DESIGN AND CONSTRUCTION OF DRAINAGE FOR A MODERN FARM IN FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

BY

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(SOIL ANDWATER OPTION).

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APPROVAL PAGE

This project has been approved by the undersigned as having met the requirement for the award of PGD in Agricultural Engineering of Federal University of Technology Minna, Nigeria.

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DEDICATION

The project is dedicated to Almighty Allah who created me and guided me to be among the believers, and who under His protection and guidance I under took this project.

Also to my parents, family and friends for their endurance, love, caring and prayer through out the course study.

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All praise belong to Allah alone, in whose hand all dominion rest. Who out of His grace gave me an unquantifiable store of energy, health and intellect that made it possible for me to embark on this project.

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ABSTRACT

Excess water may occur on the land surface or deeper down in the soil profile. The adverse effects includes unpaired crop growth and farm operations. This project therefore was undertaken to identify the causes of excess water which do occurs on the field understudy and profer solution to it by designing an efficient surface drainage system. In doing so, climatic analysis, using ten years rainfall and evapotranspiration data collected from Minna Airport was carried out. Also representative samples were collected for the determination of soil moisture content and particle size distribution. The results obtained contribute a great to an assessment of the scope for solving the problem as well as identification of the most appropriate drainage method; and also the formulation of the design discharges. Information on the soil and land conditions in the area was used for drainage planning and design. It was found that there is no define system of drainage water collection and disposal and high water table on this land.

Conclusively, shallow drainage system was adopted and recommendations were given which if adhered to will ensure an efficient surface drainage on the land.

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CHAPTER ONE

1.0 INTRODUCTION:

Land drainage is the removal of excess water from large low- lying areas e.g by excavating, pumping, improving flow of rivers stream, and erecting dykes. It can also be defined as collection and disposal of excess water from agriculture land or lowering the groundwater table below the root zone or reducing soil- salt accumulation.

In order for the irrigated crops to thrive well, accumulated water from heavy rains or flood water must be drained away immediately, so also excess water in the fields due to over- irrigation or seepage from adjacent channels should be made to drain away quickly.

If this is achieved, it will provide a conducive root environment to the crops as it is widely recognized that drainage of soils subject to water logging is necessary for satisfactory growth of most crops

The response of plants to water logging is complex; it is not due to saturation of the soil with water it' self, since plants will grow well in solution culture.

Waterlogging soil causes injury because oxygen is consumed more rapidly than it enters the soil, and anaerobic conditions develop. These influence plant growth both by inducing changes directly within the plant and by causing toxic products to be formed in the soil or changing the availability of nutrients to the plant.

1.1 JUSTIFICATIONS

Artificially draining a land is a necessary operation under two district conditions: if the soil has a high water table or if excess surface water cannot penetrate reasonable for solving the problem as well as identification of the most appropriate drainage method; and also the formation of the design discharges

Also information on the soil and land condition in the area will be used for drainage and design such as diagnosis of drainage problem, suggestion and evaluation of possible solutions and formulate design criteria.

CHAPTER TWO

LITERATURE REVIEW.

The main objective of Agricultural land drainage is to remove excess water in order to improve the profitability of farming the land.

Excess water may occur on the land surface (surface ponding) or deeper down in the soil profile (waterlogging of the rootzone due to impeded percolation or due to high water tables)

2.1 ADVERSE EFFECTS OF LACK OF DRAINAGE ON FARMING.

2.1.1 THE OCCURRENCE OF ANAEROBIC CONDITIONS: -

In well- aerated soil, the oxygen content is close to that of the atmosphere, the oxygen removed being readily replaced by diffusion from the atmosphere. Oxygen is required both for respiration by roots and by soil organisms. The demand for oxygen in soil is greatly influenced by soil temperature and the presence of a crop, reflecting the respiration requirement of the roots and the stimulation of microbial activity by root exudates.

Anaerobic conditions are most common in soils in which the drainable porosity is low or which may be prone to surface flooding, but can occur also in lighter texture soils where the ground water level rises to the soil surface; in each case the development of anaerobiosis is more rapid when soil temperature changes due to microbial activity occur. The breakdown of organic matter can lead to the formation of various substances including fatty acids and hydrocarbon gases.

(Yoshida, 1973)

2.1.2 EFFECTS OF DRAINAGE ON SOIL CONDITIONS: -

2.1.2.1 SOIL PHYSICAL CONDITIONS

The benefits of drainage of waterlogged soils may not be solely due to improved aeration. Although the main advantages may result from the improved aeration of the soil and effects on root growth and microbial activity, it is often believed that drainage can result in long-term improvements in soil structural conditions which favour root growth or the ease with which the soil can be cultivated; experiment have shown evidence of changes in soil structure and increased volume of air- filled pores at low tensions (Hundall et al; 1976).

On drainage land the greater soil strength can reduce compaction by tractor wheels thereby facilitating management. (Steinhardt and Trafford, 1974).

2.1.2.2 NITROGEN SUPPLY

The yellowing of leaves of crops which have been waterlogged is similar to that caused by nitrogen deficiency, but the extent to which the symptoms can be attributed to deficiency of No_3 –N in the soil is not clear. In anaerobic soil it is normally thought that formation of nitrate (nitrification) is almost completely inhibited, and in anaerobic soils No_3-N may be lost by denitrification and by leaching, although the latter is not affected by oxygen supply.

2.1.2.3 SOIL – BORNE DISEASE

Several soil- borne pathogens are believed to be favoured by anaerobic soil condition and can affect yield, but relatively little is known on this subject (miller and

Burke, 1975.) Thus the possible incidence of soil – borne disease should be recognized in planning and interpreting experiments on waterlogging.

2.1.3 EFFECTS OF WATERLOGGING ON ROOTS: -

2.1.3.1 ROOT GROWTH

Normal root growth of most species is dependent on the supply of oxygen in the soil. Continues waterlogging of the soil surface can greatly reduce root growth of sensitive species such as peas and reduce yield.

2.1.3.2 ROOT FUNCTION: -

Hormonal balance

Many of the symptoms of waterlogging damage such as reduced growth, chlorosis, abscission, epinasty and development of adventitious roots are characteristic of those caused by a change in hormonal balance: for example increased amounts of auxin in shoots (Philips, 1964) which may effect stem growth; increase concentration of abscisic acid in shoot (Wright and Hiron, 1972) which could contribute to senescence and stomatal closure; and increased concentrations ethylene in shoots which are associated with several symptoms of waterlogging damage, including growth of adventitious roots (Kawase, 1974).

2.1.4 NUTRIENT AND WATER UPTAKE.

Waterlogging normally leads to a reduction in the uptake of Nitrogen, phosphate and potassium and also of some minor elements. The transport of these nutrients to shoots can be reduced within one or two days and this, together with transport of mobile nutrients such as nitrogen out of older leaves, can contribute to the lower leaves characteristics of waterlogging damage.

2.1.5 EFFECTS OF WATERLOGGING ON YIELD:

At it's worst, waterlogging can cause a total kill of plants and appreciable reductions in yield of most species in less extreme conditions, even too rapid inundation of rice can reduced yield.

2.2 SOURCES OF DRAINING WATER.

Direct rainfall constitutes by far the major and most common source of excess water. Other sources include irrigation, seepage, runoff and floodwater.

2.3 DRAINAGE SYSTEMS:

A typical agricultural drainage system has the following main components.

(a) Field system:

This gathers the excess water from the land by means of a network of field drains. Two principal types may be distinguished.

(i) Groundwater drainage systems: - These are used in soils in which the excess water is able to infiltrate and percolate through the main rootzone to the subsoil/substratum and then move as groundwater flow to the drains.

(ii) Shallow drainage systems: - These are used where the infiltration or percolation of excess water is impeded at the surface or at shallow depth in the rootzone due to the presence of poorly permeable layers.

(b) Main system:

This receives water from the field systems and convey it to the outlet. A main system is usually composed of ditches and canals of differing order (tertiary, secondary and primary)

(c) Outlet: -

This is the terminal point of the whole system at which it discharges into a major element of the natural open water system of the region (inner, lake or, sea). The water lead at the outlets determines whether the area can be drained by gravity or requires pumping.

2.4 DRAINAGE REQUIREMENTS

The measures taken to improve the drainage conditions of an area ultimately depend upon the benefits these are expected to yield when compared with the costs. For agricultural drainage projects the benefits and the costs are mostly straight forward (farm) economic quantities. Drainage is one of the factors that determines the returns, others includes cropping pattern, fertilizer application, irrigation, machinery use, management skill, etc. high investments in drainage, as required for example for the installation of a pipe drainage system, may therefore not be warranted in an area with ("low level" farming (this applies to many drainage projects in the developing countries)

Soil climatologically conditions of well as the farm system employed, determine the economic scope for drainage improvements, other factors (adaptations in farming) to be considered are: -

1. Crop selection on the basis of the drainability of the land.

2. Planning of the farming calendar so as to avoid performing critical farm operations, such as planting and harvesting coinciding with a period in which excess water may be expected to occur.

3. Use of special practices (low pressure tyres, air spraying etc).

(MAFF, 1977)

CHAPTER THREE

3.0 DESIGN AND METHODOLOGY

This project was carried out in there phases:

i. Preliminary phase based on secondary source of data.

ii. Phase two- Diagnose the drainage problem in hand; to conceive possible solutions and collection of primary sources of data, which involve sampling procedure.

iii. Post field investigations which involved the laboratory analysis of the data collected of phase two.

3.1 PRELIMINARY PHASE

The study was started with library research.

General importance of land drainage and effect of waterlogging on plants were highlighted. These studies were made through a protracted research into journals, newsletter and Textbooks with related discussion. (See references cited).

This phase commenced before the field investigations, but ran concurrently with the real field survey. Another preliminary activity was that of obtaining the topographic maps of the study area which was not readily available from the survey Dept., Fed. University of Tech. Minna. Levelling of the study area was done and plotted. This was adopted and used for the research.

3.2 DIAGNOSIS OF THE DRAINAGE PROBLEM.

The identification, reconnaissance and pre-feasibility studies often take the form of short missions to the site. This involves establishing the nature and cause of the problem. In the light of the above, it was found that there was problem of high water table and bottlenecks in the collection and disposal of excess water as there was no define system of collection and disposal of water.

The harmful effects (effects on crops and farm operations etc.) were protractedly research into. Rough outline of possible solutions were made in the final design stage after a programme of further investigations are planned based upon the results of this preliminary diagnosis.

3.3 GENERAL INVESTIGATIONS

3.3.1 CLIMATE

Most drainage problems result from rainfall exceeding the ET during short or long periods. Climate analysis, therefore, are able to contribute a great deal to a better understanding and diagnosis of these problems. More specifically such analysis contribute to identification of the formulation of the design discharges. Useful types of climatic analysis in this respect include soil moisture balance calculations and rainfall depth- duration frequency studies. Average monthly rainfall and evapo-transpriaton data for a period of 10 years for Minna and it's environs was obtain from Minna Airport Meteorological station. These was used for soil moisture balance calculations.

3.3.2 TOPOGRAPHY

For feasibility studies, maps with a scale of 1:10,000 showing 0.5 – 1.0m interval contour lines, was generally suffice for the planning of the main system; and to be used to assess aspects of field drainage.

3.3.3 SOIL AND LAND

3.3.3.1 SAMPLING TECHNIQUES

In soil survey, the term "sampling" refers to a small specimen of soil take to represent a soil horizon or body of soil for some purpose. Thus the term "representative soil sample" is used (Hudgson, 1978). To enable an accurate and numerical record of the samples, systematic method of sampling was used. This involves election of items from a given population at uniform internals of time, space degree of accuracy (Hudgson, 1978) as for this study, the interval of uniform space was used (15m apart)

In picking soil samples, about 2kg soil was picked from each sampling point into polythene sample bags and sealed to avoid contamination. All the sample picked were labelled. Augar was used in boring the soil to about 90cm deep before the samples were picked.

3.3.3.2PARTICLE SIZE DETERMINATION

The process used for measuring particle size composition of soils is particle size analysis. For the purpose of this project, sieve analysis was used. The moisture content of the soil samples were taken and the samples were air-dried. A sieve analysis was made with a 'nest' of sieve placed one above the other. The top sieve has 5.mm holes, below it were sieve with successfully smaller holes, 3.35mm, 2.00mm, 1.18mm, 850μm, 600μm, 425μm, 300μm, 212μm, 150μm and63μm. Holes. A s oil sample was sub-divided into it's various sand separates by placing it on the top sieve and shake the assemble 5minutes with mechanical shaker. Each sand particle was caught on the sieve through which it could not pass. The relative proportions of sand, silt and clay in the particle size analysis of the soil is used to determine what is called soil textural class.

3.3.3.3 DETERMINATION OF SOIL TEXTURE.

The texture of the picked soil sample was determined after preparation as explained above. The textural determination was carried out using the approved method of the international institute for tropical agriculture in the manual series No1, "selected method for soil and plant analysis".

Soil samples were dispersed and particles were separated into the traditionally accepted three particle classes below:

i. Sand (coarse, 2mm – 200μm, fine 200 – 5μm). This texture have absence of cohesion and a particle structure. When water reserves are low, they show tendency to seasonal drought.

ii. Silt (coarse, 50 – 20μm, fine 20 – 2μm) soils of this type are susceptible to factors responsible for structural break down especially where silt is predominant.

iii. Clay fraction, < 2μm

CHAPTER FOUR

4.0 DATA ANALYSIS AND DESIGN.

4.1 INTRODUCTION NOTES

This chapter consists of two parts: A & B.

Part A: This consists of the characterization of the study area into soil unit, soil drainage and moisture conditions, soil moisture balance calculations and rainfall depth – duration – frequency studies.

Partb: this part consists of deductions and interpretations from observations and design.

PART A

Characteristic of the study area into soil unit

From the contour map of the study area one main land d unit was outlined:

(a) Shrub grassland area.

It is an area with flat terrain without elongation and with more or less uniform height of about 75m to 100m above sea level.

4.2 SOIL TEXTURE

The bulk of the soils here is predominantly sandy especially at the cultivated depth.

The texture of the surface layers are sandy loam from the textural triangle according to (USDA, 1976) see fig below generally, the sandy textures confer on the soils of the shrub grassland area; an absence of cohesion, when water reserves are low, these soils show a tendency to seasonal drought.

4.3 SOIL DRAINAGE AND MOISTURE CONDITIONS

The soils here were imperfectly drained especially at the surface horizon where high moisture holding capacity existed. Evidences have also shown the closeness of water table to the surface as observed not to below 50 – 60cm. High moisture holding capacity of the soils in this area takes place but the soils become highly cemented together, hardened and cracked with prolonged drought and dry season.

4.4 SOIL MOISTURE BALANCE CALCULATIONS

These calculations were done using the Average monthly rainfall depth and evapo-transpration data obtained from Airport Minna. The starting point of the calculations is the situation at the end of April when under the prevailing climatic conditions it may be safely assumed that the water table is at it's highest permitted level while the overlying soil profile is at field capacity. The soil moisture storage (S) thus is maximal ($S = S_{max}$). The soil moisture storage remains at $S_{ma}x$ as long as $P > E$, all positive (P -E) values count as excesses, to be drained.

Negative (P - E) values are deducted from the storage until $S = 0$ further negative (P -E) values count as deficits for the soils in which soil moisture balance calculation are relevant, values of S_{max} are typically of the order of 50 – 150mm for this project, 75mm was taken. The results of 1o years of average monthly periods was compiled (appendices)

4.5 RAINFALL DEPTH – DURATION – FREQUENCY STUDIES

These studies are used to derive design criteria especially to derive for q. Raining intermediate period of ½ - 2days for shallow drainage. For Agricultural drainage, design is commonly based on the control of 1 x 5 year rainfall events.

4.6 SURFACE DRAINAGE SYSTEMS

The selection of surface drainage facilities for individual field areas depends largely on the topography, soil characteristics, crops and availability of suitable outlets. These systems apply to land in which ground water drainage systems cannot be used because of the inadequate infiltration or percolation characteristics of the main rootzone and/or inadequate hydraulic conductivity in the substrata.

A typical surface drainage system consists of field drains which collect water from the land surface and removes it into the collector drains, then into the main drains and finally into the source of outlet.

4.7 SHALLOW DRAINAGE SYSTEMS

These systems comprise shallow field ditches laid out in certain patterns. Their main function is to collect surface runoff and provide shallow profile drainage, mostly through interflow four types of field ditch system may be distinguished on the basis their layout pattern, type and main function parallel field ditch system was chosen for this project.

4.8 DESIGN CRITERIA FOR SHALLOW DRAINAGE

The design criterion for shallow drainage prescribes within which span of time the excess water on the land, results from the design rainfall adopted is a 48hours rainfall of 75mm.

The main variables to be defined are: -

(a) Type and layout of the system

(b) Discharge capacity of the system (q)

(c) Field drainage base depth (W), i.e.

i.e. water level to be maintained in the field ditches.

If a crop is to be grown which can only tolerate the water table in the rootzone for one or two days per year the more stringent criteria of q = 7mm. Day and H = 0.50m should be adopted.

4.9 PARALLEL FIELD DITCH SYSTEM.

These are similar to bedding except that the channels are spaced father apart and many have a greater capacity than the dead furrows. This system is well adapted to flat, poorly drained soils with numerous small depressions that must be filled by land grading. The size of the ditch may be varied, depending on grade, soil and drainage area. The depth of the ditch should be a minimum of 20cm and have a minimum cross- sectional area of $0.5m^2$. The side slopes should machinery. Plowing operations must be parallel to the channels but planting, cultivating, and harvesting are normally perpendicular to them.

The rows having a continuous slope to ditches and maxim length for one direction is 180m, allowing maxim spacing of 360m where the rows drain in both directions.

4.10 BASIC DESIGN CRITERIA

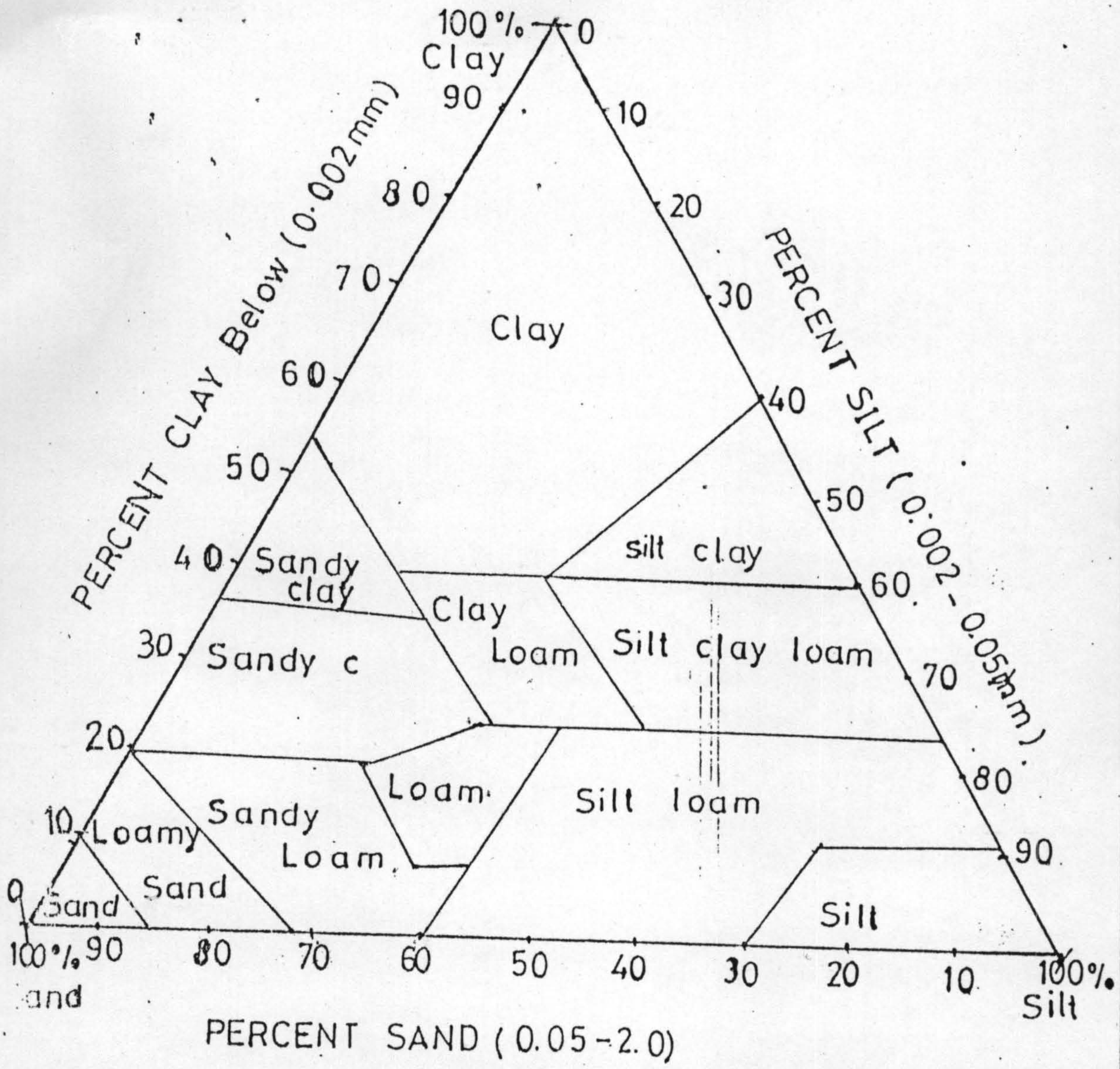
The criteria to be used depend upon the objective to be served by the drainage system. the over all objective is the artificially draining the soil in order to create favourable soil water conditions for crop growth and farm operations. A number of specific objectives may be distinguished:

i. Improvement of the rootzone aeration
ii. Early soil workability after rain
iii. Early warning up of the soil in spring
iv. Prevention of soil structural deterioration
v. Promotion of useful biological, microbiological and biochemical processes (especially related to nitrogen availability to plants)

4.11 MAIN DRAINAGE SYSTEM

Main drains will almost always be (open) canals, as these normally constitute the most economical way to convey the relatively large quantities of water involved in drainage discharge. It receive surface runoff, interflow as well as groundwater flow from field drainage systems and convey all this water to the outlet point.

TEXTURAL TRIANGLE (USDA, 1976)



NOTE: The relationship between the class name of a soil and its particle size distribution, in using the diagram the points corresponding to the percentages of sand, silt and clay present the presence of each in the soil under consideration as located on the triangle side lines respectively. Lines are then projected inward, paralled in the first case to the clay side of the triangle and in the second case parallel to the sand side. The name of the compartment in which the two lines intersect is the class name of the soil in question.

source: Banneau and Souchier (1982)

4.12 DESIGN CAPACITY THE DRAIN

The capacity of the drain is designed to remove surface water at are rate which will not cause drainage to the crops. Hitherto, in fixing the capacity, both the total water it must carry- off and maximum allowable time for the removal of the water without drainage to the crops must be determined. This time may very between 2-4 hours for sensitive crops, 2days for grains and 4-7 days for water tolerant crops.

Other considerations are: -

i. Amount of run off

ii. Rainfall intensity

iii. Hydrological soil course complex

iv. Runoff curve number (CN)

v. Run off removal time.

4.13 OPEN DRAIN CROSS – SECTION

The designed drain has the following characteristics

i. A non-silting and non- scouring velocity of flow

ii. Sufficient capacity to carry the designed run-off

iii. Adequate depth to drain the land.

iv. A stable side slope, which will not cave or slide into the drain.

Earth channels and lined canals are normally designed with trapezoidal cross sections. The size of the cross section will very with the velocity and quantity of water to be removed. Unprotected side slopes- unstable soils should generally not be steeper than 1:2

to avoid serious caving in. some general guidelines for design are presented in table below.

Limitation on flow velocity and on side slope in drainage canals (adapted from ILRI 1994)

Soil type	Maximum permissible Mean flow velocity (In m.sec^{-1}	Maximum permissible side slope
Fine sand	0.15 - 0.30	1: 2 to 3
Coarse sand	0.20 - 0.50	1: 1 ½ to 3
Loam	0.30 - 0.60	1: 1 ½ to 2
Heavy clay	0.60 - 0.80	1: 1 to 2

4.14 SIDE SLOPE

Channel side slopes are determined principally by soil texture and stability. The deeper the ditch the likely it is to cave. Side slopes be design to suit soil conditions. Suggested side slopes are sow in table below. And for this project, the side slope of 1½:1 was adopted.

By permission, from land drainage and flood production.

	Side slope – Horizontal: vertical.	
Soil	Shallow channels up to 1.2m	Deep channels – 1.2m and over
Peat and muck	Vertical	¼ : 1

Stiff (heavy) clay	½ : 1	1: 1
Clay or silt loam	1: 1	1 ½ : 1
Sandy loam	1 ½ : 1	2.1
Loose sandy	2: 1	3:1

HYDRAULIC GRADIENT AND WATER LEVELS

The hydraulic gradient should be neither too small nor too large. Values should generally not be less than 5-10cm, km-1 (0.05 – 010%.) but in flat land lower values may be used. The water level in drainage canals must meet certain freeboard requirements

4.15 ROUGHNESS COEFFICIENT

The roughness coefficient K_m should be understood as the constant of proportionality between the average flow velocity (V) and the condition $R^{2/3}$ $I^{1/2}$ .K_m values are incorporated in the monograph below

Guidelines for the selection of K_m values for the design of drainage canals (adapted from ILRI 1964).

Canal description	K_m- value n-value
(a) Small canals (water depth < 0.75m) - Sandy soil - Clayey soil	20 (0.050 15 (0.065)
(b) Medium canals (water depth 0.75-150m)	

- Sandy soil - Clayey soil	30 (0.035) 20 (0.050)
(c) Large canals (water depth > 1.50m)	40 –50 (0.020 –0.025
(d) concrete lined canals	60-80 (0.0125 –0.017)

4.16 VELOCITY FLOW OF THE CHANNEL.

Although there are number of velocity formula for open channel flows, the most commonly used is the chezy- Manning or steady uniform flow

$$V = K_m R^{2/3} I^{1/2}$$

When V = flow velocity ($M.sec^{-1}$)

The well-known limits set by Fortier and Scobey (1926) are given below. For drains of average size the velocity shall be limited within a range of 0.6 – 1.3 m/s.

Max permissible mean flow velocities in unprotected canals (in $M.\ sec^{-1}$)

Bed material	Clear water	with suspended load
Fine sand	0.45	0.75
Sandy loam, silty loam, silt	0.50 – 0.60	075 – 1.00
Loam	0.70 – 0.80	1.00- 1.10
Clay	1.10 –1.20	1.50
Gravel (fine → coarse)	0.75 - .20	1.50 - 1.80

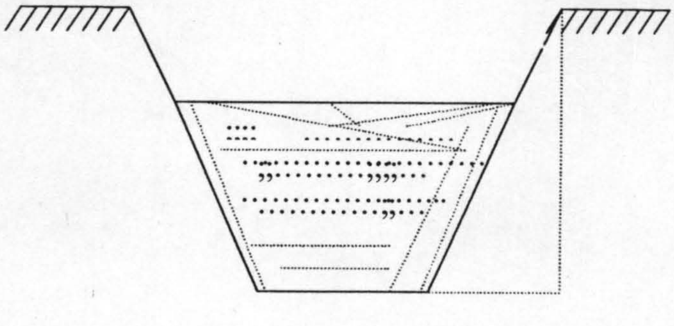
A trapezoidal cross – section have been found to be most suitable for drainage canals. As a compromise between hydraulic efficiency and other considerations, the following rations between bed width (b) and water depth (d) should approximately be adheres to:

	Recommended b/d ratios for trapezoidal canals
Small canals (d< 0.75m)	b/d = 1 (clay) – 2 (sand)
Medium canals (d = 0.75 – 1.5m)	b/d = 2 – 3
Large canals (d > 1.5m)	b/d >3 – 4

THE CROSS – SECTION OF THE CHANNEL

The shape of the cross – section of the open drain (channel) is closely related to both the velocity of flow and the type of soil encountered along the drains.

The minimum width for an open drain is 1.5m. Drains with bottom width greater than the minimum are advisable because they permit efficient machine construction and prevent serious reduction in depth due to sedimentation



A cross – section of an open channel

4.17 HYDRAULIC DESIGN

$V = CR^{½} I^{½}$ CHEZY

$C = K_m R^{1/6}$ Manning

$V = K_m R^{2/3} I^{½}$

$Q = VA = K_m R^{2/3} I^{½} A$

WHERE V = flow velocity ($M.sec^{-1}$)

Q = discharge rate ($M^{3.} sec^{-1}$)

R = hydraulic radius (M)

I = hydraulic gradient

A = wet cross – section area (m^2)

C = chezy roughness coefficient ($M^{½}.sec^{-1}$)

Km = Manning roughness coefficient ($M^{½}.sec^{-1}$)

4.18 FREEBOARD

Freeboard is meant to provide a margin of safety in case the actual discharge exceeds the designed discharge capacity of the canal. As such, the provision of freeboard conforms to the common engineering design practice of introducing a safety factor in the design. The freeboard required is often established on the basis of experience, typical guidelines being:

- Small canals ($Q < 1 - 2m^3.sec^{-1}$ .... Freeboard F = 30cm
- Large canals $Q > 5m^3.sec^{-1}$ .... Freeboard F = 50cm.

dimension of the required canal can be calculated with the chezy – manning formula as follows:

Year		Excesses (mm)
1990	-	650. 4
1991	-	792. 4
1992	-	504.8
1993	-	591.8
1994	-	930.8
1995	-	741.4
1996	-	731.3
1997	-	707
1998	-	719.1
1999	-	758
		Total = 7127

Year with high intensity of rainfall ----- 1994 = 930. 8mm.

$$\Rightarrow \frac{930\ 8mm}{1000} = 0.9308m$$

and value = depth x A= 0.9308 x $5000m^2$

= $4654m^3$

$$\Rightarrow \frac{4654}{153x24x60x60} = 0.00352m^3\ sec^{-1}$$

Q = $0.000352m^3. Sec^{-1}$

I = 0.02 %

K_m = 20

X = 1 ½

$b/d = 2$

$A = d(b + dx)$

$P = b + 2d \sqrt{1 + dx^2}$

$$R = \frac{A}{P} = \frac{d(b + dx)}{b + 2d\sqrt{1 + dx^2}} = \frac{b + dx}{b/d + 2\sqrt{1 + dx^2}}$$

for x = 11/3 and b/d = 2

$A = d(b + dx) = d(2d + 1i/3d) = 3.5d^2$

$$R = \frac{b + dx}{B/d + 2\sqrt{1 + x^2}} = \frac{(2d + 11/3)}{2 + 2\sqrt{2.25}} = \frac{3.5d}{2 + 2\sqrt{2.25}}$$

$R = 0.7d$

And $Q = K_m R^{2/3} I^{1/2} A$

:- 0.000352M3sec-1 20 (0.7d) ⅔ (0.0002) ½ $(3.5d^2)$

=> $0.000352 = 0.780d^3$

=> $d^3 = 0.000352$ => $d = \sqrt[3]{0.000451}$

=> $d = 0.077m$

:- $b = 0.154m$

Check $V = \frac{Q}{A} = \frac{0.000352}{0.0207515}$

$V = 0.017m. Sec^{-1}$

4.19 MAINTENANCE OF OPEN DRAINS.

The major problem in the maintenance of open drains is the removal of sediments and vegetation from the drains. Growth of weeds and other aquatic plants in the drains greatly retards the velocities of flow thereby decreasing the drain capacities. Silts and clay sedimentation in the drains also restricts flow of water.

Manual labour is normally employed to clean the drains. Mechanical methods by the use of bulldozers, draglines, excavators or tractor drain chains is also effective for cleaning the drains. Herbicide chemicals such as aromatic solvents are very effective in killing aquatic weeds.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.0 CONCLUSION

Excess water may occur on the land (surface ponding, often combined with water logging of the topsoil) a deeper down in the soil profile water logging of the root zone due to impeded percolation or due to high water tables). The adverse effects include impaired crop growth and farm operations. This project was undertaken to identifies the causes of excess water which do occurs on the field understudy and profer solution to it by designing an efficient surface drainage system which will increase crop production.

Climatic analysis, soil and land investigations were carried out the results obtained contributed greatly to an assessment of the scope for solving the problem as well as identification of the most appropriate drainage method; and also the formulation of the design discharges. The importance of removing excess water and salts from irrigated agricultural lands through effective drainage systems cannot be over–emphasized. Hence, with proper drainage systems on our irrigated agricultural lands, this country may eventually become self- sufficient in terms of agricultural production since on land may be forfeited due to water-logging if proper drainage systems are provided. No land is said to be useless, only the cost of reclaiming the land be high.

5.1 RECOMMENDATION

In order to provide an efficient surface drainage systems, the following recommendations should be adhered to :

i. The irrigated lands should have sufficient natural slope to provide adequate drainage in order to have good agricultural production.

ii. Outlet ditches must be large enough to carry floodwater from our agricultural lands as quickly as possible.

iii. Proper design and layout of field drains, collector drains and main drains should be strictly adhered to

iv. Surface drainage system should be designed to accommodate mechanical operations on various types of topography such as ponded area, flat field and gently sloping lands.

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