), have developed several other methods for day-to-day determination of mc (AOAC, 1970; ASAE, 1980 and AACC, 1985).

CHAPTER THREE

METHODOLOGY

3.1 LOCATION OF THE SILO

The Silo used for the study was located in Minna, Nigeria between June to September 2003.

The locations enjoy two seasons, wet and dry season the wet season is between April to October while the dry season lasts from November to March.

3.1.1 Temperature

The Temperature of the grains were determined with thermometer and HUMIDIMETER TR 400Ps meter. The Temperature from June to July was determined with thermometer. Three of the thermometer were used by inserting one on the bottom, one at the centre and one at the top for three times daily i.e. in the morning, afternoon and evening. While from August to September, the use of HUMIDIMETER was introduced by collecting the grains from twelve different points with a scruper, which also was done three times daily, i.e. in the morning, afternoon and evening. This is done by measuring 400g of the grains and put it in the Humidimeter grain chamber, which finally indicate the temperature reading of the grains.

3.1.2 Relative Humidity

The relative Humidity of the grains was determined with a digital psychrometer. This digital Psychrometer, consist of a thread inside it and four other parameters on the digital system that is the dew point, dry bulb, wet bulb and relative humidity. The thread inside it, need to be wet first with distilled water, then insert it through any of the opening within the wooden silo, then finally press the relative humidity on the digital system. The relative humidity of the grains will now be indicated in the digital system.

3.1.3 Ambient Temperature:

The ambient temperature of the grains was determined with two thermometers by attaching two smaller contains on any convenient point outside the wooden silo. One of the containers is half filled with water while the other is not. The thermometer was inserted inside the containers to serve as the wet bulb thermometer and dry bulb thermometer.

3.1.4 Moisture Content

The moisture content of the grains was determined with HUMIDIMETER TR400Ps meter. 400g of the grains was collected with a scruper, and was poured inside the grains chamber of the humidimeter which now indicate the moisture content of the grains in the digital system. The moisture content of the grains was also determined on a weekly basis.

3.1.5 Colour

Milk colour was used for the wooden silo. This was used because after carrying out an experiment by painting four different colours, on four different sticks. These sticks were kept outside for three days irrespective of weather condition (i.e. rain and sun). among the four colours, the milk colour did not wear out.

3.1.6 Mounting

There are six columns, beneath the silo. Before the mounting of the wooden silo, depth of 45cm was made on each point in other to create stability of the silo.

3.2 Environmental Factors of the Silo

A daily observation of the silo revealed that certain changes had occur on the body of the wooden structure which I stopped by repainting the silo.

3.2.1 **Effects of Biological Activity in the Grains:**

Weevil also known as snout beetle is another type of insect that could easily attack the grains. The application of phostoxine chemical and coopex (dust chemical) was applied which seriously attacked the weevil.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS

Table 1 – 14 show results of the relative humidity, dry bulb temperature, wet bulb temperature, moisture contents and temperature of the grains inside the wooden silo.

From the figures, an increase and decrease in temperature, wet bulb, dry bulb and moisture content was observed,. Each of the result will be discussed as follows.

4.1.1 **Ambient (Dry Bulb) and Silo Temperature:**

Figure 1, which is the graph of the ambient (dry bulb) Temperatures and top Temperature of the wooden silo was recorded from the month of June to the month of September shows a typical daily Temperature variation for morning, afternoon and evening periods.

Figure 2, which is the graph of the ambient (dry bulb) Temperature and the centre Temperature of the wooden silo record the month of June to the month of September, shows a typical average daily Temperature variation for morning, afternoon and evening periods.

From figure 1 and figure 2, it was observed that the dry bulb Temperature and the top Temperature of the grains in the wooden silo for the month of June to September can be compared as well as the centre Temperature and the dry bulb Temperature.

4.1.2 **Relative Humidity:**

Figure 5, is the graph of relative humidity of the silo environment. From the graph it was observed that the relative humidity for the month of June and August was predominantly high compared to the dry bulb temperature. It was observed that a rise in the relative humidity led to a decrease in the Ambient dry bulb temperature.

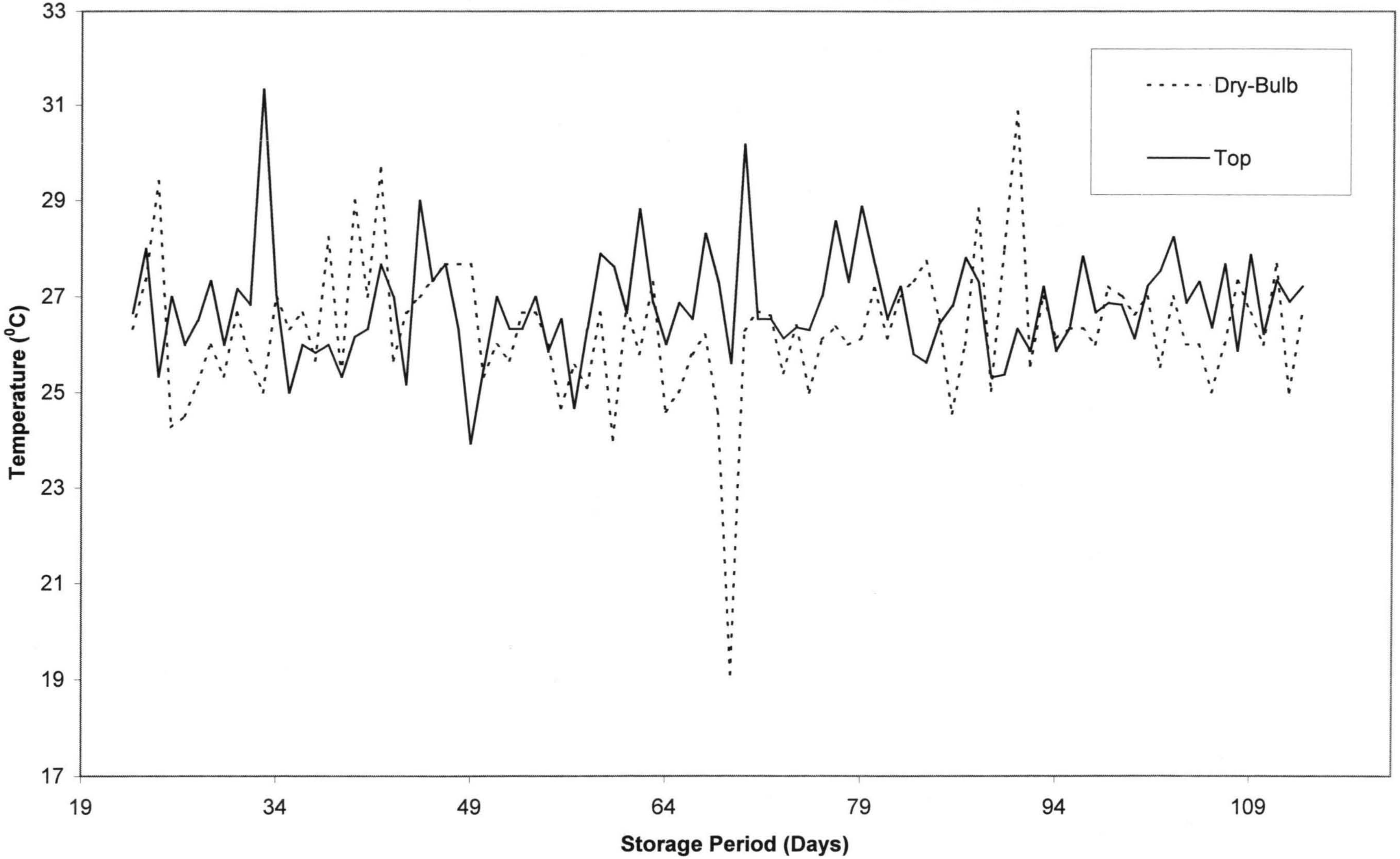

Fig. 4.1: Measured Ambient (Dry Bulb) and Silo Top Temperatures of the Wooden Silo

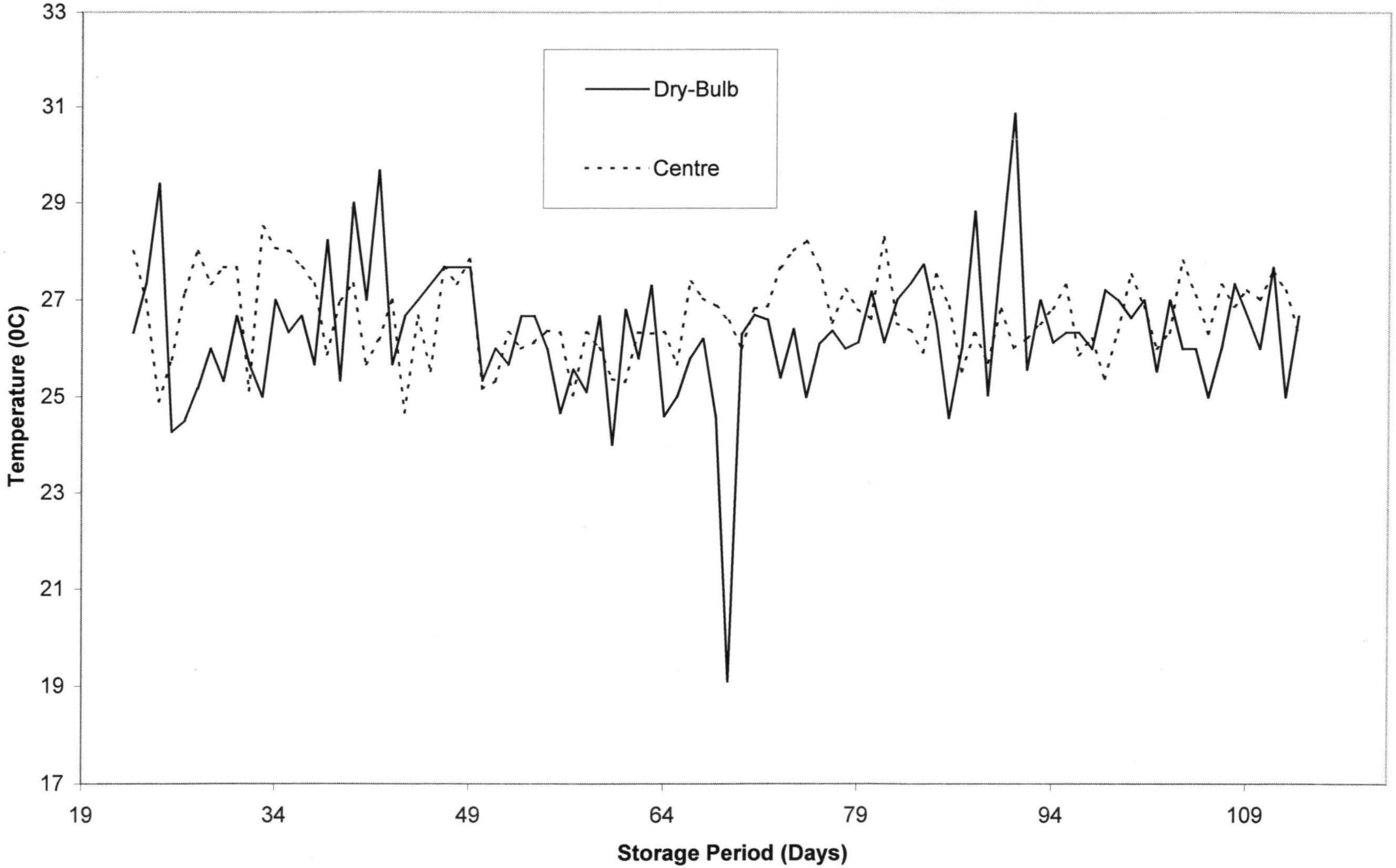

Fig. 4.2: Measured Ambient (Dry Bulb) and Silo Centre Temperatures of the Wooden Silo

From the graph it was observed that the dry bulb temperature was lower compared to the top temperature but had an increase in the month of August of about 31^0C.

High moisture content was observed during the wet season than the dry season since the silo responded in the periodic season.

The maximum acceptable level for storing maize at a temperature of about 28^0 C and for a range of product at 77% relative humidity.

In figure 2, it was observed that the centre temperature was higher compared to the dry bulb temperature at the beginning of June and then decreases on the first week of July due to weather condition.

In figure 1, there is a high decrease in dry bulb temperature in the first week of August of about 19.2^0C.

In figure 3, the bottom temperature of the grains in the wooden silo was too low in the first week of July, also dry bulb decreases in the first week of August and also increase in August ending.

Figure 4, is the comparison of top, bottom and centre were observed and a very low temperature of 17^0C in the first week of July while there was an increase on the top of the wooden silo due to high temperature in the afternoon. From the graph, it was observed that the temperature within the silo was still high in the evening. This was as a result of the heat conducted during the day, made the centre of the grains a temperature of 28^{0C}C and minimum of 24.5^0C.

The moisture contents of the stored grains measurement was determined using humidity TR 400Ps

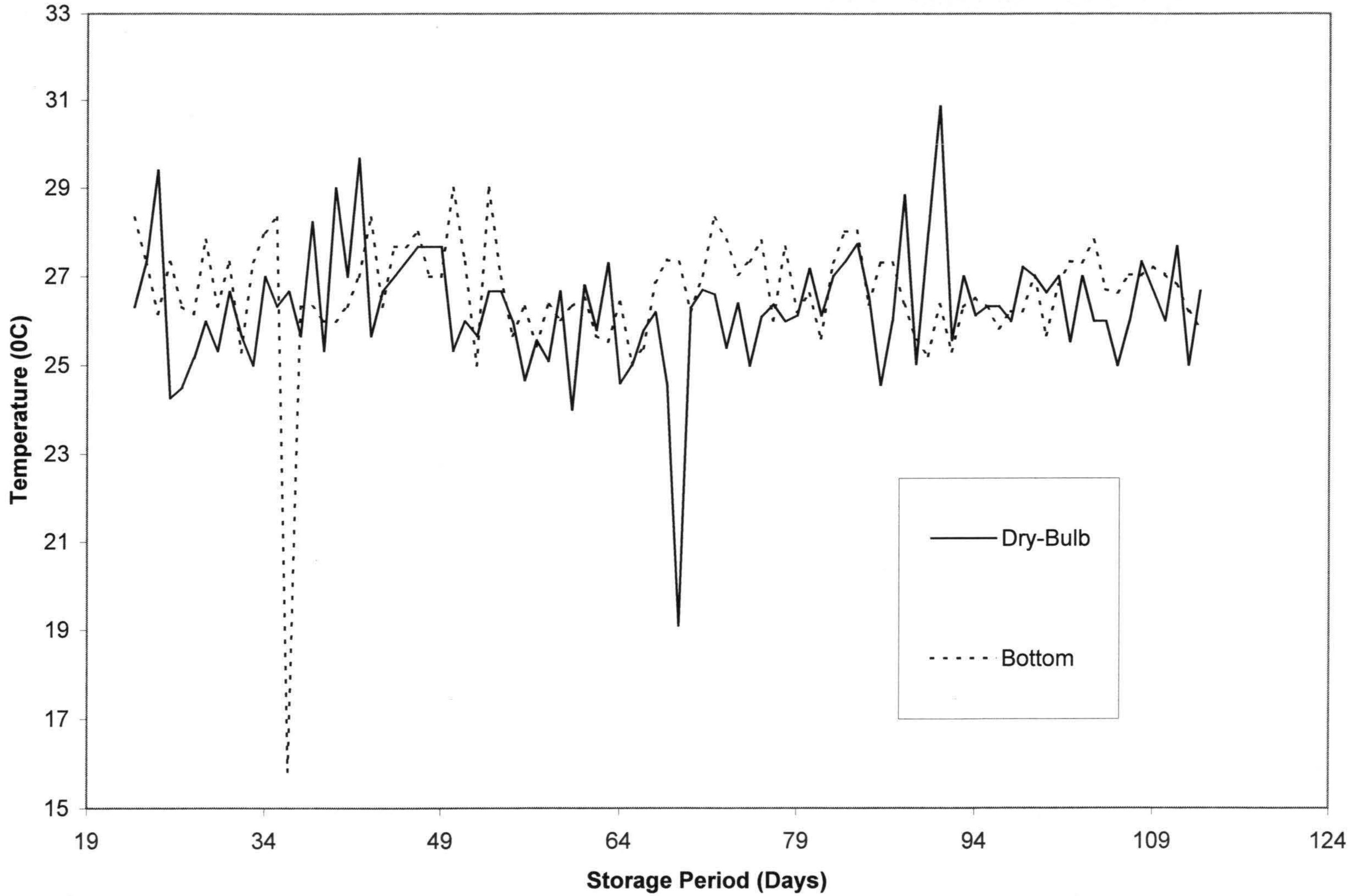

Fig. 4.3: Measured Ambient (Dry Bulb) and Bottom Temperatures of the Wooden Silo

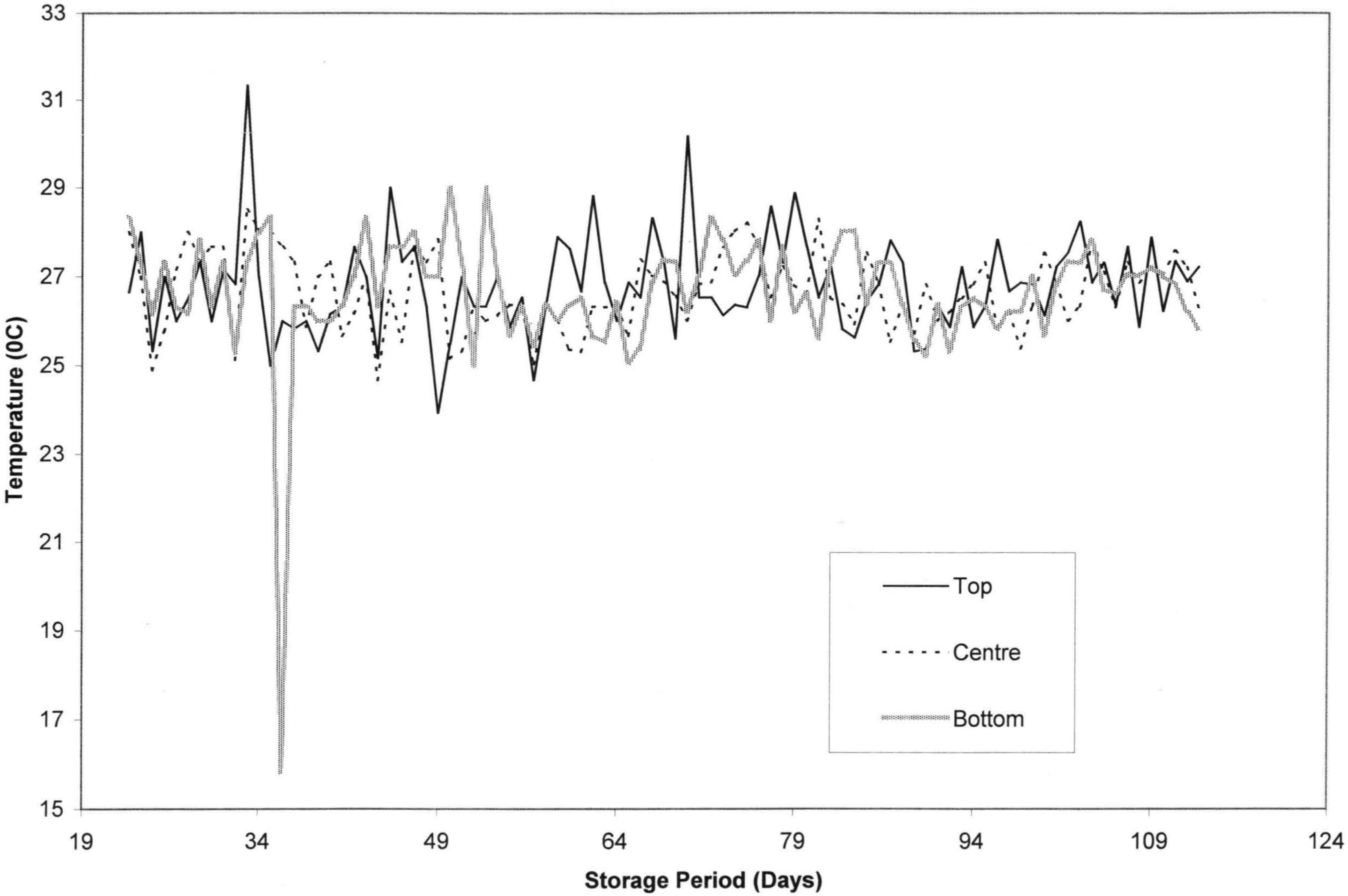

Fig. 4.4: Measured Temperatures at the Top, Centre and Bottom of the Wooden Silo

The corresponding values of Relative Humidity to temperature (^0C)

25.4^0C -	85%
23.5^0C -	86%
26.8^0C -	77%
28^0C -	77%
25.4^0C -	77%
24.1^0C -	70%

4.1.3 Moisture Content in the Wooden Silo:

Figure 6 is the graph of the moisture contents. The moisture content of June was compared with that July and was observe that the initial moisture content of July was low, that is 12.9 compared to the last week which is 13.8. That of June, the moisture content at the last week is 14.0

Figure 7, the moisture content to August was compared with that of September and was observed that the week 4 of the both months is 13.7. The moisture of August increase from 13.6 to 13.8 (week I to week 5).

4.1.4 Termite Attack: Under the wooden silo

It was observed that there was termite attack beneath the wooden silo which was prevented immediately by applying condemned engine oil in other to eradicate the termite before the termite attacked the stored grains in the wooden silo.

4.1.5 Increasing the Air Tight in the Wooden Silo:

It was observed that there is much penetration of air inside the wooden silo, which was prevented by using body filler for better storage practice. The absence of much air in the silo determines the Temperature decrease or increase in the wooden silo.

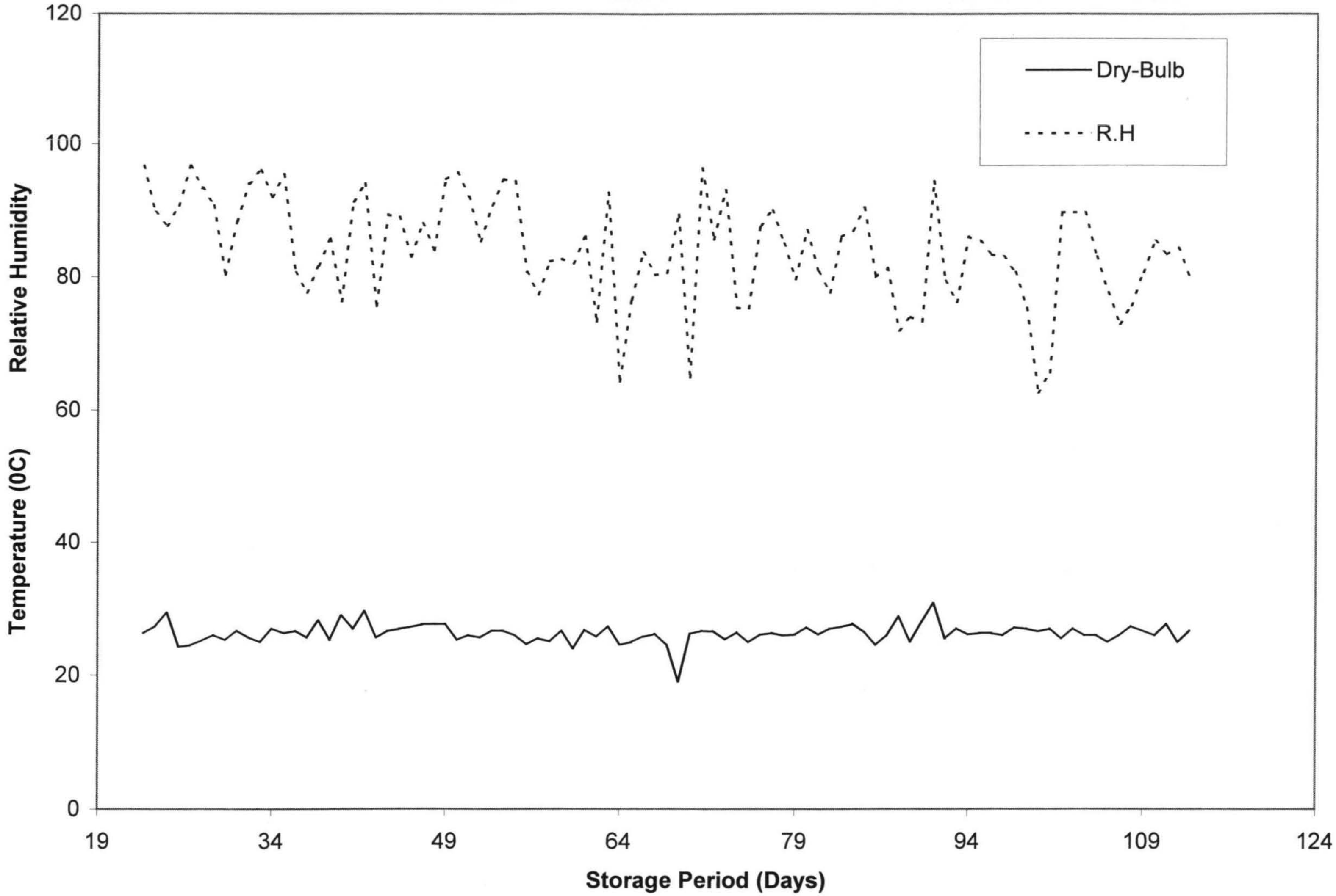

Fig. 4.5: Measured Ambient Dry Bulb Temperature and Relative Humidity of the Wooden Silo

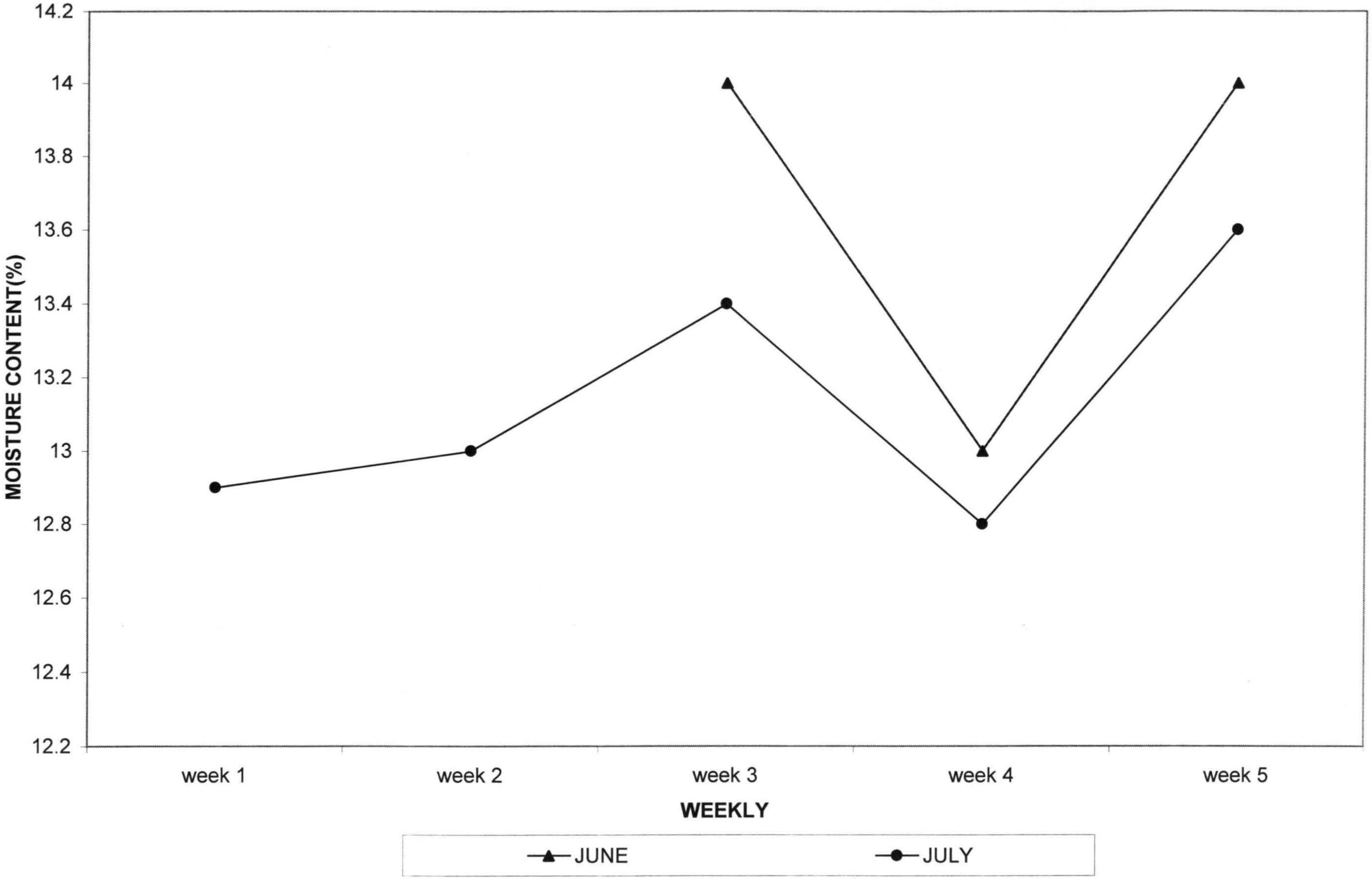

Fig. 4.6:MOISTURE CONTENT OF GRAINS(%) WEEKLY:JUNE AND JULY

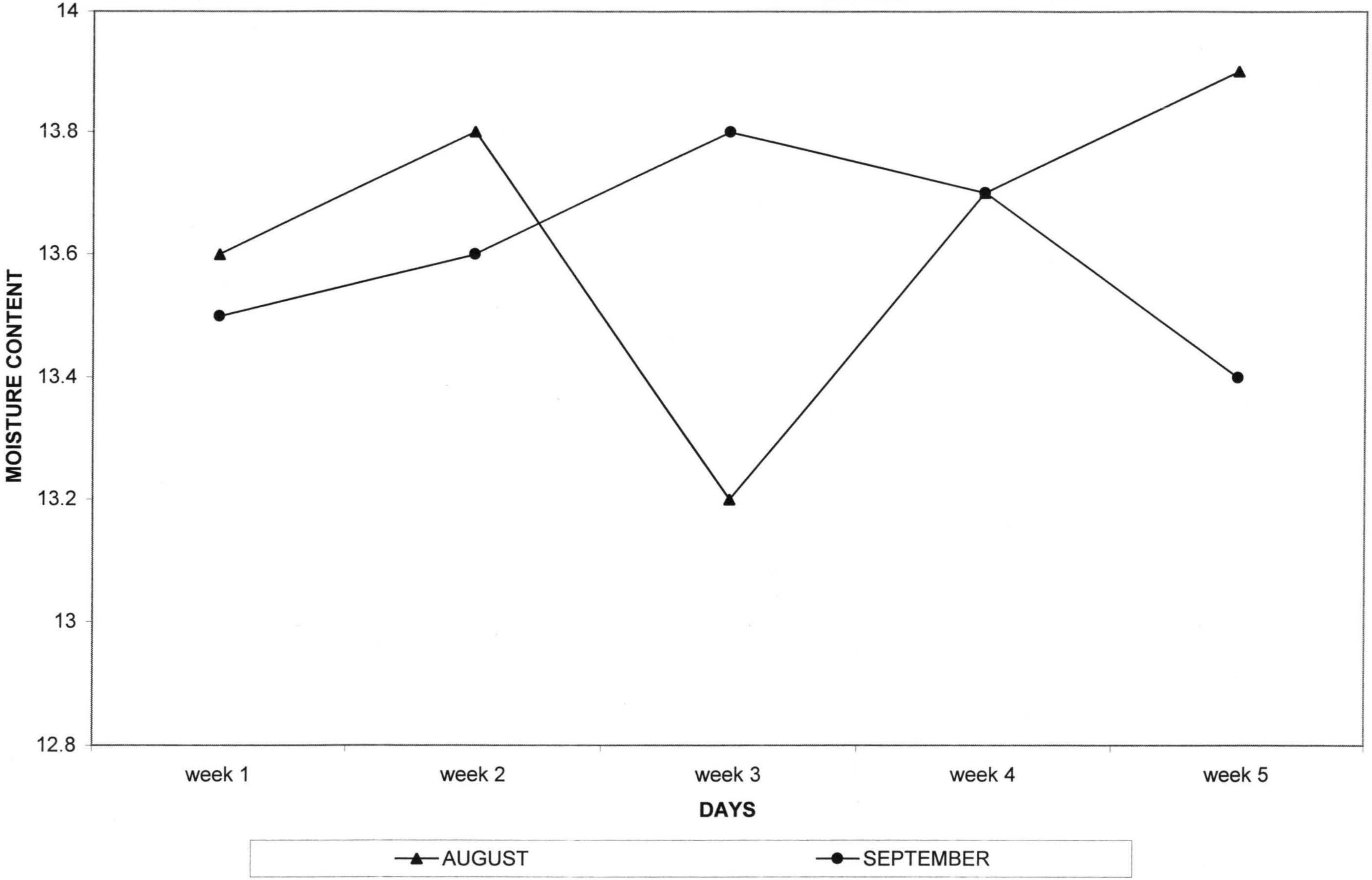

Fig. 4.7 MOISTURE CONTENT(%)

4.1.6 Wood Deterioration:

From daily observation there was no appreciable deterioration of the wooden structure. It was observed that there was a change in colour and peeling off the paint on the wooden structure, which was as a result of the effect of the sun and rain on the wooden structure.

4.1.7 Moisture Condensation:

Moisture condensation was not observed in the silo throughout the period of storage from June to September. This is as a result of low thermal conductivity of the wooden material.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

From the test carried out, it was observed that the problem of moisture condensation, which is predominant with storage structures made of steel, was not experience using the wooden silo. The results from the test confirm the variation in temperature, which is as a result of low thermal conductivity of the wooden structure. This automatically made it possible for the grains to be well stored during the period of test performed.

5.2 RECOMMENDATIONS.

The issue of storing grains within short period of 4 months cannot give an accurate result of storage process of any grains. It is necessary that the wooden silo be subjected to the environmental conditions for a much longer duration, this is to enable the test, cover all the seasons in the year for better results of storing the grains.

The test, which will cover a longer duration, will cost much and so the department of Agricultural Engineering in Federal University of Technology Minna should take interest and make funds available for further work on the project.

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APPENDIX A

TABLE 1: JUNE

		AMBIENT TEMP(C°			ROOM TEMP(C°)			M.C (%)
DAYS	Day/time	Dry bulb	Wet bulb	R.H. (%)	Top	Centre	Bottom	
	M	25.5	25	88	26	27	28	
19	N	26	25	89	27	28	27	14
	E	27.2	27	94	27	26	26	
	M	26.9	26	86	27	27	25	
20	N	30.3	28	88	27	28	26	
	E	29.3	28.5	90	25	28	28	
	M	22.2	22	79	27	28	25	
21	N	24	23	93	27	27	26	
	E	24.5	24	100	27	26	27	
	M	25	24.5	87	27	25.6	27	
22	N	29	28	65	28	26	28	
	E	30	22	61	28	27	27	
	M	26	25	92	27	28	28	
23	N	27	26	97	26	27	27	
	E	30	25	65	27	25	25	
	M	30	20	87	26	28	27	
24	N	30	25	88	26	27	26	13
	E	31	25	65	26	28	26	
	M	26	26	100	27	26	27	
25	N	27	26	96	28	27	26	
	E	28	26	81	27	28	26	
	M	23.5	23	98	28	27	28	
26	N	29.3	26	92	27	28	27	
	E	31.4	27	70	25	27	26	
	M	27	28	78	29	28	28	
27	N	22.5	21.8	92	28	27	27	
	E	28.4	28	76	27	26	30	
	M	26	25	92	25	27	29	
28	N	28	25.4	88	27	26	28	
	E	27	26	96	26	26	28	
	M	27	25	88	27	28	27	
29	N	26	26	79	28	28	29	14
	E	28	27	67	29	28	28	
	M	27	25	92	27	29	28	
30	N	26	23	98	27	28	27	
	E	26	24	100	26	27	30	

APPENDIX B

TABLE 2 JULY

		AMBIENT TEMP (C°)			ROOM TEMP (C°)			
Days	Day/time	Dry bulb	Wet bulb	R.H. (%)	Top	Centre	Bottom	M.C (%)
1	M	25	24.5	99	28	26	27	12.9
	N	27	26	92	27	27	28	
	E	30	27	78	29	28	27	
2	M	26.8	26.4	100	24	23.7	28	
	N	30	26.8	79	25	26	27	
	E	31.4	27	84	27	25	26.5	
3	M	23.8	22	88	27	24.5	27	
	N	24	23.7	97	28	23.8	28	
	E	25	24	87	26	29	27	
4	M	23.5	22	92	27	28	24	
	N	24	23.4	98	26	27	27	
	E	26	25.2	100	25	26.5	28	
5	M	26	24	91	25.5	27	27	
	N	25	25	89	26	28	16	
	E	24.5	24.3	100	28	29	25.5	
6	M	25	25	89	29	29	26.5	
	N	26	24	90	28	27.5	28	
	E	27	23.8	93	25	25.5	29	
7	M	23	22.3	77	27	28	27.5	13
	N	26	25	79	26	27	26.5	
	E	27	26.3	85	25	28	25	
8	M	25	24	88	28	28	27	
	N	27	26	85	27	27	28	
	E	28	26.5	92	26.5	28	27	
9	M	25	24	91	25.5	23.4	23.9	
	N	27	26	93	27	25	24	
	E	28	27	98	28	27	28	
10	M	25	24	99	29	28	28	
	N	24	23.3	89	34	29.5	28	
	E	26	25	100	31	28	26	
11	M	26	25	99	25	27.8	27	
	N	27	26	89	28	28.7	28	
	E	28	27	88	28	27.7	29	
12	M	25	24	89	27	27	28	
	N	26	24	100	23	28	29	
	E	28	25.7	97	25	29	28	
13	M	28	25	87	25	28	26	
	N	26	23	77	26	28	25.5	
	E	26	24	78	27	27	26	
14	M	24	23	88	25.5	25	25	13.4
	N	26	25	70	26	28	26	
	E	27	26	75	26	29	28	
15	M	29.2	26	75	26	25.4	26	
	N	27	26	92	27	27.2	25	

	E	28.5	27	78	25	25	28	
16	M	28	25	77	25	26	26	
	N	25	24	92	26	28	25	
	E	23	22	88	25	27	27	
17	M	29	27	75	25.5	28	25	
	N	30	26	65	26	29	26	
	E	28	27	89	27	25	27	
18	M	28	26	88	25	27	26	
	N	27	25	91	26	25	25	
	E	26	25	95	28	25	28	
19	M	25	25	90	27	27	26	
	N	30	27	92	28	25	28	
	E	34	29	100	28	26.5	27	
20	M	25	24.5	87	27	27	28	12.8
	N	24	23	75	28	28	28	
	E	28	27	65	26	26	29	
21	M	26	25	88	26.5	24	27	
	N	25	24	89	25	25	26	
	E	29	28	91	24	25	26	
22	M	28	27	96	28	25	28	
	N	27	25	90	27	27	27	
	E	26	25.7	81	32	28	28	
23	M	29	27	96	27	26	28	
	N	28	28	55	28	25	27	
	E	25	24	98	27	25.6	28	
24	M	28	27	99	28	28	27	
	N	27	25	65	29	27	28	
	E	28	26	100	26	28	29	
25	M	28	25	89	25	27	26	
	N	29	28	88	26	27	27	
	E	26	25	75	28	28	28	
26	M	27	26	96	23.8	28.2	27	
	N	28	27	92	25	27.3	28	
	E	28	27.2	96	23	28	26	
27	M	28	26	87	27	24	28	13.6
	N	23	22	100	25.5	26.5	29	
	E	25	24	100	24	25	30	
28	M	27	25	84	27	29	26	
	N	26	25	92	26	23	28	
	E	25	23	100	28	24	28	
29	M	25	24.5	84	26	25	24	
	N	26	25	82	27	26	25	
	E	26	25	90	26	28	26	
30	M	27	25	88	25	23	30	
	N	26	25.2	91	26	28	29	
	E	27	26	93	28	27	28	
31	M	26	26	91	26	25	27	
	N	25	24.5	95	28	25.4	26	
	E	25	25	98	27	28	28	

APPENDIX C

TABLE 3. AUGUST ROOM TEMPERATURE (^0C)

Day/Time.	Ambient Temperature (^0C)		Relative Humidity (^0C)	1	2	3	4	5	6	7	8	9	10	11	12	M.C
	Dry Bulb	Wet Bulb														
1. M	26.0	25.0	88.0	26.0	26.0	25.0	25.0	26.0	26.5	25.0	28.0	25.0	26.0	26.0	24.0	
N	25.0	25.0	95.0	25.0	27.8	26.0	25.2	27.0	28.0	26.0	26.0	26.8	27.0	25.8	26.0	
E	27.0	24.5	100.0	28.0	27.0	26.0	25.3	28.0	27.8	24.0	28.0	26.7	27.0	24.3	28.0	
2. M	25.0	24.0	87.0	25.2	27.8	25.0	30.0	25.0	28.0	25.0	27.0	25.0	23.0	27.8	28.0	
N	24.0	23.0	77.0	26.8	28.0	23.0	28.0	23.0	26.0	26.0	26.0	26.0	25.0	26.3	27.0	
E	25.0	23.0	78.0	26.7	26.0	24.0	27.8	28.0	27.0	28.0	23.0	28.0	26.0	25.7	26.0	
3. M	26.0	25.3	78.2	28.0	26.0	23.0	27.0	23.0	24.0	24.0	24.0	23.0	25.2	28.0	25.0	
N	25.4	23.8	78.0	27.0	25.2	24.2	26.0	26.0	23.0	28.0	26.0	22.3	25.2	27.0	24.8	
E	25.3	24.8	76.0	22.0	28.0	28.0	25.0	27.0	26.0	23.0	26.0	25.3	26.3	23.0	24.6	
4. M	26.0	24.0	88.0	26.4	25.3	28.0	23.0	28.0	27.0	28.0	27.0	26.0	24.0	25.0	25.8	
N	25.0	23.0	76.0	25.8	24.9	27.8	28.0	27.0	28.0	30.0	23.0	27.0	27.0	26.0	26.4	13.6
E	24.3	24.0	83.0	27.2	30.0	28.0	24.0	26.0	29.0	29.0	25.5	29.0	23.0	25.0	27.4	
5. M	25.0	24.0	85.0	25.6	27.0	28.2	27.0	26.0	24.3	25.0	27.3	24.0	29.0	29.0	28.2	
E	28.0	25.5	86.0	27.0	25.0	27.8	26.5	25.8	26.0	25.0	27.0	26.0	23.0	28.0	30.0	
N	27.0	26.0	77.0	240	24.0	26.2	27.0	24.6	26.0	26.0	26.7	28.0	24.3	29.0	31.0	
7. M	25.2	22.0	75.0	26.0	28.0	29.0	23.4	26.1	29.0	27.0	25.2	21.9	29.0	28.0	29.0	
N	28.0	27.0	88.0	25.0	27.0	24.3	24.2	25.3	25.0	25.0	28.2	24.0	24.0	24.0	28.1	
E	27.2	26.0	95.0	28.0	29.0	25.2	25.3	24.8	23.0	26.8	30.0	30.0	26.0	26.3	27.4	

APPENDIX C Continuation

8. M	27.0	24.5	65.0	27.0	25.2	30.0	24.3	26.2	26.3	29.0	26.0	23.4	32.0	31.0	27.4	
N	26.0	25.0	55.0	23.0	26.3	29.0	28.2	27.3	24.0	34.0	25.0	30.0	30.0	29.0	26.3	
E	25.0	24.0	100.000	24.0	27.4	23.0	24.3	28.1	29.2	30.0	26.0	31.2	34.0	28.2	25.1	
9. M	26.0	25.0	92.0	29.0	24.0	24.0	25.2	28.1	24.5	26.1	26.1	26.1	26.1	29.0	28.0	
N	27.0	25.0	99.0	28.0	23.0	25.0	26.4	27.2	26.2	24.3	27.3	28.2	25.2	28.1	27.0	
E	28.0	26.0	87.0	27.0	23.0	26.0	27.0	29.0	27.3	25.3	28.2	27.3	23.4	23.4	28.0	
10. M	27.0	25.0	55.0	26.0	24.0	24.8	24.0	29.0	24.0	281	26.2	23.2	23.4	25.2	26.1	
N	23.0	23.0	60.0	27.0	27.0	25.8	25.0	28.0	26.5	26.1	27.6	23.1	26.2	26.3	25.2	
E	24.0	23.0	78.0	25.0	28.0	26.0	26.0	27.0	27.0	26.5	28.4	26.7	28.4	24.3	28.1	
11. M	26.0	24.0	77.0	28.0	27.0	25.4	26.0	25.0	26.5	30.0	30.0	28.2	27.0	24.5	28.0	13.8
N	25.0	24.5	88.0	23.0	26.0	26.2	27.0	24.0	26.0	34.0	25.5	29.0	26.0	26.2	27.0	
E	24.0	23.0	65.0	24.0	25.0	25.0	28.0	26.3	30.0	26.0	27.0	28.0	23.0	25.2	27.0	

APPENDIX C Continuation

12 M	25.4	23.5	86.0	25.0	26.0	26.4	24.0	26.0	32.0	34.0	29.0	28.3	29.0	26.2	25.0	
N	26.8	24.0	74.0	26.0	25.0	24.0	29.0	30.0	34.0	26.0	31.2	29.0	26.5	28.7	24.3	
E	25.3	24.3	91.0	24.2	24.8	28.0	23.0	31.0	33.0	28.0	34.0	22.0	28.2	29.0	29.0	
13. M	27.0	25.0	65.0	26.0	26.0	25.2	29.0	24.3	26.5	28.3	26.3	25.4	29.0	29.0	28.0	
N	26.2	25.0	86.0	30.0	27.2	25.0	25.4	29.3	29.3	27.8	27.8	28.3	28.0	24.0	29.0	
E	25.4	24.0	90.0	31.0	28.0	26.0	29.0	29.8	29.8	25.4	26.2	32.0	29.0	29.0	28.0	
14. M	24.0	23.0	74.0	28.2	27.0	27.0	26.0	28.0	24.7	29.8	25.2	29.1	26.5	24.3	26.5	
N	23.0	22.2	68.5	34.0	25.2	26.0	24.0	29.0	29.0	34.0	30.1	28.3	27.3	28.2	27.0	
E	27.0	25.4	100.0	31.0	26.3	27.0	25.0	29.3	28.1	33.0	32.0	27.3	28.1	29.3	28.1	
15. M	28.0	26.0	91.0	26.70	28.0	28.9	24.9	28.7	29.2	25.2	29.3	23.0	29.0	21.7	28.3	
N	25.0	24.2	84.0	28.0	29.0	27.4	28.2	24.3	24.3	26.4	24.0	27.0	31.0	19.2	24.3	13.2
E	24.3	24.0	93.0	28.0	28.0	26.4	23.3	23.3	23.9	28.7	24.0	28.0	30.0	28.4	29.2	
16. M	26.2	25.8	73.0	27.4	29.0	26.4	25.4	28.1	27.3	26.2	26.3	29.0	31.0	36.0	28.1	
N	27.0	25.4	65.0	24.3	26.0	26.3	26.3	25.2	26.2	23.3	24.4	30.0	32.0	30.0	27.5	
E	28.0	27.20	55.0	26.0	25.0	27.4	27.4	26.3	24.4	24.5	28.0	32.0	34.0	32.0	26.4	
17. M	27.0	27.0	91.0	27.0	28.2	24.5	24.5	29.0	26.5	28.2	24.30	23.4	24.0	28.1	29.1	
N	26.0	23.0	98.0	26.0	27.4	30.1	25.0	28.0	26.0	29.2	29.3	26.0	23.5	29.0	24.8	
E	27.2	25.0	100.0	28.2	28.2	28.3	28.2	27.2	2450	28.3	25.3	25.2	24.50	33.0	29.0	
18. M	25.0	24.2	65.0	22.0	29.4	30.0	29.0	28.0	25.4	28.1	29.4	29.3	23.3	26.7	23.3	
N	27.0	26.0	93.0	30.0	26.3	34.0	25.0	27.2	24.2	23.4	28.3	26.3	24.5	25.1	24.3	
E	28.0	27.0	99.0	30.0	31.0	28.5	26.0	26.1	26.2	25.3	29.2	28.1	28.3	28.1	26.1	

19. M	25.0	25.0	85.0	29.4	34.0	24.3	25.3	28.0	26.3	29.0	25.3	25.6	28.5	23.50	26.3	
N	27.0	25.2	96.0	28.0	29.0	26.0	26.0	30.0	28.2	25.0	29.0	23.3	29.2	2424.1	25.0	
E	24.3	24.0	98.2	26.4	28.0	27.0	28.0	32.0	25.6	29.0	26.4	28.1	28.0	25.0	30.0	
20. M	25.0	25.0	84.0	25.2	29.0	25.6	28.2	31.2	29.2	26.4	25.4	26.3	25.0	24.5	28.4	
N	26.2	25.0	68.0	26.8	29.0	27.8	24.6	30.0	29.0	25.2	29.3	29.0	28.0	26.3	27.4	
E	28.0	27.0	74.0	27.8	24.0	29.0	30.0	28.5	28.5	29.2	28.1	28.0	29.0	27.0	26.8	
21. M	23.0	22.0	89.0	25.2	26.2	25.2	25.2	30.1	28.5	23.3	29.3	21.3	26.3	24.0	28.1	
N	27.0	25.2	63.0	29.0	28.2	26.1	29.2	32.0	27.3	26.3	24.5	23.0	24.0	26.3	30.0	
E	25.2	24.8	74.0	31.0	29.0	28.3	29.3	32.0	25.4	28.1	30.0	28.1	23.0	27.3	34.0	
22. M	26.0	26.0	83.0	30.0	30.0	27.3	27.2	28.2	29.2	28.2	25.2	26.2	25.4	26.1	28.1	
N	27.0	25.2	86.0	29.8	32.0	24.6	28.3	29.3	28.3	27.4	26.3	28.2	26.3	28.3	23.3	13.7
E	25.4	24.0	94.0	23.0	32.0	28.2	29.1	28.3	27.2	29.3	27.8	29.4	28.1	29.0	24.5	

APPENDIX C Continuation

23. M	26.4	24.8	78.0	24.5	26.3	26.4	24.4	25.2	24.0	27.8	25.2	29.0	29.0	29.0	26.3	
N	28.0	28.0	92.0	26.3	24.0	25.3	25.2	26.4	25.0	27.0	24.0	30.0	32.0	28.0	24.8	
E	25.2	24.0	100.0	27.0	29.0	29.2	24.8	28.3	26.4	28.0	29.0	31.0	29.4	27.4	25.4	
24. M	26.0	24.8	89.0	25.0	30.0	28.3	24.8	26.3	25.5	24.0	28.0	28.0	26.4	29.0	23.4	
N	27.0	26.0	88.0	24.0	29.0	27.4	28.2	27.0	29.0	27.0	29.0	26.3	27.0	28.0	29.0	
E	25.0	24.0	78.0	26.0	28.1	29.2	29.3	28.0	28.0	26.0	25.0	27.0	28.0	27.0	31.0	
25. M	29.0	28.0	77.0	28.0	28.2	28.2	23.4	27.0	24.0	27.0	24.0	27.8	27.0	28.0	33.0	
N	25.0	23.4	76.0	31.0	26.1	27.2	26.3	27.0	26.0	28.0	29.0	32.0	26.0	29.0	31.0	
E	24.8	24.0	86.0	32.0	24.3	28.3	24.5	26.0	28.0	27.2	28.0	31.0	30.0	23.0	29.0	
26. M	26.0	25.0	98.0	23.4	25.3	27.2	27.3	25.0	24.9	25.4	24.8	34.0	26.0	27.0	34.0	
N	28.0	27.0	77.0	27.8	26.2	24.8	26.8	27.8	25.8	27.0	26.8	28.0	27.0	28.0	30.0	
E	27.4	26.4	86.0	28.0	27.8	23.0	29.3	31.0	31.0	280	25.2	27.0	28.0	24.3	24.0	
27. M	26.8	26.0	77.0	23.4	29.0	29.0	25.4	32.0	28.2	31.0	30.0	25.4	30.0	27.0	26.0	
N	25.0	24.8	86.0	26.0	24.8	28.3	24.8	33.0	29.0	32.0	28.0	26.0	27.0	29.0	25.3	
E	27.0		79.0	25.9	25.8	24.3	23.30	34.0	26.8	29.8	29.0	27.0	27.0	27.2	26.4	
28. M	28.0	27.0	88.0	28.9	29.0	29.2	29.0	29.8	25.2	25.5	27.8	28.0	28.0	28.0	27.4	
N	27.0	24.2	80.0	29.0	24.3	27.8	24.8	29.0	25.6	26.0	25.2	27.4	27.2	26.2	28.2	
E	26.2	25.4	65.0	32.0	29.0	24.6	29.0	28.0	28.2	26.0	26.4	27.0	28.0	25.4	29.0	
29. M	29.0	27.0	86.0	33.0	28.0	29.0	26.3	27.8	27.0	25.7	24.0	29.0	24.8	26.0	24.3	
N	25.0	24.0	87.0	24.0	23.0	28.0	24.3	27.8	26.7	26.3	25.0	28.0	26.8	28.0	27.0	13.9
E	28.0	25.0	85.0	34.0	26.0	24.0	26.3	24.8	28.0	28.0	28.0	25.5	24.0	24.0	28.4	

APPENDIX C Continuation

30. M	29.0	27.0	890.	31.4	28.0	-27.4	29.3	24.7	25:2	27.0	24.8	26.3	27.0	27.0	29.0
N	27.4	25.0	87.0	28.2	26.4	29.0	24.8	25.2	26.7	26.0	25.3	25.8	25.0	24.8	24.0
E	26.8	24.2	85.0	29.0	27.8	28.0	27.3	26.8	28.2	25.3	26.2	26.2	28.3	25.3	29.0

APPENDIX D

TABLE 4 SEPTEMBER ROOM TEMPERATURE (^{O}C)

DAY/ TIME	AMBIENT TEMPERATURE (^{O}C)		RELATIVE HUMIDITY (%)	1	2	3	4	5	6	7	8	9	10	11	12	MC
	DRYBULD	WETBULD														
1 M	26.5	24.0	89.0	25.0	250	26.0	27.0	26.0	27.0	25.0	28.0	25.0	26.0	27.0	30.0	
N	28.0	25.0	92.0	26.0	26.0	27.0	26.0	28.0	28.0	30.0	27.0	26.0	27.0	26.0	28.0	
E	26.0	26.0	90.0	27.0	27.0	28.0	27.0	28.0	25.0	29.0	28.0	25.0	28.0	25.0	29.0	
2 M	25.0	24.0	75.0	26.0	30.0	29.0	29.0	29.0	27.0	28.0	27.0	24.0	29.0	29.0	27.0	
N	26.0	25.0	65.0	25.0	27.0	28.0	28.0	28.0	27.0	27.0	26.0	25.0	28.0	28.0	28.0	
E	23.0	22.0	100.0	24.0	28.0	27.0	27.0	26.0	26.0	26.5	24.0	26.0	27.0	26.0	29.0	
3 M	27.0	25.0	90.0	28.0	28.0	26.0	28.0	27.0	26.0	27.0	25.0	27.0	26.0	27.0	28.0	
N	26.0	26.0	86.0	27.0	29.0	27.0	26.0	26.0	27.0	26.0	24.0	28.0	27.0	26.0	29.0	13.5
E	25.0	24.0	68.0	26.0	30.0	25.0	27.0	25.0	28.0	25.0	23.0	26.0	28.0	29.0	30.0	
4 M	27.0	26.0	55.0	30.0	27.0	27.0	25.0	24.5	28.0	29.0	27.0	28.0	27.0	30.0	31.0	
N	28.0	24.0	65.0	28.0	28.0	28.0	26.0	23.0	27.0	28.0	26.0	27.0	26.0	26.0	30.0	
E	31.0	28.0	96.0	27.0	24.0	24.0	25.0	27.0	26.0	26.0	27.0	25.0	28.0	29.0	26.0	
5 M	25.0	25.0	71.0	25.0	28.0	25.0	25.0	28.0	25.0	28.0	24.0	24.0	24.0	28.0	24.0	
N	24.5	24.0	85.0	26.0	27.0	25.0	24.0	27.0	24.0	29.0	23.0	26.0	26.0	27.0	25.0	
E	26.0	25.0	66.0	27.0	27.0	24.0	26.0	22.0	26.0	25.0	25.0	25.0	25.0	25.0	26.0	
6 M	27.0	27.0	56.0	25.0	21.0	24.0	26.0	25.5	29.0	27.0	30.0	23.0	26.0	25.0	29.0	
N	28.0	28.0	77.0	26.0	27.0	23.5	25.0	27.0	27.0	26.0	25.0	26.0	27.0	26.0	26.0	
E	29.0	26.0	87.0	27.0	26.0	27.0	24.0	78.0	25.0	26.0	28.0	25.2	28.0	28.0	27.0	

7 M	31.0	25.5	96.0	25.0	24.0	24.0	28.0	27.0	25.0	24.0	25.0	26.0	25.0	24.0	29.0	
N	32.0	28.0	91.0	26.0	29.0	30.0	27.0	28.0	27.0	27.0	28.0	27.0	26.0	27.0	24.0	
E	29.0	27.0	96.0	27.0	30.0	27.0	25.5	25.0	24.0	27.0	25.0	26.0	27.0	28.0	27.0	
8 M	28.0	27.0	84.0	24.5	25.0	25.0	25.0	30.0	26.0	27.0	25.0	25.0	28.0	27.0	25.0	
N	24.0	23.0	78.0	28.0	28.0	28.0	26.5	28.5	25.0	28.0	26.0	26.0	25.0	28.0	23.0	
E	25.0	24.0	76.0	27.0	24.0	24.0	25.5	27.0	23.0	27.0	27.0	27.0	27.0	24.0	26.0	
9 M	26.0	26.0	74.0	25.0	29.0	28.0	25.0	25.0	28.0	29.0	26.0	27.0	27.0	25.0	25.0	
N	27.0	25.0	83.0	28.0	26.0	27.0	23.0	26.0	29.0	28.0	24.5	31.0	28.0	27.0	27.0	
E	28.0	27.0	72.0	29.0	27.0	29.0	27.0	27.0	28.0	27.0	24.0	33.0	28.0	28.0	28.0	
10M	29.0	28.0	85.0	27.0	24.0	28.0	25.0	25.0	26.0	27.0	25.0	27.0	26.0	25.0	24.0	
N	25.0	24.0	86.0	29.0	28.0	27.0	27.0	25.0	27.0	25.0	27.0	24.0	24.0	26.0	29.0	13.6
E	24.5	22.0	87.0	28.0	26.0	24.0	28.0	26.0	28.0	28.0	28.0	27.0	25.0	27.0	28.0	
11M	26.0	25.0	92.0	27.0	30.0	26.0	27.0	29.0	27.0	27.0	29.0	28.0	23.0	28.0	23.0	
N	25.0	24.0	81.0	26.0	34.0	28.0	26.0	29.0	25.0	28.0	28.0	27.0	24.5	27.0	35.0	
E	28.0	23.0	83.0	25.0	28.0	27.0	24.0	30.0	26.0	26.0	27.0	26.0	25.0	26.0	25.0	
12M	24.0	24.0	86.0	24.0	27.0	28.0	25.0	30.0	25.0	24.0	23.0	28.0	29.0	25.0	28.0	
N	27.0	35.0	81.0	27.0	26.0	24.0	27.0	27.0	27.0	27.0	24.0	27.0	27.0	27.0	27.0	
E	28.0	26.0	83.0	24.0	25.0	26.0	28.0	28.0	28.0	26.0	27.0	25.0	28.0	26.0	30.0	

APPENDIX D Continuation

13. M	26.0	25.0	88.0	24.0	27.0	28.0	27.0	25.0	21.0	28.0	26.0	27.0	31.0	26.0	25.0	M.C
N	27.0	27.0	91.0	26.0	26.0	29.0	26.0	26.0	30.0	27.0	26.0	27.0	25.0	27.0	24.0	
E	25.0	24.0	70.0	28.0	27.0	24.0	24.0	27.0	29.0	26.0	25.0	30.0	30.0	28.0	25.0	
14. M	27.0	26.0	78.0	27.0	28.0	26.0	25.0	25.0	28.0	23.0	27.0	29.0	29.0	24.0	27.0	
N	28.0	27.0	88.0	25.0	27.0	25.0	26.0	24.0	27.0	24.0	26.0	28.0	28.0	25.0	25.0	
E	27.0	25.0	76.0	26.0	25.0	27.0	27.0	25.0	26.0	25.0	25.0	27.0	27.0	26.0	29.0	
15. M	26.0	24.0	56.0	28.0	27.0	26.0	24.5	27.0	24.0	24.0	29.0	30.0	25.0	27.0	25.0	
N	27.0	25.0	87.0	27.0	28.0	27.0	27.0	26.0	28.0	25.0	28.0	25.0	26.0	28.0	27.0	
E	28.0	26.0	83.0	26.0	27.0	28.0	28.0	27.0	27.0	26.0	27.0	26.0	27.0	27.0	28.0	
16. M	27.0	27.0	53.0	25.0	26.0	27.0	26.0	28.0	26.0	25.0	25.0	24.0	24.0	25.0	25.0	
N	26.0	25.0	67.0	28.0	25.0	26.0	24.0	29.0	25.0	26.0	25.0	25.0	27.0	27.0	27.0	
E	27.0	25.0	68.0	27.0	24.0	25.0	25.0	20.0	27.0	27.0	28.0	27.0	26.0	28.0	25.0	
17. M	28.0	26.0	65.0	25.0	25.0	28.0	26.0	27.0	27.0	25.0	26.0	30.0	29.0	25.0	28.0	
N	27.0	25.0	55.0	26.0	28.0	27.0	27.0	28.0	28.0	27.0	27.0	29.0	27.0	24.0	27.0	13.8
E	26.0	25.0	77.0	28.0	27.0	28.0	26.0	26.0	27.0	26.0	27.0	30.0	28.0	27.0	26.0	
18. M	27.0	26.0	78.0	29.0	28.0	27.0	25.0	25.0	25.0	25.0	25.0	30.0	28.0	24.0	29.0	
N	25.0	27.0	91.0	30.0	28.0	28.0	26.0	26.0	26.0	27.0	26.0	29.0	27.0	27.0	28.0	
E	24.0	27.0	100.0	32.0	26.0	25.0	27.0	28.0	27.0	28.0	27.0	28.0	28.0	28.0	27.0	
19. M	26.0	25.0	98.0	34.0	29.0	25.0	25.0	31.0	28.0	26.0	28.0	27.0	25.0	30.0	31.0	
N	27.0	24.0	75.0	27.0	30.0	26.0	27.0	27.0	28.0	25.0	27.0	28.0	26.0	29.0	32.0	
E	28.0	28.0	96.0	27.0	30.0	27.0	28.0	27.0	27.0	26.0	25.0	27.0	29.0	28.0	34.0	
20. M	27.0	25.0	98.0	28.0	31.0	30.0	25.0	30.0	25.0	29.0	27.0	28.0	28.0	27.0	28.0	
N	24.0	26.0	95.0	29.0	34.0	26.0	26.0	29.0	26.0	28.0	25.0	27.0	27.0	26.0	27.0	

APPENDIX D Continuation

21. M	26.0	23.0	78.0	25.0	25.0	28.0	28.0	30.0	31.0	27.0	25...0	27.0	25.0	27.0	27.0	
N	25.0	25.0	94.0	24.5	26...0	27.0	29.0	30.0	26.0	28.0	24.0	28.0	26.0	28.0	28.0	
E	27.0	26.0	77.0	26.0	27.0	28.0	28.0	29.0	27.0	27.0	26.0	27.0	27.0	29.0	27.0	
22. M	24.0	25.0	76.0	27.0	24.0	25.0	25.0	29.0	28.0	27.0	25.0	27.0	26.0	25.0	27.0	
N	24.0	22.0	78.0	28.0	26.0	26.0	26.0	28.0	27.0	26.0	27.0	26.0	27.0	27.0	25.0	13.7
E	27.0	25.0	79.0	27.0	27.0	27.0	27.0	27.0	25.0	25.0	26.0	27.0	28.0	26.0	28.0	
23. M	27.0	27.0	56.0	26.0	28.0	30.0	28.0	26.0	26.0	27.0	27.0	29.0	27.0	28.0	24.0	
N	25.0	25.0	86.0	27.0	28.0	27.0	29.0	25.0	28.0	26.0	28.0	28.0	27.0	27.0	260	
E	26.0	25.0	77.0	27.0	27.0	26.0	28.0	25.0	27.0	27.0	27.0	27.0	28.0	27.0	25.0	
24. M	27.0	26.0	78.0	28.0	27.0	28.0	25.0	26.0	25.0	25.0	27.0	26.0	25.5	27.0	24.0	
N	28.0	27.0	76.0	29.0	28.0	27.0	30.0	27.0	28.0	26.0	27.0	26.0	26.0	27.0	25.0	
E	27.0	25.0	73.0	28.0	25.0	26.0	34.0	28.0	27.0	25.0	27.0	26.0	26.0	25.0	26.0	
25. M	27.0	24.0	75.0	27.0	29.0	27.0	27.0	28.0	27.0	28.5	34.0	27.0	29.0	28.0	25.0	
N	17.0	23.0	79.0	28.0	28.0	26.0	28.0	27.0	24.5	29.0	25.0	28.0	30.0	27.0	280	
E	26.0	25.0	88.0	26.0	28.0	25.0	27.0	28.0	27.0	30.0	26.0	27.0	29.0	26.0	27.0	
26. M	25.O	24.0	88.0	25.0	30.0	25.0	28.0	27.0	27.0	27.0	28.0	27.0	27.0	29.0	29.0	
N	27.0	26.0	77.0	29.0	24.0	27.0	27.0	24.0	28.0	26.0	28.0	26.0	26.0	28.0	30.0	
E	26.0	25.0	91.0	28.0	25.0	26.0	28.0	25.0	27.0	28.0	29.0	24.0	27.0	27.0	25.0	
27. M	27.0	25.0	96.0	25.0	27.0	25.0	29.0	26.0	29.0	27.0	27.0	27.0	29.0	26.0	27.0	
N	28.0	26.0	98.0	26.0	28.0	24.0	30.0	25.0	28.0	28.0	28.0	26.0	28.0	27.0	28.0	
E	27.0	26.0	56.0	27.0	29.0	28.0	24.0	27.0	27.0	29.0	27.0	28.0	27.0	25.0	29.0	
28.M	25.0	24.0	76.0	26.0	24.0	27.0	26.0	25.0	28.0	25.0	26.0	29.0	23.0	24.0	27.0	
N	26.0	25.0	87.0	27.0	24.5	28.0	27.0	24.0	27.0	26.0	24.0	30.0	26.0	25.0	28.0	

APPENDIX D Continuation

29.M	25.0	25.0	27.0	28.0	25.0	26.0	24.0	24.0	25.0	28.0	26.0	28.0	28.0	27.0	27.0	
N	27.0	25.0	77.0	29.0	24.0	24.0	25.0	27.0	26.0	27.0	25.0	26.0	27.0	28.0	26.0	13.4
E	28.0	27.0	76.0	28.0	26.0	27.0	26.0	26.0	25.0	25.0	27.0	27.0	25.0	27.0	30.0	
30. M	27.0	26.0	78.0	24.0	27.0	25.0	28.0	29.0	27.0	25.0	25.0	27.0	27.0	27.0	25.0	
N	25.0	24.0	86.0	26.0	28.0	26.0	27.0	25.0	28.0	26.0	27.0	26.0	29.0	28.0	25.0	
E	26.0	25.0	78.0	27.0	27.0	27.0	24.0	26.0	27.0	27.0	28.0	27.0	28.0	28.0	29.0	

Table 5 APPENDIX E

The Average Temperature of Dry Bulb, Wet Bulb, Relative Humidity, Top, Centre, and Bottom all in Degree Centigrade of June.

Days	Dry-Bulb	Wet-Bulb	R.H	Top	Centre	Bottom
19	26.23	25.66	90.33	26.66	27.0	27.0
20	28.83	27.5	88	26.33	27.66	26.33
21	23.56	23.0	90	27	27.0	26.0
22	28.0	24.83	71	27.66	26.2	27.33
23	27.66	25.33	84	26.66	26.66	26.66
24	30.33	23.33	80	26.0	7.66	26.33
25	27.0	26.0	92.33	27.33	27.0	26.33
26	28.06	25.33	86.66	26.66	27.33	27.0
27	25.96	25.93	82	28.0	27.0	28.33
28	27.0	25.46	92	26.0	26.33	28.33
29	27.0	26.0	78	8.0	28.0	28.0
30	26.33	24.0	96.66	26.66	28.0	28.33

Table 6 APPENDIX F

The Average Temperature of Dry Bulb, Wet Bulb, Relative Humidity, Top, Centre, and Bottom all in Degree Centigrade of July.

Days	Dry-Bulb	Wet-Bulb	R.H	Top	Centre	Bottom
1	27.33	25.83	89.66	28.0	27.0	27.33
2	29.4	26.73	87.66	25.33	24.9	26.16
3	24.27	23.33	90.66	27.0	25.77	27.33
4	24.5	23.53	96.66	26.0	27.16	26.33
5	25.17	24.43	93.33	26.5	28.0	26.16
6	26.0	24.25	90.66	27.33	27.33	27.83
7	25.33	24.53	80.33	26.0	27.67	26.33
8	26.67	25.5	88.33	27.16	27.67	27.33
9	25.67	25.67	94	26.83	25.13	25.3
10	25.0	24.1	96	31.33	28.5	27.33
11	27.0	26.0	92	27.0	28.07	28.0
12	26.33	24.56	95.33	25.0	28.0	28.33
13	26.67	24.0	80.66	26.0	27.67	15.83
14	25.67	24.67	77.66	25.83	27.33	26.33
15	28.23	26.33	81.66	26.0	25.87	26.33
16	25.33	23.67	85.66	25.33	27.0	26.0
17	29.0	26.67	76.33	26.16	27.33	26.0
18	27.0	25.33	91.33	26.33	25.67	26.33
19	29.67	27.0	94	27.67	26.17	27.0
20	25.67	24.83	75.66	27.0	27.0	28.33
21	26.67	25.67	89.33	25.17	24.67	26.33
22	27.0	25.9	89	29.0	26.67	27.67
23	27.33	26.33	83	27.33	25.53	27.67
24	27.67	26.0	88	27.67	27.67	28.0
25	27.67	26.0	84	26.33	27.33	27.0
26	27.67	26.73	94.66	23.93	27.83	27.0
27	25.33	25.67	95.66	25.5	25.16	29.0
28	26.0	24.33	92	27.0	25.33	27.33
29	25.67	24.83	85.33	26.33	26.33	25.0
30	26.67	25.4	90.66	26.33	26.0	29.0
31	26.67	25.4	94.66	27.0	26.13	27.0

APPENDIX G

Table 7: **The Average Temperature of Dry Bulb, Wet Bulb, Relative Humidity and Twelve (12) Point in the Silo of which Point 1 (Bottom), Point 6 (Centre) and Point 10 (Top) for Month of August.**

Day	Dry Bulb	Wet Bulb	R.H	1	2	3	4	5	6	7	8	9	10	11	12
1	26.0	24.83	94.33	26.33	26.9	25.67	25.01	27.01	27.07	25.0	27.43	25.01	26.87	25.4	26.3
2	24.67	23.33	80.67	26.23	27.27	24.0	28.24	25.17	27.0	26.33	25.61	26.31	26	27.70	27.0
3	25.57	24.63	77.4	25.67	26.4	23.0	26.17	25.34	24.18	25.0	25.31	23.42	25.31	26.0	24.37
4	25.1	23.67	82.33	26.47	26.73	27.93	25.0	27.0	28.0	25.0	25.0	27.51	29.67	25.31	25.67
5	26.67	25.17	82.67	25.53	25.33	27.4	26.67	25.21	25.63	25.03	26.87	26.0	28.67	29.31	29.93
6	24.0	22.33	82.0	25.33	27.0	26.47	26.17	25.63	25.91	24.01	25.17	26.37	27.0	28.86	29.0
7	26.8	25.0	86.0	26.3	28.0	26.1	24.3	25.4	25.6	26.2	27.3	25.3	26.3	26.1	28.1
8	25.8	24.5	73.3	24.6	26.2	27.3	25.5	27.2	25.3	31.0	25.6	28.1	32.0	29.3	26.1
9	27.3	25.3	92.6	28.0	23.3	25.0	26.0	28.0	25.6	25.0	27.0	27.2	24.6	26.6	27.6
10	24.6	23.6	64.3	26.0	26.3	25.0	28.0	28.1	25.6	26.8	24.1	25.8	26.9	25.2	26.3
11	25.0	23.6	76.6	25.0	25.8	25.3	25.0	25.0	27.5	30.0	27.3	28.4	25.3	25.3	27.3
12	25.8	23.6	83.6	25.4	25.0	26.3	25.3	29.0	32.1	29.3	31.4	26.4	26.7	27.3	26.0
13	26.2	24.7	80.3	29.0	26.5	25.4	27.6	28.3	27.2	27.1	26.6	28.5	28.2	28.1	28.3
14	24.6	24.7	80.6	31.0	26.1	26.6	25.0	28.7	27.2	32.2	29.1	28.2	27.1	26.5	27.3
15	19.1	25.2	89.3	27.5	28.6	27.1	26.4	28.3	26.7	26.6	26.0	30.0	23.1	23.1	27.2
16	26.3	25.8	64.9	25.7	26.6	26.3	26.3	26.5	25.9	24.6	26.2	30.3	32.3	32.6	27.3
17	26.7	25.0	96.3	27.0	27.9	27.6	25.9	28.0	25.6	28.5	26.3	24.8	24.0	30.0	27.6
18	26.6	25.7	85.6	27.3	28.9	30.8	26.6	27.1	25.2	25.6	28.9	27.9	25.3	26.3	24.5
19	25.4	24.7	93.0	27.9	30.3	25.7	26.4	30.0	26.7	27.6	26.9	25.6	28.5	24.2	27.1
20	26.4	25.6	75.3	26.6	27.3	27.4	27.6	29.9	28.9	26.9	27.6	27.7	27.3	25.9	27.5
21	25.0	24.0	75.3	28.4	27.8	26.5	27.8	31.3	27.0	25.9	27.9	24.1	26.1	25.8	30.7
22	26.1	25.0	87.67	27.13	31.33	26.63	28.06	28.33	28.07	28.18	26.12	27.93	26.33	27.67	25.3
23	26.37	25.33	90.0	25.83	26.33	26.86	24.35	26.39	25.03	27.31	26.03	30.0	30.07	28.17	25.07
24	26.0	24.06	85.0	25.0	29.27	28.13	27.23	27.01	27.32	25.63	27.31	27.01	27.03	28.0	27.8
25	26.13	25.23	79.67	30.33	26.2	27.83	24.51	26.67	26.0	27.33	27.0	30.27	27.67	26.67	31.0
26	27.18	26.03	87.0	26.26	26.03	25.0	27.38	27.93	27.23	26.83	25.27	29.69	27.0	26.33	29.33
27	26.13	24.66	80.67	24.67	26.23	27.33	24.17	33.0	27.67	30.68	29.0	26.03	28.0	27.67	25.67
28	27.01	25.04	77.67	29.93	27.86	26.87	27.33	28.93	26.32	25.94	26.18	27.33	27.67	26.33	28.07
29	27.33	25.33	86.0	30.33	25.67	27.0	25.37	26.27	27.03	26.56	25.67	27.33	24.63	26.0	26.33
30	27.73	25.33	87.0	29.53	27.4	28.13	27.13	25.57	26.7	26.02	25.17	25.93	26.68	25.7	27.3

APPENDIX H

Table 8 : **The Average Temperature of Dry Bulb, Wet Bulb, Relative Humidity and Twelve (12) Point in the Silo of which Point 1 (Bottom), Point 6 (Centre) and Point 10 (Top) for Month of September.**

Day	Dry Bulb	Wet Bulb	R.H	1	2	3	4	5	6	7	8	9	10	11	12
1	26.53	25.0	90.33	26.0	26.0	27.0	26.56	27.35	27.43	28.0	27.33	25.13	27.0	26.0	29.33
2	24.56	23.63	80.0	25.0	28.33	28.0	28.0	27.83	26.89	27.01	25.61	25.0	28.0	27.86	28.0
3	26.0	25.0	81.33	27.0	29.0	26.0	27.0	26.0	27.0	26.0	24.0	27.0	27.0	27.53	29.0
4	28.83	26.0	72.0	28.33	26.33	26.33	25.31	24.67	27.0	27.89	27.63	26.83	27.0	28.33	29.0
5	25.03	24.76	74.0	26.0	27.53	24.86	25.0	25.89	25.0	27.33	24.0	25.0	25.0	26.87	25.0
6	28.0	27.0	73.33	26.0	24.67	24.86	25.31	26.83	27.0	26.31	27.63	24.61	27.0	26.31	27.53
7	30.86	26.63	94.33	26.0	27.86	27.0	26.92	26.83	25.33	26.73	26.0	26.31	26.0	26.53	26.81
8	25.56	26.61	79.33	26.33	25.83	25.83	25.31	28.53	24.87	27.53	26.0	26.0	26.81	26.53	24.83
9	27.0	24.38	76.23	27.33	27.33	28.0	25.0	26.0	28.53	28.0	24.67	30.17	27.67	26.91	26.91
10	26.13	24.33	86.0	28.0	26.0	26.68	26.83	25.53	27.0	26.93	26.91	26.0	25.0	26.0	27.0
11	26.33	24.0	85.33	26.0	20.53	27.0	25.81	29.33	26.0	27.0	28.0	27.0	24.0	27.0	27.67
12	26.33	28.33	83.33	25.0	26.0	26.0	26.81	28.63	26.67	25.83	24.33	26.87	28.0	26.0	28.67
13	26.0	25.33	83.0	26.0	26.63	27.0	25.83	26.0	26.67	27.0	25.83	28.0	28.71	27.0	24.53
14	27.21	26.0	80.67	26.0	26.83	26.0	26.0	24.63	27.0	24.0	26.0	28.0	28.31	25.0	27.0
15	27.0	25.0	75.33	27.0	27.31	27.0	26.5	26.51	26.53	25.0	28.0	27.0	26.0	27.31	26.83
16	26.63	25.61	62.67	26.61	25.0	26.0	25.0	25.33	26.0	26.0	26.0	25.53	26.53	26.83	25.51
17	27.0	25.63	65.67	26.32	26.67	27.63	26.33	27.0	27.33	26.0	26.67	29.87	28.0	25.33	27.0
18	25.53	26.61	89.67	30.33	27.33	26.83	26.0	26.33	26.0	26.67	26.0	29.0	27.33	26.33	28.0
19	27.0	25.83	89.67	29.33	29.67	26.0	26.63	28.21	27.71	25.81	26.81	27.31	26.83	29.0	32.33
20	26.0	25.33	89.67	27.0	31.67	27.67	26.0	29.0	26.0	28.0	26.0	27.0	26.67	25.67	28.0
21	26.0	24.83	83.0	25.03	26.0	27.67	28.33	29.67	28.0	27.33	25.0	27.33	26.0	28.0	27.33
22	25.0	24.0	77.67	27.33	27.33	25.67	26.0	26.0	28.0	26.67	26.0	26.0	26.67	27.0	26.0
23	26.0	25.63	73.0	26.67	26.67	27.67	28.33	28.33	25.33	27.0	26.67	27.67	28.0	27.33	27.33
24	27.33	26.0	75.67	28.33	26.67	26.67	27.0	29.67	27.0	26.67	25.33	27.0	26.0	25.67	25.67
25	26.67	24.0	80.67	27.0	28.33	26.0	27.33	27.67	26.0	29.03	28.33	27.32	29.33	27.0	27.0
26	26.0	25.0	85.33	27.33	26.33	26.0	27.67	25.33	27.33	27.0	28.33	25.67	26.67	28.0	28.0
27	27.67	25.67	83.33	26.0	28.0	25.67	27.67	26.0	28.0	28.0	27.33	27.0	28.0	26.0	28.0
28	25.0	24.33	84.33	27.0	24.33	28.0	27.0	25.67	27.67	26.0	25.0	29.33	25.33	25.0	27.33
29	26.67	25.63	80	28.33	25.0	25.53	25.0	25.67	25.33	26.67	26.0	27.0	26.67	27.33	27.67

Table 9 APPENDIX I

Note: The following average points 1, 2, 3, 4 is (Bottom), points 6, 5, 7, 8 is (Centre) while points 10, 9, 11, 12 is (Top) for the months of August, respectively.

Days	Dry-Bulb	Wet-Bulb	R.H	Top	Centre	Bottom
1	26.0	24.83	94.33	25.86	26.37	25.67
2	24.67	23.33	80.67	26.53	26.33	26.33
3	25.57	24.63	77.4	24.67	25.03	25.43
4	25.1	23.67	82.33	26.33	26.33	26.37
5	26.67	25.17	82.67	27.89	26.01	26.03
6	24.0	22.33	82.0	27.63	25.37	26.33
7	26.8	25.0	86.0	26.67	25.31	26.53
8	25.8	24.5	73.3	28.81	26.33	25.67
9	27.3	25.3	92.6	26.87	26.31	25.53
10	24.6	23.6	64.3	26.01	26.34	26.43
11	25.0	23.6	76.6	26.87	25.67	25.07
12	25.8	23.6	83.6	26.53	27.37	25.38
13	26.2	24.7	80.3	28.31	27.03	26.87
14	24.6	23.7	80.6	27.31	26.87	27.37
15	19.1	25.2	89.3	25.61	26.57	27.33
16	26.3	25.8	64.9	30.17	26.01	26.21
17	26.7	25.0	96.3	26.53	26.83	27.01
18	26.6	25.7	85.6	26.53	26.87	28.32
19	25.4	24.7	93.0	26.13	27.67	27.83
20	26.4	25.6	75.3	26.37	28.01	27.04
21	25.0	24.0	75.3	26.31	28.21	27.34
22	26.1	25.0	87.67	27.01	27.66	27.81
23	26.37	25.33	90.0	28.57	26.53	26.01
24	26.0	24.06	85.0	27.31	27.21	27.67
25	26.13	25.33	79.67	28.87	26.81	26.21
26	27.18	26.03	87.0	27.67	26.61	26.62
27	26.13	24.66	80.67	26.53	28.29	25.61
28	27.01	25.04	77.67	27.21	26.52	27.31
29	27.33	25.33	86.0	25.81	26.37	28.01
30	27.73	25.33	87.0	25.63	25.92	28.03

Table 10 APPENDIX J

Note: The following average points 1, 2, 3, 4 is (Bottom), points 6, 5, 7, 8 is (Centre) while points 10, 9, 11, 12 is (Top) for the months of September, respectively.

Days	Dry-Bulb	Wet-Bulb	R.H	Top	Centre	Bottom
1	26.53	25.0	90.33	26.43	27.53	26.37
2	24.56	23.63	80.0	26.81	26.87	27.31
3	26.0	25.0	81.33	27.81	25.53	27.31
4	28.83	26.0	72.0	27.31	26.32	26.37
5	25.03	24.76	74.0	25.32	25.71	25.57
6	28.0	27.0	73.33	25.38	26.82	25.21
7	30.86	26.63	94.33	26.33	26.01	26.37
8	25.56	26.61	79.33	25.87	26.22	25.31
9	27.0	24.38	76.23	27.21	26.51	26.31
10	26.13	24.33	86.0	25.87	26.83	26.52
11	26.33	24.0	85.33	26.33	27.31	26.31
12	26.33	28.33	83.33	27.83	25.87	25.83
13	26.0	25.33	83.0	26.67	26.21	26.21
14	27.21	26.0	80.67	26.87	25.38	26.21
15	27.0	25.0	75.33	26.83	26.34	27.01
16	26.63	25.61	62.67	26.13	27.53	25.67
17	27.0	25.63	65.67	27.22	26.87	26.81
18	25.53	26.61	89.67	27.53	26.01	27.33
19	27.0	25.83	89.67	28.23	26.33	27.31
20	26.0	25.33	89.67	26.87	27.81	27.81
21	26.0	24.83	83.0	27.31	27.1	26.71
22	25.0	24.0	77.67	26.36	26.31	26.63
23	26.0	25.63	73.0	27.67	27.31	27.04
24	27.33	26.0	75.67	25.87	26.87	27.01
25	26.67	24.0	80.67	27.87	27.21	27.21
26	26.0	25.0	85.33	26.23	27.01	27.03
27	27.67	25.67	83.33	27.34	27.57	26.81
28	25.0	24.33	84.33	26.89	27.2	26.21
29	26.67	25.63	80	27.21	26.31	25.83

Table 11 APPENDIX K

Table : Ambient Temperature for the Month of June.

Days	Ambient Temperature	R.H	Top	Centre	Bottom
19	25.94°C	90.33	26.66	27.0	27.0
20	28.16 °C	88	26.33	27.66	26.33
21	23.28 °C	90	27	27.0	26.0
22	26.41 °C	71	27.66	26.2	27.33
23	26.49 °C	84	26.66	26.66	26.66
24	26.83 °C	80	26.0	7.66	26.33
25	26.5 °C	92.33	27.33	27.0	26.33
26	26.69 °C	86.66	26.66	27.33	27.0
27	25.94 °C	82	28.0	27.0	28.33
28	26.23 °C	92	26.0	26.33	28.33
29	26.5 °C	78	8.0	28.0	28.0
30	25.16 °C	96.66	26.66	28.0	28.33

Table 12

APPENDIX L

Table : Ambient Temperature for the Month of July.

Days	Ambient Temp. °C	R.H	Top	Centre	Bottom
1	26.58 °C	89.66	28.0	27.0	27.33
2	28.06 °C	87.66	25.33	24.9	26.16
3	23.75 °C	90.66	27.0	25.77	27.33
4	24.01 °C	96.66	26.0	27.16	26.33
5	24.8 °C	93.33	26.5	28.0	26.16
6	25.13 °C	90.66	27.33	27.33	27.83
7	24.93 °C	80.33	26.0	27.67	26.33
8	26.08 °C	88.33	27.16	27.67	27.33
9	25.67 °C	94	26.83	25.13	25.3
10	24.55 °C	96	31.33	28.5	27.33
11	26.6 °C	92	27.0	28.07	28.0
12	25.44 °C	95.33	25.0	28.0	28.33
13	25.35 °C	80.66	26.0	27.67	15.83
14	25.17 °C	77.66	25.83	27.33	26.33
15	27.28 °C	81.66	26.0	25.87	26.33
16	24.5 °C	85.66	25.33	27.0	26.0
17	27.83 °C	76.33	26.16	27.33	26.0
18	26.16 °C	91.33	26.33	25.67	26.33
19	28.33 °C	94	27.67	26.17	27.0
20	25.25 °C	75.66	27.0	27.0	28.33
21	26.17 °C	89.33	25.17	24.67	26.33
22	26.45 °C	89	29.0	26.67	27.67
23	26.83 °C	83	27.33	25.53	27.67
24	26.83 °C	88	27.67	27.67	28.0
25	26.83 °C	84	26.33	27.33	27.0
26	27.2 °C	94.66	23.93	27.83	27.0
27	25.5 °C	95.66	25.5	25.16	29.0
28	25.16 °C	92	27.0	25.33	27.33
29	25.25 °C	85.33	26.33	26.33	25.0
30	26.08 °C	90.66	26.33	26.0	29.0
31	25.25 °C	94.66	27.0	26.13	27.0

Table 13 APPENDIX M

Table : Ambient Temperature for the Month of August.

Days	Ambient Temp. °C	R.H	Top	Centre	Bottom
1	25.41 °C	94.33	25.86	26.37	25.67
2	24 °C	80.67	26.53	26.33	26.33
3	25.1 °C	77.4	24.67	25.03	25.43
4	24.38 °C	82.33	26.33	26.33	26.37
5	25.92 °C	82.67	27.89	26.01	26.03
6	23.16 °C	82.0	27.63	25.37	26.33
7	25.9 °C	86.0	26.67	25.31	26.53
8	25.15 °C	73.3	28.81	26.33	25.67
9	26.3 °C	92.6	26.87	26.31	25.53
10	24.1 °C	64.3	26.01	26.34	26.43
11	24.3 °C	76.6	26.87	25.67	25.07
12	24.7 °C	83.6	26.53	27.37	25.38
13	25.45 °C	80.3	28.31	27.03	26.87
14	24.15 °C	80.6	27.31	26.87	27.37
15	22.15 °C	89.3	25.61	26.57	27.33
16	26.05 °C	64.9	30.17	26.01	26.21
17	25.85 °C	96.3	26.53	26.83	27.01
18	26.15 °C	85.6	26.53	26.87	28.32
19	25.05 °C	93.0	26.13	27.67	27.83
20	26 °C	75.3	26.37	28.01	27.04
21	24.5 °C	75.3	26.31	28.21	27.34
22	25.55 °C	87.67	27.01	27.66	27.81
23	25.85 °C	90.0	28.57	26.53	26.01
24	25.03 °C	85.0	27.31	27.21	27.67
25	25.68 °C	79.67	28.87	26.81	26.21
26	26.60 °C	87.0	27.67	26.61	26.62
27	25.39 °C	80.67	26.53	28.29	25.61
28	26.02 °C	77.67	27.21	26.52	27.31
29	26.33 °C	86.0	25.81	26.37	28.01
30	26.53 °C	87.0	25.63	25.92	28.03

Table 14 APPENDIX N

Table : Ambient Temperature for the Month of September.

Days	**Ambient Temp. °C**	**R.H**	**Top**	**Centre**	**Bottom**
1	25.76 °C	90.33	26.43	27.53	26.37
2	24.09 °C	80.0	26.81	26.87	27.31
3	25.5 °C	81.33	27.81	25.53	27.31
4	27.41 °C	72.0	27.31	26.32	26.37
5	24.89 °C	74.0	25.32	25.71	25.57
6	27.5 °C	73.33	25.38	26.82	25.21
7	28.74 °C	94.33	26.33	26.01	26.37
8	26.08 °C	79.33	25.87	26.22	25.31
9	25.69 °C	76.23	27.21	26.51	26.31
10	25.23 °C	86.0	25.87	26.83	26.52
11	25.16 °C	85.33	26.33	27.31	26.31
12	27.33 °C	83.33	27.83	25.87	25.83
13	25.66 °C	83.0	26.67	26.21	26.21
14	26.60 °C	80.67	26.87	25.38	26.21
15	26 °C	75.33	26.83	26.34	27.01
16	26.12 °C	62.67	26.13	27.53	25.67
17	26.31 °C	65.67	27.22	26.87	26.81
18	26.07 °C	89.67	27.53	26.01	27.33
19	26.41 °C	89.67	28.23	26.33	27.31
20	25.66 °C	89.67	26.87	27.81	27.81
21	25.41 °C	83.0	27.31	27.1	26.71
22	24.5 °C	77.67	26.36	26.31	26.63
23	25.81 °C	73.0	27.67	27.31	27.04
24	26.66 °C	75.67	25.87	26.87	27.01
25	25.33 °C	80.67	27.87	27.21	27.21
26	25.5 °C	85.33	26.23	27.01	27.03
27	26.67 °C	83.33	27.34	27.57	26.81
28	24.66 °C	84.33	26.89	27.2	26.21
29	26.15 °C	80	27.21	26.31	25.83

APPENDIX O

COSTING OF THE MATERIAL

S/No.	Item	Quantity	Unit Price (₦)	Total Price (₦)
1.	½ Plywood	6 Sheets	1,800:00	10,800:00
	¼ Plywood	1	1,100:00	1,100:00
2.	2-3 Timber	6	110:00	660:00
	2-2 Timber	12	150:00	1,800:00
3.	Paint Emulsion	2	350:00	700:00
4.	Bags of Maize	6	1,200:00	7,200:00
5.	Nails	3	60:00	180:00
6.	**Chemicals:**	3	70:00	210:00
	i. Phostoxine	1	2,200:00	2,200:00
	ii. Coopex (Dust chemical	1	1,500:00	1,500:00
7.	Body Filler	¼ tin	1,000:00	1,000:00
8.	Padlock	3	70:00	210:00
9.	Workmanship			6,500:00
10.	Copper constantan	12	375:00	4,500:00
	Total	:	=	**38,560:00**

Plate 1:

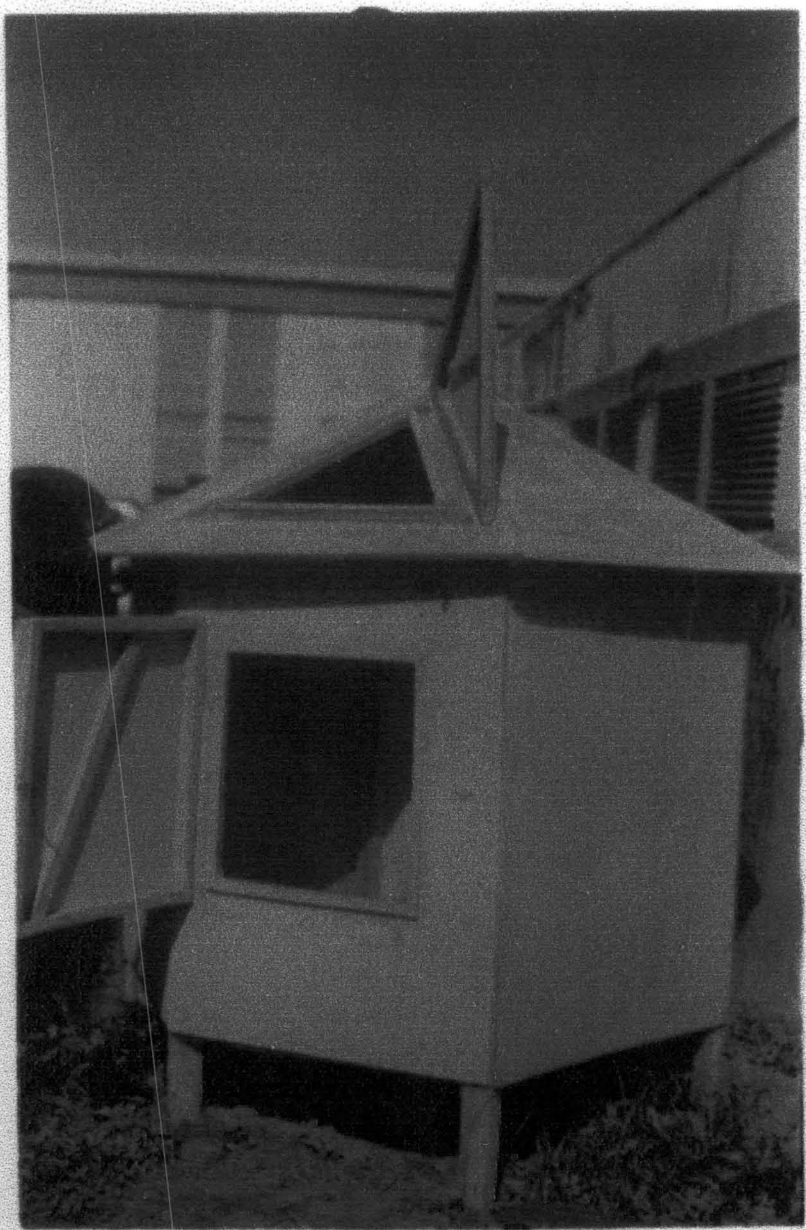

PLATE 1: THE CONSTRUCTED WOODEN SILO

Plate 2:

ATE 2: THE INTERNAL VIEW OF THE WOODEN SILO