PERFORMANCE EVALUATION OF A PORTABLE EXISTING SPRINKLER IRRIGATION SYSTEM USING BAMBOO PIPES

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LETTER OF CERTIFICATION

This is to certify that this thesis has been read and approved as meeting the requirement of the Department of Agricultural Engineering, for the award of post-graduate Diploma (PGD).

SUPERVISOR ---------------------------- 6/12/2001 ---------------------
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HOD ---------------------------- 28/09/2001 ---------------------
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DEDICATION

This Research work is sincerely dedicated to my LORD JESUS CHRIST and the families of IGE, OLAYEMI and YEYE-ODU

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ABSTRACT

The research work is focused on the potentialities of using banboo pipes (bambusa Vuligaries) as a piping material for irrigation. This is aimed at substituting that rather expensive and costly imported irrigation materials with the locally, readily available and inexpensive piping materials. The technology of the removal of the diaphragms of the Bamboo culm before it could be used as water conveyance and method of coupling them together were looked into. The results of the Experiment carried out on the uniformity Co-efficient of Bamboo as an irrigation piping material gave an average of 89. 63%, an average diameter of 20.90m, the average area of coverage was 343. 08m^2 and the average water distribution efficiency is 87.08%. The major disadvantages of using banboo as piping material are bursting of the pipe under a high pressure and the high leakage from the joints. It is therefore recommended that bamboo pipes should be used under a low pressure. The cost analysis for using both local and imported irrigation-piping materials were carried out for an area of 0.4ha of land. Using the local material as irrigation piping material for 4000m^2 cost a sum of sixty-eight thousand, seven hundred and twenty five naira (N68,725.00) while the cost for the same area of land using imported materials is three hundred and seventy-two thousands, eight hundred naira only (N372,800.00).

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ABBREVATIONS

A	=	Area
B	=	Breath
OC	=	Degree Centigrade
CM	=	Centimeter
Eta	=	Actual crop Consumptive use
ETo	=	Reference crop Evapo-Transpiration
G	=	Gramme
Hr	=	Hour
K	=	Kobo
Kc	=	Crop co-efficient
Kg	=	Kilogram
Km	=	Kilometer
L	=	Length
Lt	=	Litre
M	=	Metre
M^2	=	Square metre
M^3	=	Cubic metre
Max	=	Maximum
Min	=	Minute
Min	=	Minimum
Mm	=	Millimeter
N	=	Naira
P	=	Daily light percentage
PE	=	Effective Rainfall
Sec	=	Second

T	=	Temperature
Temp	=	Temperature
Vol	=	Volume

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CHAPTER ONE

1.0 INTRODUCTION

The need to produce sufficient food and Fibers to feed the daily increasing of our population is a great challenge. The rain fed cropping must be supplemented with irrigation so that the food production will be through out the year to enable us meet this great task. Hence, the need to find an alternative material to conventional imported pipe for irrigation works cannot be overemphasized. There is the need to provide adequate information for irrigation Engineers who are seeking for an alternative to conventional imported irrigation pipes. Hence, this research work.

Irrigation is generally defined as the application of water to the soil to supply moisture essential for the plant growth and there-by eliminate the moisture limitation to the crop production. The practice includes the development of water Sources, the conveyance system, method of effective application and effective waste water disposal system along with necessary/efficient managements to achieve the intended purposes.

The imported conventional pipes used in irrigation projects includes; plastic pipes, Galvanrized (G.I.) pipes, P.V.C pipe, Asbesto, Aluminium (A.I) pipe and steel corrugated pipe. All these piping materials are imported and of-course very expensive. However, they are in no doubt very good materials for water conveyance.

In consideration of the present financial situation of this country (Nigeria) which had precipitated the propagation of many economy adjustment programmes, among which is the present Structural Adjustment programme (SAP) and also taking into consideration, the low income of peasant and medium income farmers that constituted the majority of the farming community, all the above mentioned conventional pipes are very expensive and therefore, are beyond their reach economically. Hence there is a need to seek for an alternative cheaper and locally available material that can be afforded by the farmers interms of cost and maintenance. Hence, the use of Bamboo pipes as an alternative for steel and Aluminum (A.I) pipes becomes imperative.

There is no doubt that an inexpensive and readily availability local materials will arose the interest of the peasant farmers, the medium income scale farmers and others interested large scale farmer to invest into this very laudable science of irrigation.

For this research work, the Bamboo pipe material used is the Bambusa Vulgaris because of its abundant, early maturity, sizes and the success of this species in a similar project carried out in Nigeria (Nwa, 1981).

The most common specy of Bamboo pipe through out this country is the Bambusa Vulgaris. It originated from Asia and just like other Bamboo species, it attained full height in the first year of its growth. The maximum height attainable is between fifteen meters (15m) and forty meters (40m) while internal diameter rages between 50mm to 125(mm) (Sanglivi, 1985)

The main focus of this project work is to study the possibility of using Bamboo for water conveyance for irrigation projects instead of imported conventional pipes. The performance evaluation of the Bamboo system of irrigation would involves the management, efficiency and the cost analysis of the system.

The success of this project would help the peasant farmers that could not afford sprinkler irrigation system by conventional pipes to start using Bamboo pipe for sprinkler irrigation system which is expected to give almost the same results. Furthermore, the use of Bamboo would save greatly the Federal Government of Nigeria a lot of foreign reserve that would have been used in the importation of pipes for irrigation. Finally, the use of Bamboo pipe for sprinkler irrigation system will no doubt be economically viable as compared to that of the conventional imported pipes.

1.1 OBJECTIVES OF THE PROJECT:-

The main objectives of the project is performance evaluation of an existing sprinkler irrigation system using Bamboo.

The study would specifically look into :-

1.1.1 Determination of uniformity Co-efficient of the system.

1.1.2 Compare the cost of using Bamboo and the conventional pipes per unit area

1.1.3 Determination of radius and area of coverage of the Bamboo sprinkler irrigation system.

1.2.0 PROJECT JUSTIFICATION

The Performance Evaluation of the sprinkler irrigation system is carried out to provide adequate information to Irrigation Engineers seeking for alternative to imported conventional pipes. This research work is aimed at challenging the Researchers to intensify more efforts into both chemical and physical properties of Bamboo. This research work would allow the peasant farmers to be able to set up more successful pilot irrigation schemes to boost food production. This would allow both peasant and commercial farmers to put Bamboo pipes into more use than ever by using them for water conveyance in the field of Agriculture. It would also save the Federal Government of Nigeria a lot of foreign Reserves that would had been used in the importation of irrigation pipes

1.3 THE SCOPE OF THE PROJECT :-

The scope of this project involves the determination of :-

1.3.1 The Uniformity Co-efficient of the system.

1.3.2 Cost analysis of the use of Bamboo pipe per unit area and the imported conventional pipes.

1.3.3. The diameter and area of coverage of the existing system

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 IMPORTANCE OF IRRIGATION:-

In 1968, Gulhati of India stated well the importance of irrigation in the world. Irrigation in many countries is an old art as old as civilization - but for the whole world, it is a modern science, the science of survival.

The pressure of survival and the need for additional food supplies to feed our teaming population which increases every day are necessitating a rapid expansion of irrigation. Even though irrigation is of first important in the more arid regions of the world, it is becoming increasingly important in humid regions.

Israelsen and Hansen (1962) stated that irrigation is an age-old art. Historically, civilization has followed the development of irrigation. The antiquity of irrigation is well documented throughout the written history of mankind. Genesis made mention of Anraphel, king of Shinar, a contemporary of Abraham, who probably identical with Hammurabi, the sixth king of the first dynasty of Babylon. He developed laws, bearing the name of Hammurabi, indicating that the people had to depend upon irrigation for existence. One of the laws of Hammurabi states that if a man neglects to strengthen his bank of the canal and water carry away the meadow, the man in whose bank the breach is opened shall render back the corn which he caused to be lost.

The letter of Hammurabi about 2000 BC revealed a busy Governmental Administrator who wastes no words when instructing his officers.

Further mention of irrigation is fund in second kings 5:16-17 and he said, thus said the Lord, make this valley full of ditches. For thus said the Lord, ye shall not see winds neither shall ye see rain; yet that valley shall be filled with water, that ye may drink, both yee and your cattles and your beasts.

An ancient Assyrian Queen supposed to have lived before 2000 BC, is credited with directing her Government to divert the water, the Nile to irrigate the desert lands of Egypt. Irrigation canals supposed to have been built under this Queen of Assyria are still delivering water. Thus the, are records and evidence of continuous irrigation for thousands of years in the valleys of the Nile and for comparatively long periods like wise in Syrcas Persia, India, Java and Italy.

Egypt claim to have had the World's oldest dam, 355ft (108.20m) long and 40ft (12.19m) high, built 5038 years ago to store water for drinking and for irrigation. Basin irrigation introduced on the Nile about 3300 BC still play an important role in Egyptian Agriculture.

In China, where reclamation was begun more than 4000 years ago, the success of early kings was measured by their wisdom and progress in water control activities. King Yu, of Asia-Dynasty (2200BC) was elected king by the people as a reward for his outstanding work in water control. (Israelsen and Hansen, 1962).

2.2 IRRIGATION IN NIGERIA.

Irrigation by Shadof method was introduced into Nigeria between 1297 and 1596 from Egypt.(Usan, 1972), since then the importance of irrigation to increase food production had been taken seriously. However, the rate of expansion of irrigated area had been very slow. (Nwa, 1991).

Peasant farmers continued to use the Shadof method of irrigation and small pumps for irrigation along rivers, streams, Banks, near ponds, lakes and Fadama areas for the growth of their crops such as tomatoes, vegetables wheat, rice e.t.c.

In the present days, the involvement of private sector in complex irrigation is very limited. Infact, installation and maintenance of complex irrigation systems had been left solely into the hands of both the Federal and State Governments as a result of high cost of the initial installation and the subsequent maintenance. The Federal Government of Nigeria had established a number of large irrigation schemes such as Nigeria sugar company. Bacita (NISUCO), River Basin and Rural Development Authorities (R.B. & RDA), The Savanna Sugar Company (NUMA) that produced sugar cane under large scale irrigation.

2.3 TYPES OF IRRIGATION.

The four major types of irrigation methods are as follows:-

a) Surface irrigation method

b) Subsurface irrigation method

c) Trick drip irrigation method

d) Over head irrigation method.

2.3.1 SPRINKLER IRRIGATION SYSTEM:-

The sprinkler irrigation system is the method where-by water is supplied to the surface of the soil in the form of spray, some what as in ordinary rain. This is achieved by the flow of water under pressure through the conveyance and distribution system and discharged through small orifices or nozzles (Israelsen and Hansen, 1962).

2.3.2 COMPONENT OF SPRINKLER SYSTEM

The component of a sprinkler system includes the following:-

a) WATER SOURCES:-

The source of water is a place where water is obtained for irrigation purposes which is mostly from Dams, Weirs, Wells, etc.

b) ENERGY SOURCES (WATER PUMP)

The main source of energy for sprinkler irrigation system is water pump. Water pump is usually used to generate the required pressure to lift water from the source to the point of usage through pipes.

$$\text{System capacity } (Qn) = \frac{25Adq(L/s)}{9Hfi} \quad \text{----------------------(1)}$$

Where

Q = System capacity in(L/s or m^3/s)

A = Area of the field to be irrigated (m^2)

dg = Cross depth in (mm)

H = Operational hours per day (hr)

Fi = Irrigation frequency

c) MAIN LINE:-

This is the first medium through which the entire water lifted by water pump is transmitted and later distributed to the laterals. Hezen Williams equation is used to determine the sizes of both main and lateral lines.

$\frac{\Delta H}{\Delta L}$ = 15.270 Q_n 1.852_D - 4.871------------------------(2)

Where

ΔH	=	Energy dropped by friction (m)
ΔL	=	Length of the pipe section (m)
Qn	=	Total discharge in the pipe (L/s or m^3)
D	=	Inside diameter of the pipe (m)

d) LATERAL LINES:-

These are the media into which water convey from the main line branches and distributed to the Rivers for final spray by the Nozzles.

$\Delta H / \Delta L$ = 5.35Q_n 1.852_D -4.871---------------------------(3)

Where

ΔH	=	Energy dropped by friction (m)
ΔL	=	Length of the pipe section (m)
Qn	=	Total discharge in the pipe (L/s or m^3)
D	=	Inside diameter of the pipe (m)

e) **RISERS AND NOZZLES:-**

The water conveyed by the lateral line is distributed into the Risers which is directed to the sprinkler head that finally sprayed the water on the surface of soil or on the plants like rain.

2.4.0 TYPES OF SPRINKLER IRRIGATION SYSTEM.

There are six classified classes of sprinkler irrigation systems according to their portability.

a) Portable system

b) Semi Portable System

c) Semi Permanent System

d) Permanent System

e) Solid Set System

f) Centre Pivot System (Israelsen and Hansen, 1962)

2.4.1 TYPES OF SPRINKLER'S

a) Rotating Sprinkler Head

b) Fixed Nozzle Pipe

c) Perforate Pipe

d) Big Bus/Traveller Irrigation Gun

e) Centre Pivot Irrigation Head

f) Hydrostatic Power Roll Wheel Irrigation Head

g) Rain gun irrigation head. (Israelsen and Hausen, 1962)

2.5 ADAPTABILITY OF SPRINKLER IRRIGATION:-

The sprinkler irrigation system or method is suitable for almost all types of crops except Rice and Jute which required a lot of water (pounding) which is achieved mostly through flooding. It is equally suitable for almost all types of soils, except fine textured soil (heavy clay soils) having infiltration rate less that 4mm/hr.

This method of irrigation does not required land levelling operation which is one of the most expensive aspect of irrigation practices. It is not very good where there is a drainage problem and windy areas. Sprinkler irrigation system is widely used. (Israelsen and Hansen 1962)

2.6 EVAPO - TRANSPIRATION:-

Evapc - Transpiration or consumptive use is the sum of two terms.

a) **EVAPORATION**:- This is the water evaporating from adjacent soils, water surface or from the surface of leaves of the plants. Water deposited by dews, rainfall, or sprinkled irrigation and subsequently evaporated with-out entering the plant stem is part of consumptive use.

b) **TRANSPIRATION**:-

This is the water that enter plant, stems and roots which is used to build plant tissues or being passed through leaves of the plant into the atmosphere.

Consumptive use can be applied to water requirements of crop on a field, farm project or valley. When the consumptive use of the crop is known, the water use of 'arge units can be calculated.

Bleney -criddle developed a simplified formula using the mean monthly temperature, the monthly percentage day and time- hours of the year for the arid Western Region of the United States. Their formula had been used extensively by the soil conservation service of the united states Department of Agriculture, where several data had been collected to determine the value of the Co-efficient to be used for various crops.

By multiplying the mean monthly temperature (t) by the monthly percentage of day - time hours of the year (p) there is obtained a consumptive use factor expressed mathematically as follows.

$$ET_o = P(0.46t + 8.13) \text{ -------------------------------(4)}$$

Where

ET_O	=	Reference Crop Evapo - Transpiration (mm/day)
P	=	Percentage of day - time hours
t	=	Mean temperature in (^{0}C) (Israelsen and Hansan, 1962)

2.6.1 COEFFICIENT OF UNIFORMITY:-

The co-efficient of uniformity is the measurable index of the degree of uniformity obtainable for any size of sprinkler operating under a given conditions. The uniformity co-efficient is affected by pressure nozzle relation, sprinkler spacing and wind condition.

$$C_U = 100 \left(1.0 - \frac{\Sigma x}{MN}\right)\% \quad \text{-------------------------------(5)}$$

Where

C_U	=	Uniformity co-efficient
Σx	=	Numeric derivations of Individual observations from the average application rate (mm)
M	=	Average values of all observations (mm)
N	=	Total number of observation points (Michael 1986).

2.7 EXTENT OF IRRIGATION:-

The extent of irrigation depends largely on the main factors vis

(a) Availability of Land

(b) Availability of water.

Total area of land irrigated in the world is over four hundred million acre (160 million hectares) Israelsen and Hansen (1962) explained the area of land irrigated in the world.

2.7.1 THE FUTURE OF IRRIGATION GROWTH

As the population of the World continues to increase, the demand for food and fibres for the people will also increase. With irrigation water, many of these lands will become highly productive .By the application of irrigation water, the productivity of the land now producing food under natural rainfall had been greatly increased.

As long as the population is increasing each decade, the demand for future utilization of irrigation water would also increase.

2.7.2 ECONOMICS OF IRRIGATION:-

In order to evaluate irrigation practices, Economics is a very important tool, since irrigation is largely meant for the purpose of profit maximization. Higher profits resulting from more efficient production will ultimately result in lower prices for the consumers and lower prices result in more consumption of food and fibres. The greater availability of food and fibres results in higher standard of living for the people of the World.(Israelsen and Hansen, 1962)

Irrigation projects as well as other Engineering and Agricultural works, are for the purpose of making the World a better place of living.(Lucas, 1962)

2.8 NATURE OF BAMBOO:-

Bamboo is tall, treelike, ornamental grass belonging to the family of Bavoseae family of poeceae of the order gramitae (Arber,1965 and encyclopedia Britannic 1981). Its vegetative axes (rhizome, culm and culm branches) consist of series of nodes and internodes that are segmented (Mcculve, 1966). The internodes are cylindrical and hollow closing at the nodes with a brittle convex woody solid known as diaphragm fig 1.

Growth in Bamboo is a very fast process when there is a favourable condition. Bamboo attain their full height in the first year of their growth. (Sanghvi, 1985). Different species of Bamboo attain cutting or falling age between the period of 2-10 years. Bamboo production can be by any of the following means:- planting of seeds, raising seedlings, layering, planting of rhizomes or offsets, vegetative cutting and nodal cutting (Lessard and choninord, 1980). From the past records, it has shown clearly that the height attainable by matured Bamboo of various species ranges between 15m to over 40m while the diameter varies between 2.5 cm to 30.5 cm (Standfield and Lowe 1970, Ency. American 1967).

Bamboo species differ from each other in the following manner which form basis for their classification.

(a) **Rhizomatic difference**:- Two types of rhizome exist, pachymorph and leptomorphy. The former shows rhizome fusing on one another and exhibiting sympodial or clump type characteristics and later grows by lateral extension of rhizome exhibiting open culm characteristics Fig. 1

(b) **Culm habit**:- Based on this, Bamboo may be classified as being erect (sympodial or clump forming), climbing, intermediate between density culmed and single stemmed.

(c) **Flowering habit**:- Some Bamboo flowers periodically, while others do not, some die after flowering, some do not though the culm may look defoliated and temporarily weakened. (Lessard et, al, 1980)

2.9 BAMBOO PIPES FOR IRRIGATION WATER CONVEYANCE

Bamboo pipe, for irrigation system is very common in Asian Countries, especially in India, Cylon, Serinkuka and others. In African Countries, the use is known in Ethiopia, Tanzania etc. Here in Nigeria, very little is known about this fact. Hence the introduction of this locally available inexpensive material as a substitute for the most imported and very expensive conventional pipes is highly welcomed. This will actually solve the problem of material importation for irrigation especially the steel pipes

Ayanniyi (1995) carried out a research work on the physical properties of Bamboo and its preparation as irrigation pipes for a low pressure sprinkler system. She concluded that bamboo pipes are suitable for irrigation pipes under a low pressure.

2.10 OCCURRENCE AND DISTRIBUTION OF BAMBOO:-

More than 75 general and over 1000 species of Bamboo exist world wide (Encyclopaedia Britannica, 1981) with 45 general and 750 species occuring in the monson area of tropical Asia. India alone has 20 general with more than 1000 species and the total area of land put into production of Bamboo is about 9.57 million hectare having an annual out put of 3.23 million tones. In China about 2.9 Million hectares nearly 3% of the country's total forest area is used in Bamboo production. More than 36 general and about 300 species can be found in philippine. Other countries where bamboo are fund include Bangadeshi: 10 general with 28 species, Japan, 13 general with 66 species. Indonisia about 55 general, with 66 species, Sri Lanka: 7 general and 14 species, Thailand :12 general and 41 species, Malayso: 75 general with 44 species, and Burma: 20 general with 90 species. (Lessard and Chonier 1980). The extent of Bamboo production in Africa and America have not been quantified.

2.11 BAMBOO IN NIGERIA:-

About 4 general of Bamboo exist in Nigeria namely Bambusa, Oxytenanthera Guadella and Dendrocalamus. In all 75 species have been confirmed by various authors (Lucas, 1972 and standard, et.al 1970).

2.12. USES OF BAMBOO WORLD WIDE

Bamboo has been put into various uses in different parts of the World, namely

(a) **Agriculture**:-Suitable for aforestation, it is also used in making Agricultural implement handles, Agricultural poles, screen sieves, fruit container, food basket and water condiut as irrigation and Drainage pipes (Lessard, et al, 1980).

(b) **Hand-Craft**:-This includes making combs, bottles, blind, bridges, brooms, lanterıns, ubrella handle, hats, mats creates, baskets, toys, spear, bow, arrows, fans, brushes, chain, flag poles, walking stick, dust pan, wall building, thatching and roofing, load vessels, stabilizer for haystick, cooking utensils, coffins, scaffolding and cadder. Others include making of food drill Cordage wrapper, ornamentals and tiles. (Lessard et al, 1980 and Wengue 1967).

(c) **Food:-** The seed of bamboo are taken as food, also the tender shoots can be consumed as vegetable (Ency. America, 1967).

(d) **Chemical Product**:- A lot of chemical can be gotten from bamboo even on Industrial basis, masses of silika can be extracted from the joints and have been in use a long time as medicine. (Ency. American, 1967). Most species of bamboo are rich in Cyenide Compounds (in leaves, roots and stems) which is an important industrial chemical. Other chemicals derivable from bamboo include Diesel Oil, potassium which is used in soap making. There is high percentage of it in D.strictus, charcoal inside an electric batteries and fish oil deodorizer (Lucas, 1972).

(e) **Bamboo Fibre**:- Very strong cloth used as wearing apparels are got from bamboo, packaging axle boxes, Americans railway carriages are made from bamboo (Lucas, 1972)

(f) **Paper Making**:- Paper industry make use of bamboo as raw material. The species that have been used for this purposes includes :- D.Strictus, B.Tulda, B.Vulgaris, B.Balcon, O.Monostrigaria, to mention but few (Lucas 1972 and Lessard et al, 1980)

2.13 BAMBOO AS A DRAINAGE PIPE

There is the need to separate this from general Agricultural use of Bamboo being the subject matter. An experiment carried out on bamboo to ascertain the possibility of using it as field drainage yielded a good result of maximum drain flow rate of 32 Liters per minute (Nwa, 1984). Beside the success of the project mentioned above, rural communities in Taiwan and Ethopia have been having their drinking water through bamboo pipes laid underground for the past 15 and 5 years respectively (Hewel, 1981). In Magina, Tanzania for instance, the villages have been having uninterrupted portable water supply through a 7.5 km network of bamboo pipe line (Sanghvi, 1981). Analogy that can be drawn from this therefore, is that if a pipe can conduct water for 15 years underground, it could as well be used as drain for some number of years. It has also been discovered that the bamboo equaled plastic drains in performance and at the same time cheaper. Records also have it that bamboo had been used as drain pipe in Ethiopia in the time of Emperor Menebic (Hewel, 1981).

2.14 TREATMENT OF BAMBOO:-

Though bamboo is relatively cheap as drainage pipe, the problem of failure resulting into constant replacement of pipes normally crop up, hence, there is need, to seek for ways of increasing it durability. Average life for untreated bamboo is one year in hot climates, 5-6 years in moderate good climate, 6-7 years in cool climate when in contact with ground (Lessard et al, 1980). This is due to the attack of wood destroying agents such as

(a) Fungi:- Brown Rot, while Rot and soft.

(b) Infects:- Beetles, termites and borers.

However, treated bamboo have been found to have served for up to 15 years in Taiwan. The treatments they are subjected to can be classified into non-chemical and chemical treatments (Lessard et al, 1980).

1. Non Chemical Treatments:- This include any types of treatment that can be administered without the use of the preservatives and they are as follows:-

(a) Curling (b) Smoking (c) White Washing

(d) Plastering using cow dung (e) Soaking.

2. **Chemical Treatment**:- This include all forms of treatment involving those of preservatives, namely:

a. (i) Soaking Bamboo in tank of water and 5% solution of copper - chro arsenic composition:

(ii) Soaking Oil containing bamboo in oil soluble preservatives.

(iii) Diffusion method of chemical impregnation

(iv) Use of Osmosis treatment.

(v) Streaming and quenching.

b. Boucherie process

c. Steeping method or But treatment

d. Sap treatment

e. Hot and Cold bath pressure treatment.

2.15 MECHANICAL AND HYDRAULIC PROPERTIES OF BAMBOO

(a) Hydraulic property of Bamboo as a piping material:- Several experiment conducted for past years have shown that hydraulic property of bamboo is with limited when compared with other conventional piping materials such as plastic, steel etc. Studies showed that the average values of Mannings (n) and Hazen William's (c) roughness co-efficients vary between 0.013 to 0.016 and 75-90 respectively (Sanglivi, 1985)

One major problem facing the use of bamboo as piping material is bursting when certain pressure is exceeded. This is related to internal diameter and wall thickness of bamboo as bursting pressure tends to increase with smaller internal diameter. The relationship between thickness of bamboo pipes and bursting pressure have been studied. It is noted that for thickness values of between 6-12 mm, the bursting pressure increase from 3 to 9 bar. (Sanghvi, 1985)

(b) The mechanical property of bamboo as piping material:- The following conclusions were reached on the strength of bamboo by previous experiment with special reference to Bambusa Vulgaris which incidentally happens to be the most commonly found in Nigeria. Bamboo obeys Hooke's law for a fairly small strain.

(i) The limit of proportionality and the ultimate compressive point on stress/strain curves are the same.

(ii) The strength of bamboo increases in transverse bending with moisture increment.

(iii) The node of bamboo sets weakness in bamboo with compressed longitudinally in direction parallel to the grain.

(iv) The strength of bamboo are fairly close to those of the wood family (Omojola and Omoniyi 1976).

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 LOCATION AND CLIMATE:

The project was carried out on the field of lower Niger River Basin and Rural Development Authority Ejiba area office, "Yagba West local Government of Kogi State. The project site is on latitude 08^0. 30'N and longitude 04^0 28'E.

The annual mean rainfall of yagba West is 1185mm. The rain start about March and ends around November every year. Usually more rainfall is recorded in July and September than in August as a result of what is called August break which usually takes place in late July to the middle of August every year.

The climate of Yagba West like every other places is divided into two distinct weathers. The first being rainy season which is normally March to November and the second being dry season which is normally November to March every year.(Ralambondrainy, 1970)

The wind directions are multi-directional but they are more frequent in the Western and South Westerly directions with the speed of 1.90 kilometer per hour to 18 km/hr. The pattern is much similar in the rainy season but the essential difference is that the speeds are greater in the South Western direction in the rainy season and greater in the Western direction during the dry season. (Ralambondrainy, 1970).

The average maximum temperature of Yagba West is 33^0c and the average mean temperature is 26.75^0c. The relative humidity (R.H) ranges between 35 to 90 percent (35-90%). The Relative Humidity is usually very high during the rainy season and very low during the dry season of the year. As a result of the dryness of the wind or air during this period.

The soils of the project site were developed from intrusive Precambrian basement complex rocks which include those that are rich in quartz and ferromaynetisin mineral. The rock are mainly granite, geniuses and some ballast

The slope is moderately flat and has an infiltration rate of 10.mm/day.

3.2 DESIGN CRITERIA:-

When designing for a sprinkler irrigation system, there are some design criteria to be taken into consideration, since the design of an irrigation system is very complex and not readily subjected to quantitative analysis.

For this project work, the following design criteria were taken into consideration

1. To store water required into the root zone of the crops. The amount of water to be stored varies with the crops to be grown and the month of growing season.
2. To obtain a reasonable uniform application of water system that will provide satisfactory control under all conditions.
3. To minimise the soil erosion. Actually, soil erosion is considerably reduced

   by sprinkler irrigation system, since the quantity of irrigation water could be controlled to one's desire.
4. To minimise run-off of irrigation water from the field, by surface irrigation, sizeable quantity of water are wasted from the end of most fields, but in sprinkler irrigation system, run-off is greatly minimised.

3.3.0 MATERIALS FOR THE SPRINKLER SYSTEM.

Bamboo pipe is the material used for the water conveyance of the system. It is of various size depending on what it is being used for as discussed below. For this work the rotating sprinkler head was used.

3.3.1 MAIN LINE:

The main line was constructed of one hundred and forty four millimeters (144 mm) diameter and (4 m) four meters length of the bamboo. The solid nods ranges from two hundred and fifty millimeters to four hundred millimeters (250mm -400m) interval.

3.3.2 LATERAL LINE

Bamboo pipe of one hundred and six millimeters (106 mm) diameter and three meter (3 m) lengths were used for the lateral line. The solid nods of the bamboo also raged from two hundred and fifty to four hundred millimeters (250mm - 400 mm) interval.

3.3.3 RISER.

The Riser is made of bamboo of twelve millimeter (12mm) diameter and 0.6m in height. The solid nods ranges from two hundred and fifty to three hundred (250 mm - 3000 mm) interval.

3.3.4 INSTALLATION AND COUPLING OF THE SYSTEM:-

A suitable site within the farm field was selected and prepared for the installation of the sprinkler irrigation system. An Earth dam was constructed to impound enough water for the use during the experiment. The water pump which is the source of pressure was installed at the dam site with both the suction and delivery hoses fixed to the water pump at their respective places provided for each on the water pump.

Both the suction and delivery hoses were fixed to the pump-by the use of hose, clips and tyre tube to avoid leakage. After the connection to the water pump, the suction hose was inserted into the pool of water in the dam after the foot value had been correctly fixed to it.

3.4.1 COUPLING OF THE MAIN LINE TO THE WATER PUMP.

All the prepared bamboo pipes were conveyed to the filed which had been prepared for the experiment for installation. The first pipe was connected to the delivery hose and tightened together with clips and tyre tube to avoid leakages from the joint. Other subsequent bamboo pipes were coupled together in the same manner.

3.4.2 COUPLING OF THE LATERALS TO THE MAIN.

The lateral couplers were fixed to the bored holes on the main line. Water hoses were used to join them together and then tightened together with chips and pieces of tyre tubes. The first lateral pipe was connected to the coupler and tightened together with water hose, clips and pieces of tyre tubes. Other pipes were coupled in the same manner.

3.4.3. COUPLING OF RISERS TO THE LATERIALS:

The Risers seats were fixed into the holes bored on the lateral pipes and tightened with piece of tyre tubes to the lateral pipes. The risers were then fixed in their seats and coupled together with water hose, tightened with clips and pieces of tyre tube to avoid water leakages.

3.4.4. COUPLING OF SPRINKLER HEADS TO THE RISERS

Nipples and Sprinkler heads were selected and taken to the workshop were they were fixed together and tightened on a vice with spanners. They were later coupled to the risers with water hose, lightened together with clips and pieces of rubber tube to avoid water leakages.

3.5 EVAPO - TRANSPIRATION:-

Blaney - Criddle formula developed in 1950 was used to determine the evapo-transpiration (crop water consumptive use)

ET_O = $P(0.46t + 8.13)$. where

ET_o = Reference crop evapo-transpiration (mm/day)

P = Percentage of day-time (hour)

T = Mean temperature in (^{0}C).

3.6 DETERMNATION OF CO-EFFICIENT OF UNIFORMITY

Grids of 2m intervals were made around the sprinklers, cans were set at these distances to collect water sprayed from the sprinkler nozzles. Twenty-six (26) cans were used to collect the prayed water while the system was in operation for one hour.

The sprayed water collected from the nozzles after one hour of the system been operated in the twenty six cans were taken to the laboratory for measurement.

Water obtained in each can was poured into a graduated measuring cylinder and the readings were recorded .

From practical field experience, wind is one of the major limitation that militate against the performance of sprinkler irrigation system, the experiment was performed between the hour of 9am to 10 am.

The experiment was carried out three times subjected to the same condition; and the results are recorded.

3.7 DETERMINATION OF AREA OF COVERAGE.

Three ranging poles were arranged to obtain a straight line of the wetted area. Measuring tape was used to measure the diameter of the wetted area. The measurement was carried out by two persons and the reading recorded.

The area of coverage was computed using the simple cross-sectional area equation.

WHERE

$$A = \frac{\pi D^2}{4} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

A = Cross-sectional Area wetted. (m^2)

D = Diameter of wetted area (m)

π = A constant 3.141592654

or

$A = \pi r^2$

r = radius of wetted area which is half of the diameter.

3.8 AVERAGE VALUES

The three calculated Co-efficients of uniformity the coverage diameter and the areas of coverage were added together and divided by three, to obtained the average values.

3.9 COST ANALYSIS:-

Design for one 0.4 hectare ($4000m^2$) of land was made to know the material requirement for both local materials (bamboo pipes) and the conventional imported pipes. The correct market prices were obtained for both materials and the total cost for both materials were estimated .

The total cost for both materials were compared and inference was made

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 DETERMINATION OF EVAPO-TRANSPIRATION (ET_O)

Blaney-criddle formula developed in 1950 and the data given in table 1 were used in the determination of crop Reverence Evapo-transpiration (ET_O). The results are shown in table 2.

TABLE I:- Average Maximum and Minimum Temperature of Ilorin from October 1999 to April, 2000

Month	Average Max Temp ^{0}c	Average Min Temp ^{0}c	Average Mean Temp ^{0}c(t)
October	32.60	21.30	26.95
November	34.40	22.10	28.25
December	32.20	18.20	25.20
January	32.90	22.10	27.50
February	34.00	23.20	28.60
March	33.9	22.50	28.20
April	33.15	23.25	28.20

TABLE 2: MONTHLY AND DAILY CONSIMPTIVE USE (ET_O)

Month	P.Value	t.Value	ETo mm/day	ETo mm/month
October	0.27	26.95	5.54	171.74
November	0.26	28.25	5.49	164.70
December	0.26	25.20	5.13	159.03
January	0.26	27.50	5.40	167.40
February	0.27	28.60	5.75	166.67
March	0.27	28.20	5.70	176.70
April	0.28	28.20	5.91	177.30

TABLE 3: DAILY AND MONTHLY ACTUAL CONSUMPTIVE USE (ET_O) AND VOLUME OF WATER REQUIRED.

$$\text{Volume} = \frac{\text{Area (Eta-PE) m}^3}{1000}$$

MONTH	ET_O	K_C	Eta mm	PE mm	ETa-PE mm	Area mm^2	Vol. m^3
OCT	5.54	1.15	6.37	2.01	4.36	4000	17.44
	171.74	1.15	197.50	62.31	135.19	4000	540.16
NOV.	5.49	1.15	6.31	0.00	6.31	4000	25.24
	164.70	1.15	189.41	0.00	189.41	4000	757.64
DEC.	5.13	1.15	5.90	0.00	5.90	4000	23.60
	159.03	1.15	182.88	0.00	182.88	4000	731.52
JAN.	5.40	1.15	6.21	0.00-	6.21	4000	24.84
	167.40	1.15	192.51	0.00	192.51	4000	770.08
FEB.	5.75	1.15	6.61	0.22	6.39	4000	25.56
	166.67	1.15	191.67	6.38	185.29	4000	741.16
MAR.	5.70	1.15	6.56	3.30	3.26	4000	13.04
	176.70	1.15	203.21	102.30	100.91	4000	403.64
APRIL	5.91	1.15	6.80	1.85	4.95	4000	19.80
	177.30	1.15	203.90	55.50	148.40	4000	593.60

Total Volume required in October

$$\frac{135.19 \text{ X } 4000}{1000} = \frac{540760}{1000} = 540.76M^3$$

4.2 DETERMINATION OF COEFFICIENT OF UNIFORMITY

Sprinkler - 4.365 x 2.381 mm nozzles at 2.8 kg/cm^3.

Spacing - 20.6m x 20.6m

Wind - 3.4 km/hr from South West

Humidity - 40 percent.

Time of test - 1.0 hour.

Tables 4-6 showed the amount of water, collected in cans (observations) from the sprinkled water by the sprinklers during the field test on a square plot bounded by four sprinklers. The measurements are in cm. The diameters of the sprinkled water by one sprinkler is as shown under each table.

TABLE 4:- **Data Obtained from the First Field Test.**

C_1	C_2	C_3	C_4	C_5	C_6
S	8.1	7.8	7.0	8.5	S
9.4	8.6	7.2	6.5	8.0	8.1
7.2	9.5	6.7	9.2	8.1	7.5
6.2	7.2	6.4	9.4	6.4	6.5
S	9.0	7.0	7.3	8.2	S

Diameter of the sprayed water by the sprinkler is 20.75mm

Note that "S" indicates the location of the Sprinklers.

TABLE 5:- **Data Obtained from the Second Field Test**

C_1	C_2	C_3	C_4	C_5	C_6
S	8.6	7.3.	6.2	8.0.	S
8.6.	7.2.	7.0.	6.4.	8.4.	8.1.
8.5.	9.1.	6.2.	8.0.	6.7.	7.3.
9.0.	7.2.	6.1.	7.8.	7.4.	6.5.
S	7.2	8.0	7.4.	6.8.	S

Diameter of the sprayed water by the sprinkler is 21.0 m

TABLE 6:- **Data Obtained from the Third Field Test**

C_1	C_2	C_3	C_4	C_5	C_6
S	9.1.	7.2.	9.3.	8.4.	S
10.1	8.6.	7.3.	6.8.	6.6.	8.1.
9.4.	6.8	6.7.	8.0.	7.4.	8.2.
8.9.	7.2.	8.0.	7.4.	6.6.	7.9.
S	7.4	7.5	6.9.	7.7.	S

Diameter of the sprayed water by the sprinkler is 20.95 m
C= can

4.2.1 COMPUTATION OF UNIFORMITY CO-EFFICIENTS

Christiansen equation developed in 1942 and the data given in tables 4-6 were used in computation of the uniformity Coefficients and the results are as shown in tables 7-9.

TABLE 7:- Computation of Uniformity Co-efficient for Test I

Observations	Frequency	Application Rate x Frequency	Numerical Deviation	Frequency x Deviation
9.5	1	9.5	1.78	1.78
9.4	1	9.4	1.68	1.68
9.2	1	9.2	1.48	1.48
9.1	1	9.1	1.38	1.38
9.0	1	9.0	1.28	1.28
8.6	1	8.6	0.88	0.88
8.5	1	8.5	0.78	0.78
8.2	1	8.2	0.48	0.48
8.1	3	24.3	0.38	1.1480
8.0	1	8.0	0.28	0.28
7.8	1	7.8	0.08	0.08
7.5	1	7.5	0.22	0.22
7.3	1	7.3	0.42	0.42
7.2	3	21.6	0.52	1.56
7.0	2	14.0	0.72	1.44
6.7	1	6.7	1.02	1.02
6.5	2	13.0	1.22	2.44
6.4	2	12.8	1.32	2.64
6.2	1	6.2	1.52	1.52
	26	200.7		22.50

$$\text{Mean} = \frac{200.7}{26} = 7.72$$

$$Cu = 100\left(1.00 - \frac{\Sigma X}{Mn}\right)$$

$$= 100\left(\frac{1-22.5}{200.7}\right)$$

$$= 100\,(1-0.112)$$

$$= 100 \times 0.88789$$

$$= 88.789\% \quad = 88.79\%.$$

TABLE 8:- **Computation of Uniformity Co-efficiency for test II**

Observation	Frequency	Application rate x Frequency	Numerical Deviation	Frequency x Deviation
9.1.	1	9.1.	1.6.	1.6.
9.0.	1	9.0.	1.5.	1.5.
8.6.	2	17.2.	1.1.	2.2.
8.5.	1	8.5.	1.0.	1.0.
8.4.	1	8.4.	0.9.	0.9.
8.1.	1	8.1.	0.6.	0.6.
8.0.	3	24.0.	0.5.	1.5.
7.8.	1	7.8.	0.3.	0.3.
7.4.	2	14.8.	0.1.	0.2.
7.3.	2	14.6.	0.2.	0.4.
7.2.	3	21.6.	0.3.	0.9.
7.0.	1	7.0.	0.5.	0.5.
6.8.	1	6.8.	0.7.	0.7.
6.7.	1	6.7.	0.8.	0.8.
6.5.	1	6.5.	1.0.	1.0.
6.4.	1	6.4.	1.1.	1.1.
6.2.	2	12.4.	1.3.	2.6.
6.1.	1	6.1.	1.4.	1.4.
	26	195		19.2

Mean = 195/26 = 7.5

$$Cu = 100\left(1.00 - \frac{\Sigma X}{mn}\right)$$

$= 100(1-19.2/195)$

$= 100(1-0.09846)$

$= 100 \times 0.901538$

$= 90.15\%$

======

TABLE 9 Computation of uniformity co-efficient for test III

Observation	Frequency	Application rate X Frequency	Numerical Deviation	Frequency X Deviation
10.1.	1	10.1	2.27	2.27
9.4.	1	9.4	1.57	1.57
9.3.	1	9.3	1.47	1.47
9.1.	1	9.1	1.27	1.27
8.9.	1	8.9	1.07	1.07
8.6.	1	8.6	0.77	0.77
8.4.	1	8.4	0.57	0.57
8.2.	1	8.2	0.37	0.37
8.1	1	8.1	0.27	0.27
8.0.	2	16.0	0.17	0.34
7.9.	1	7.9	0.07	0.07
7.7.	1	7.7	0.13	0.13
7.5.	1	7.5	0.33	0.33
7.4.	3	22.2	0.43	1.29
7.3.	1	7.3	0.53	0.53
7.2.	1	7.2	0.63	0.63
6.9.	2	13.8	0.93	1.86
6.8.	2	13.6	1.03	2.06
6.7.	1	6.7	1.13	1.13
6.6.	2	13.2	1.23	2.46
	26	203.5		20.46

Mean = 203.5/26 = 7.8269= 7.83

$$cu = 100 \left(1.00 - \frac{\Sigma X}{mn}\right)$$

$$= 100 \left(1.00 - \frac{20.46}{203.5}\right)$$

$$= 100 \quad (1.00\text{-}010054)$$

$$= 100 \times 0.899459$$

$$= 89.95\%$$

Average (C_u) = 88.79 + 90.15 + 89.95/3

= 268.89/3

= 89.63%

======

4.3 COMPUTATION OF AREAS

Diameter obtained from the first experiment is 20.75m

$$\text{Area} = \frac{\pi D^2}{4}$$

π= 3.14

$$\text{Area I} = \frac{\pi \times (20.75)^2}{4}$$

= 3.14 x 430.56/4

= 1352.65/4

= 338.20m^2

Diameter obtained from the second field test is. 21.0m

$$\text{Area II} = \frac{\pi \times (21)^2}{4}$$

= 3.14 x 441/4

= 1385.44/4

= 346.32m^2

Diameter obtained from third field is 20.95m

$$\text{Area III} = 3.14 \times \frac{(20.95)^2}{4}$$

= 3.14 x 438.90/4

= 1378.85/4

$= \quad 344.71m^2$

Average area of coverage

$$= \frac{338.20 + 346.32 + 344.71}{3}$$

$$= \frac{1029.23}{3}$$

$$= 343.08m^2$$

$$\text{Average Diameter} = \frac{20.75 + 21.0 + 20.95}{3} = \frac{62.7}{3} = 20.9m$$

4.4 DESIGN FOR NO OF ALUMINUIM PIPES

The area of the field is 100m by 40m

(a) The length of each pipe is 6m

$$\text{Main line} = \frac{100m}{6m} = 16.66 = 17\text{pipes}$$

b. Nos. of pipes on the lateral line

$$= \frac{40m}{6m} = 6.67 = 7 \text{ pipes}$$

c. $$\text{Total Nos.} = \frac{100}{12} = 8.33 = 9 \text{ laterals}$$

d. Total Nos. of pipes on the lateral line

$$= 8x9 = 72 \text{ pipes.}$$

4.5 DESIGN FOR THE NUMBER OF BAMBOO PIPES

The length of Bamboo pipe for main line is 4m while the length for laterals is 3m

(a) Main line $= \frac{100m}{4m} = 25 = 25$ Pipes

(b) Lateral line $= \frac{40m}{3m} = 13.33 = 14$ Pipes

(c) Total Nos. of Laterals = 100 = 8.33 = 9 Laterals

(d) Total Nos. of pipes on the lateral = 14x9 = 126 Pipes

4.6 COST AND ESTIMATE FOR BAMBOO AND ALUMINIUM PIPES

TABLE 10: COST AND ESTIMATE OF BAMBOO PIPES FOR AN AREA OF 4000M^2

S/N	DESCRIPTION OF ITEMS	QTY	RATE N : K	AMOUNT N : K
1.	Main line pipe	25	35 : 00	875 : 00
2.	Lateral line pipe	126	30 : 00	3, 780 : 00
3.	Lateral coupler	16	300 : 00	4,800 : 00
4.	Riser Seat	32	250 : 00	8,000 : 00
5.	Clips (Large size)	304	60 : 00	18,240 : 00
6.	Clips (Small size)	64	45 : 00	2,880: 00
7.	Water hose (small size)	3m	150 : 00	450 : 00
8.	Water hose (large size)	5m	400 : 00	2,000 : 00
9.	Riser pipe	32	25 : 00	800 : 00
10.	Nipple	32	200 : 00	6, 400 : 00
11.	Treatment of Bamboo pipes	200	500 : 00	10, 000 : 00
12.	Tyre tube (Used)	10	50 : 00	500 : 00
13	Labour for installation of the System			10, 000 : 00
				68,725 : 00

TABLE 11: COSTA AND ESTIMATE OF ALUMINIUM PIEPS FOR AREA OF 4000M^2

S/N	DESCRIPTION OF ITEMS	QTY	RATE N : K	AMOUNT N : K
1.	Main line pipe	17	4000 : 00	68, 000 : 00
2.	Lateral line pipe	72	2,500 : 00	180,000 : 00
3.	Tee joint	16	1,350 : 00	24,800 : 00
4.	Main line stopper	2	2000 : 00	4000 : 00
5.	Lateral line stopper	16	1,250 : 00	20.000 : 00
6.	Riser pipe	32	1000 : 00	32,000: 00
7.	Rubber seal large size	34	300 : 00	10, 200 : 00
8.	Rubber seal small size	144	200 : 00	28.8000 : 00
9.	Labour for installation			5000 : 00
				372,800 : 00

4.7.0 DISCUSSIONS OF THE RESULTS

4.7.1 FACTORS AFFECTING THE USE OF BAMBOO PIPES

The fact that Bamboo is relatively cheap for sprinkler irrigation system is a reality. However, the greatest problem of this material compared to the using of the conventional imported irrigation pipe is its failure resulting to into constant replacement of pipes normally cropped up. Hence there is the need to seek for ways of increasing its durability.

An average life for untreated bamboo pipe is one year in a very hot climate, five to six years in a moderately cool climate, and six to eight years is a cool climate when buried in the ground. In all the cases, water should fills it up, in order to prevent it from the attack of wood destroying agents such as :-

(a) Fungi, brown and white rots.

(b) Insects, Butlers, termites and borers.

A well treated bamboo pipes have been found to have served for up to 15 years in Taiwan(Lessard et al, 1980).

4.7.2 PROBLEMS AND SOLUTIONS

As soon as all the couplings were completed, the water pump was primed and the pump started to pump water into the bamboo pipes for the performance evaluation of the system. Two major problems encountered during the performance evaluation were serious leakages from the joints and the bamboo pipe bursting. The system was dismantled to ascertain the factors responsible for these problems. On examination of the system, the following were discovered to be the factors responsible for the problem.

(a) It was discovered that the bamboo pipes were too dry. The moisture contents of the fibres were low and hence could not resist the pressure generated by the water pump thus, resulting in pipe bursting. The system was coupled , filled with water and left for three days to allow the fibres absorb enough water.

(b) The leakages at the joints were examined and, it was discovered that the holes bored on the main and laterals for lateral and risers take-off were too wide which is the cause of the great leakage. Water hose was obtained, cut into the required lengths and fixed into the couplers and replaced.

When the above measures were tackle , the bursting of pipes stopped while the water leakages were greatly reduced. Thus, a very good performance of the system was achieved see fig. 4.

4.7.3 COEFFICIENT OF UNIFORMITY:-

A uniformity co-efficient of 85 percent or more is considered satisfactory (Michael, 1986)

The experiment carried out on the performance evaluation of the sprinkler Irrigation system using bamboo pipes showed an average uniformity co-efficient of 89.63%

This is a prove that, bamboo pipe is a suitable piping material for irrigation. Hence a suitable substitute for the imported conventional pipes for irrigation.

4.7.4 RADIUS OF COVERAGE

Using conventional pipes, the radius of coverage for the type of sprinkler used for the performance evaluation, under normal conditions is 12m.

The experiment carried out with the bamboo system gave an average radius of 10.45m which is very close to 12m. Therefore, a prove that bamboo pipe is a good alternative to the imported conventional pipes for irrigation

4.7.5 AREA OF COVERAGE

Using the imported conventional pipe, the area of coverage for the type of sprinkler used is 452.39m^2 under normal conditions.

The experiment carried out with bamboo pipes showed an average area of 343.08m^2. Hence a good prove that bamboo pipe is a good piping material for irrigation.

4.7.6 COST ANALYSIS:

4.7.6 COST ANALYSIS:

An Estimate of Sixty - eight thousand, seven hundred and twenty-five (68,725.00) Naira only for sprinkler irrigation system using bamboo is obtained while an estimate of three hundred and seventy-two thousand, eight hundred naira (N372,800.00) is obtained for using Conventional-Imported Aluminium pipes for the same area of field ($4000m^2$).

The estimate of using Imported-Conventional pipes for an area of $4000m^2$ compared to using bamboo pipe for the same area of field ($4000m^2$) is 5.42 times, to obtained almost the same result.

4.7.7 DURABILITY OF BAMBOO PIPES

A well treated bamboo pipe will last for between fifteen and twenty-five years when buried under the ground and well maintained while the conventional imported aluminium pipe if well maintained lasts for twenty to thirty years. (Hewel, 1981)

4.8 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and Recommendations are drawn from the research work.

4.8.1 CONCLUSIONS

i Bamboo culms (pipes) are potentially suitable as irrigation piping materials at a low pressure, based on the results obtained from the experiments.

(ii) The cost of setting a sprinkler irrigation system using bamboo culms is sixty-eight thousand, seven hundred and twenty-five (N68,725.00) Naira for a field of ($4000m^2$) while three hundred and seventy-two thousand, eight hundred (N372,800.00) Naira for using a conventional imported pipes for the same hectare of land.

(iii) The use of bamboo pipes in the field of irrigation as an alternative to this expensive and imported irrigation materials will actually serve as a means of conserving our foreign Exchange.

4.8.2 RECOMMENDATIONS.

i. The Federal Government of Nigeria should discourage in totality the indiscriminate cutting and burning of bamboo forest.

ii. The use of Insecticide and fungicides to combat the insects and fungi that are likely to attack buried bamboo pipes is highly recommended for the improvement of the durability of the Bambusa Vulgaris culm.

iii. Lack of straightness in the length of the bamboo culm (Bambusa Vulgaris) limits its usage as piping materials. It is therefore recommended that research efforts should be directed towards producing a more straight bamboo culms.

The Japanese approach of producing uniform straight bamboo could be experimented on Bambusa Vulgaris (Ralmoh drainy, 1983) or new species of bamboo be introduced such as phyllostach's nigra which is naturally straight.

(iv) The use of hole saw is recommended since it is made available in several diameters and drills perfectly and efficiently without tendency to shear as experienced with other drill bits, its usage therefore should be encouraged.

(v) It is important that further researches be carried out on the use of bamboo pipe as piping materials for irrigation, such as

(a) The head lost in Bamboo

(b) The particle sedimentation in bamboo

(vi) Changes in the physical appearance of bamboo pipes subjected to the following conditions.

(a) Bamboo pipe completely filled with water and left in the open field for several days. Open every 24 hours to note any loss of water and refill up.

(b) Bamboo pipe half filled with water and left in the open for several days and monitored any change in the level of water and always maintain the same level.

(c) Bamboo pipe completely filled with water, left in the open field, monitor the change of water without refilling until water dried up.

(d) Bamboo pipe half filled with water, left in the open field and monitor the change in level of water with out refilling until it dried up.

(e) Bamboo pipe just left in the open field without water in the pipe.

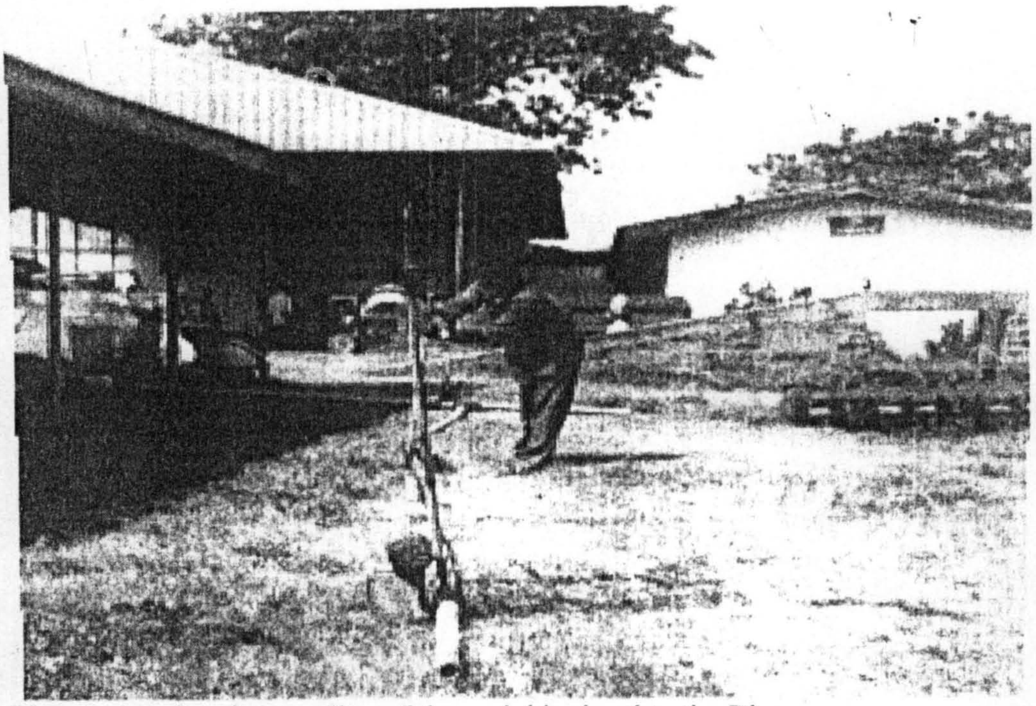

Plate 1. showing the coupling of the sprinkler head to the Riser

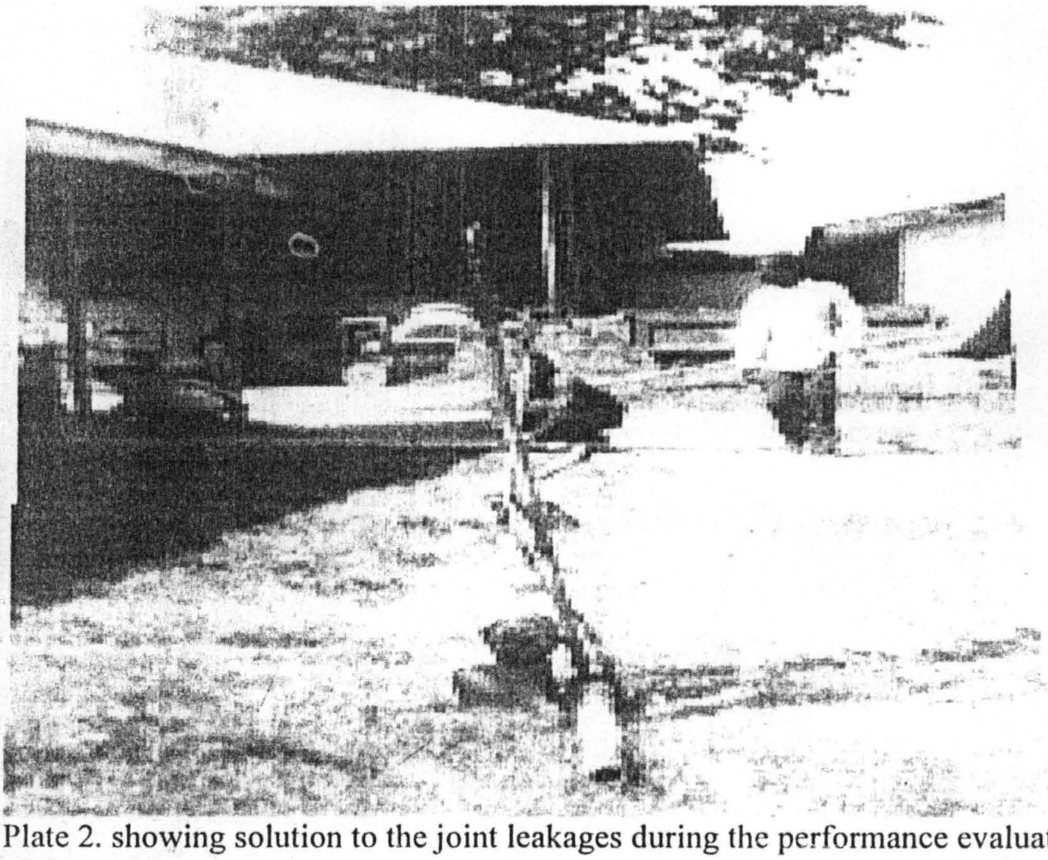

Plate 2. showing solution to the joint leakages during the performance evaluation of the system.

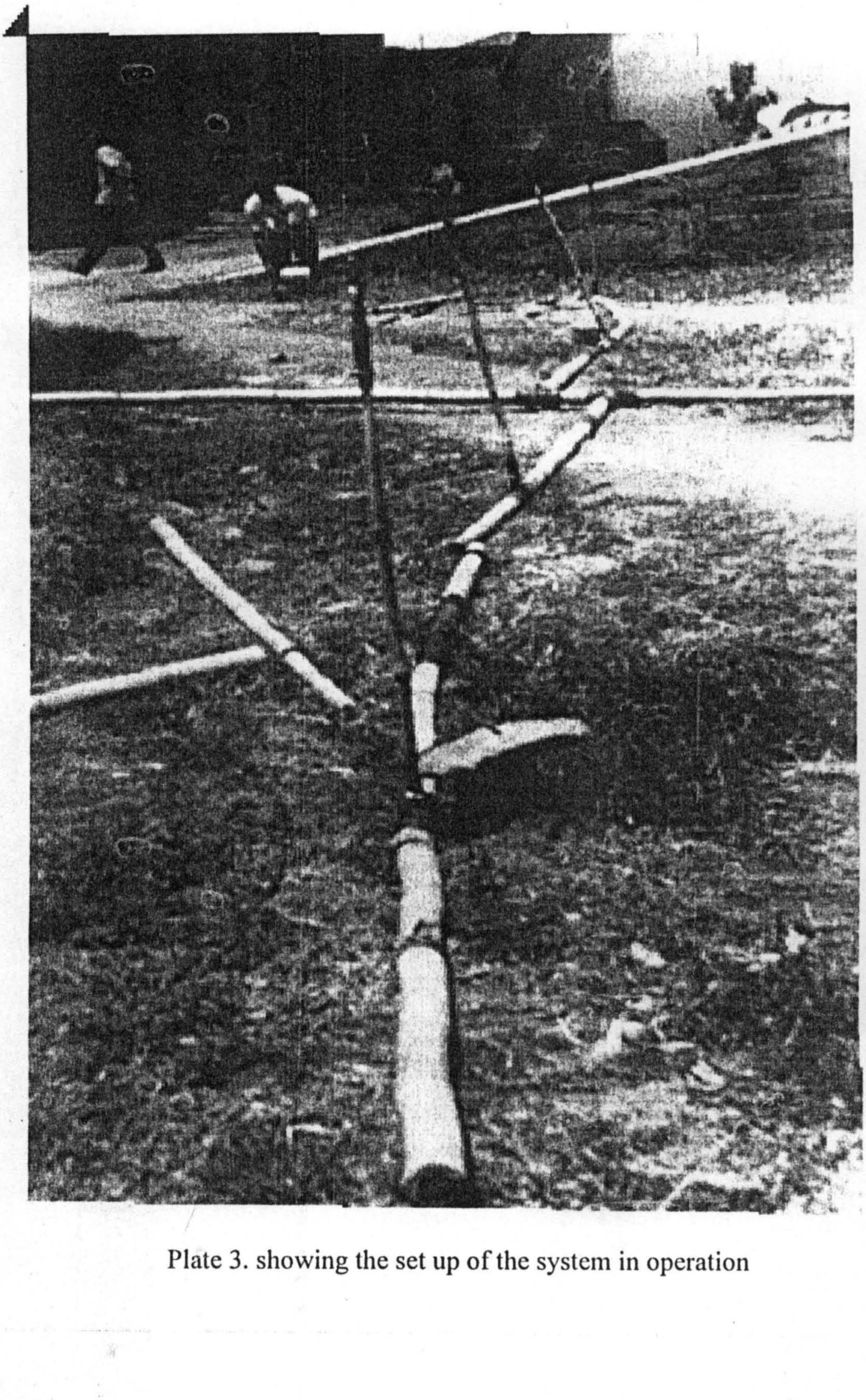

Plate 3. showing the set up of the system in operation

APPENDIX 1

COMPUTATIONS:-

ETo = P(0.46t + 8.13) where

ETo = Reference Crop Evapo-Transpiration (mm/day)

P = percentage of day time {hours}

t = Mean Temperature (^{0}c).

October ETo - 0.27 (0.46 x 26.95 + 8.13 = 5.54 mm/day (5.54 x 31 = 171.74 mm/m)

November ETo - 0.26 (0.46 x 28.25 + 8.13) = 5.49 mm/day = (5.49 x 30 = 164.7mm/m)

December - 0.26 (046 x 25.20 + 8.13) = 5.13mm/day = (5.13 x 31 = 159.03 mm/m)

January - 0.26 (0.46 x 27.50 + 8.13) = 5.40mm/day = (5.40 x 31 = 167.40mm/m)

February - 0.27 (0.46 x 28.60 + 8.13) = 5.75mm/day - (5.75 x 29 = 166.67mm/m)

March - 0.27 (0.46 x 28.20 + 8.13) = 5.70mm./day = (5.70 x 31 = 176.70mm/m)

April ETo - 0.28 (0.46 x 28.20 + 8.13 = 5.91mm/day = (5.91 x 30 = 177.30mm/m)

APPENDIX II

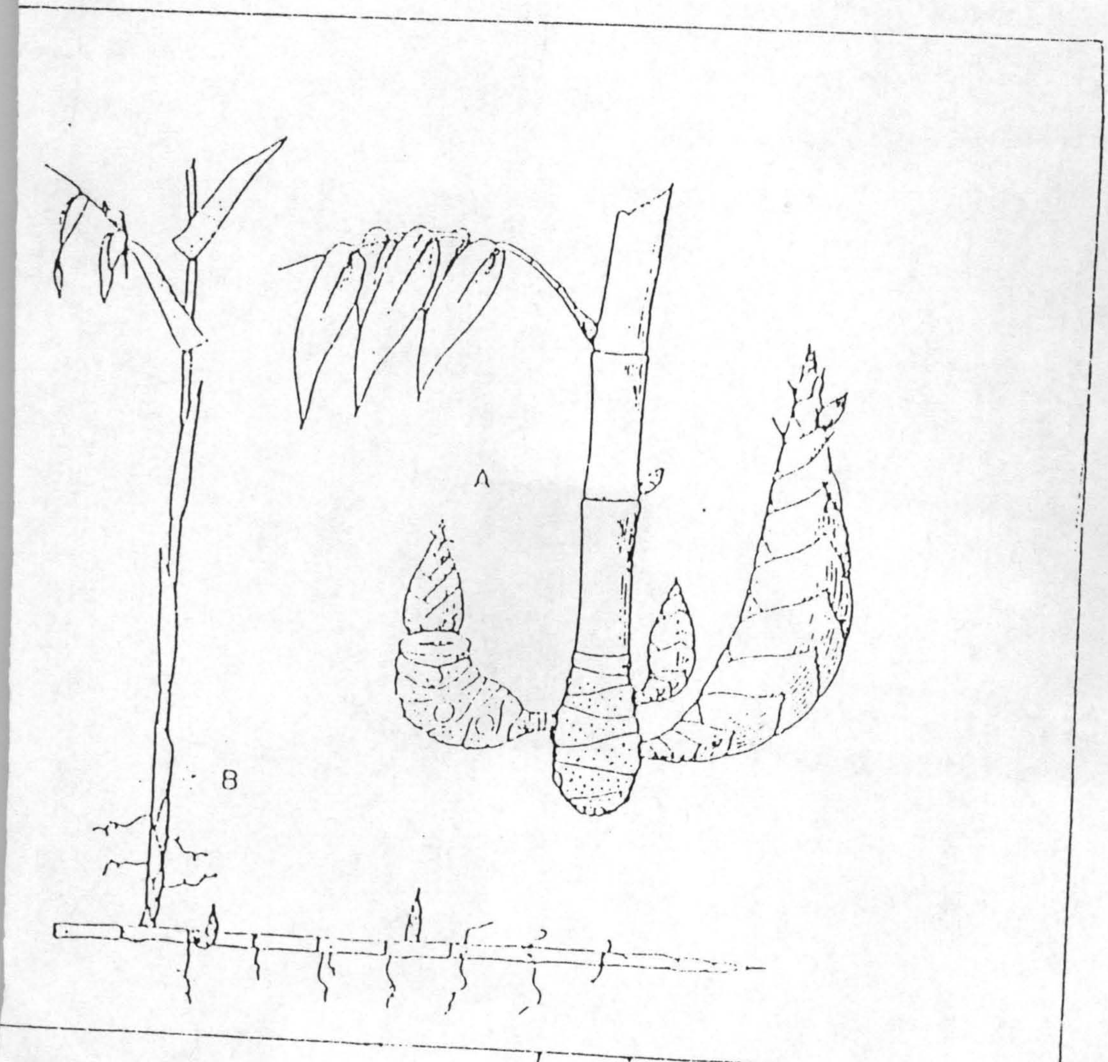

Fig: I Diagram showing Rhiozomatic difference in bamboo

(A) Parchymorph (B) Leptomorph

(McCLURE 1966)

APPENDIX III

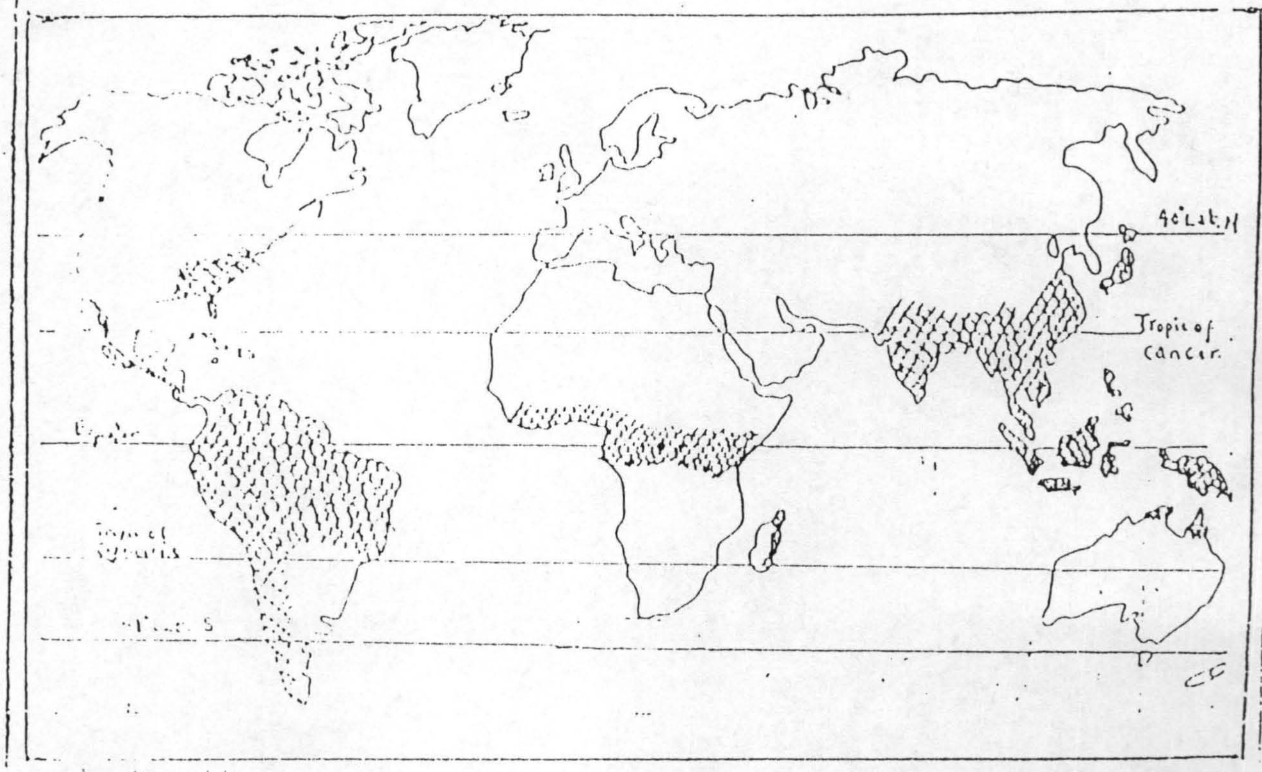

Fig 2 a WORLD DISTRIBUTION OF BAMBOO
(Ralambondrainy 1987)

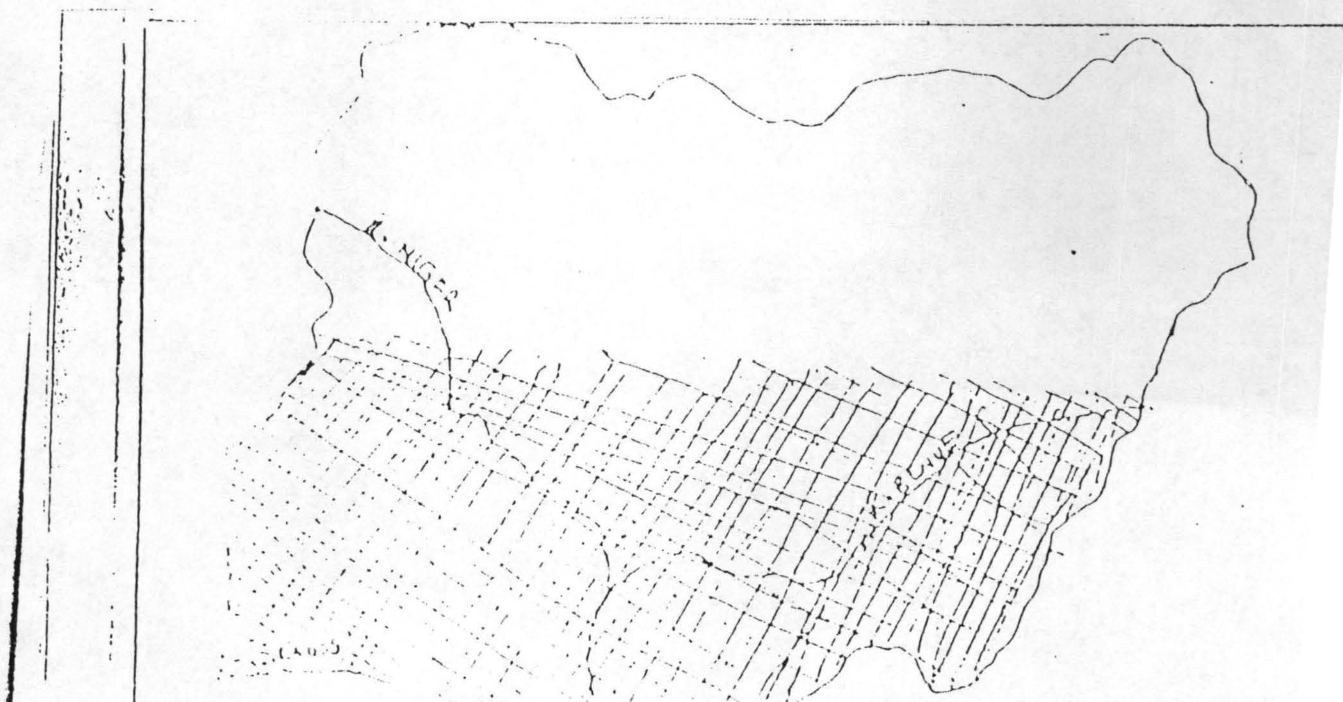

Fig 2 b DISTRIBUTION OF BAMBOO IN NIGERIA (Ogedegbe 1986)

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